Department of Energy
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P.O. Box 550
Richland, Washington 99352

10-AMCP-0138

MAY 05 2010

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

INTEGRATED 100 AREA REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN, ADDENDUM 3: 100-BC-1, 100-BC-2, AND 100-BC-5 OPERABLE UNITS, DOE/RL-2008-46-ADD3, REVISION 0, AND SAMPLING AND ANALYSIS PLAN FOR THE 100-BC-1, 100-BC-2, AND 100-BC-5 OPERABLE UNITS REMEDIAL INVESTIGATION/FEASIBILITY STUDY, DOE/RL-2009-44, REVISION 0

This letter transmits the following approved documents to the U.S. Environmental Protection Agency for information:

> Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units, DOE/RL-2008-46-ADD3, Revision 0; and
>
> Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/Feasibility Study, DOE/RL-2009-44, Revision 0.

This Work Plan Addendum 3 and corresponding Sampling and Analysis Plan describe the specific background and work scope associated with the 100-BC Area Operable Units.

If you have any questions, please contact me, or your staff may contact Briant Charboneau, of my staff, on (509) 373-6137, or Joe Franco, Assistant Manager for the River Corridor, on (509) 376-6628.

Sincerely,

Matthew S. McCormick, Assistant Manager
for the Central Plateau

AMCP:GLS

Attachments

cc: See Page 2

MAY 05 2010

cc w/attachs:
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Administrative Record (100-BC-1, 100-BC-2, and 100-BC-5 Operable Units)
Environmental Portal

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DOE/RL-2008-46-ADD3
Revision 0

Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
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Approved for Public Release;
Further Dissemination Unlimited

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Revision 0

Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

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Title: *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*

Concurrence:

U.S. Department of Energy, Richland Operations Office

Signature 3-23-2010 Date

U.S. Environmental Protection Agency

Signature 3·23·2010 Date

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Executive Summary

This document is Addendum 3 of DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*[1]. The purpose of a work plan is to explain the Remedial Investigation/Feasibility Study (RI/FS) project background and rationale, and to present detailed plans for investigation of a contaminated site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[2] (CERCLA). This document supports final remedy selection under CERCLA for the 100-BC Operable Units (OUs) at the Hanford Site. The CERCLA RI/FS results are also intended to address *Resource Conservation and Recovery Act of 1976*[3] (RCRA) corrective action requirements for areas of RCRA concern. Five areas (Figure ES-1) have been defined for the River Corridor: 100-BC Area, 100-K Area, 100-D and 100-H Areas, 100-N Area, and 100-F Area, which is combined with 100-IU-2 and 100-IU-6 OUs. These areas combine groundwater contamination, soil contamination sites, and facilities in geographic areas that encompass the 100 Area National Priorities List[4] sites. Planning for the 300 Area is addressed separately.

The Integrated Work Plan (DOE/RL 2008-46) implements an approach designed to reach final Record of Decision (ROD), describes key features of the planning process to support implementation of this approach, and provides important key regulatory considerations and risk assessment uncertainties common to the 100 Area. This document, Addendum 3 to the Work Plan, provides site-specific information for 100-BC. The 100-BC Area includes the 100-BC-1 and 100-BC-2 source OUs, and the 100-BC-5 groundwater OU. Figure ES-1 shows the location of 100-BC and proximity to other River Corridor Areas.

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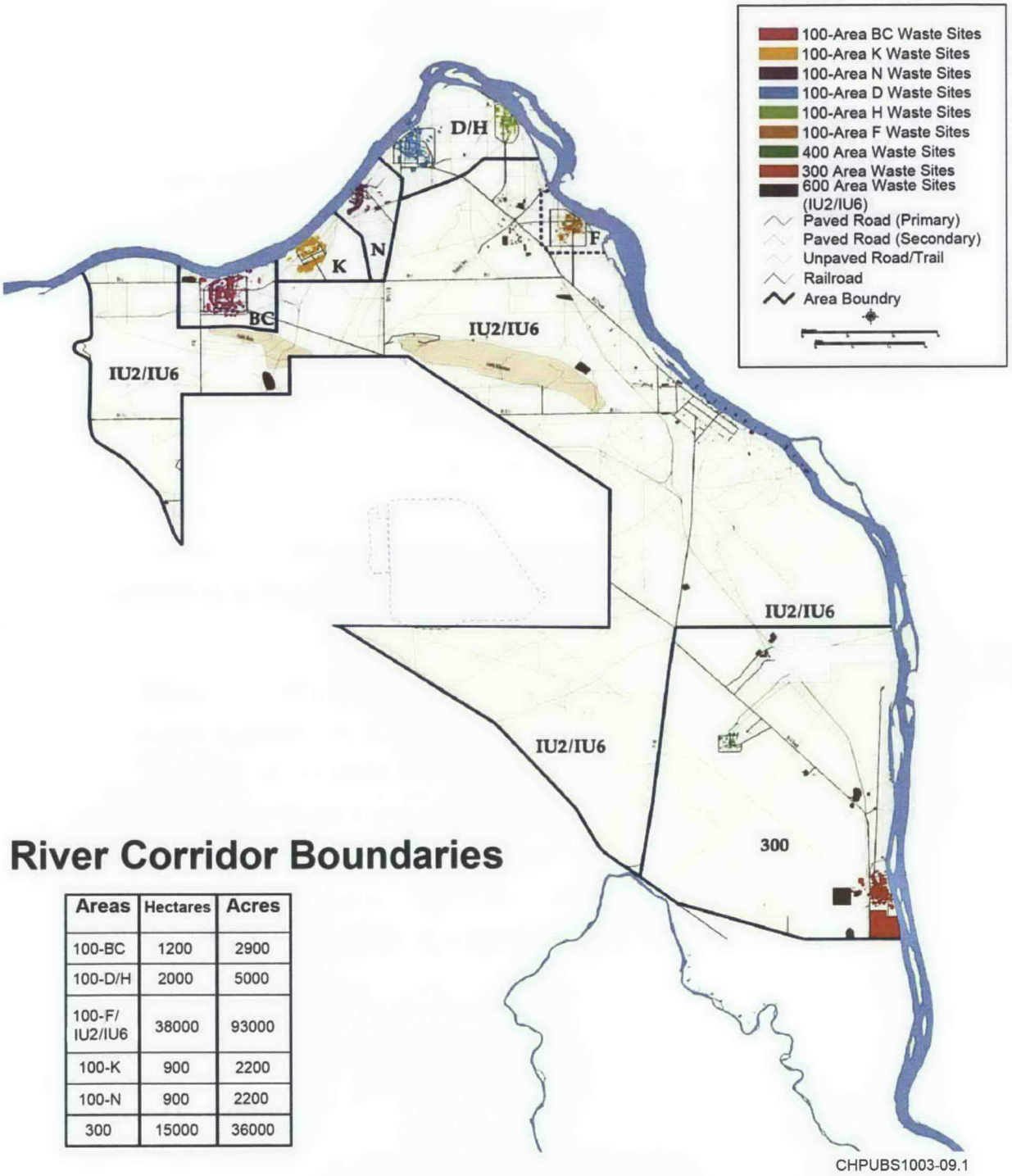
[1] DOE/RL-2008-46, 2009, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[2] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

[3] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

[4] 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2009/julqtr/40cfr300AppB.htm.



River Corridor Boundaries

Areas	Hectares	Acres
100-BC	1200	2900
100-D/H	2000	5000
100-F/ IU2/IU6	38000	93000
100-K	900	2200
100-N	900	2200
300	15000	36000

Figure ES-1. River Corridor Boundaries

This addendum is based on the premise that there are data gaps and uncertainties that should be addressed to support the final Record of Decision. In 100-BC, groundwater monitoring, contaminated soil removal, and facility demolition and removal have been completed over the past decade and additional work is planned for the next few years. The results of these activities provide the basis for identifying the remaining uncertainties needed to be addressed to make a final ROD.

A systematic planning process was used to develop a program for data collection and analysis to support the final ROD at 100-BC. The following sections discuss key elements that were identified during this systematic planning process.

Investigation work at 100-BC will be conducted in accordance with the Integrated Work Plan (DOE/RL-2008-46). No exceptions are noted in this addendum.

Site Background

The 100-BC area is located in the northern portion of the Hanford Site adjacent to the Columbia River (Figure ES-1). It covers more than 11.54 km^2 (4.45 mi^2) of land along the southern shore of the Columbia River. Background information for this area includes the known hydrogeologic information; past operational history of the facilities (with an emphasis on disposal operations); source remedial actions and their effectiveness; and the results of any treatability and characterization studies.

Appendix A presents maps of the facilities and source sites. Ninety-five waste sites are assigned to the 100-BC-1 OU, and 55 sites are assigned to the 100-BC-2 OU. The 100-BC-1 OU contains waste units associated with the original plan facilities constructed to support B Reactor operation, as well as the cooling water retention basin systems for both B and C Reactors. The 100-BC-2 OU contains waste sites associated with the facilities to support C Reactor operations and other waste sites at 100 BC, including most of the solid waste burial grounds.

Table 3-3 provides summary information of the status of waste sites for each OU. As of December 3, 2009, 70 sites have been dispositioned according to the interim action ROD, with another six estimated to be interim closed by spring 2010. An additional 40 sites require no action (26 No Action and 14 Not Accepted). No Action indicates that the site does not require any further remedial action under RCRA Corrective Action, CERCLA, or other cleanup standards. While the Interim Closed Out remedial actions satisfied the interim action RODs, they may not satisfy final ROD requirements. An additional

26 sites (25 Accepted and one Discovery) remain to be dispositioned (Table 3-4). These remaining sites are scheduled to be dispositioned by 2012. Only one waste site, 100-C-7, has not been remediated.

Initial Evaluation

The primary sources of contamination in 100-BC are two water cooled nuclear reactors (105-B and 105-C) and the structures (e.g., fuel storage basins) and processes (e.g., sodium dichromate process) associated with reactor operations. The reactors and processes associated with operations generated large quantities of liquid and solid wastes.

Solid wastes consisted of sludge, reactor components, and various other contaminated items. Waste generated from reactor operations was contaminated with radionuclides, hazardous chemicals, or both. Wastes released to the environment created secondary sources of contamination where contaminants could be retained in the subsurface (vadose zone) and released over long periods beneath ponds, ditches, and cribs; burial grounds; and unplanned release sites.

Fluctuating river stage, leakage from retention basins, cribs, and trenches have influenced the distribution of contaminants in the subsurface. Water mounding from leakage at these facilities during operations was considered the greatest factor in the widespread observation of groundwater contamination of hexavalent chromium (Cr (VI)), strontium-90 (Sr-90), and tritium at 100-BC in the subsurface. Once discharges ceased in 1968, the mound dissipated in the Hanford formation with preferential drainage into the Columbia River under the influence of the natural flow direction.

Conceptual Site Model

The Conceptual Site Model (CSM) is a site description that organizes the available information and provides a summary of the site conditions. The CSM was developed to depict what was known about the site history (including process history), level and location of contamination, and information needed to support decisions about remediation. The CSM was used to identify data and information gaps, establish data needs, and design a field program to address the gaps.

Hexavalent chromium, tritium, and Sr-90 contamination has been detected at concentrations above the water quality standards in the upper part of the unconfined aquifer of 100-BC. The extent of contamination has not been defined spatially in all

locations, and the vertical distribution of contamination has not been fully characterized throughout the aquifer. In addition, not all groundwater contaminants of potential concern (COPCs) are routinely monitored.

The historical records show that dissolved Cr(VI) was primarily released into the environment in two types of solutions: the stock solutions used to make reactor coolant, and the reactor coolant itself. There are known releases of concentrated sodium dichromate to the soil at 100-BC (Chapter 2), but the extent of the contamination in groundwater is not well defined.

Groundwater upwelling sampling and analysis in the Columbia River channel was performed in fall 2009, and follow up sampling is planned for early 2010. Preliminary results indicate Cr(VI) levels above the ambient water quality criteria in the hyporheic zone.

Sr-90 was also present in solid waste disposed at various burial grounds, and contamination appears to be limited to the upper part of the unconfined aquifer. The plume may continue to persist in groundwater due to Sr-90 sorbed to soil within the periodically re-wetted zone.

Tritium is present as a result of implementation of the P-10 Tritium Separation Project at the 105-B and 108-B facilities. Tritium waste streams, in the form of decontamination fluids, encapsulated tritium gas, and contaminated process equipment, were disposed primarily to the 116-B-9 Crib, 118-B-1 Burial Ground, and 118-B-6 Burial Ground.

Work Plan Rationale and Tasks

Based on the previous information available and the current understanding of contaminants at 100-BC, a list of data gaps (or statements of uncertainty) was identified as presented in Table ES-1. Each data gap defines a need for information to reduce or eliminate uncertainty to the degree needed to make a final cleanup decision.

The proposed field sampling locations are shown in Figure ES-2. Several ongoing programs (e.g., facility demolition, waste site remediation, and river pore water sampling) are also expected to provide data that will resolve many of the uncertainties identified for 100-BC. The Sampling and Analysis Plan (DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial*

Investigation/Feasibility Study[5]) identifies only those data collection activities that these ongoing programs will not address. The RI/FS report developed for the 100-BC OUs will take full advantage of data and information developed by ongoing groundwater monitoring and remediation programs that are available during the development of the report. The results of ongoing deactivation, decommissioning, decontamination, and demolition, waste site interim remediation actions, and groundwater monitoring activities, in addition to proposed investigations, will be used in the selection of final remedies and will be incorporated into the RI/FS and proposed plan, which will lead to a final ROD.

Project Schedule

The RI/FS and proposed plan are estimated to be complete by November 30, 2011, and the ROD is estimated to be issued by April 30, 2012.

[5] DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/Feasibility Study*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Table ES-1. 100-BC Data Gaps

Data Gap	Data Gap No.	Data Need	Description	Additional Data Collection Recommended?	Scope of Work	Justification
Verification data have not been collected from 100-C-7 according to the IROD.	1	Verification data are needed (after remediation) to complete interim remedial action at 100-C-7.	Collect verification samples and monitoring as applicable to assess impacts to groundwater and the Columbia River.	Yes	Conduct verification sampling and monitoring as applicable during the excavation of this waste site to the top of the unconfined aquifer.	100-C-7 has been characterized to the depth of the water table. Although this site has been remediated to the depth of 4.6 m (15 ft), soil concentrations exceed interim remedial action goals for protection of groundwater and the Columbia River.
Data are needed to refine the CSM of contaminant distribution beneath remediated waste sites.	2	Data are needed to assess the nature and vertical extent of contamination beneath select remediated waste sites.	Drill boreholes at select remediated waste sites. Excavate test pits into select remediated waste sites. Collect and analyze samples to assess the nature and vertical extent of contamination.	Yes	Drill boreholes into remediated waste sites as shown in Figure 4-1. Conduct test pit sampling at select remediated waste sites. Collect and analyze soil samples as described in the SAP (DOE/RL-2009-44). Waste sites with proposed boreholes are 100-B-5, 116-B-5, 116-B-14, 116-C-5, and 118-B-6. Waste sites with proposed test pits are 118-B-8:3, 116-B-6B, and 116-B-9. Conduct sampling to address Data Gap No. 7.	Characterization is needed to validate interim remedial action, including analysis for additional COPCs, and address uncertainty regarding the nature and extent of residual contamination in the vadose zone.
Data are needed to refine the CSM of contaminant distribution beneath and around reactor structures.	3	Data are needed to determine the nature and vertical extent of the contamination in the vadose zone around the 105-B and 105-C reactor structures.	Drill boreholes around 105-B and 105-C to assess the nature and vertical extent of contamination in the vadose zone.	Yes	Drill boreholes near the 105-B and 105-C reactors in locations shown in Figure ES-1. Collect and analyze soil samples as described in the SAP (DOE/RL-2009-44). Conduct sampling to address data gap No. 7.	The nature and extent of vadose zone contamination associated with the reactors has not been defined.
The nature and extent of contamination in the unconfined aquifer above cleanup standards has not been defined in select areas or for all COPCs.	4	Data are needed to identify groundwater contaminants and define the extent of contamination horizontally and vertically.	Cr(VI), tritium, and Sr-90 contamination has been detected at concentrations above water quality standards in the upper part of the unconfined aquifer in 100-BC. The extent of contamination has not been defined spatially in all locations. The vertical distribution of contamination has not been characterized. Not all groundwater COPCs are routinely monitored. Groundwater monitoring wells will be installed and monitored to define the extent of contamination.	Yes	Install six new groundwater monitoring wells (details provided in text). Well 1: A well to create a shallow/deep pair to characterize and monitor vertical distribution of contaminants. Well 2: A well to define the contaminant plumes near the river, to be placed southeast of the intake structure. Well 3: A well placed to provide information on chromium and Sr-90 distribution within the unconfined aquifer in a cluster with existing wells 199-B3-47 (water table) and 199-B2-12 (RUM), and provide vertical hydraulic gradient data. The well will be placed where the chromium concentrations at the top of the aquifer are historically highest. Well 4: A well west of the C Reactor to define the western extent of contamination. Well 5: A well in the southeastern corner of 100-BC to define the southern extent of contamination. Well 6: A well screened in the first water bearing unit within the RUM and paired with Well C7665 to confirm the conditions of Well 199-B2-12, which is screened in the RUM and has no contamination. Sample new and existing monitoring wells for all groundwater COPCs. Details are found in the SAP (DOE/RL-2009-44).Conduct sampling to address Data Gap No. 7.	Analyzing samples from new and existing wells for all COPCs will provide data on the nature and extent of groundwater contamination. Groundwater quality data collected during drilling of new wells will determine how deep in the aquifer contamination is present.

Table ES-1. 100-BC Data Gaps

Data Gap	Data Gap No.	Data Need	Description	Additional Data Collection Recommended?	Scope of Work	Justification
The level of contamination entering the Columbia River is not well known.	5	Data are needed to confirm results of previous pore water sampling, to observe concentration trends over time, and to better define areas of contamination under the river. Data from the aquifer tube network are needed to monitor concentrations over time and with depth near the river.	Groundwater upwelling sampling and analysis in the Columbia River channel was performed in fall 2009, and follow-up sampling is planned for early 2010. It is expected these data will provide additional insight regarding contaminant levels entering the river and groundwater/river mixing ratio within the biotic zone (upper 30.5 cm; ~12 in. of substrate). Evaluate additional methods (e.g., new rounds of pore water samples in the fall of 2010, horizontal aquifer tubes in the biotic zone) in appropriate 100-BC locations to validate/update the pore water sampling.	Yes	Collect groundwater upwelling (pore water) samples in the Columbia River. Focus on sites where contamination was detected in previous pore water sampling and where specific conductance indicates groundwater upwelling (details provided in text and DOE/RL-2009-44). Continue routine sampling of existing aquifer tubes per DOE/RL-2000-59, *Sampling and Analysis Plan for Aquifer Sampling Tubes*, Rev. 1, or subsequent revisions. Install three new aquifer tube clusters to provide better coverage (details provided in text and DOE/RL-2000-59).	Additional sampling is needed to define the nature and extent of contamination in the hyporheic zone.
The fate and transport of contaminants beneath the unconfined aquifer has not been evaluated over a sufficiently large area of 100-BC.	6	Only one well has been completed within the RUM aquitard unit in 100-BC. Data are not available to evaluate the integrity of the aquitard unit, or fate and transport within the aquitard.	The RUM unit is currently considered an aquitard. The integrity of the aquitard unit and potential transport within the aquitard has not been evaluated in 100-BC. Groundwater monitoring wells will be installed to appropriate depths to determine the fate and transport characteristics of the aquitard.	Yes	Collect split spoon soil samples at total depth of 1.5 m (5 ft) into the RUM from the new proposed wells (data gap No. 4), and the four new wells (Wells C7505, C7506, C7507, and C7665) being installed per SAP DOE/RL-2009-61, *Sampling and Analysis Plan for Four Groundwater Monitoring Wells in the 100-BC Decision Unit.* Drill one well (Well No. 6 from Data Gap No. 4) into the RUM to the first water producing unit and collect soil and groundwater samples. Sampling details are listed in DOE/RL-2009-44.	These data are needed to confirm that the RUM is an aquitard beneath 100-BC and determine if water within the RUM is contaminated.
Data are needed for a better understanding of hydrogeological conditions, aquifer interactions, and Cr(VI) mobility through the vadose zone.	7	Geological characterization, physical, and hydraulic property data are needed to support modeling and analysis.	On select soil samples, estimate soil properties and hydraulic properties, determine level of contamination, and perform batch and column leach contact tests.	Yes	Drill and sample soil and groundwater from proposed groundwater wells and boreholes (Data Gap No. 4). Details are found in the SAP (DOE/RL-2009-44). Install one new well (Well No. 3) screened near the base of the unconfined aquifer near existing Wells 199-B3-47 (water table) and 199-B2-12 (RUM). Collect soil and water samples throughout the thickness of the unconfined aquifer and the top of the RUM. Install pressure transducers in the three wells to obtain information about vertical hydraulic gradients. Install and monitor pressure transducers in selected other wells to determine horizontal hydraulic gradient and vertical gradient using wells installed as multi-depth pairs per Data Gap No. 4. Conduct batch and column leach tests from soil samples collected at 100-C-7.	Support fate and transport modeling and examine the persistence of contaminants.
Data are needed to reduce the uncertainty in spatial and temporal distribution of groundwater contamination.	8	Groundwater chemistry data are needed to reduce uncertainty in determining risks due to groundwater contamination.	Obtain data that are spatially representative of the area, representative of river stage influence, and inclusive of all COPCs.	Yes	Collect and analyze groundwater samples from 18 groundwater monitoring wells (see text) at three river stages (high, low, and transitional) to characterize the spatial and temporal extent of groundwater contamination. Details are found in the SAP (DOE/RL-2009-44).	Groundwater data are needed to address uncertainties associated with the RCBRA.

Table ES-1. 100-BC Data Gaps

Data Gap	Data Gap No.	Data Need	Description	Additional Data Collection Recommended?	Scope of Work	Justification

Notes:

DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/Feasibility Study.*

DOE/RL-2000-59, *Sampling and Analysis Plan for Aquifer Sampling Tubes,* Rev. 1.

DOE/RL-2009-61, *Sampling and Analysis Plan for Four Groundwater Monitoring Wells in the 100-BC Decision Unit.*

COPC = contaminant of potential concern

CSM = conceptual site model

IROD = interim action record of decision

RCBRA = River Corridor Baseline Risk Assessment

RUM = Ringold Upper Mud

SAP = Sampling and Analysis Plan

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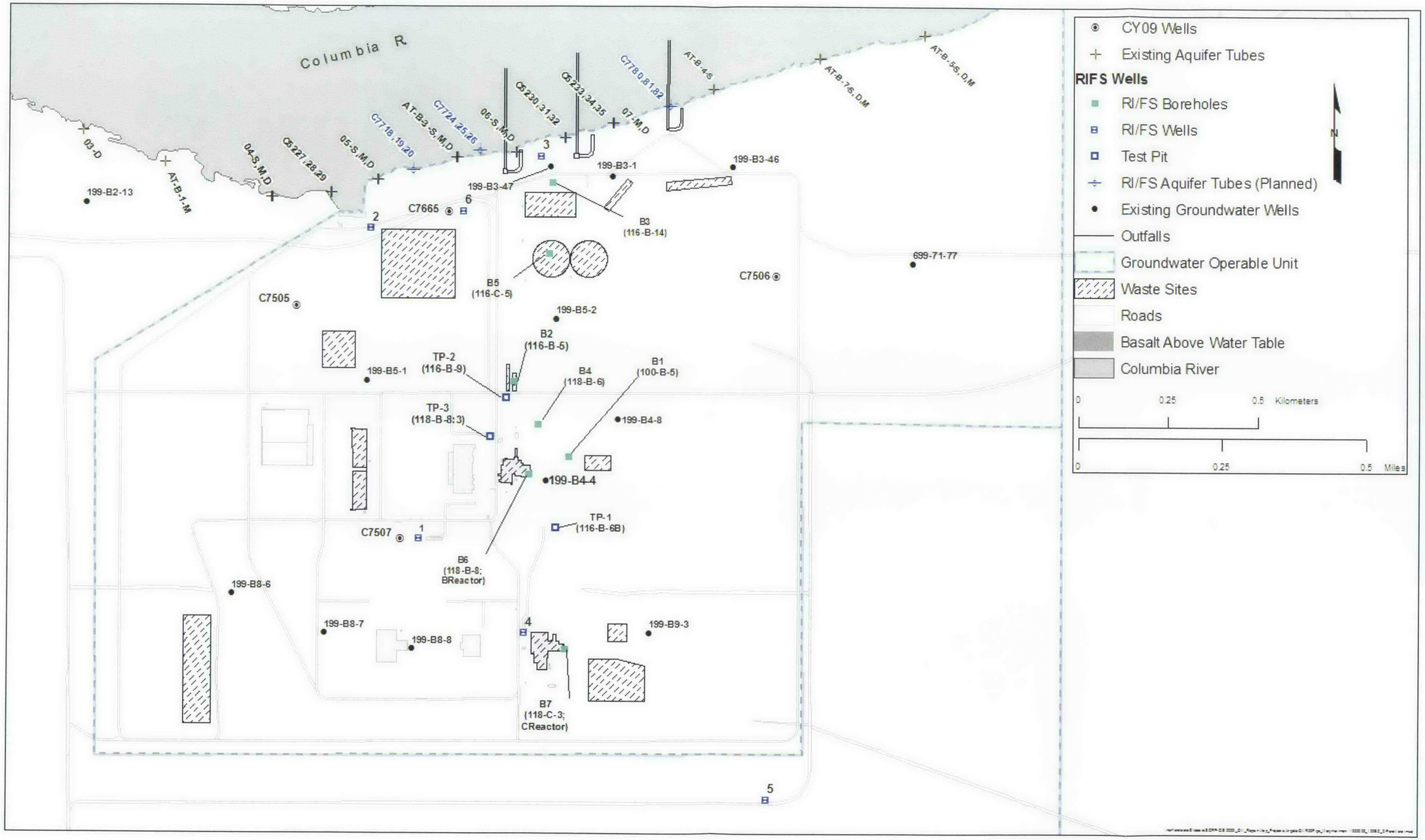

Figure ES-2. Proposed RI/FS Sampling Locations for Soil and Groundwater for 100-BC

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Terms

AEA	*Atomic Energy Act of 1954*
ARAR	applicable or relevant and appropriate requirement
BCM	Bank Cubic Meters
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
COPC	contaminant of potential concern
Cr(VI)	hexavalent chromium
CSM	conceptual site model
CVP	cleanup verification package
D4	deactivation, decommissioning, decontamination, and demolition
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DQO	data quality objectives
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	Explanation of Significant Difference
EWS	Export Water System
Fm	Formation
FS	feasibility study
FSB	Fuel storage basin
FY	fiscal year
GPR	ground penetrating radar
GPS	Global Positioning System

HAER	Historic American Engineering Record
IC	ion chromatography
ICP	inductively coupled plasma
IROD	interim action record of decision
ISS	interim safe storage
K_d	soil distribution coefficient
LFI	limited field investigation
MCL	maximum contaminant level
mg/L	milligrams per liter
NEPA	*National Environmental Policy Act of 1970*
NRHP	National Register of Historic Places
OU	operable unit
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goals
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RCBRA	River Corridor Baseline Risk Assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RESRAD	RESidual RADioactivity
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RTD	removal, treatment, and disposal
RSVP	remaining site verification package
RUM	Ringold Formation Upper Mud
SAP	sampling and analysis plan

SME	subject matter experts
Sr-90	strontium-90
TCLP	Toxicity Characteristic Leaching Procedure
Tri-Party Agreement	Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit
UPR	unplanned release
VOA	volatile organic analyte
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System

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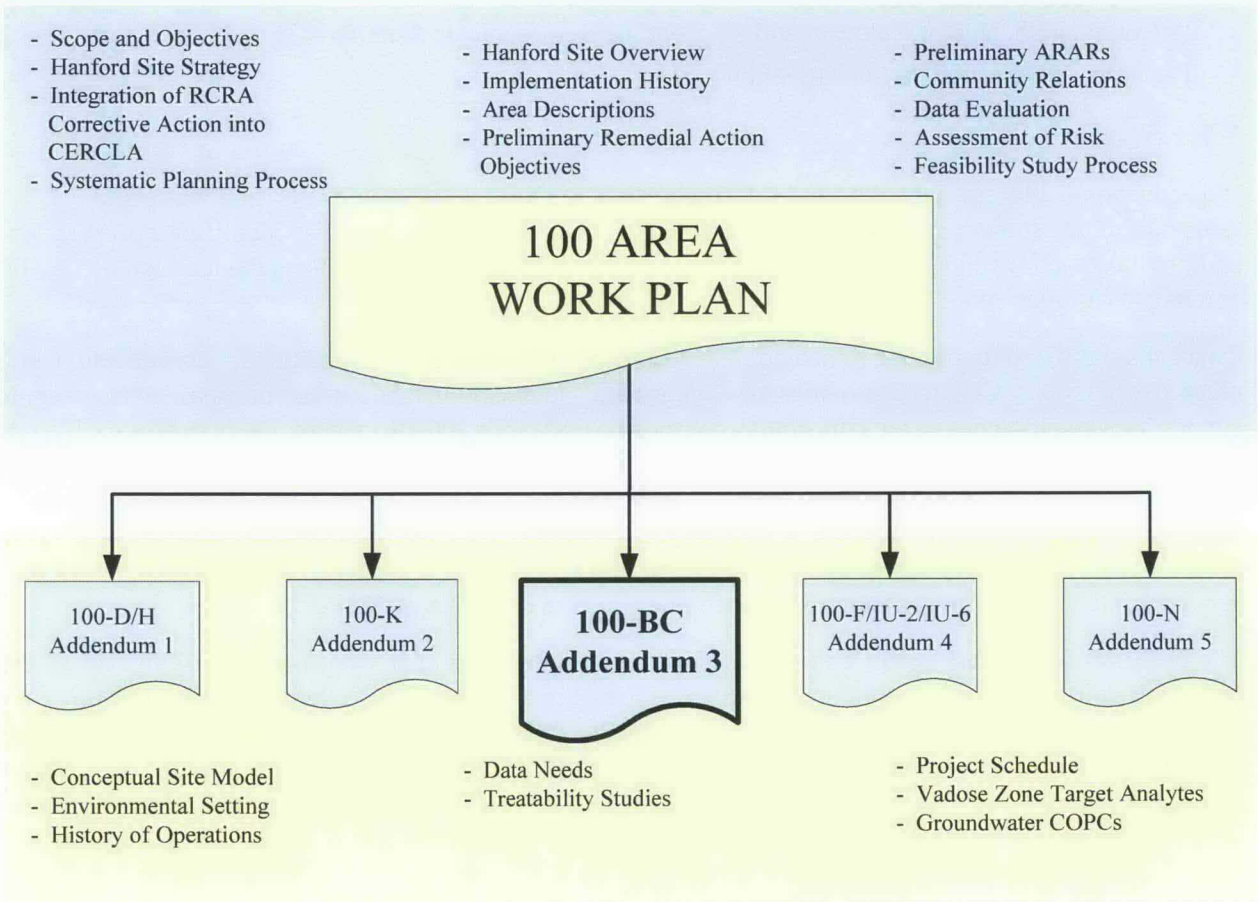
1 Introduction

This document is Addendum 3 to DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan*. This addendum describes 100-BC and the planned efforts to conduct a remedial investigation (RI) in support of a final record of decision (ROD) for the 100-BC Operable Units (OUs). The 100-BC area includes the 100-BC-1 and 100-BC-2 Source OUs and the 100-BC-5 Groundwater OU. The Integrated Work Plan (DOE/RL-2008-46) contains the planning elements that are common to all the Hanford Site 100 Area source and groundwater OUs and a summary of the RI/Feasibility Study (FS) tasks. Figure 1-1 shows the relationship between the RI/FS Work Plan and this addendum.



ARAR applicable or relevant and appropriate requirement
CERCLA *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC contaminant of potential concern
RCRA *Resource Conservation and Recovery Act of 1976*

Figure 1-1. Relationship Between the Integrated Work Plan and Addenda

This addendum was developed through interview sessions, workshops, and task team work organized through the Systematic Planning Process with the participation of subject matter experts (SMEs). The planning process was guided by the needs of the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA).

The following sections of the Integrated Work Plan (DOE/RL-2008-46) are included by reference:

- Assessment of Baseline and Residual Risks in the 100 Areas (Section 3.6)
- Preliminary Remedial Action Objectives (Section 4.1)
- Preliminary Remediation Goals (Section 4.2)
- Potential Applicable or Relevant and Appropriate Requirements (Section 4.3)
- Preliminary Remedial Actions (Section 4.5)

1.1 Scope

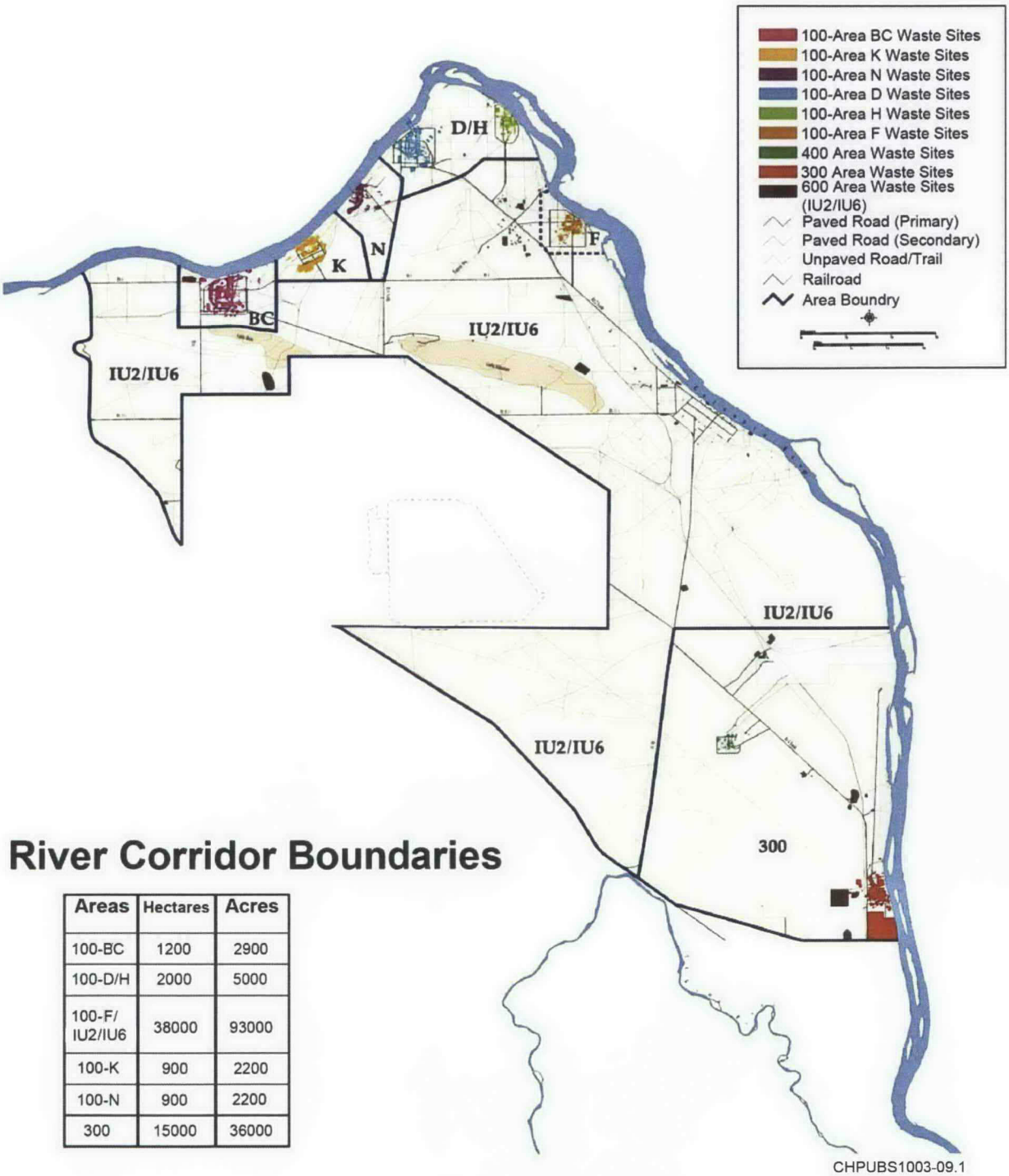
This addendum addresses the data and information needed to support groundwater and waste site remediation investigations associated with the 100-BC OUs. The addendum also identifies a process to address those needs significant to selection of a remedial action. Figure 1-2 shows the location of 100-BC and its proximity to other 100 Area OUs.

Data gaps significant to making remediation decisions are addressed through additional data collection and other investigations. Chapter 2 provides the background and environmental setting information necessary to support the development of the conceptual site model (CSM) for 100-BC. Chapter 3 discusses the initial evaluation and CSM components. The CSM is a useful tool to guide characterization and identify effective remediation actions. A CSM is a representation of the site, which organizes the information available and summarizes the site conditions. More importantly, a CSM can be used to identify data gaps and establish the programmatic priority for sampling and testing hypotheses. Chapter 4 discusses the work plan rationale and associated tasks. The general project schedule is included in Chapter 5.

The identification of data needs led to development of a sampling and analysis plan (SAP) that establishes characterization activities specific to the 100-BC OUs. The SAP (DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/ Feasible Study*) includes a field sampling plan that provides the sampling strategy and techniques that will be used to obtain the supplemental data required for the RI/FS. The SAP also provides a quality assurance project plan (QAPjP) to ensure that collected data meet the appropriate quality assurance (QA) and quality control (QC) requirements.

1.2 100-BC Remediation Accomplishments

Considerable amounts of environmental remediation and restoration activities have been completed and are planned at the Hanford Site. These activities include characterization of groundwater plumes and their potential sources, cleanup of the soil, and testing of new and alternative treatment methods specific to the issues and contaminants on the Hanford Site. Information about the cleanup progress in general is in the Integrated Work Plan (DOE/RL-2008-46), and cleanup activities specific to 100-BC is provided in Chapters 2 and 3.



River Corridor Boundaries

Areas	Hectares	Acres
100-BC	1200	2900
100-D/H	2000	5000
100-F/ IU2/IU6	38000	93000
100-K	900	2200
100-N	900	2200
300	15000	36000

Figure 1-2. River Corridor Boundaries

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2 Site Background and Environmental Setting

The Integrated Work Plan (DOE/RL-2008-46) provides an overview of regional geology, site background, and environmental setting information common to the 100 Area. Chapter 2 of this Addendum describes the background and environmental setting of 100-BC and provides descriptive information regarding the facilities, waste sites, waste generating processes, and hydrogeologic framework for 100-BC.

Information in this section primarily comes from WHC-SD-EN-TI-220, *100-B Area Technical Baseline Report*; WHC-SD-EN-RPT-004, *Summary of 100 B/C Reactor Operations and Resultant Wastes, Hanford Site;* and other contemporary sources documenting interim remedial actions (e.g., Waste Information Data System [WIDS]).

2.1 Environmental Setting

Numerous environmental, geologic, and hydrogeologic investigations have been conducted in 100-BC. The following sections summarize the findings of these investigations and the factors that affect contamination impacts at the Hanford Site. The environmental setting dictates much of the behavior of contamination within and through the vadose zone and groundwater.

2.1.1 Topography

Much of the surface and subsurface of the topography of 100-BC is relatively flat inland from the Columbia River. The area has been disturbed and graded extensively by human activity since reactor construction began in the 1940s through present day waste site remedial activities. The surface elevations range from approximately 149 m (490 ft) above mean sea level at the southern border to 131 m (430 ft) near the river. The surface topography changes are greatest near the Columbia River where the riverbank slopes steeply (10:1 grade) to the river shoreline and drops approximately 9 m (30 ft) from the edge of the terrace toward the river to an elevation of approximately 122 m (400 ft).

Significant topographic features near 100-BC include Gable Butte to the south as well as an extensive gravel beach that is exposed along the north boundary of the area along the Columbia River during periods of low river stage. On the upstream end of the area, the bank is less steep and broadens into a gently sloping (50:1 grade), 150 m (492-ft) wide shoreline (PNL-8143, *Fiscal Year 1991 Report on Archaeological Surveys of the 100 Areas, Hanford Site, Washington*).

2.1.2 Geology

The following information specific to 100-BC is mainly summarized from WHC-SD-EN-TI-133, *Geology of the 100-B/C Area, Hanford Site, South-Central Washington.*

The 100-BC area is underlain by Miocene (approximately 17 to 8.5 million years before present) basalt of the Columbia River Basalt Group and late Miocene to Pleistocene (approximately 10.5 million to 12,000 years before present) suprabasalt sediments. The Columbia River Basalt Group is greater than 3,000 m (9,800 ft) thick. The suprabasalt sediments are over 184 m (600 ft) thick.

Most of this sedimentary sequence can be divided into two main units important to understanding contaminant fate and transport: the Ringold Formation (Fm) of late Miocene to middle Pliocene age (approximately 10.5 million to 3 million years before present) and the Hanford formation of Pleistocene to Recent age (approximately 1 million to 12,000 years before present). The Hanford formation and upper sections of the Ringold Fm Unit (Unit E) constitute the vadose zone at 100-BC. Holocene surficial deposits of silt, sand, and gravel form the veneer at the surface. Figure 2-1 shows the generalized stratigraphy of 100-BC.

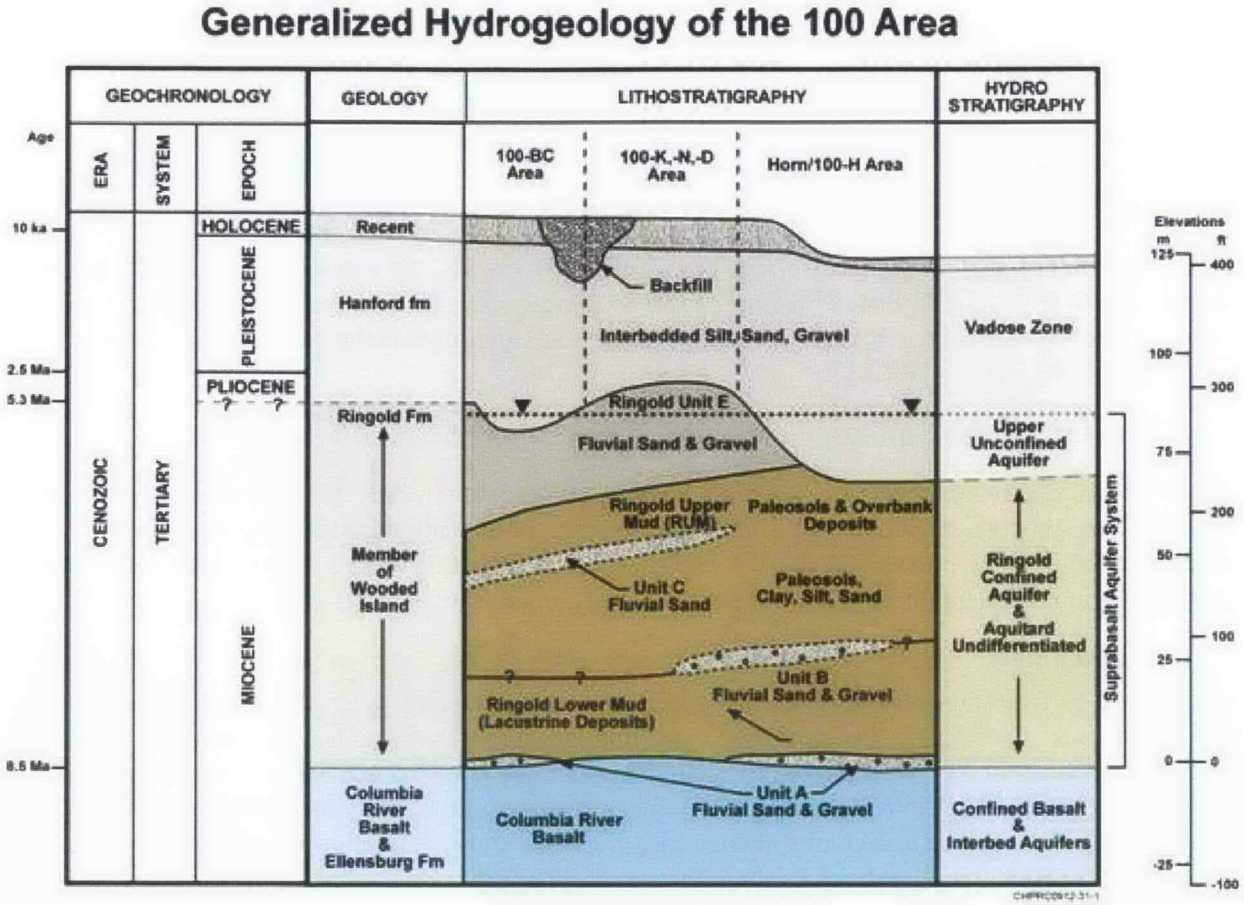

Figure 2-1. Stratigraphy and Hydrogeologic Units of 100-BC

2.1.2.1 Ringold Formation

The Ringold Fm beneath 100-BC contains most of the units commonly encountered elsewhere at the Hanford Site. The fluvial gravel and sand units A, B, C, and E (in ascending order) are present and interbedded with fine grained lacustrine and fluvial overbank deposits and paleosols. All of these units are penetrated by Well 199-B3-2, a well in the northeastern corner of 100-BC that was decommissioned in the 1990s, shown on Figure 2-2. All the 100-BC wells and their associated boreholes are listed in Table 2-1, with construction details. The Ringold Fm is approximately 198 m (650 ft) thick at this location. The Ringold Fm is much thinner (21 m [70 ft]) at Well 699-63-89, approximately 4 km (2.5 mi) to the southwest.

The deepest Ringold Fm Unit (Unit A) is approximately 18 m (60 ft) thick in Well 199-B3-2 and consists of sandy gravel, sand, and sandy silt. The Ringold Fm Lower Mud overlies Unit A. It is approximately 44 m (143 ft) thick and consists primarily of silt and clay.

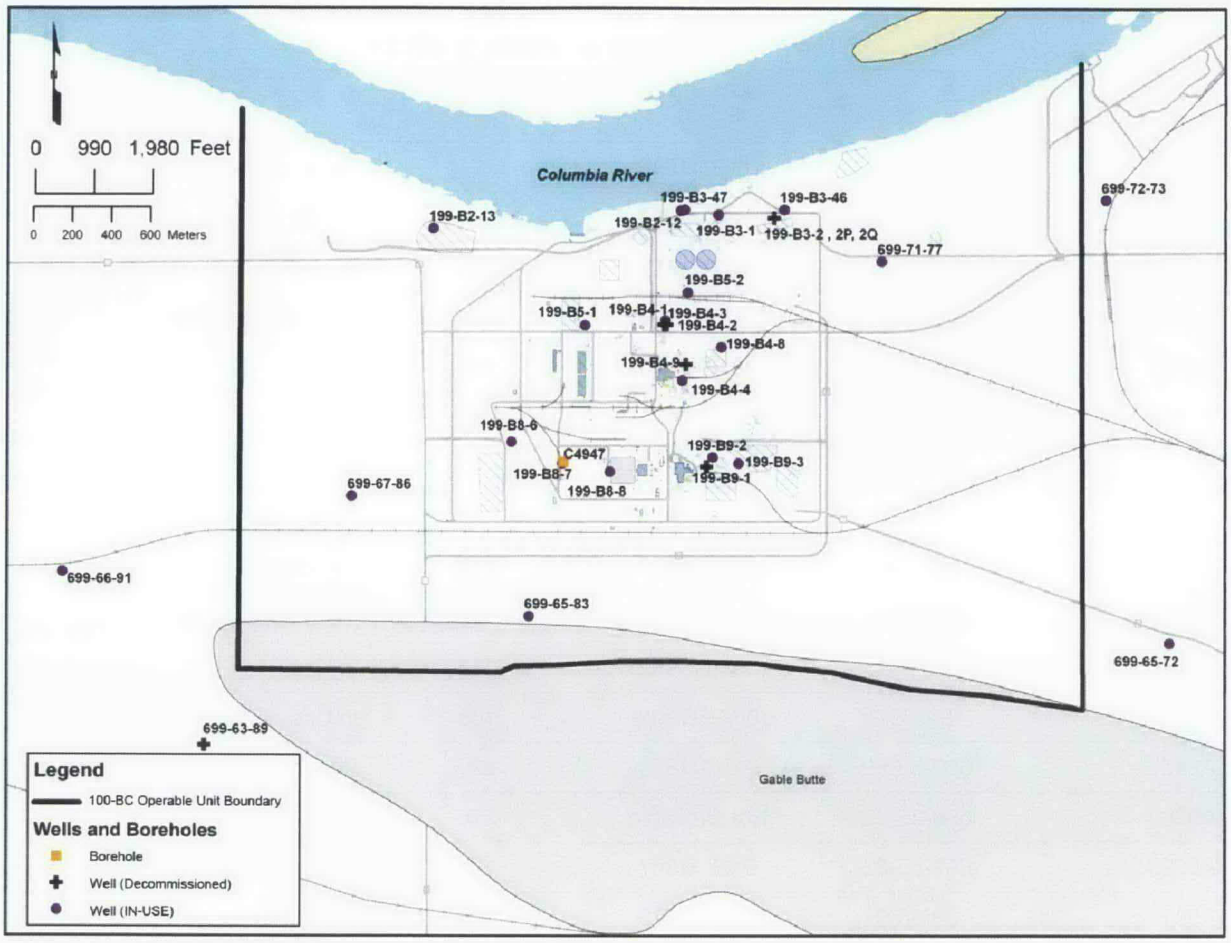

Figure 2-2. Locations of Select Wells and Boreholes Significant to Geologic Understanding

Table 2-1. Wells and Boreholes in 100-BC

Well Identifier	Well Name	Drill Completion Date	Drilled Depth (ft)	Status
A4550	199-B2-12	05/28/1992	178.8	In Use
A4551	199-B2-13	03/24/1992	40	In Use
A4552	199-B3-1	04/13/1953	63	In Use
A9505	199-B3-2	09/21/1953	790	Decommissioned
A9825	199-B3-2P	09/21/1953	790	Decommissioned
A9808	199-B3-2Q	09/21/1953	790	Decommissioned
A4553	199-B3-46	02/28/1992	66.77	In Use
A4554	199-B3-47	06/23/1992	61	In Use
A4555	199-B4-1	02/23/1949	90	In Use
A5539	199-B4-2	02/28/1949	90	Decommissioned

Table 2-1. Wells and Boreholes in 100-BC

Well Identifier	Well Name	Drill Completion Date	Drilled Depth (ft)	Status
A4556	199-B4-3	02/23/1949	91	Decommissioned
A4557	199-B4-4	09/13/1960	105	In Use
A4559	199-B4-8	02/21/1992	90.4	In Use
A4560	199-B4-9	05/28/1992	92.8	Decommissioned
A4561	199-B5-1	08/31/1962	151	In Use
A4562	199-B5-2	06/23/1992	75	In Use
A4563	199-B8-6	07/08/1992	91	In Use
C5671	199-B8-7	07/23/2007	92	Candidate for Decommissioning*
C5672	199-B8-8	08/02/2007	112	Candidate for Decommissioning*
A4564	199-B9-1	07/10/1952	117	Decommissioned
A4565	199-B9-2	06/15/1992	118	In Use
A4566	199-B9-3	06/09/1992	109	In Use
A8956	699-63-89	04/11/1973	220	Decommissioned
A5302	699-65-72	Not available	216	In Use
A5303	699-65-83	04/30/1967	121	In Use
A5311	699-66-91	05/31/1973	190	In Use
A5313	699-67-86	10/09/1962	467	In Use
A5322	699-71-77	09/10/1962	300	In Use
A5323	699-72-73	09/20/1961	200	In Use
C4947	C4947	08/09/2005	96	Decommissioned

* To be decommissioned prior to additional work at the 100-C-7 waste site.

Two intervals of silty to gravelly sand are intercalated with muddy sediments. The two sandy intervals (2.4 and 1.8 m [8 and 6 ft]) probably correlate with Ringold Fm Unit B. Unit B is thicker and better developed in the northeast and pinches out to the southwest.

Ringold Fm Unit C overlies Ringold Fm Unit B and its associated muds. It is predominantly a coarse grained series of silty sand to sandy gravel. In Well 199-B3-2, Unit C is approximately 34 m (113 ft) thick.

Muddy deposits that directly overlie Unit C are informally termed the Ringold Fm Upper Mud (RUM) Unit. Few of the wells in 100-BC reached this unit in depth, and only Well 199-B3-2 penetrated it fully. In that well, the RUM Unit is approximately 34 m (110 ft) thick. The top of the RUM Unit is at an elevation of 88 m (290 ft) above mean sea level in Well 199-B3-2 and in other wells in the eastern 100-BC that were drilled to the top of the unit. One new borehole in western 100-BC, C7505 (199-B5-5)

encountered the RUM Unit at the lower elevation of 73 m (240 ft) above mean sea level, approximately 15 m (50 ft) deeper than anticipated.

The uppermost unit of the Ringold Fm in 100-BC is Ringold Fm Unit E, which comprises predominantly sandy gravel. This unit is approximately 30 m (100 ft) thick at well 199-B3-2.

2.1.2.2 Hanford Formation

The Hanford formation ranges in thickness from more than 30 m (100 ft) in the southern and southeastern portions of 100-BC to less than 15 m (50 ft) near the Columbia River (WHC-SD-EN-TI-133). The Hanford formation is an unofficial designation that consists of gravel, sand, and silt deposited by cataclysmic flood waters that drained out of glacial Lake Missoula during the Pleistocene age (DOE/RW-0017, *Draft Environmental Assessment: Reference Repository Location Hanford Site, Washington*).

The Hanford formation is divided into three facies: (1) gravel dominated, (2) sand dominated, and (3) silt dominated (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*). While the gravel dominated facies are observed throughout 100-BC, the sand dominated facies were observed locally and cannot be correlated between boreholes. Silt dominated facies are not significant in 100-BC.

The Hanford formation is characterized by large to very large, cobble to boulder size clasts in open framework gravels that include discrete sand lenses with minor to no silt and clay material. The grains typically are sub-round to round gravel and sub-angular to round in the sand grain fraction. The gravel dominated facies typically are well stratified and contain little to no cementation (WHC-SD-EN-TI-132, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*). Boulder gravel in the upper 6 to 15 m (20 to 50 ft) demonstrates the high energy depositional environment created during the Missoula Floods (Hanford formation). These deposits prove difficult to penetrate by drilling activities (WHC-SD-EN-TI-133).

2.1.2.3 Hanford/Ringold Contact

The Hanford formation generally is more transmissive and permeable than the Ringold Fm, and the contact between the two formations potentially affects contaminant transport in the vadose zone and groundwater. The Hanford formation is often difficult to differentiate from the Ringold Fm Unit E. Differentiation between the different geologic units is based on characteristics such as a basalt clast content, gravel content, coloration, and cementation. The Hanford formation typically is less cemented than the Ringold Fm and has greater gravel content. Hanford formation gravels may display salt-and-pepper and gray coloring, while Ringold Fm gravels are generally more oxidized and reddish-brown to yellow-red in color.

Because of the boulders and cobbles found in the Hanford formation and Ringold Fm Unit E, drilling of many wells was accomplished by "hard tooling" with a cable tool drilling rig to ensure reaching the desired depth. This method pulverizes the gravel and may wash away fine grained sediment, making it difficult to log the characteristics that could otherwise differentiate the two formations. Therefore, the Hanford/Ringold contact has not been determined in many boreholes because of poor preservation of these characteristics during borehole drilling.

The contact between Ringold Fm Unit E and the Hanford formation is important because the saturated hydraulic conductivity for the gravel dominated sequence of the Hanford formation is one to two orders of magnitude higher than the more compacted and locally cemented Ringold Fm Unit E. A higher hydraulic conductivity allows for an increased flow of groundwater through the material than in those with lower conductivity. Because hydraulic conductivity varies with the formation, different groundwater level responses may occur where channels now filled with the Hanford formation have been scoured into

the Ringold Fm Unit E. These buried channels could become preferential pathways for contaminated groundwater during high river stages (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

2.1.2.4 Surface Deposits

Recent localized surficial deposits and backfill overlie the Hanford formation and the Ringold Fm. These Holocene surficial deposits consist of silt, sand, and gravel that form a thin (less than 4.9 m [16 ft]) veneer across much of the Pasco Basin. These sediments were deposited by a mix of eolian and alluvial processes during the past 10,000 years.

2.1.3 Hydrogeology

Liquid waste, including radionuclides and hazardous chemicals, has been discharged to the surface and subsurface in 100-BC. A portion of these contaminants has reached groundwater. An understanding of groundwater flow is necessary to monitor groundwater properly, track the spread of these contaminants, and evaluate remedial actions.

Between 1949 and 1962, eight wells (199-B3-1, 199-B3-2, 199-B4-1, 199-B4-2, 199-B4-3, 199-B4-4, 199-B5-1, and 199-B9-1 [Figure 2-2]) were completed at 100-BC (DOE/RL-90-08, *Remedial Investigation/Feasibility Study Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland, Washington*). The deepest well (199-B3-2) was drilled to 241 m (790 ft) below ground surface (bgs). This is the only well at 100-BC to penetrate the surface of the basalt unit. Other 100-BC wells were constructed so that the screened interval was installed near (just below) or across the unconfined aquifer at the groundwater interface. In general, these wells are completed at approximately 30 m (100 ft) bgs. Data collected from these well borings are used to discuss the hydrogeology of 100-BC in this section.

In 100-BC, the groundwater system comprises several hydrostratigraphic units. From shallowest to deepest, these include the following:

- Vadose (unsaturated) zone: depending on location, the vadose zone may include either the Hanford formation gravels or the Ringold Fm Unit E gravels. The vadose zone is 2 m to 30 m (6.5 ft to 98 ft) thick beneath 100-BC.
- Unconfined aquifer: predominantly Ringold Fm Unit E gravels.
- Uppermost aquitard: RUM Unit.
- Series of confined and semiconfined aquifers in the Ringold Fm (Units C, B, and A), separated by fine grained deposits (overbank and paleosol).
- Basalt aquitard and basalt-confined aquifers (the shallowest of which is the Rattlesnake Ridge interbed).

The unconfined aquifer is composed primarily of the Ringold Fm Unit E. Aquifer thickness ranges from 33.5 m (110 ft) near the river to 48 m (157 ft) in new Well 199-B5-5. Near the Columbia River, the water table rises into the overlying Hanford formation where the Ringold Fm Unit E has been eroded (WHC-SD-EN-TI-133) during periods of high river stage. Below the unconfined aquifer, the Ringold Fm consists of a series of aquitards and water bearing zones. The low permeability of the RUM Unit provides the characteristics needed to define the base of the unconfined aquifer. The RUM Unit is encountered at elevations ranging from 72.5 to 88.4 m (238 to 290 ft) above mean sea level.

The hydrogeology of 100-BC reflects the interactions among surface water (Columbia River), groundwater (unconfined to confined aquifers), and the vadose zone. Of key importance is the

Columbia River, which has played a major role in the depositional and erosional processes that helped to produce the sediment and geologic features at 100-BC. Groundwater flow directions and gradients are highly dependent on river stage, with greater effects near the river. Diminished gradient effects are delayed, diminishing effects up to several hundred meters from the shoreline. These gradients affect both the short term and long term movement of contaminants to the river.

Although the long term net transport of contaminants in groundwater is toward the river, groundwater movement toward the river is impeded or reversed during high river stage as river water infiltrates the near-river groundwater as bank storage. During these high river stage (spring) conditions, groundwater contaminants are displaced inland by river water, and contaminant discharge to the river is reduced.

Groundwater elevations range over 1.8 m (6 ft) near the river, while inland the range is diminished to approximately 0.4 m (1.3 ft). This range is largely due to the effects of river stage. Groundwater data have been collected from the 100-BC groundwater monitoring wells and aquifer tubes during quarterly to biennial monitoring events for more than 10 years. Figure 2-3 shows the current groundwater monitoring well and aquifer tube locations (DOE/RL-2008-01, *Hanford Site Groundwater Monitoring Report for Fiscal Year 2007*). Appendix A shows decommissioned groundwater monitoring wells.

River data are collected from a Columbia River gauge installed at 100-BC. These data were compared with water table elevation data that had been continuously recorded at wells 199-B3-1, 199-B4-1, and 199-B4-4 (DOE/RL-93-37, *Limited Field Investigation Report for the 100-BC-5 Operable Unit*) (Figure 2-2 shows well locations). While river stage effects are observed in Well 199-B3-1 (near the river), no relationship between river stage and water table levels is apparent for 199-B4-1 and 199-B4-4, located near the B Reactor (DOE/RL-93-37).

The water table depth at 100-BC ranges from approximately 12 m (40 ft) at the north to approximately 30 m (100 ft) at the southern margins. Based on these depths, the water table elevation is estimated at approximately 120 m to 122 m (395 ft to 401 ft) above mean sea level, as presented in Figure 2-4 (DOE/RL-2008-66, *Hanford Site Groundwater Monitoring Report for Fiscal Year 2008*). The water table is located in the Ringold Fm across most of the site. Near the river, the water table may extend into the overlying Hanford formation.

2.1.3.1 Groundwater Flow

The unconfined aquifer is of most immediate concern regarding potential risk to humans and aquatic receptors from groundwater contamination. Groundwater flows away from the reactor areas toward the river with low river stage groundwater discharges observed as shoreline seeps. Generally, 100-BC groundwater flow in the unconfined aquifer is to the north, toward the Columbia River, as shown in Figure 2-4 and Figure 2-5 (WHC-EP-0394-5, *Groundwater Maps of the Hanford Site, June 1992*; DOE/RL-2008-01).

The groundwater in 100-BC flows as follows:

- Groundwater enters 100-BC primarily from the west (A), where the Columbia River provides partial recharge to groundwater, and from Gable Butte (B) and Gable Gap (C).
- Groundwater flows northward from the reactor areas (D) toward the Columbia River, with some discharge occurring at seeps along the shoreline. During high river stage, recharge occurs from the Columbia River as indicated by a much shallower gradient and reversed flow direction (E).

When river stage is high, the flow direction periodically shifts toward the southeast (PNNL-14287, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring and Assessment Network for*

the 100-BC-5 and 100-FR-3 Operable Units). The aquifer is characterized by approximately 30 m (100 ft) of coarse grained fluvial sediment. The water table defines the top of the unconfined aquifer. The typical water table elevation varies from approximately 122 m (399 ft) in the southern portion of 100-BC to about 120 m (393 ft) near the river (Figure 2-4).

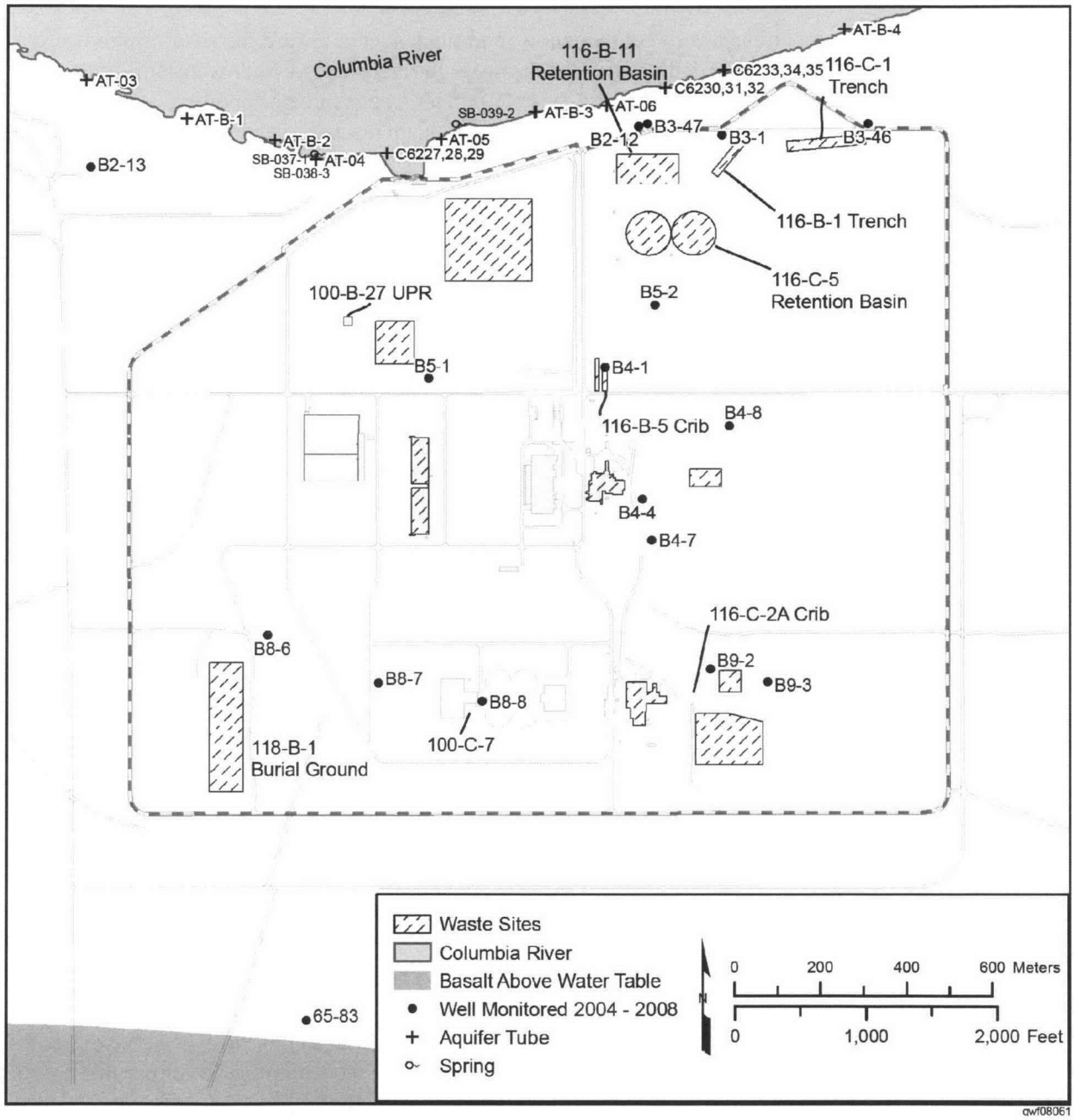

Figure 2-3. Current Monitoring Wells and Aquifer Tubes in 100-BC

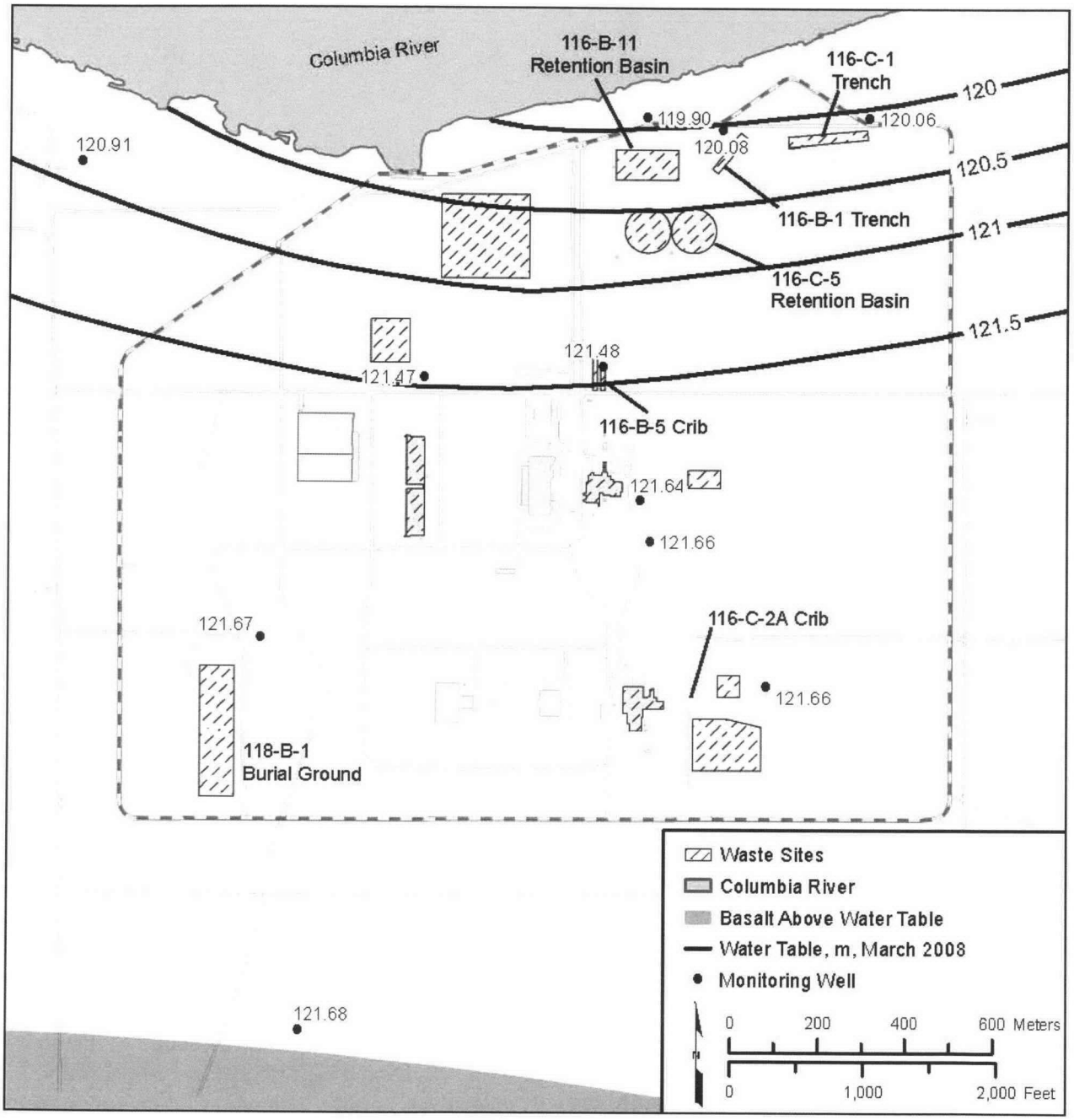

Figure 2-4. 100-BC Water Table Map 2008

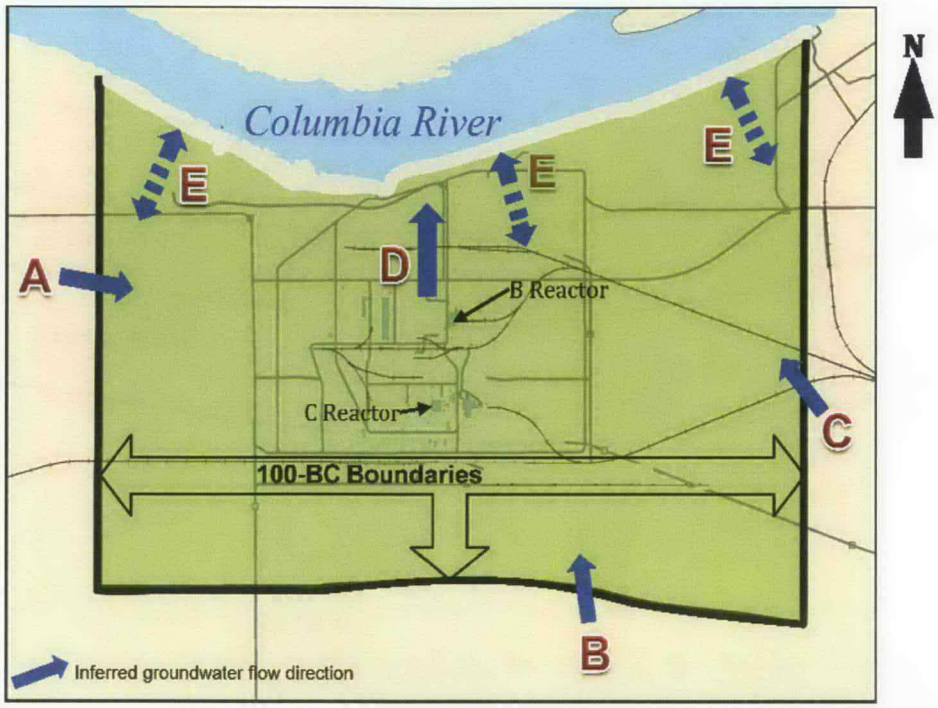

Figure 2-5. Illustration of 100-BC Groundwater Flow Patterns

2.1.3.2 Hydraulic Gradients

Hydraulic gradients and flow directions change over various time scales and magnitudes based on changes in river stage. River stage is primarily a function of controlled releases from the Priest Rapids Dam upstream of the Hanford Site. Diurnal fluctuations range up to 1.5 m (5 ft) based on hourly variations in water release rates, which are controlled by the Priest Rapids Dam (WASH-1538, *Environmental Statement Waste Management Operations: Hanford Reservation Richland, Washington*). River stage fluctuates seasonally up to approximately 3 m (10 ft). Similar to the other 100 Area reactor sites, the flow directions and gradients at 100-BC are highly influenced by fluctuations in river stage near the shoreline. The delayed effects of river stage fluctuations are more than 900 m (3,000 ft) inland (WHC-EP-0394-5). Wells discussed in this section are shown in Figure 2-2 and Appendix A.

The hydraulic gradient is relatively low in the southern portion of 100-BC (DOE/RL-2008-66). During low river stage, groundwater flows toward the Columbia River. During high river stage, groundwater gradients in the near river area are generally away from the river. Further, hydraulic gradients are directly affected by seasonal, deep percolation of precipitation and rapid snow melt; river stage; upward leakage from deeper groundwater systems; and lateral flow of the unconfined aquifer from elsewhere at the Hanford Site. During high river stage, the vertical hydraulic gradients near the river are generally downward, and during low river stage, vertical hydraulic gradients are generally upward. The magnitude of vertical hydraulic gradients inland in 100-BC have not been evaluated.

In March 2008, relatively steep gradients were observed near the river (DOE/RL-2008-66) in the western, eastern, and northern regions of the Hanford Site. Shallower gradients extend in a broad arc from 100-BC eastward to the southeastern portion of the 100-F Area. The steeper gradients likely are related to the water table's presence in the Ringold Fm (lower permeability than the Hanford formation) compared with

shallower gradients of the Hanford formation, where the water table is present in the Hanford formation (DOE/RL-2008-01).

The Ringold Fm uppermost confined aquifer occurs within a water bearing zone of the upper paleosols and overbank deposits (RUM). Water level elevation data collected during the 1993 limited field investigation (LFI) (DOE/RL-93-37) indicate the hydraulic potential is generally upward between monitoring well 199-B2-12 (screened in this water bearing unit of the RUM) and adjacent shallow monitoring well 199-B3-47 (screened in the upper portion of Unit E). However, during low river stage, a slight downward potential was observed. At this time, the water level elevation in Well 199-B2-12 ranged from 0.02 m (0.07 ft) lower to 0.77 m (2.5 ft) higher than in Well 199-B3-47 (DOE/RL-93-37). While piezometers 199-B3-2P and 199-B3-2Q were completed and screened in the Ringold Fm Unit and the Saddle Mountain Basalts, respectively, water level data from these wells sometimes were identical. This suggested leakage across the well seal material (cement) between the two piezometers (PNL-6894, *Procedures for Ground-Water Investigations*). Therefore, their water level data were not dependable for estimating the vertical hydraulic gradient.

Additional data are needed to provide further characterization of the vertical gradient between geologic units at 100-BC.

2.1.3.3 Hydrogeologic Characteristics

Data were collected from boreholes and wells across the 100 Area to provide area wide physical properties data for characterization and to initiate cleanup planning (DOE/RL-93-37). Twelve soil samples collected from four depths in wells 199-B3-47, 199-B4-9, and 199-B9-2 were analyzed for bulk density, particle size distribution, moisture content, moisture retention, saturated hydraulic conductivity, and unsaturated hydraulic conductivity at 10 percent moisture content after full saturation. However, the analytical results were recognized as potentially biased toward finer grained sediment because of the influences of the cable tool sampling methods used.

2.1.3.4 Hydraulic Conductivity

In 1988, slug tests were conducted using methodology described in Bouwer and Rice, 1976, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells" at several wells across 100-BC. Data from Wells 199-B2-12, 199-B2-13, and 199-B3-46 (well locations shown in Figure 2-2) were used to calculate representative hydraulic conductivity. Based on the test results, hydraulic conductivity values were estimated at 0.0007 to 0.002 cm/s (2 to 6 ft/day) for deep well borehole 199-B2-12, completed in the confined Ringold Fm aquifer. Hydraulic conductivities in the unconfined aquifer were calculated to be 0.02 cm/s (50 ft/day) in well 199-B2-13 and 0.005 cm/s (15 ft/day) in well 199-B3-46 (WHC-SE-EN-TI-023, *Hydrologic Information Summary for the Northern Hanford Site*).

Calculations of vertical hydraulic conductivity from well boreholes 199-B2-12, 199-B4-9, and 199-B9-2 (Appendix A, BC Reactor Area Map) indicate a range of 0.0001 to 0.0004 cm/s (0.4 to 1.2 ft/day) for the Hanford formation. Soil from the same wells indicated vertical hydraulic conductivity at an estimated average of 0.0002 to 0.0006 cm/s (0.7 to 1.7 ft/day) for the Ringold Fm at 100-BC (DOE/RL-93-37). However, the actual vertical hydraulic conductivities were predicted to be higher than those calculated from laboratory data because the cable tool sampling methods tend to bias sample material toward the finer grained scale.

2.1.3.5 Recharge and Discharge

Shallow groundwater beneath 100-BC receives recharge from the river along reaches to the north and northwest (DOE/RL-2008-66). Additional recharge may occur by deep percolation of precipitation and

rapidly melting snow, upward leakage from deeper groundwater systems, and lateral flow of unconfined groundwater from elsewhere at the Hanford Site. The volumes and durations of such discharge are not quantified (DOE/RL-93-37).

Past liquid disposal resulting in groundwater mounding affected groundwater flow and potentially, contaminant transport. Drainage into vadose zone soils in areas of former high liquid waste discharge sites may still be occurring, although the drainage rate would be much lower than under higher moisture content conditions that were present during reactor operations.

2.1.4 Environmental Resources

Environmental resources are widespread across the Hanford Site, with significant cultural and historical heritage resources established from the riverfront environment to the ridge tops (DOE/EIS-0119F, *Addendum (Final Environmental Impact Statement): Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*). The Hanford Reach National Monument was formed to place high priority on shrub-steppe community habitat maintenance and enhancement for native species throughout the Monument. Washington State has designated shrub-steppe communities as priority habitat because of their significance to a number of wildlife species and the scarcity of this habitat type. In addition, the U.S. Department of the Interior has identified native shrub and grassland steppe in Washington and Oregon as an endangered ecosystem.

2.1.4.1 Flora

Before regulation of river flows by dams, trees were generally not found along the Columbia River shoreline habitat, with the exception of small willows and a few juniper trees near 100-BC and other river shorelines. The most common tree to establish itself along the shoreline is mulberry (PNNL-6415, *Hanford Site National Environmental Policy Act [NEPA] Characterization*).

Large tracts of land adjacent to 100-BC that were farmed are now dominated by stands of cheatgrass. Despite these old fields, many locations on the Hanford Site are relatively free of non-native species and are extensive enough to retain characteristic populations of shrub-steppe plants and animals. Unaffected areas support desert shrubs and drought resistant grasses and forbs. The predominant plant community at 100-BC is sagebrush/Sandberg's bluegrass/cheatgrass. Other shrub communities are dominated by bitterbrush, hopsage, and rabbitbrush (PNNL 6415). A relatively narrow riparian zone supports grasses, sedges, and scattered deciduous shrubs and trees such as willow, mulberry, and Siberian elm.

No plant species on the Hanford Site are currently listed as threatened or endangered under the *Endangered Species Act of 1973*. Several plant species listed as threatened or endangered by Washington state, including the awned halfchaff sedge (*Lipocarpha aristulata*), grand redstem (*Ammannia robusta*), lowland toothcup (Rotala ramosior), and persistentsepal yellowcress (*Rorippa columbiae*), are restricted to wetlands in the riparian zone of the Columbia River, such as may be found in or near 100-BC (PNNL-6415 Rev. 18).

2.1.4.2 Fauna

General 100 Area fauna are described in Chapter 2 of the Integrated Work Plan (DOE/RL-2008-46). No other fauna specific to 100-BC have been identified.

2.1.4.3 Critical Habitats

No plant species on the Hanford Site are currently listed as threatened or endangered under the *Endangered Species Act of 1973* (16 USC 1531, et seq.). Several plant species listed as threatened or endangered by Washington State, including the awned halfchaff sedge (*Lipocarpha aristulata*), grand redstem (*Ammannia robusta*), lowland toothcup (*Rotala ramosior*), and persistent sepal yellowcress (*Rorippa columbiae*) are restricted to wetlands in the riparian zone of the Columbia River, such as may be found in or near 100-BC (PNNL-6415).

Two species of federal listed endangered fish, the Upper Columbia River spring-run Chinook salmon and the steelhead, occur in the Hanford Reach. The spring-run Chinook salmon do not spawn in the Hanford Reach, but use it as a migration corridor. Steelhead spawning has been observed in the Hanford Reach. The bull trout is listed as threatened by the National Marine Fisheries Service, but is not considered a resident species and is rarely observed in the Hanford Reach (DOE/RL-2005-40, *100-B/C Pilot Project Risk Assessment Report*).

2.1.5 Human Resources

Some of the most important archaeological sites in the region are located at the Hanford Site. These sites are listed on the National Register of Historic Places (NRHP) as individual sites or as archaeological districts. Cultural, environmental, and historical information of the 100 Area is provided in detail in the Integrated Work Plan (DOE/RL-2008-46). To understand impacts to cultural resources and to reduce the need to perform extensive reviews on highly disturbed areas, disturbance maps and reports have been completed for 100-BC (PNNL-6415). Information specific to 100-BC is included in this section.

Restricted access to the Hanford Site has facilitated the preservation of these sites. Furthermore, hydroelectric and agricultural development have not destroyed these culturally significance sites, as has been experienced elsewhere in the Columbia River Basin. In addition, other natural resources and sacred sites important to the Native American communities with ancestral ties to the Hanford Site have been preserved (PNL-9785, *Data Compendium for the Columbia River Comprehensive Impact Assessment*). Through the Cultural Resources Review process, DOE/RL, river corridor closure contractor cultural resource specialists, Tribal Nation representatives, and project and site planners work together to protect resources important to the Native American community and other interested parties.

2.1.5.1 Prehistoric Archaeological Resources

A high density of archaeological resources is associated with the Native American cultural landscape in 100-BC. Three are located partially within 100-BC, and 35 have been recorded within the immediate vicinity of 100-BC during archaeological surveys completed during 1995 (PNNL-6415).

Several archaeological sites (45BN447, 45BN446, and 45BN1422) located near 100-BC have been investigated. Test excavations conducted in 1991 at archaeological site 45BN447 revealed large quantities of deer and mountain sheep bone and projectile points dating from 500 to 1,500 years ago. Archaeological site 45BN446 is considered eligible for listing in the NRHP partially because it may contain new information about the Frenchman Springs and Cayuse Phases of mid-Columbia prehistory. Data recovery efforts conducted at archaeological site 45BN1422 in 2006 documented a discrete activity area (dating between approximately 2,860 and 2,450 years ago) marked by three interrelated features associated with freshwater mussel shell processing.

Farther downriver, as recorded in 1968, site 45BN118 consisted of 18 to 24 housepits and associated artifacts including cobble tools and hopper mortars. The site was considered a large, open air camp or village. It was determined that this site was a contributing element to the Savage Island Archaeological District, listed on the NRHP in 1976. By 1989, surface evidence of the housepits was lacking, but fire-cracked rock, a few flakes, anvil stones, bits of fish and mammal bones, and mussel shell fragments were observed in an area extending along the shoreline. The shell layers were described as extending from 1 m (3.2 ft) to over 2 m (6.4 ft) below the surface (PNL, 1989, *Archaeological Site Monitoring Form: 45BN118*). By 2001, grasses and bushes had grown over the site to the extent that only two possible housepits were located, with none of the previously recorded artifacts observed (PNNL, 2001, *Archaeological Site Form: 45BN118*).

2.1.5.2 Cultural Resources

Many sites related to hunting and religious activities are located at the west end of Gable Butte. These sites are associated with the Gable Mountain-Gable Butte Cultural District (PNNL-6415).

Three sites associated with early settlers, the Fry and Conforth Farm, Bruggerman's Warehouse, and the Coyote Rapids Hydroelectric Pumping Plant—all of which are eligible for listing on the NRHP (PNNL-6415), are located in 100-BC.

Historic archaeological resources include the remains of Haven Station, a small stop on the former Chicago, Milwaukee, St. Paul, and Pacific Railroad, located to the west of 100-BC. The only structure associated with the Early Settlers/Farming landscape in 100-BC is the Hanford Irrigation and Power Company pumping plant built at Coyote Rapids during 1908 and located east of 100-BC.

2.1.5.3 Cold War Resources

The 105-B Reactor was the world's first full scale plutonium production reactor and is recognized as a National Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers (1976), a Nuclear Historic Landmark by the American Nuclear Society (1993), and a National Civil Engineering Landmark by the American Society of Civil Engineers (1994). The B Reactor has been listed on the NRHP since 1992, and was recorded by the Historic American Engineering Record (HAER) in 2000. It was named a National Historic Landmark in 2008 (PNNL-6415). Conversion of the facility into a public museum with an interpretive center is planned.

HAER documentation of the B Reactor was completed in 1999 (DOE/RL-2001-16, *Historic American Engineering Record B Reactor (105-B Building) HAER No. WA-164*). Fourteen buildings and structures within the reactor area have been recorded on historic property inventory forms. Of that number, the following ten were selected as representative examples of buildings and structures eligible for the NRHP as contributing properties within the Historic District and recommended for individual documentation:

- 104-B-1 Tritium Vault
- 104-B-2 Tritium Laboratory
- 105-B Reactor
- 105-B-Rod Tip Cave
- 116-B Reactor Exhaust Stack
- 117-B Exhaust Air Filter Building
- 118-B-1 Solid Waste Burial Trench
- 181-B River Pump House
- 182-B Reservoir
- Pump House

An assessment of the contents of the B Reactor was conducted to locate and identify Manhattan Project and Cold War era artifacts that may have interpretive or educational value in potential exhibits. Thirty-nine industrial artifacts were identified and tagged, with many displayed as interpretive exhibits in the reactor building. Tagged artifacts from the D and F Reactors were transferred to the B Reactor for display as interpretive exhibits (PNNL-6415).

2.2 100-BC OUs – Overview

The 100-BC area is located in the northern portion of the Hanford Site adjacent to the Columbia River (Figure 1-2). It covers more than 11.54 km^2 (4.45 mi^2) of land along the southern shore of the Columbia River. The river stretch along 100-BC is a part of the Hanford Reach National Monument, which is an important ecological, cultural, historical, and recreational resource. Background information for this area includes the known hydrogeologic information; past operational history of the facilities (with an emphasis

on disposal operations); source remedial actions and their effectiveness; and the results of any treatability and characterization studies.

For remediation purposes, 100-BC is also divided into source and groundwater OUs. Appendix A presents maps of the facilities and source sites. Ninety-five waste sites are assigned to the 100-BC-1 OU, and 55 sites are assigned to the 100-BC-2 OU. The 100-BC-1 OU contains waste units associated with the original plan facilities constructed to support B Reactor operations, as well as the cooling water retention basin systems for both B and C Reactors. The 100-BC-2 OU contains waste sites associated with the facilities to support C Reactor operations and other waste sites at 100 BC, including most of the solid waste burial grounds. The 100-BC-1 and 100-BC-2 OUs address source contamination associated with liquid, solid, and unplanned release waste sites. The 100-BC-5 groundwater OU generally comprises the groundwater near 100-BC affected by contaminant releases. A final ROD has not yet been developed for the 100-BC OUs, and active groundwater remediation has not occurred.

2.2.1 B and C Reactor History and Description

The 105-B and 105-C Reactors were the focus of production activities. The two reactors were supported by multiple facilities associated with services for water treatment, air filtration, nuclear fuel handling, effluent disposal, and laboratories, with various other administrative buildings (WHC-SD-EN-TI-220).

The B Reactor construction, which started in March 1943, was completed in 13 months. After comprehensive equipment testing, the reactor was first activated in September 1944. Figure 2-6 shows the B Reactor during its production period in 1944. This reactor was the first of three original Hanford reactors built during World War II as part of the Manhattan Project, with a primary mission of building an atomic bomb. The design, operation, and waste management process at the B Reactor was the first of its kind in practice. The original Hanford reactors represented the basis for subsequent reactor design and conduct of operations, especially with regard to handling radioactive materials and waste management.

Figure 2-6. Northeastern Aerial View of the B Reactor in 1944

After its war-time production, the B Reactor was thought to be nearing the end of its effective operational life because of growth and distortion of its graphite core. From March 1946 to June 1948, the reactor was taken offline to preserve its capability. Subsequent improvements in processes and technologies allowed the restart of the reactor and continued use after 1948. The B Reactor was permanently deactivated in

1968. The B Reactor is slated for historic preservation, with conversion of the facility into a public museum (Figure 2-7).

Figure 2-7. 105 B Reactor in 2005

The C Reactor was constructed in 1951 and 1952, with initial startup in November 1952. In addition to its plutonium production mission, the C Reactor was used for reactor physics and operations testing and as a pilot scale version for the next generation of reactors at 100-K (WHC-SD-EN-RPT-004). The C Reactor was deactivated in April 1969, and has subsequently been placed into interim safe storage (ISS) until its final disposition. The ISS process was initiated in 1996 and completed in 1998 (DOE/RL-2005-45, *Surplus Reactor Final Disposition Engineering Evaluation*). Figure 2-8 shows the C Reactor from 1953, Figure 2-9 shows the reactor during ISS in 1998, and Figure 2-10 shows the reactor after ISS completion in 2007. The ISS process is a series of actions taken to protect retired reactors from environmental degradation and to prevent the spread of contamination by providing an upgraded, weather resistant shell to isolate the reactor core until final remedial activities are conducted. These actions also minimized the facility footprint by removing peripheral reactor buildings and equipment and disposing of the debris.

Once the plutonium production and other missions at the reactors ended, DOE issued a ROD for the decommissioning of surplus production reactors at the Hanford Site (58 FR 48509, "Record of Decision: Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington"). After deactivation of reactors, infrastructure networks were placed in standby mode or decommissioned. These activities occurred in phases according to their ages and capabilities of the facilities and as resources allowed (PNL-MA-588, *Resource Book–Decommissioning of Contaminated Facilities at Hanford*; WHC-EP-0478, *Summary of the Hanford Site Decontamination, Decommissioning, and Cleanup FY 1974 Through FY 1990*). Follow-on housekeeping and decommissioning activities began in 100-BC as part of a sitewide initiative in 1973, after deactivation of the remaining single-pass reactors. This effort progressed as resources allowed from 1974 through 1990, with building demolition, surplus equipment salvage or redeployment, and active operations maintenance at a minimal level.

Building and facility wastes remaining in the 100 Area sometimes exist in demolished ductwork, concrete, paint, equipment, insulation, cracks, crevices, and remaining process piping and tanks that were left in place after earlier demolition. More contemporary remediation efforts result in contaminated debris

being hauled to the Environmental Restoration Disposal Facility (ERDF) and uncontaminated debris demolished and left in place (BHI-01399, *108-F Biological Laboratory D&D Closeout Report*).

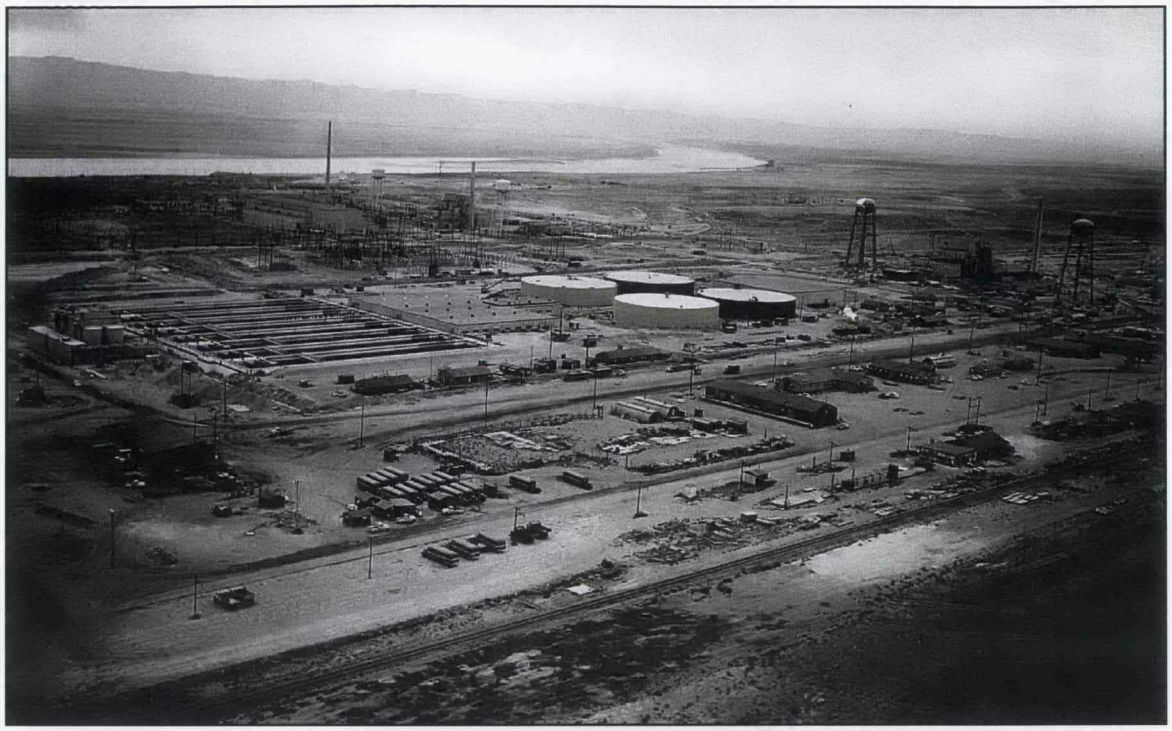

Figure 2-8. Northeastern Aerial View of the C Reactor (at right) in 1953

Figure 2-9. The C Reactor During ISS Implementation in 1998

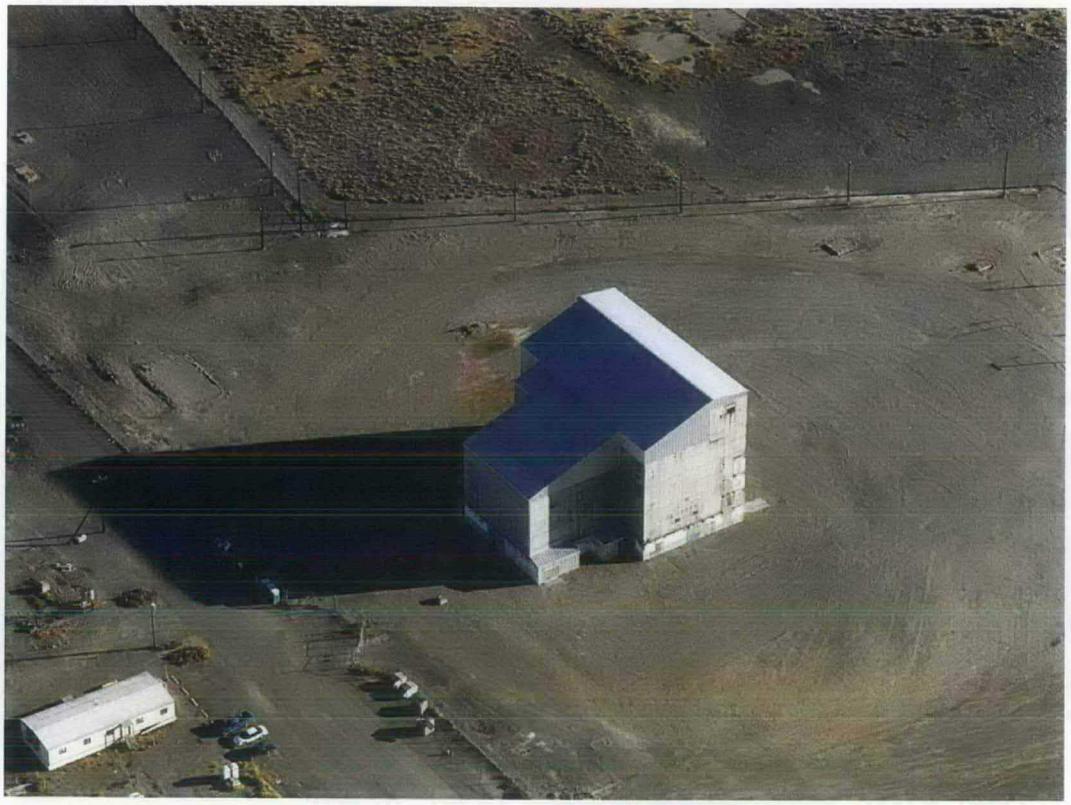

Figure 2-10. Reactor C After ISS (2007)

2.2.2 Facility History and Description

This section provides the description and history of facilities used in 100-BC and identifies the status of these structures. Seventy-six facilities were used or constructed in 100-BC. Figure 2-11 (1966) and Figure 2-12 (2008) contrast the condition of 100-BC during production versus the recent status of facilities and waste sites. Waste sites and facilities have been largely removed at 100-BC, and scarring of the landscape from past construction and remedial activities is evident in both photos.

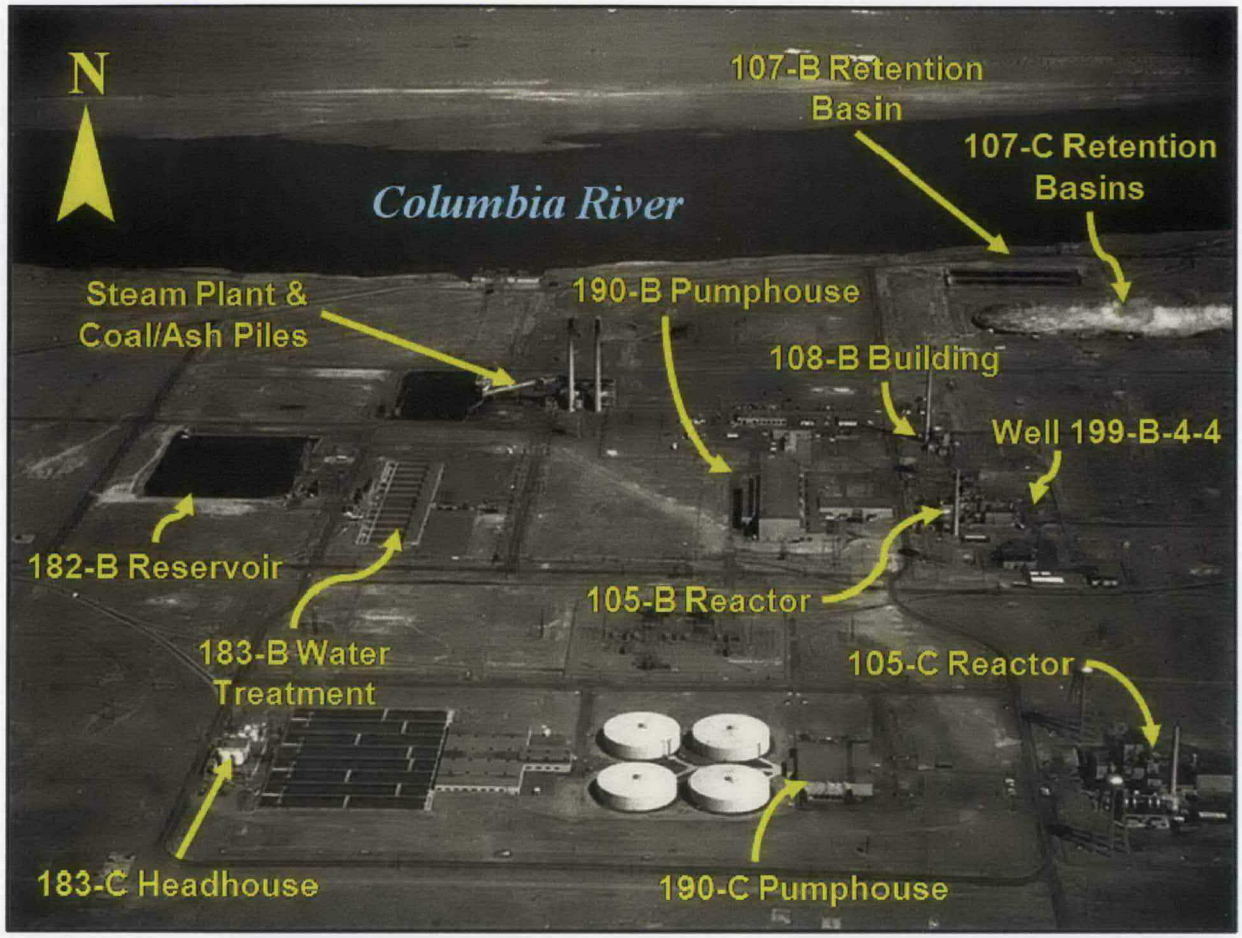

Figure 2-11. 100-BC Major Features During Reactor Operations in 1966

The facilities have a status of active, inactive, removed, or demolished. Table 2-2 summarizes the status of facilities within 100-BC. Appendix C contains a description and history of each facility.

Table 2-2. Summary Information on the Status of 100-BC Facilities

	Reclassification Status			
Total Number of Facilities*	**Demolished**	**Removed**	**Active**	**Inactive**
76	59	8	3	6

Notes:

This summary of facilities is current as of January 7, 2010.

Status Definitions:

Active: Facility is occupied and/or in use (supports Hanford Site missions).

Inactive: Facility is no longer in use and is waiting decommissioning and demolition.

Demolished: Facility has been removed to grade (slab or foundation remains).

Removed: Facility foundation has been removed and any substructure is 0.3 to 0.9 m (1 to 3 ft) below grade.

* Does not include Mobile Offices or Contractor Trailers

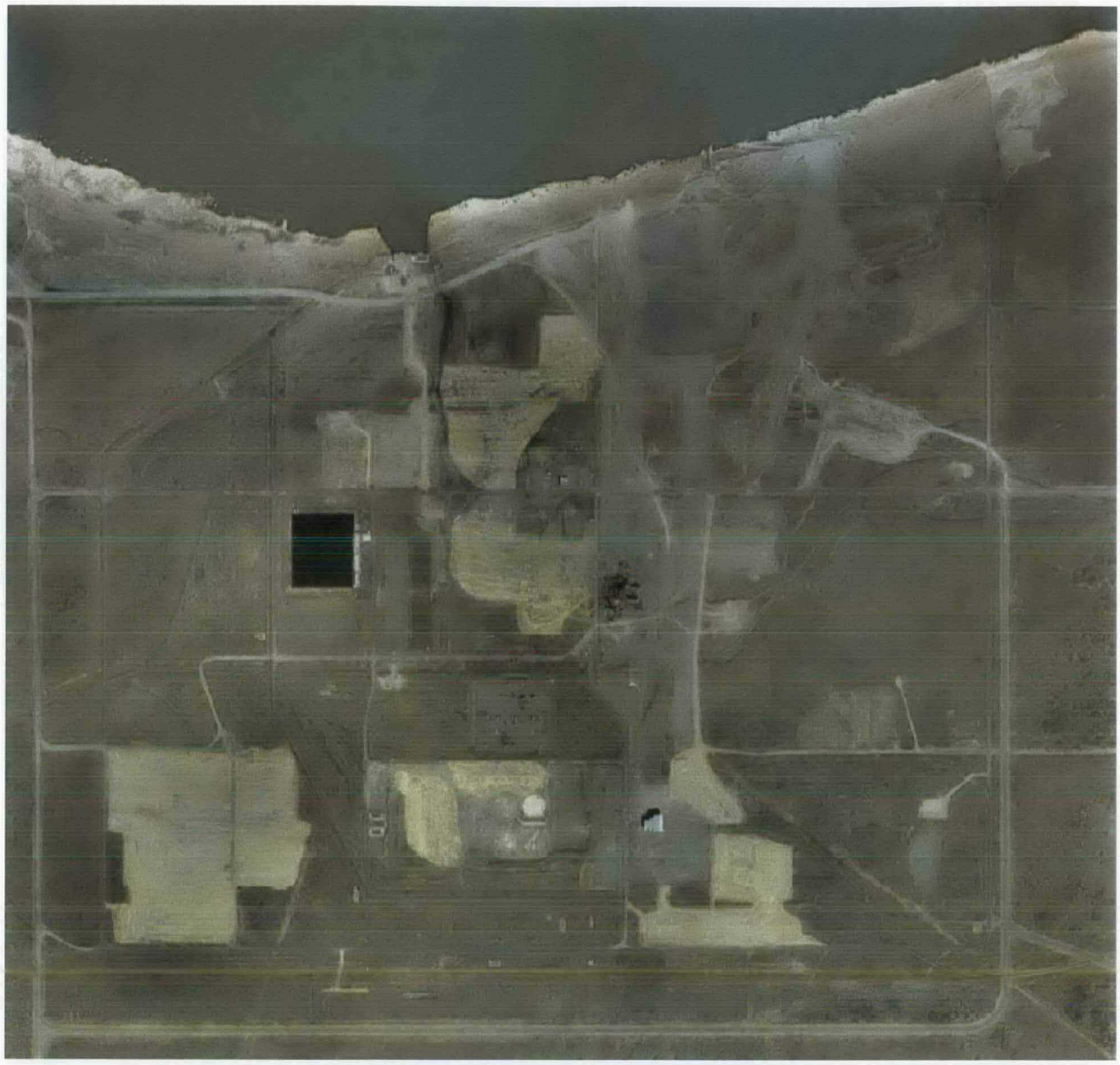

Figure 2-12. Conditions at 100-BC in April 2008

Facilities that were used during operation of the reactor make up most of the demolished and removed facilities. These structures consist of the retention basins, reactor stacks, office and storage building, maintenance shops, process plants, electric substations, storage tanks, and pump stations. Active facilities include an electric substation (151-B), pump station (181-B), and a process reservoir (182-B) that supplies water to the 200 Area. The inactive facilities are the 105-B Reactor Building, the 105-C Reactor Building, the 116-B Exhaust Stack, the 119-B Laboratory, the 1608-B Pump Station, and the 181-C Pump Station.

2.2.3 Export Water System

One facility of particular interest regarding its potential contribution to groundwater contaminant distribution is the Export Water System (EWS) (Figure 2-13). The EWS (including the 182-B Reservoir) is an operating system that could affect contaminant transport and groundwater flow.

Raw water is used in large quantities (millions of L/day [gal/day]) at the Hanford Site for process water, fire control, dust suppression, and other non-potable uses. Water is pumped from the Columbia River to large capacity reservoirs located in the 100 Area as part of the EWS. These reservoirs supply a network of large diameter (1.07 m [42 in.]) pipelines to smaller pipelines traversing the 100 Area and connecting to moderately sized distribution reservoirs located on the Central Plateau. A key component of this system is the 182-B Reservoir, which is the primary reservoir and one of two remaining structures at the Hanford Site that is used to store large quantities of untreated, raw water. The other reservoir used for this purpose is located in 100-D and is the backup facility (FH, 2008, *November 6 & 7 Facilitated Session and the 182D Reservoir Repair and Modification Report and Long Term Export Water Supply System Alternatives Study*).

The 182-B Reservoir is one of the few facilities still in operation at Hanford that dates back to the Manhattan Project era. Therefore, its age and condition are of potential concern. During its operation, water may have leaked from the reservoir, possibly resulting in higher than normal local groundwater elevations. However, no data are present regarding the condition of the reservoir. A leak test was conducted in 1999, which compared the volume pumped from 182-B to the 200 Area, with the purpose of determining leakage volume along the system. The test indicated leakage "within acceptable limits" for the length of the piping system. No other investigation has been conducted, and the integrity of the reservoir is unknown.

Although numerous buildings and waste sources have been removed or demolished since reactor deactivation, EWS components are close to facilities and waste sites that were demolished in place before current regulatory standards were applicable and possibly contain residual contamination. Rapid repair or replacement of the EWS facilities is not currently planned, and the proximity of some waste sites to aging EWS components represents a potential, enhanced means of contaminant transport in the vadose zone to groundwater. The repairs and changes necessary to provide continued reliable EWS service to maintain Hanford Site operations are anticipated to take substantial time and resources (several years and an estimated order of magnitude project cost of $30 to $50 million [FH, 2008]).

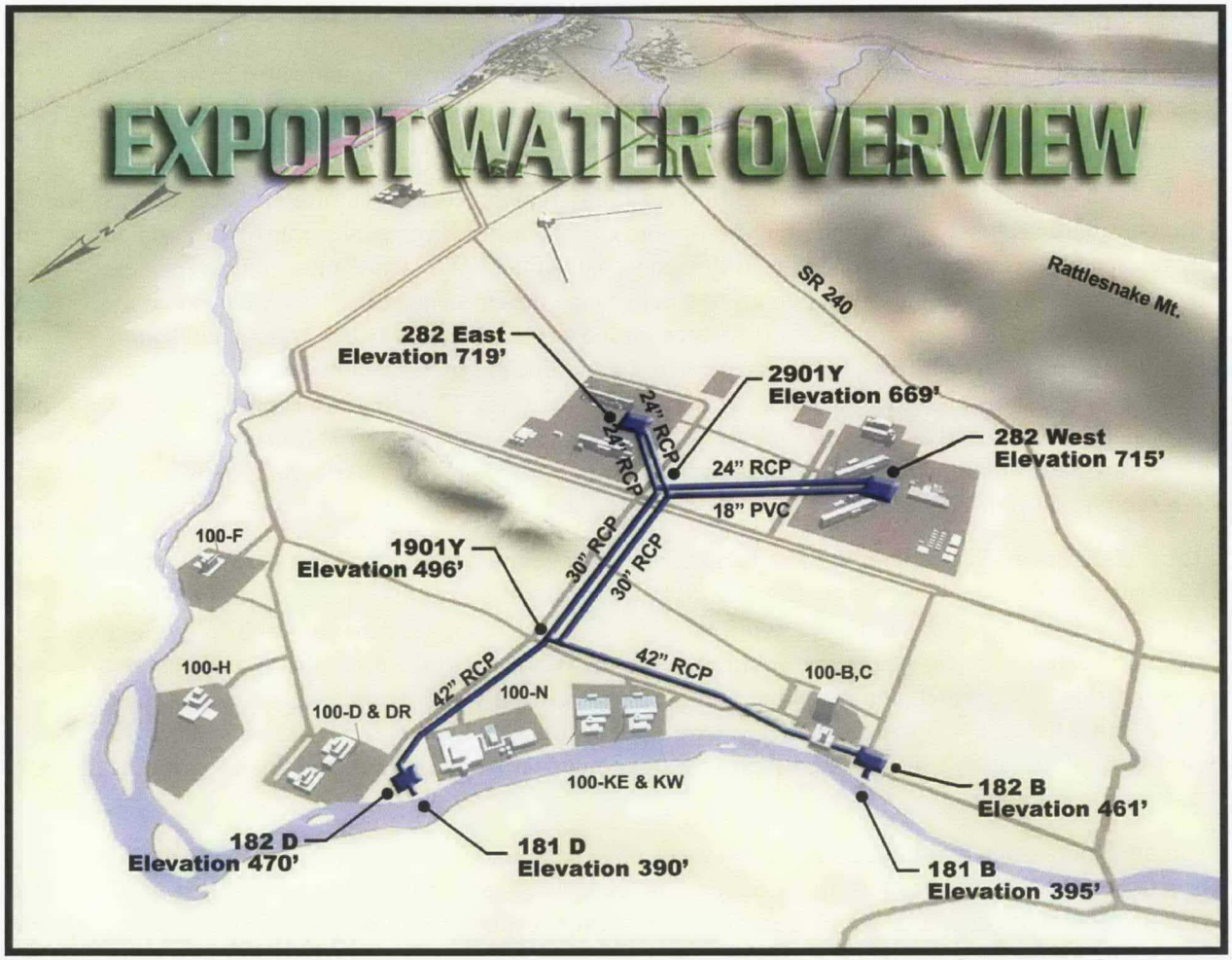

Figure 2-13. EWS Plan View

2.2.4 Process History

The primary activities associated with environmental contamination in 100-BC were the production and use of treated Columbia River water to cool the reactors during operations. Over the operational lifetime of the 105-B and 105-C Reactors, approximately 5 trillion L (about 1.3 trillion gal) of cooling water were produced and passed through these reactors. As cooling water was produced and used, intentional effluent disposal and unintentional discharges of process chemicals introduced contaminants directly into the soil column underlying the production facilities and into the Columbia River.

Cooling water from the reactors contained chemicals and radioactive isotopes from breached fuel cladding. A major contaminant in cooling water was sodium dichromate, which was added to cooling water to minimize tube corrosion. It is estimated that more than 7,270 metric tons (8,013 tons) of sodium dichromate were used between 1944 and 1969. Radiological contaminants included activation products (e.g., Cr-51, tritium, Co-60) and fission products (e.g., Cs-137, Sr-90, uranium, and plutonium isotopes) released through breached fuel cladding.

Contaminant categories from reactor operations include the following:

- Process inputs
  - Raw materials to be processed through the reactor, such as uranium fuel and cooling water.
  - Process chemicals for water conditioning and inhibiting corrosion (e.g., sodium dichromate). Water management, which was crucial to the operation of the reactors, represents a major input subsystem.
  - Materials used for reactor maintenance, such as acids, solvents, and heavy metals.
- Process outputs
  - Product and waste isotopes, such as Pu-239 and Sr-90, respectively
  - Radioactively and chemically contaminated materials (solid and liquid wastes)
  - Radioactively and chemically contaminated cooling water
  - Uncontaminated waste materials

Most of the irradiated fuel elements were shipped to the 200 Area for chemical processing, but some metallurgical studies on irradiated fuel and tritium production and separation were performed in the 100 Area. Approximately 44 kg (97 lb) of spent fuel was recovered from the 118-B-1 and 118-C-1 Burial Grounds during interim remedial action. In addition, during production, fuel element failures and infrastructure failures (e.g., pipe leaks) led to losses of contaminated materials to the environment.

Other substantial infrastructure (e.g., office buildings, laboratories, and subsurface piping) was installed at 100-BC to support reactor maintenance and operation. Wastes resulting from supporting production operations were similarly disposed to each area according to phase, quantity, radioactivity, and composition (liquids, solids; high/low mass or volume; high level, low level; strictly chemical; and septic). Liquid and solid waste disposal locations were constructed and waste management practices were developed to handle these materials consistently. Facilities and waste sites used for discarding non-radioactive materials (e.g., solvents, chemicals) were relatively small in magnitude.

2.2.4.1 Hexavalent Chromium Facilities

To produce reactor coolant for the 105-B and 105-C Reactors, Columbia River water was pumped to the 183-B and 183-C facilities where impurities were removed by conventional physical and chemical water treatment processes. Sodium dichromate was applied at the 183-B, 183-C, and 190-B facilities for corrosion protection. The facilities and associated waste sites where sodium dichromate was handled, transferred, or disposed to 100-BC are considered the Cr(VI) facilities, and are shown in Figure 2-14.

Available documentation does not describe the detailed method of sodium dichromate addition over time, but the process solution mixed with the cooling water was derived from either solid sodium dichromate or highly concentrated liquid stock solutions. Bulk sodium dichromate salt and high concentration sodium dichromate solutions were used as stock material to make 10 to 15 percent process solution batches. Initially, dry materials were used at both water treatment plants, with the use of concentrated dichromate liquid phased in over time. High concentration (greater than 70 weight percent) sodium dichromate solutions were used as the stock material after 1953 at the C Reactor and starting in 1956 at the B Reactor (WHC-SD-EN-RPT-004) as part of Project CG-558, until closure of the reactors. These materials were received at 100-BC by rail and truck tankers and transferred to storage facilities.

The 10 to 15 percent concentration solution was metered into the cooling water stream downstream of the flocculation/sedimentation basin as the water was prepared for use in the reactor. Locations where concentrated sodium dichromate was used or transferred at the B and C Reactors include the following:

- Water Treatment Processing – B Reactor
  - 108-B Chemical Pump House.
  - 100-B-14 Sodium dichromate and sodium silicate lines (no photo, below ground).
  - 185-B/190-B Process Pump House.
- Water Treatment Processing – C Reactor
  - 183-C Head House and Filter Building.
  - Process sewer piping (100-C-9:1) is believed to have been the pathway for a large sodium dichromate spill that occurred in 1966 (DUN-1295, *Douglas United Nuclear, Inc. Monthly Report September, 1966*; Schwab, 2008, "Historical Information for 100D/DR Area Uses of Chromic Acid and Sodium Dichromate: Supplement to IOM 129547").

Complete conversion to a liquid sodium dichromate feed system was believed to be implemented at the B Reactor by the end of 1960, and earlier at the C Reactor, between 1953 and 1959 (Schwab, 2008; HW-64555, *Irradiation Processing Department, Monthly Record Report*). Pipelines and other plant modifications required to stage and transfer sodium dichromate liquid included the following:

- Modifying an existing underground pipeline (100-B-28) between the 183-C Head House (100-C-7:1) to transfer sodium dichromate solution between an external 132,450 L (35,000 gal.) storage tank at the head house to feed tanks in the 183-B Filter Plant Pump House (100-B-22).
- Converting a soft water line leading from the 184-B Power House, connecting the 183-C Head House (100-C-7) and 183-B Filter Plant Pump House (100-B-22), to transfer liquid sodium dichromate solution. This line was installed during the construction of the 183-C Head House and Filter Building.

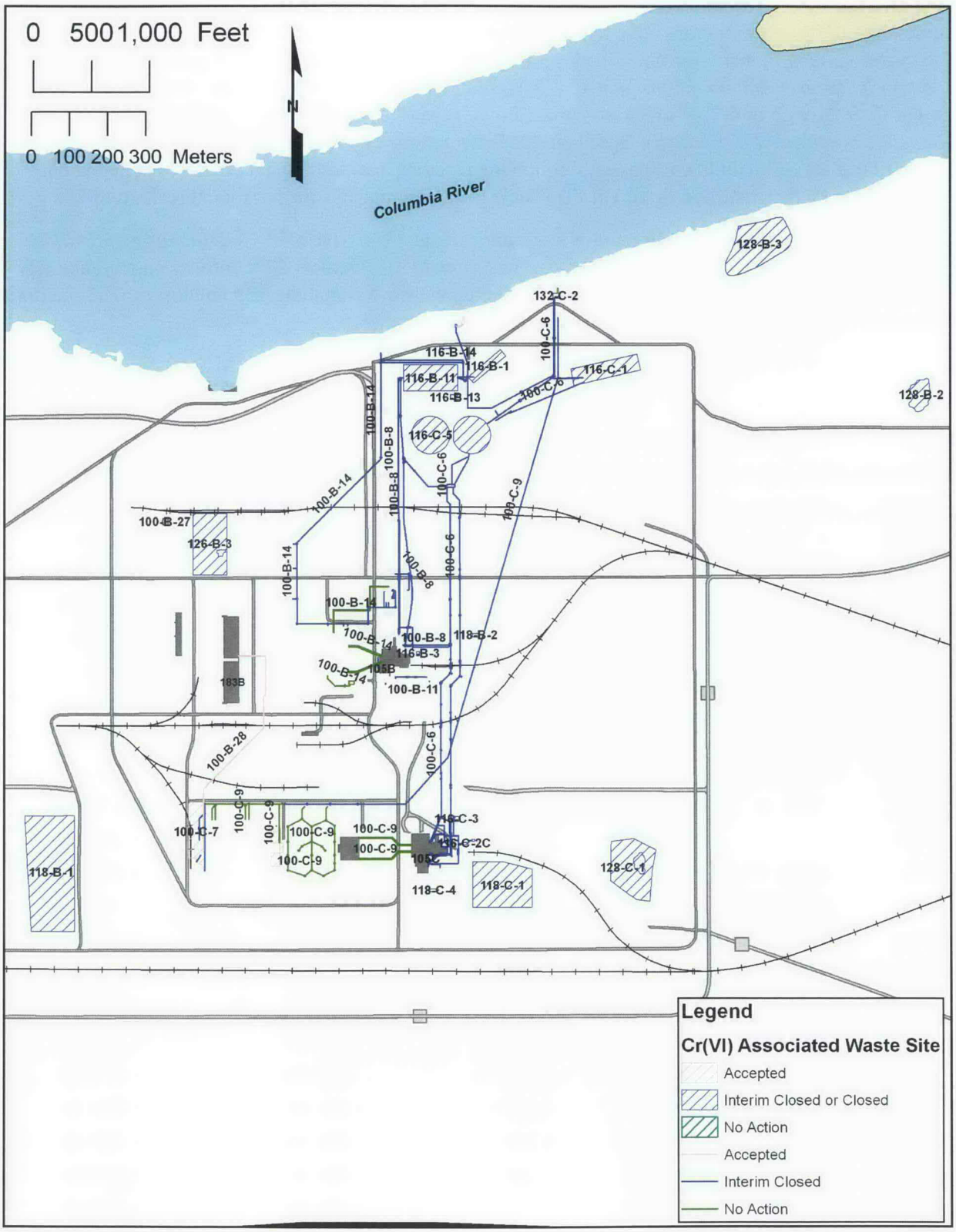

Figure 2-14. Hexavalent Chromium Facilities and Waste Sites in 100-BC

Initially, the 105-C Reactor coolant water had a Cr(VI) concentration of about 700 µg/L to 800 µg/L. Over time, the Cr(VI) concentrations were reduced to 350 µg/L in 1960, and to 175 µg/L in late 1967. However, no corresponding reduction in Cr(VI) concentrations were noted for the 105-B Reactor (DUN-4847, *Quarterly Report Contamination Control—Columbia River April – June 1968*), and the volume of cooling water flow through both reactors was increased over time (DUN-6888, *Historical Events—Single Pass Reactors and Fuels Fabrication*). Based on this information, a total coolant volume of about 5.01 trillion L (1.33 trillion gal) passed through the reactors, and this coolant water contained about 2.78 million kg (6.12 million lb) of Cr(VI) (Table 2-3), assuming a concentration threshold of 700 µg/L.

Delivery of the 70 percent solution into the storage tank at 183-C (DUN-1818, *Discharge of Sodium Dichromate Solution Compliance with Executive Order 11258*, October 27, 1966) was not completely efficient, and yellowish stained soil around the storage tank location indicate some losses. The fraction of delivered 70 percent solution lost to the subsurface is not known.

Table 2-3. Cr(VI) Mass Discharge Estimates Based on 105-B and 105-C Reactor Coolant Throughput

	Estimated Yearly Throughput (L/yr)[a]				
Year	105-B Reactor	105-C Reactor	Coolant Volume Total	Cr(VI) Inventory[b,c] (kg)	Calculated Dry Sodium Dichromate (kg/yr)
1944	2.27E+10	0	2.27E+10	1.59E+04	4.15E+04
1945	9.08E+10	0	9.08E+10	6.36E+04	1.66E+05
1946	9.08E+10	0	9.08E+10	6.36E+04	1.66E+05
1947	0	0	0.00E+00	0.00E+00	0.00E+00
1948	4.54E+10	0	4.54E+10	3.18E+04	8.30E+04
1949	9.08E+10	0	9.08E+10	6.36E+04	1.66E+05
1950	9.08E+10	0	9.08E+10	6.36E+04	1.66E+05
1951	9.08E+10	0	9.08E+10	6.36E+04	1.66E+05
1952	9.08E+10	1.17E+10	1.03E+11	7.18E+04	1.87E+05
1953	9.08E+10	1.41E+11	2.32E+11	1.62E+05	4.24E+05
1954	9.08E+10	1.41E+11	2.32E+11	1.62E+05	4.24E+05
1955	9.08E+10	1.41E+11	2.32E+11	1.62E+05	4.24E+05
1956	9.08E+10	1.41E+11	2.32E+11	1.62E+05	4.24E+05
1957	1.4E+11	1.41E+11	2.81E+11	1.97E+05	5.14E+05
1958	1.4E+11	1.41E+11	2.81E+11	1.97E+05	5.14E+05
1959	1.4E+11	1.41E+11	2.81E+11	1.97E+05	5.14E+05
1960	1.4E+11	1.59E+11	2.99E+11	1.56E+05	4.09E+05
1961	1.4E+11	1.59E+11	2.99E+11	1.56E+05	4.09E+05
1962	1.4E+11	1.59E+11	2.99E+11	1.56E+05	4.09E+05
1963	1.4E+11	1.59E+11	2.99E+11	1.56E+05	4.09E+05
1964	1.4E+11	1.59E+11	2.99E+11	1.56E+05	4.09E+05
1965	1.4E+11	1.59E+11	2.99E+11	1.04E+05	2.70E+05
1966	1.4E+11	1.59E+11	2.99E+11	1.04E+05	2.70E+05

Table 2-3. Cr(VI) Mass Discharge Estimates Based on 105-B and 105-C Reactor Coolant Throughput

Year	Estimated Yearly Throughput (L/yr)[a]			Cr(VI) Inventory[b,c] (kg)	Calculated Dry Sodium Dichromate (kg/yr)
	105-B Reactor	105-C Reactor	Coolant Volume Total		
1967	1.4E+11	1.59E+11	2.99E+11	1.04E+05	2.70E+05
1968	1.17E+10	1.59E+11	1.71E+11	1.38E+04	3.59E+04
1969	0	5.31E+10	5.31E+10	9.29E+02	2.43E+03
Totals			**5.01E+12**	**2.78E+06**	**7.27E+06**

Notes:

a. Yearly throughput taken from DUN-61, *Reactor Operations Daily Report Form BM-5000-126.1 (10-65)*.

b. Inventory estimate is based on a threshold concentration of 700 µg/L (7E-7 kg/L) at the 105-B Reactor.

c. In 1960, 105-C Reactor reduced concentration to 350 µg/L and 175 µg/L in 1968 (DUN-4847, *Quarterly Report Contamination Control—Columbia River April – June 1968*).

Cooling water treatment accounted for the majority of sodium dichromate used. Reactor cooling water was generated, passed through the reactors, and discharged at an average rate of about 230,000 L/min (62,000 gal/min) per reactor (DOE/RL-97-1047, *History of the Plutonium Production Facilities at the Hanford Site Historic District, 1943-1990*). Figure 2-15 shows the primary liquid waste disposal sites. Sites that received a high volume of radioactive waste are shown in Table 2-4 and Figure 2-16.

Figure 2-15. Southern View of 100-BC Showing Primary Liquid Waste Disposal Features (April 2002)

Table 2-4. 100-BC High Volume Radioactive Liquid Effluent Disposal Sites

Site Code	Description
100-B-8	The 105-B Reactor Effluent Pipelines.
116-B-1	Site is a liquid waste disposal trench that received effluent routed from the 107-B retention basin.
116-B-2	Trench was used to receive ~4.16 million L (1.1 million gal) of storage basin water that had been contaminated when a fuel rod was accidentally cut in half in the 105-B Fuel Storage Basin.
116-B-3	Wooden Pluto crib received 105-B cooling water wastes that had been contaminated by cladding ruptures of fuel elements.
116-B-4	Crib received spent acid and rinse water from the 105-B Dummy (fuel element spacers and reactor hardware) Decontamination Facility.
116-B-5	Crib received liquid wastes from the 108-B Building.
116-B-6A	Crib received radioactive liquid wastes from fuel element spacer decontamination, and equipment decontamination performed in the 111-B Building.
116-B-6B	Crib received radioactive liquid wastes from fuel element spacer decontamination, and equipment decontamination performed in the 111-B Building.
116-B-9	French drain received waste water from the P-10 Storage Building drain.
116-B-10	Quench tank was used to collect liquid decontamination wastes from the 108-B Tube Examination and Experimental Facility.
116-B-11	Retention basin was used to hold 105-B Reactor cooling water effluent to allow for thermal cooling and radioactive decay prior to release to the Columbia River.
116-B-12	Crib received drainage from the confinement system in the 117-B Building seal pits.
116-B-13	Trench received low-level sludge waste from the bottom of the 107-B retention basin.
116-B-14	Trench received low-level sludge waste from the bottom of the 107-B retention basin.
100-C-6	Pipelines include the 105-C Reactor cooling water effluent pipelines.
116-C-1	Trench received effluent overflow from the 107-C Retention Basin during reactor outages due to ruptured fuel elements.
116-C-2A	105-C Pluto Crib and associated processes.
116-C-5	Basins received 105-B and 105-C Reactors cooling water effluent for radioactive decay and thermal cooling prior to release to the Columbia River.

Notes:

Based on the Radioactive Liquid Effluent Waste Sites Interim Action ROD (EPA/ROD/R10-99/039, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington*).

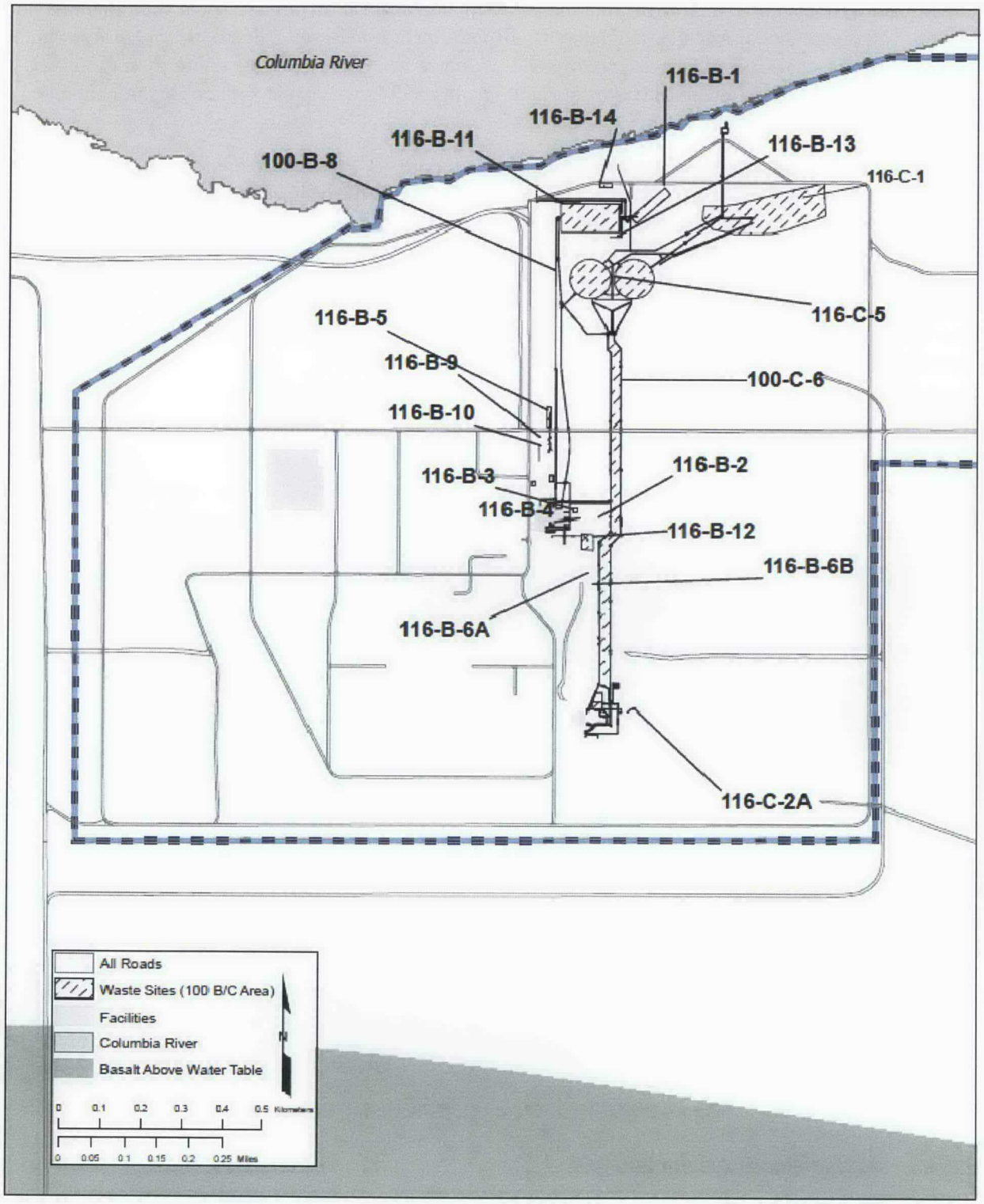

Figure 2-16. 100-BC High Volume Radioactive Liquid Effluent Disposal Sites

Reactor coolant grade water was also used to fill the fuel storage pool. The effluent from the fuel storage basins was disposed to trenches close to the reactors. Cooling water and fuel storage basin effluents had Cr(VI) concentrations of 0.5 to 2 mg/L. Decontamination solutions using higher concentrations of sodium

dichromate were also used at 100-BC, but management and disposition of these spent solutions was not always well documented. Avenues available for disposal included the soil column, the process sewer, and outfall piping discharging to the river. In Figure 2-17, hot water vapor is visible rising from the 116-C-1 Crib at left and 116-C-5 Retention Basins at right. Facility 1904-C is visible to the right, and Facility 1904-B-2 is visible to the left.

Radioactively contaminated coolant was discharged to the 116-B-1 Overflow Trench between 1946 and 1955 and to the 116-C-1 Trench between 1952 and 1968. PNNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford: Volume 2 – Engineered-Facility Sites*, Vol. 2, estimated total coolant volumes of 60 million L (15.8 million gal) and 100 million L (26.4 million gal) containing 60 kg (132 lb) and 100 kg (220 lb) of Cr(VI) at 116-B-1 and 116-C-1, respectively, during that time frame. These estimates assume a Cr(VI) concentration of about 350 µg/L, a lower concentration level that was not reached during operations at the 105-C Reactor until about 1960. These estimates are therefore probably somewhat low, but by no more than a factor of two.

Figure 2-17. River Effluent Outfalls During Operations

2.2.4.2 Hexavalent Chromium Sources

A significant loss of Cr(VI) occurred during operations in 1966. A transfer pump was left on overnight and 53,980 L (14,280 gal) of concentrated sodium dichromate solution flooded a sump, flowing into the process sewer and to the river outfall (DUN-1295). The entire contamination field resulting from this event is uncertain, but all evidence is that the flooding occurred at 183-C and went out through the 100-C-9:1 Sewer. Residue from this event is considered a very likely potential source for soil contamination observed at 100-C-7 (the 183-C Pump House end).

Other sources of chromium discharges were leaks or overflows in and around the outfall structure and releases from small liquid discharge facilities, piping that carried reactor coolant, and some solid wastes (e.g., sludges).

- 100-C-7 (183-C Pump House Area) – Elevated Cr(VI) is present in deep soil beneath the pump house, and the remaining concrete foundation is heavily stained with chromium.
- 100-C-7:1 (183-C Head House Area) – Elevated Cr(VI) is present in deep soil north of the head house. Several potential sources are located here, but the most likely candidates are either a leak/seal issue on the 100-B-28 Dichromate Transfer Pipeline and/or general spillage in the railcar unloading area.
- 100-B-27 – Cr(VI) contamination extends to groundwater west of 126-B-3. Contaminants observed in and around this location could be the result of uncontrolled solid waste disposal during operations. This site was excavated to groundwater in 2009.
- 185/190-B Facility – During demolition "extensive" dichromate staining was observed within parts of the facility.

Radioactive coolant discharge also occurred at two Pluto cribs near the reactors. The 116-B-3 Crib east of the 105-B Reactor received waste briefly from 1951 to 1952, while the 116-C-2 Facility east of the 105-C Reactor received waste between 1952 and 1968. An estimated 4,000 L (1,037 gal) of coolant containing 4,000 kg (8,818 lb) of Cr(VI) were discharged to 116-B-3 and 7.5 million L (2 million gal) of coolant containing 990 kg (2,182 lb) of Cr(VI) were discharged to 116-C-2. The relatively long operating time for the 116-C-2 Pluto Crib is considered to have affected the nature and extent of other contaminants (e.g., Sr-90) at the waste site.

Finally, decontamination fluids used to clean radioactively contaminated equipment and containing Cr(VI) in the form of chromic acid were discharged at several facilities near the reactors including the 116-B-4 French drain, the 116-B-6 Crib near the 105-B Reactor, and the 116-C-2 Pluto Crib near the 105-C Reactor. Reported discharges at the 105-B Reactor were 310,000 L (82,000 gal) containing 1,100 kg (2,420 lb) of chromium. The quantity of decontamination fluids discharged at the 116-C-2 Pluto Crib is not known. However, the relatively higher concentrations of Cr(VI) and entrainment of radioactive materials in these wastes make this waste stream important to understand for this site.

2.2.4.3 Strontium-90 Sources

Strontium-90 (Sr-90) is a fission product in ruptured fuel element debris that would have been routinely present in radioactively contaminated fluids (e.g., reactor coolant and decontamination fluids). In the largest quantities of liquid waste, such as reactor coolant, it was present at relatively low concentrations. For example, Hazard Ranking System of Waste Sites (PNL-6456, Vol. 2), estimates an inventory of 1.64 Ci in the 100 million L (26.4 million gal) of contaminated reactor cooling water disposed in the 116-C-1 for an average concentration of 16,000 pCi/L.

The largest estimated inventories associated with a liquid discharge site are at the 116-C-2 Pluto Crib, which consisted of a crib and a sand filter that strained particulate from reactor coolant, decontamination solutions from the 105-C Metal Examination Facility, and the 105-C Decontamination Wash Pad (Figure 2-18). The 116-C-2 Waste Site operated over a long period of time (17 years) and received more highly contaminated effluents than the retention basins.

Hazard Ranking System of Waste Sites (PNL-6456, Vol. 2), estimated quantities of Sr-90 of 1.8 Ci and 0.98 Ci at the sand filter and crib, respectively. Given the estimated volume of 7.5 million L (1.98 million gal), the estimated average concentration is 370,000 pCi/L. This contamination concentration estimate is

one order of magnitude greater than at 116-C-1, which received only reactor coolant. This estimate was supported by measurements of residual radioactivity taken in 1976 (UNI-946, *Radiological Characterization of the Retired 100 Areas*). Figure 2-19 shows the Sr-90 waste sites.

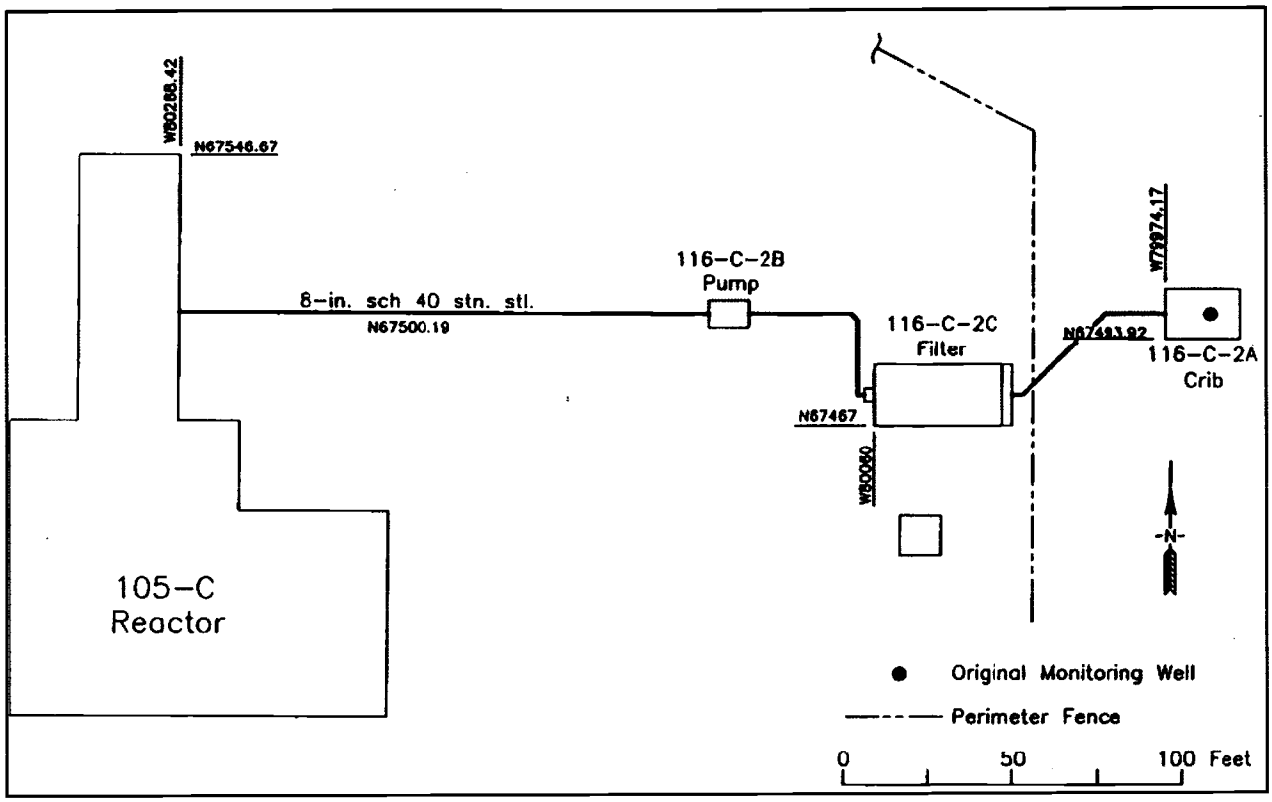

Figure 2-18. Configuration of the 116-C-2 Pluto Crib East of 105-C Reactor (WHC-SD-EN-TI-220, *100-B Area Technical Baseline Report*)

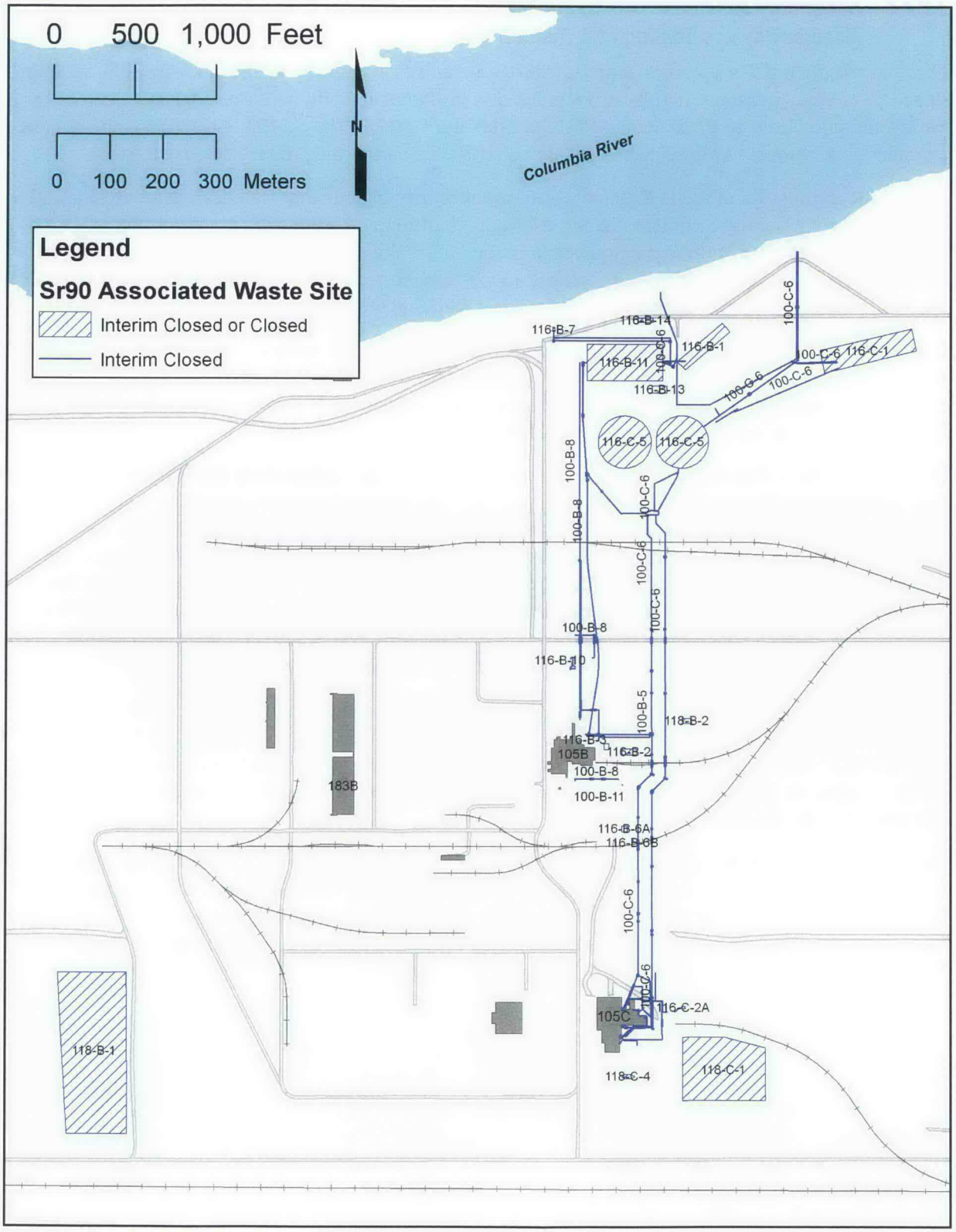

Figure 2-19. Strontium-90 Waste Sites

2.2.4.4 Secondary Missions: Tritium and Isotope Production at B Reactor and Reactor Physics Testing at C Reactor

Each reactor often had a specific secondary mission that was dictated by Hanford's general production stance. Secondary missions at 100-BC included other isotope production (B Reactor) and reactor physics testing and pilot scale up (C Reactor) (WHC-SD-EN-RPT-004; WHC-SD-EN-TI-220). As they emerged, secondary operational missions were considered critical as part of the primary defense mission.

The secondary mission of the B Reactor was to produce tritium and other isotopes related to national defense and for potential commercialization. Tritium facilities and waste sites are identified in Figure 2-20. In 1949, tritium extraction began in the 108-B Building (P-10 Plant) in 100-BC (Figure 2-21.). The lithium-aluminum and, for a short period, lithium-fluoride target elements were transferred to the 108-B Facility after irradiation in one of the Hanford Site production reactors.

Intermittent tritium extraction operations were performed at 100-BC between 1949 and 1952. Tritium separation operations were terminated at the B Reactor in 1952, when that process was transferred to the Savannah River Plant in South Carolina. Other isotopes produced at B Reactor include Po-210, Tm-170, Ir-192, La-140, and Np (WHC-SD-EN-RPT-004).

In the case of the B Reactor operations, and because of its tritium manufacture and separation mission, large quantities of tritium contaminated material were disposed to the vadose zone (CVP-2007-00006, *Cleanup Verification Package for the 118-B-1, 105-B Solid Waste Burial Ground*). Tritium waste streams, in the form of decontamination fluids, encapsulated tritium gas, and contaminated process equipment, were disposed primarily to the 116-B-9 Crib, 118-B-1 Burial Ground, and 118-B-6 Burial Ground. Tritium concentrations in groundwater continue to exceed drinking water standards (DWS). Residual solid wastes containing tritium disposed in the vadose zone have been identified and removed from 100-BC, thereby reducing the threat to groundwater and the environment.

In addition to solid and liquid wastes, gaseous emissions were also discharged into the environment during production (DOE/RL-2005-49, *RCBRA Stack Air Emissions Deposition Scoping Document*; PNWD-0222 HEDR, *Radionuclide Releases to the Atmosphere from Hanford Operations, 1944-1972*). However, gaseous emissions are not suspected of being a major contributor to groundwater or soil contamination in 100-BC.

The C Reactor's secondary mission at Hanford was conducting experiments to examine the effects of systemwide power level increases for both new and older reactors. Additionally, the C Reactor was furnished with a metal examination facility capable of holding and shielding bare irradiated fuel elements for metallurgical testing. Wastes from these tests were discharged to underground tanks (Figure 2-22) for disposal.

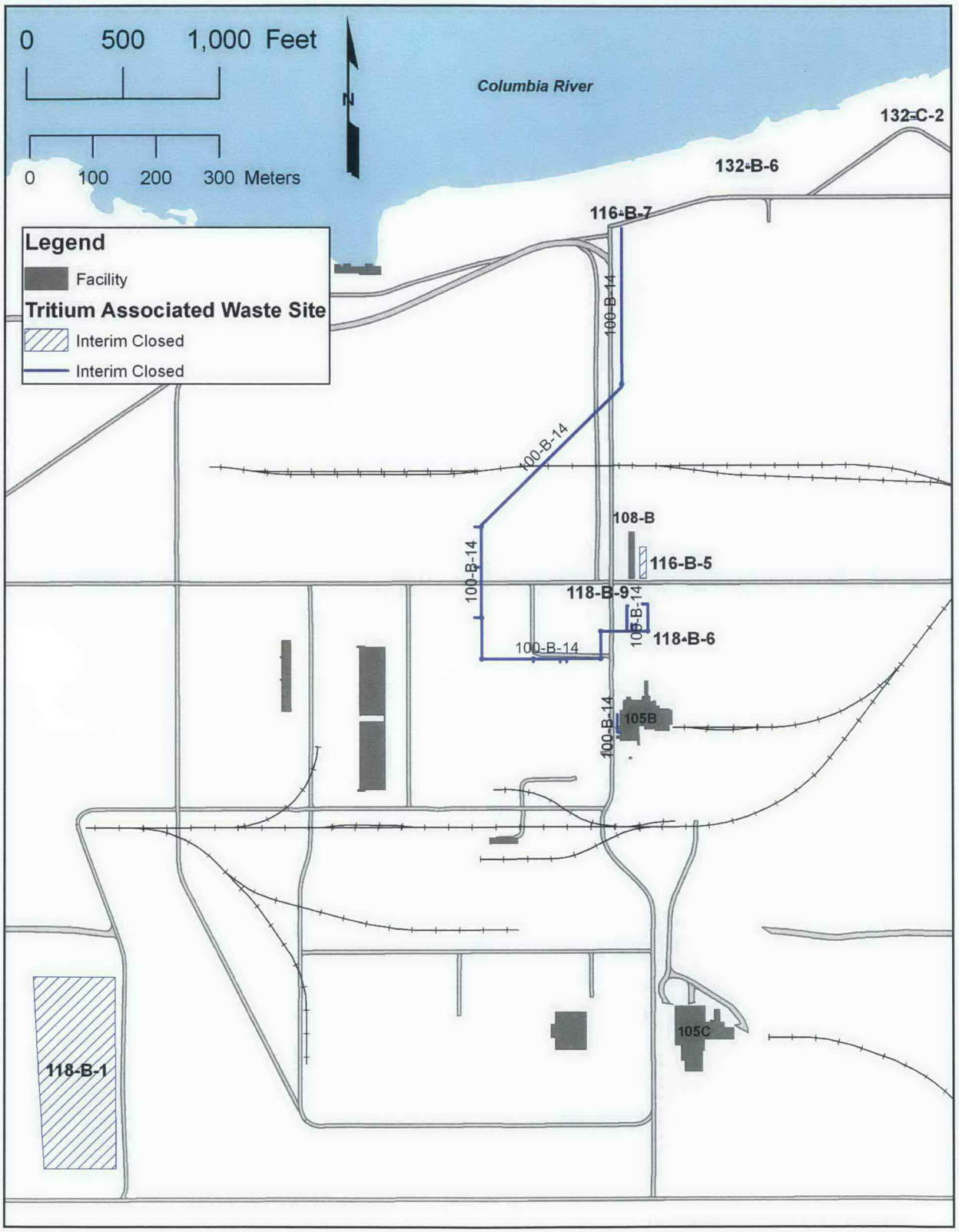

Figure 2-20. Tritium Facilities and Waste Sites

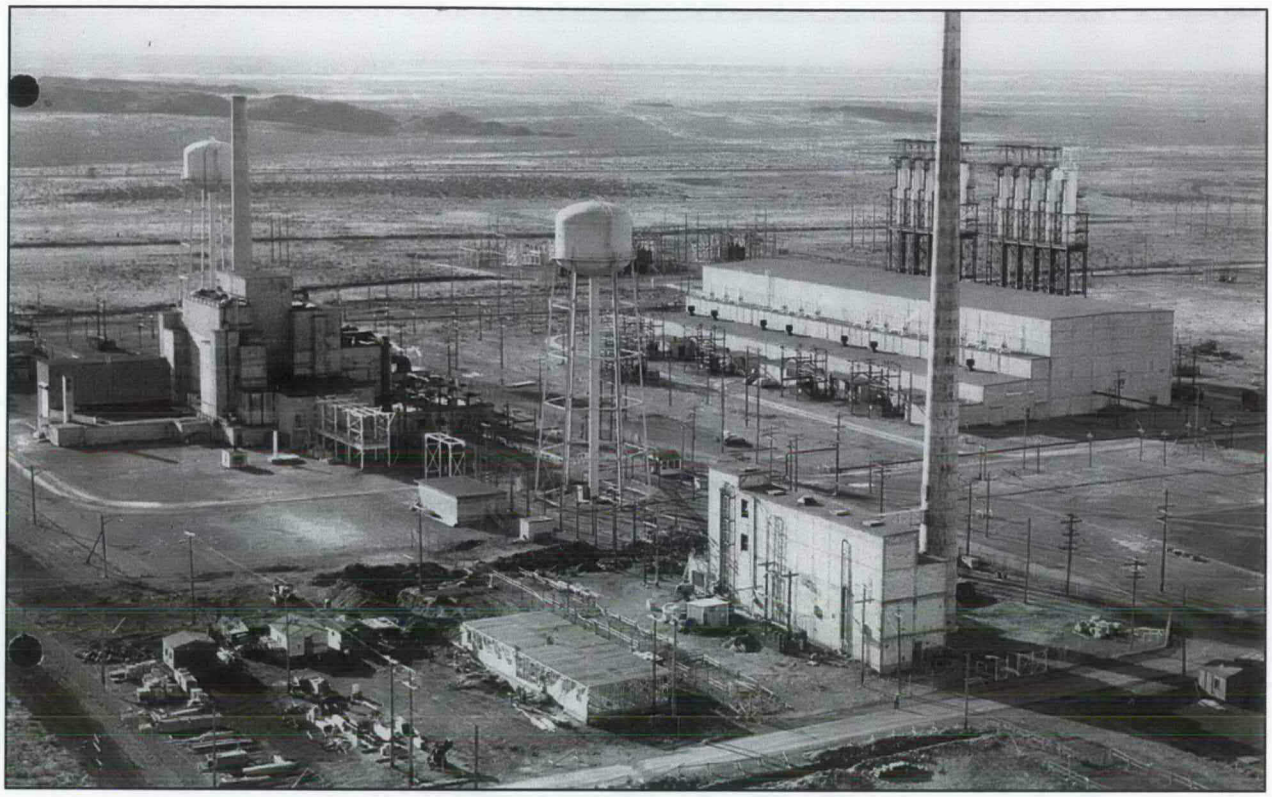

Figure 2-21. 100-B Chemical Pump House/Tritium (P-10) Facility in Foreground at Right, with 105-B and 190-B in the Background (1950)

Figure 2-22. 116-C-3 Chemical Waste Tank Removal in 2007

3 Initial Evaluation

This chapter summarizes the initial evaluation of existing data and describes the preliminary CSM for 100-BC. The preliminary CSM expresses the current understanding of site conditions in the area and allows for the identification of data gaps and data needs in conjunction with the systematic planning process described in the Integrated Work Plan (DOE/RL-2008-46). The CSM is developed as a discussion of contaminant sources, nature and extent, fate and transport, and exposure pathways and receptors.

3.1 Contaminant Sources

Liquid and solid wastes from reactor operations and associated facilities were released to the soil column and the Columbia River. Wastes released to the environment created sources of contamination such as liquid waste sites (i.e., ponds, ditches, and cribs), burial grounds, unplanned release sites, facilities/ structures, pipelines/outfalls, and remaining or orphan sites that may continue to impact soil, groundwater, and the Columbia River.

Other activities that contributed substantially to environmental contamination at 100-BC as part of the production effort include infrastructure leaks associated with water treatment and corrosion control for reactor cooling water; material losses from chemical spills and ruptured fuel slugs; and waste discharges from decontamination of the reactor and maintenance equipment (HW-84619, *Summary of Environmental Contamination Incidents at Hanford, 1958 – 1964*; UNI-946).

3.1.1 Primary Sources of Contamination

The primary sources of contamination in 100-BC were the two water-cooled nuclear reactors (105-B and 105-C) and the structures (e.g., fuel storage basins [FSB]) and processes (e.g., sodium dichromate process) associated with reactor operations. The reactors were built to irradiate uranium-enriched fuel rods from which plutonium and other special nuclear materials were created and extracted. The extraction process was conducted in the 200 Area. The reactors and processes associated with operations generated large quantities of liquid and solid wastes.

Effluent generated during operations consisted primarily of contaminated reactor cooling water, FSB water, and decontamination solutions. Cooling water consisted of river water treated to remove dissolved solids and enhanced with chemicals to reduce corrosion. Cooling water contaminants consisted of fuel materials, fission and irradiation byproducts, and Cr(VI) (used as a corrosion inhibitor). Solid wastes consisted of sludge, reactor components, and various other contaminated items. Waste generated from reactor operations was contaminated with radionuclides, hazardous chemicals, or both.

Deliberate and unintended releases of waste resulting from operations were the primary contaminant release mechanisms. Liquid contaminants were released directly to the environment by discharging effluent to temporary surface impoundments, cribs, ditches, and the Columbia River. The high volumes of water released to select areas resulted in increased potential for chemical and radioisotope transport to the groundwater, especially for the more mobile contaminants. Solid waste was placed in unlined burial grounds.

3.1.2 Secondary Sources of Contamination

Wastes released to the environment created secondary sources of contamination where contaminants could be retained in the subsurface and released over long periods of time, such as ponds, ditches, and cribs; burial grounds; and unplanned release sites. Secondary sources can also impact the environment through the following secondary release mechanisms.

- Re-suspension of contaminated soil via wind or excavation activities
- Direct contact with contaminated soil
- Biotic uptake of contaminants via direct contact with soil or ingestion of soil, vegetation, or other animals
- Migration of contaminated liquids through the soil column via infiltration or percolation
- External radiation

Contaminant sources (i.e., waste sites and facilities) are listed in Appendices B and C. Waste sites and facilities that are presumed contaminant sources for Cr(VI), Sr-90, and tritium (the three contaminants exceeding water quality standards in groundwater), are provided in Figures 2-14, 2-19, and 2-20 in Chapter 2.

3.2 Previous Investigations

This section summarizes results of previous investigations including a radiological characterization performed in 1975 (UNI-946), an LFI conducted in the early 1990s, and the remediation of waste sites, which began in 1996. This section also describes the previous 100-BC treatability tests, leach tests, and the ongoing investigations at the 100-C-7 waste site. The remedial actions implemented to date have significantly reduced contaminant inventories and resulting impacts to the environment.

3.2.1 Initial Vadose Zone Radiological Characterization–1975

The purpose of this investigation was to establish approximate radionuclide inventories, distribution, and concentrations at inactive solid and liquid wastes sites, reactors, and associated facilities. The focus of the sampling activities was liquid waste receiving sites and retention basins. Shallow boreholes were drilled in and adjacent to waste site boundaries, as presented in Table 3-1.

Table 3-1. Summary of Borehole Locations Used in the Initial Radiological Characterization – 1975

Waste Site	Number of Boreholes	Media	Maximum Depth of Investigation (ft bgs)
116-B-11 (107-B) Retention Basin	22	Soil	38
116-B-1 Trench	4	Soil	20
116-C-5 (107-C) Retention Basin	4	Soil	23
116-C-1 Trench	15	Soil	35
100-B Junction Box Leak	6	Soil	30
100-B Effluent Line Leak	4	Soil	35
116-B-2 Trench	4	Soil	25
116-B-3 Crib	1	Soil	15
116-B-5 Crib	3	Soil	22.5
116-B-6-1 Crib	1	Soil	22.5
116-C-2 Crib	3	Soil	50
116-C-2-1 Effluent Line Leak	1	Soil	30

Table 3-1. Summary of Borehole Locations Used in the Initial Radiological Characterization – 1975

Waste Site	Number of Boreholes	Media	Maximum Depth of Investigation (ft bgs)
116-C-2-2 Crib	2	Soil/Sludge/Concrete	30
118-B-1 Burial Ground	14	Soil	33

Samples were analyzed for the following constituents, all of which were detected in significant concentrations (greater than 1 pCi/g):

C-14	Co-60	Cs-134	Cs-137	Eu-152
Eu-154	Eu-155	Ni-63	Pu-238	Pu-239/240
Sr-90	Tritium	Uranium		

This early study was narrow in its scope in that only concentrations and inventories of the selected radionuclides were reported, and no chemical contaminants were assayed. In particular, Ni-63, which is generally present at activities on the same order of magnitude as Co-60, was reported for only some samples; Tc-99 was not evaluated; and the daughters of Sr-90 and Cs-137, which have approximately the same activities as their parents, were not included in summaries of total activity (DOE/RL-90-07, *Remedial Investigation/Feasibility Study Work Plan for the 100-BC-1 Operable Unit, Hanford Site, Richland, Washington*).

An additional part of this study collected samples from retention basin sludge and concrete, and from effluent line scale and sludge. The samples were analyzed for radionuclides and the inventories of radionuclides for the facilities and sites were calculated.

Sample boreholes drilled through the floor of the 116-B-11 and 116-C-5 Retention Basins indicated that the majority of contamination was within a few meters of the basin floor (UNI-946). The 116-B-11 Retention Basin contained a calculated inventory of approximately 118 Ci in 1976, of which 92 Ci were attributed to the 6.4 cm- (2.5-in.-) thick sludge layer, and the remaining 26 Ci were attributed to the soil fill and the basin concrete. Based on the sampling results, the 116-C-5 Basin was estimated to contain a radionuclide inventory of approximately 13 Ci in 1975. Of this total, the sludge contributed 9 Ci and the soil fill contributed 4 Ci.

Samples collected near the bottom of the 116-B-1 Trench in 1976 indicate the calculated radionuclide inventory for the trench and soil column, based on the radionuclides analyzed, was 3.1 Ci, contributed primarily by Eu-152. Radionuclide contamination was significant to the sampled depth of 6 m (20 ft) (UNI-946). In addition to radionuclide contamination, approximately 7 kg (15 lb) of sodium dichromate are estimated to have been disposed to this trench with cooling water discharges (PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford: Volume 1 – Evaluation Methods and Results*, Vol. 1).

Investigation of the 116-C-1 Trench also indicates contamination was found in and beneath the trench along the entire length, and consisted primarily of Sr-90, Co-60, Eu-152, Eu-154, and Cs-137. In many borings, concentrations of radionuclides were still increasing at depths of 9 to 11 m (30 to 36 ft), indicating the limits of the contaminated soil column may not have been reached. Thus, the estimated radionuclide inventory described is limited to the trench and soil column to a depth of 9 m (30 ft) bgs (UNI-946).

3.2.2 100-BC Limited Field Investigations – Vadose Zone

LFIs were performed in the 100-BC-1, 100-BC-2, and 100-BC-5 OUs in the early 1990s. Results of these investigations are presented in DOE/RL-93-06, *Limited Field Investigation Report for the 100-BC-1 Operable Unit*; DOE/RL-94-42, *Limited Field Investigation Report for the 100-BC-2 Operable Unit*; and DOE/RL-93-37. These reports summarize characterization efforts performed mainly to assess impacts associated with discharging effluent to the soil column.

The LFIs performed in the early 1990s identified the following 29 high priority waste sites in 100-BC:

116-B-1 Liquid Waste Disposal Trench	116-C-2A Pluto Crib
116-B-2 Fuel Storage Basin Trench	116-C-2B Pluto Crib Pump Station
116-B-3 Pluto Crib	116-C-2C Pluto Crib Sand Filter
116-B-4 Dummy Decontamination French Drain	116-C-5 Retention Basin
116-B-5 Crib	118-B-5 Ball 3X Burial Ground
116-B-6A Crib	118-B-7 Solid Waste Burial Ground
116-B-6B Crib	118-B-10 Solid Waste Burial Ground
116-B-7 Outfall Structure	126-B-2 Clear Wells
116-B-9 French Drain	128-B-3 Burn Pit
116-B-10 Dry Well	132-B-4 Filter Building
116-B-11 Retention Basin	132-B-5 Gas Recirculation Facility
116-B-12 Crib	132-B-6 Outfall Structure
116-B-13/14 Sludge Burial Trenches	132-C-2 Outfall Structure
100-B-8 Process Effluent Pipes	116-C-1 Process Effluent Trench
100-C-6 Process Effluent Pipes	

The sites were investigated using cable tool drilling of boreholes, backhoe excavation of test pits, and soil sampling and analysis. Geophysical logging was also performed. Table 3-2 describes the vadose zone borehole and test pit sampling conducted at 100-BC. Boreholes and test pits were decommissioned and backfilled.

Table 3-2. Summary of 100-BC LFI (Vadose Zone)

Waste Site	Number of Boreholes	Maximum Depth of Investigation (ft)	Analyte List	
116-B-1 Trench	1	27	ICP/AA Metals Mercury VOC SVOC PCBs Pesticides Gross alpha Gross beta Tritium	Gamma Spectroscopy Strontium-90 Technetium Carbon-14 Alpha Spectroscopy Total activity Anions/IC Fluorides Sulfates Nitrates Nitrites
116-B-2 Trench	1	22.5		
116-B-3 Crib	1	16.8		
116-B-5 Crib	1	17		
116-C-5 Retention Basin	1	20		
116-C-2A Crib	1	57		
116-C-1 Trench	Test Pits (2)	20/42*		

Table 3-2. Summary of 100-BC LFI (Vadose Zone)

Waste Site	Number of Boreholes	Maximum Depth of Investigation (ft)	Analyte List

* The test pit was excavated to the water table 12.8 m (42 ft) bgs after the implementation of the LFI and interim remedial actions. The analyte list included Cs-137, Eu-152, 154, 155, Ni-63, Sr-90, Pu-238, 239/240, U-238, Am-241, Co-60, Cr(VI), mercury, and lead.

AA = atomic absorption
IC = ion chromatography
ICP = inductively coupled plasma
PCB = polychlorinated biphenyls
SVOC = semi-volatile organic compound
VOC = volatile organic compound

The LFI report concluded that the radiological contamination of vadose zone soil is the primary concern, as previously suspected. Following are the principal radionuclides detected in soil samples during the LFI:

Am-241	C-14	Cs-137	Co-60	Eu-152
Eu-154	Pu-238	Pu-239	K-40*	Ra-226*
Sr-90	Th-228*	Tritium	U-233/234	U-238

* These are naturally occurring radionuclides that were not increased by 100-BC processes.

The principal metals detected in soil samples during the LFI include chromium, barium, mercury, zinc, and iron. Volatile and semi-volatile organic compounds detected during the LFI include the following.

acetone*	benzo(a)anthracene	benzo(b)fluoranthene
benzo(k)fluorathene	chrysene	diethylphthalate*
di-n-butylphthalate*	flouranthene	pentachlorophenol

* Common analytical laboratory contaminants.

Contaminant concentrations and locations generally confirm historical information documented in the Radiological Characterization of the 100-Areas (UNI-946). The vertical distributions of contamination beneath the 116-C-2A Crib and the 116-B-2 Trench are shown in Figures 3-1 and 3-2, with correlation to stratigraphy and their engineered structures. Conditions at these waste sites represent the worst-case sites based on effluent volumes discharged, sample data, or both. Some data were available to assess the lateral extent of contamination. The depth of remedial action is inserted into the profile as an indicator of soil removed during remedial actions conducted approximately eight years after LFI completion.

Higher contaminant concentrations in the profile for the 116-B-2 Trench are generally present within 1.5 m (5 ft) of the bottom of the trench. All concentrations are below remedial action goals (RAGs) for the protection of groundwater and the Columbia River.

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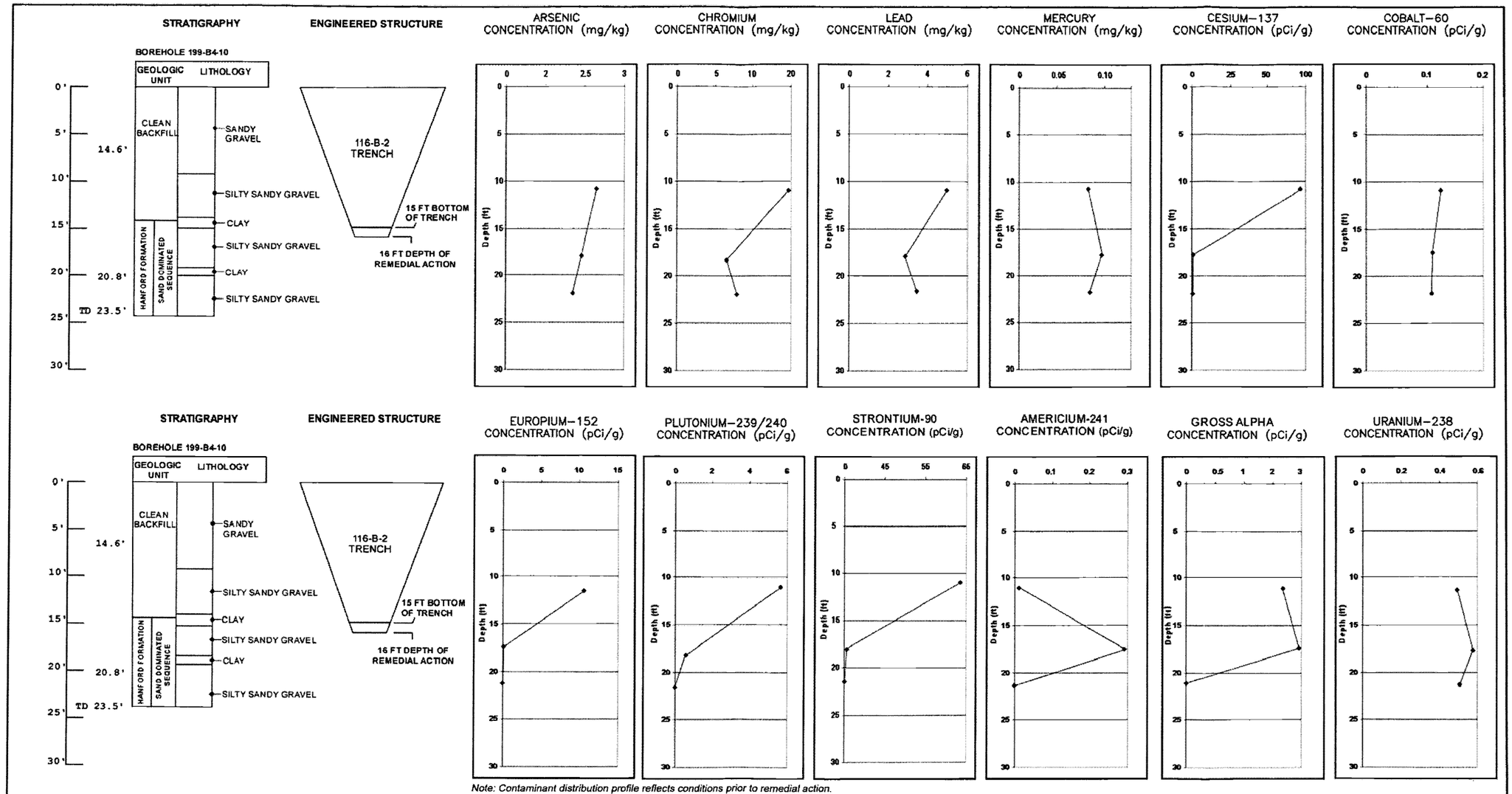

U.S DEPARTMENT OF ENERGY DOE RICHLAND OPERATIONS OFFICE	100-BC-1 Operable Unit 116-B-2 Trench

Figure 3-1. Vertical Profile of 116-B-2 Trench

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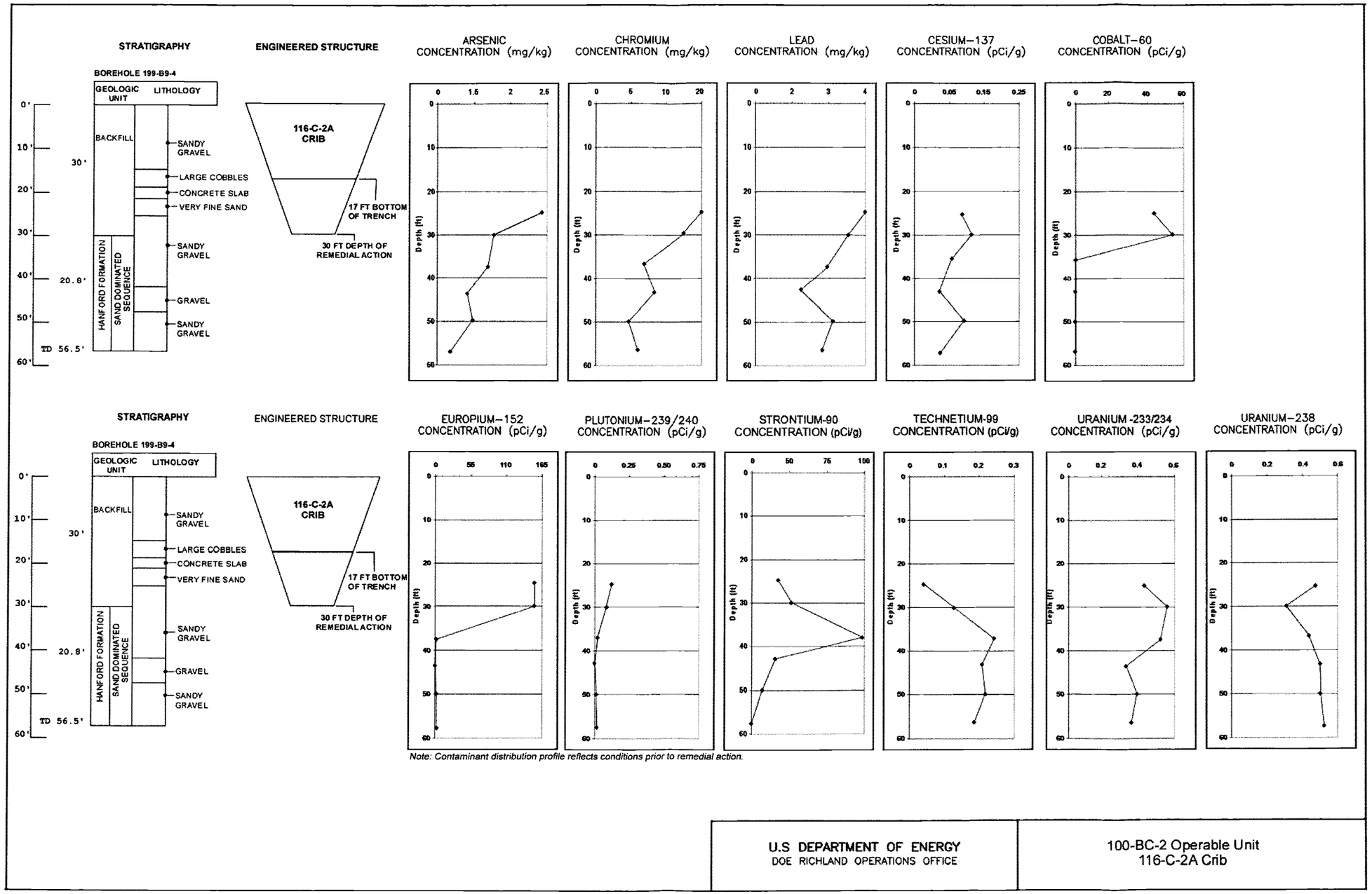

Figure 3-2. Vertical Profile of 116-C-2A Crib

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The profile of contamination beneath the 116-C-2A Crib shows that contaminant concentrations generally decrease with depth in the vadose zone, with the exception of Tc-99 and U-238. Technetium-99 and U-238 concentrations increase with depth, although Tc-99 concentrations are below the RAG of 0.46 pCi/g; U-238 concentrations are below the background concentrations of 1.1 pCi/g.

3.2.3 100-BC Limited Field Investigations – Groundwater

In 1992 and 1993, 100-B/C Area monitoring wells were sampled for a comprehensive list of analytes as part of the 100-BC-5 LFI. Results are described in Limited Field Investigation Report (DOE/RL-93-37). The LFI sampling identified the following analytes as contaminants of potential concern (COPCs) for human health or ecological risks, with the maximum concentration detected shown:

- Volatiles and semivolatile organic compounds: acetone (26 μg/L) (a common laboratory contaminant), trichloroethene (3 μg/L), and bis(2-ethylhexyl)phthalate (11 μg/L).
- Inorganics and metals: aluminum (327 μg/L), iron (318 μg/L), and vanadium (17.8 μg/L)
- Radionuclides: Am-241 (0.021 pCi/L), C-14 (110 pCi/L), gross beta (290 pCi/L), Tc-99 (130 pCi/L), U-233/234 (1.2 pCi/L), and U-238 (1.1 pCi/L)
- Other analytes: ammonia (0.4 mg/L), chemical oxygen demand (30 mg/L), chloride (13.8 mg/L), sulfide (57.1 mg/L), total dissolved solids (283 mg/L), total organic carbon (10 mg/L), total organic halides (136 μg/L), and pH (8.3).

The LFI concluded that the only COCs for groundwater were Sr-90 and tritium. However, at the time of the LFI, Cr(VI) was not included in the analyte list.

3.2.4 Previous Studies and Treatability Tests

In 2001, a pilot risk assessment study was initiated in 100-BC to begin the evaluation of the protectiveness of remedial actions under interim action RODs. These activities provided lessons learned and helped refine the approach for assessment of risk in the remainder of the River Corridor (DOE/RL-2005-40, Draft B). The impacts of source area and groundwater contamination to human health and ecological risk were addressed. The shoreline areas within 100-BC were sampled according to the River Corridor Baseline Risk Assessment (RCBRA) sample design (DOE/RL-2004-37, *Risk Assessment Work Plan for 100 Area and 300 Area Component of the RCBRA)* to support a consistent risk characterization approach for the entire Hanford Site shoreline. Data from characterization of waste sites within 100-BC were also used to support risk characterization for the RCBRA.

A study was conducted in 1994 involving the 118-B-1 Solid Waste Burial Ground (DOE/RL-94-43, *118-B-1 Excavation Treatability Test Plan*). During this study, test pit excavation locations were selected based on geophysical survey results (WHC-SD-EN-TI-137, *Geophysical Investigation of the 118-B-1 Burial Grounds, 100-B/C Area, Hanford Site, Washington*). Using these surveys to guide excavation provided positive results for identifying waste anomalies and excavation boundaries in a few locations.

In April 1990, a treatability test using in situ vitrification was conducted at the 116-B-6A Crib site. In situ vitrification is a thermal treatment process that converts contaminated soil into a chemically inert and stable glass and crystalline product (PNL-8281, *In Situ Vitrification of a Mixed-Waste Contaminated Soil Site: The 116-B-6A Crib at Hanford*). This test was a technology demonstration rather than a remedial action to stabilize waste.

The in situ vitrification melt at this site reached 4.3 m (14 ft) bgs and produced a block of vitrified material between 10.7 and 12.2 m (35 to 40 ft) in diameter, approximately 3.8 m (12 ft) high, and weighing between 726 and 816 metric tons (800 and 900 tons). The vitrified material was removed during remediation of the 116-B-6A/116-B-16 Site and was disposed to ERDF (CVP-99-00011, *Cleanup Verification Package for the 116-B-6A Crib and 116-B-16 Fuel Examination Tank*). Further treatment using in situ vitrification has not been performed.

3.2.5 100-BC Hexavalent Chromium Leach Test Studies

Multiple leach studies have been performed for Cr(VI) on soil from 100-BC. Results of recent column leach studies are presented in PNNL-17674, *Geochemical Characterization of Chromate Contamination in the 100 Area Vadose Zone at the Hanford Site*. Results show multiple categories of Cr(VI) with different leaching behavior. The dominant category is highly mobile with a distribution coefficient (K_d) at or near zero. A separate batch leach test performed for soil from the 100-B-27 site also showed that Cr(VI) present had a K_d at or near zero. Additional leach tests are needed to quantify the behavior of Cr(VI) at 100-C-7 more precisely.

3.2.6 100-BC Orphan Site Evaluation

An orphan site evaluation was initiated in April 2004, in 100-BC to identify and address orphan sites. Orphan sites are newly discovered areas of potentially hazardous waste. The first areas selected for these activities were the 100-BC-1 and 100-BC-2 OUs. A historical review and field walk-down of the area was conducted. The resulting data were compiled and evaluated, and new waste sites were entered into the WIDS database.

The historical review included examining the construction, operation, decontamination and decommissioning (D&D), and remedial action activities conducted in the area from 1943 to 2004. This included reviewing and evaluating reports, drawings, and photographs relevant to those activities. The initial 2004 field walk-down has been supplemented during 2009 to cover 100-BC, a total of 11.54 km^2 (4.45 mi^2). Global Positioning System (GPS) technology has been used to define the locations of artificial features, and these locations were digitally photographed. For select sites, ground penetrating radar (GPR) was also employed. Figure 3-3 presents the areas covered in the field walk-downs.

The historical review identified five new waste sites, while the field walk-down identified three new waste sites and modified an existing waste site. The GPR activities identified one new waste site. A number of sites were also identified as potential WIDS sites, including railroad tracks, underground electrical cables, and active facilities such as the 151-B Substation and the Hanford Water Transport System (181-B River Pump House, 182-B Reservoir, and associated piping). The status of these sites has not been determined at this time. The discovery process will continue at 100-BC until all identified sites are dispositioned.

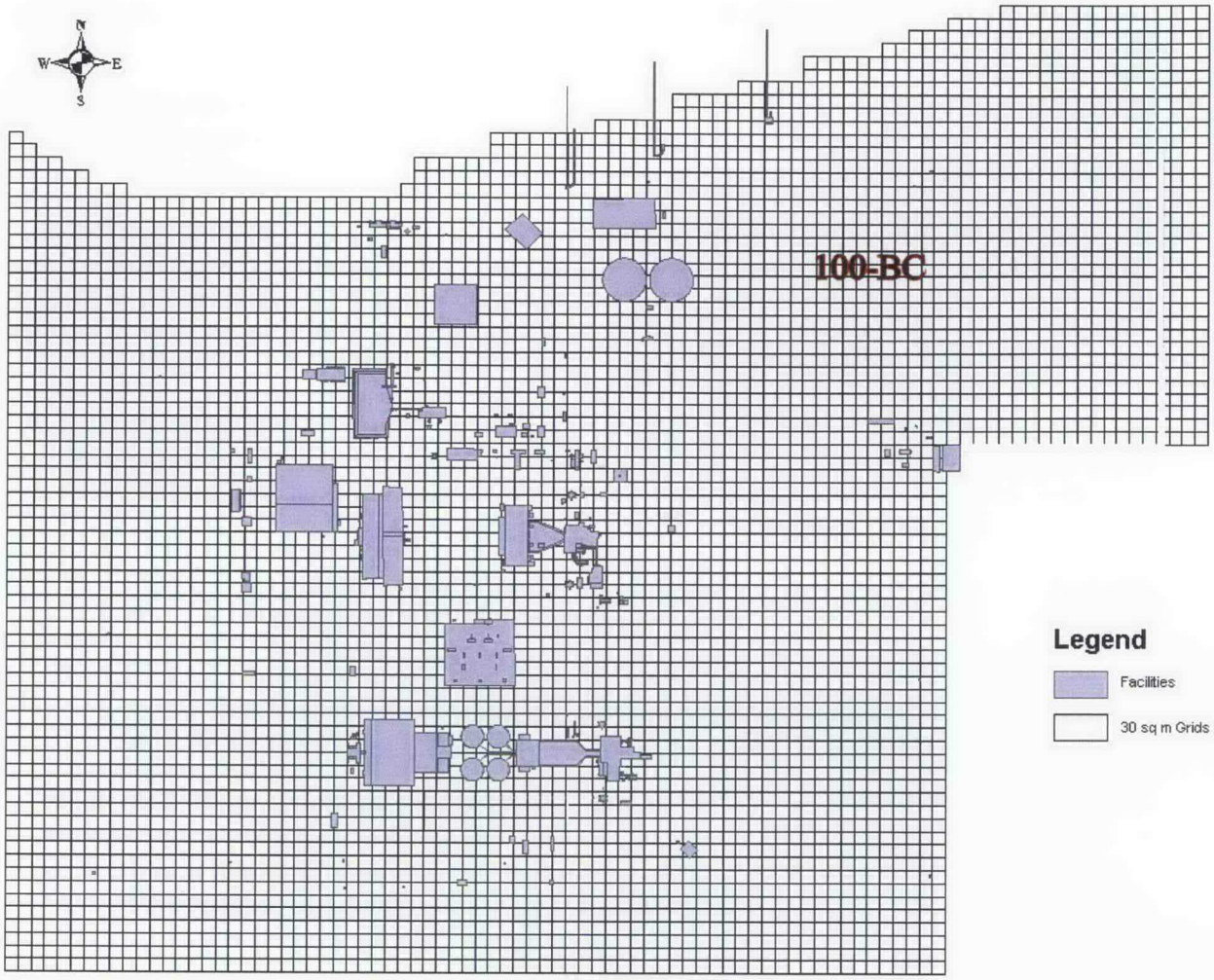

Figure 3-3. Area Addressed by 100-BC Orphan Sites Evaluation Process

3.3 Interim Remedial Actions and Existing Waste Site Contamination

Remediation and characterization of the waste sites began in 1996 under the authority provided by the interim action RODs and monitoring plans. Remediation has consisted mainly of removal, segregation, storage, treatment, and disposal of soil, debris, and waste material and then backfilling remediated waste sites. Approximately 992 million kg (2.2 billion pounds) of contaminated soil and debris has been removed from 100-BC.

3.3.1 Waste Sites Description and History

As of December 3, 2009, 150 waste sites (including sub-sites) exist within 100-BC. Appendix A provides maps of the waste site locations. These waste sites consist mainly of inactive past-practice waste sites described as trenches, ditches, cribs, burial grounds, and unplanned releases. Ninety-five sites are assigned to the 100-BC-1 OU, and 55 sites are assigned to the 100-BC-2 OU. Table 3-3 provides summary information of the status of the waste sites. The various site status categories are defined as follows:

- Closed Out: A reclassification status indicating that due to actions taken, a waste management unit meets applicable cleanup standards or closure requirements. It should be noted that many remediation waste sites were identified as "Closed Out" based on a previous classification scheme. Since all the

associated RODs are interim action RODs, these waste sites are considered "Interim Closed" based on current definitions.

- Interim Closed: A reclassification status indicating that due to actions taken, a waste management unit meets cleanup standards specified in an interim action ROD or action memorandum, but for which a final action ROD has not been issued.
- No Action: A reclassification status indicating a waste site does not require any further remedial action under *Resource Conservation and Recovery Act of 1976* (RCRA) Corrective Action (42 USC 6901, et seq.); *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) (42 USC 9601, et seq.); or other cleanup standards. This is based on an assessment of quantitative data collected for the waste site.
- Not Accepted: A classification status indicating an assessment was made that a WIDS site is not a waste management unit and is not within the scope of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Section 3.1. This classification requires DOE and lead regulatory agency (EPA) approval.
- Accepted: A classification status indicating an assessment has been made that a WIDS site is a waste management unit as defined in the Tri-Party Agreement Action Plan (Ecology et al., 1989b), Section 3.1.
- Discovery: An initial classification status indicating evidence of a potential waste site and the assessment is not yet complete. This is the classification of a newly discovered WIDS site.
- Rejected: This classification status indicates that a waste site does not require remediation under RCRA Corrective Action, CERCLA, or other cleanup standards based on qualitative information such as a review of historical records, photographs, drawings, walkdowns, ground penetrating radar scans, and shallow test pits. Such investigations do not include quantitative measurements.

Appendix A contains a map of all sites in the area. Appendix B provides a description and history for each waste site and identifies available contaminants of concern (COCs) from close out documentation as is current as of December 3, 2009. Appendix C provides the facility description, location, and status as of January 7, 2010. Table 3-4 presents the current plan of action for the remaining accepted and discovery sites.

Table 3-3. Summary Information on the Status of 100-BC Waste Sites

Reclassification Status	Waste Sites	Closed Total	Interim Closed Total	No Action Total	Not Accepted Total	Accepted Total	Discovery Total	Rejected Total
Reclassification of 100-BC-1 OU Waste Sites								
Closed[a]	**116-B-16, 1607-B3, 1607-B4, 116-B-3**, 116-B-6A**	**5**						
Interim Closed[b]	100-B-5**, 100-B-8, 100-B-8:1**, 100-B-8:2**, 100-B-12, 100-B-14, 100-B-14:1**, 100-B-14:2, 100-B-16, **100-B-18**, **100-B-20**, **100-B-21:2**, **100-B-21:3**, 116-B-1**, 116-B-2, 116-B-4, 116-B-5, 116-B-6B, 116-B-7**, 116-B-9, 116-B-10, 116-B-11**, 116-B-12, 116-B-13**, 116-B-14**, 118-B-5, 118-B-10, 120-B-1, 126-B-3**, 128-B-2**, 128-B-3, 132-B-6**, 1607-B2, 1607-B2:1, 1607-B2:2, 1607-B7, 116-C-1**, 116-C-5**, 132-C-2**		39					
No Action[c]	100-B-2, 100-B-3, 100-B-10, 100-B-11**, 100-B-14:3, 100-B-14:4**, 100-B-14:5**, 100-B-14:6, 100-B-14:7**, **100-B-21:1**, 100-B-22:1, 100-B-24, 100-B-26**, 116-B-15, 118-B-9, **126-B-2**, 132-B-1, 132-B-3, 132-B-4, 132-B-5, 1607-B1, 600-230			22				
Not Accepted[d]	100-B-4, 100-B-7, 100-B-17, 100-B-29, 128-B-1, 600-231, 600-253				7			
Accepted[e]	100-B-15, **100-B-19**, 100-B-21, **100-B-21:4**, 100-B-22, **100-B-22:2**, 100-B-25**, 100-B-27**, 100-B-28**, 100-B-32, 100-B-33, 118-B-8, 132-B-2, 1607-B5, 1607-B6,					15		
Discovery[f]	None						0	
Rejected[g]	118-B-7, 126-B-1, 126-B-4, 600-34, 600-56, 600-67, 600-264							7
Total 100-BC-1 OU – waste sites		5	39	22	7	15	0	7
Reclassification of 100-BC-2 OU Waste Sites								
Closed	118-C-3:2	1						
Interim Closed	100-B-1, **100-B-23**, 118-B-1**, 118-B-2**,118-B-3, 118-B-4, 118-B-6, 1607-B-8, 1607-B9, 1607-B10, 1607-B11, 100-C-3, 100-C-6:1**, 100-C-6:2**, 100-C-6:3**, 100-C-6:4**, 100-C-9, 100-C-9:1**, 100-C-9:2, 116-C-2A**,116-C-2B**, 116-C-2C**,116-C-3**,116-C-6, 118-C-1**,118-C-2, **118-C-3:3**, 118-C-4**,128-C-1**,600-232, 600-233		31					
No Action	100-C-9:3**, 100-C-9:4**, 132-C-1, 132-C-3			4				
Not Accepted	100-B-30, 100-C-2, 100-C-4, 100-C-5, 100-C-8, 124-C-4, 600-252				7			
Accepted	100-B-31, 118-B-8:1, **118-B-8:2**, 118-B-8:3**, 100-C-6, 100-C-6:5, 100-C-7, 100-C-7:1,118-C-3, 118-C-3:1					10		
Discovery	100-C-7:2						1	
Rejected	600-33							1
Total 100-BC-2 OU – waste sites		1	31	4	7	10	1	1
Total – 150 waste sites		**6**	**70**	**26**	**14**	**25**	**1**	**8**

Notes:

Bold text denotes a site identified through the orphan site evaluation process.

Underlined text denotes a site that has been remediated and is awaiting completion of the Remaining Site Verification Process (see Current Plan of Action for Remaining Accepted and Discovery Sites).

This summary of waste sites is current as of December 3, 2009. Information was obtained from the Stewardship Information System. WIDS waste site definitions originate from RL-TPA-90-001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)."

* Additional information provided in Appendix B.

** Sites received Cr(VI) waste stream.

a. Closed: A reclassification status indicating that due to actions taken, a waste management unit meets applicable cleanup standards or closure requirements. (Note: Many remediation waste sites were identified as "Closed Out" based on a previous classification scheme. Since all the associated RODs are interim action RODs, these waste sites are considered "Interim Closed" based on current definitions.)

b. Interim Closed Out: A reclassification status indicating, due to actions taken, a waste management unit meets cleanup standards specified in an Interim Action Record of Decision or Action Memorandum, but for which a Final Record of Decision has not been issued.

c. No Action: A reclassification status indicating a waste site does not require any further remedial action under *Resource Conservation and Recovery Act of 1976* (RCRA) Corrective Action, *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), or other cleanup standards based on an assessment of quantitative data collected for the waste site.

d. Not Accepted: A classification status indicating an assessment has been made that a WIDS site is not a waste management unit and is not within the scope of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Section 3.1. This classification requires lead regulatory agency approval.

e. Accepted: A classification status indicating an assessment has been made that a WIDS site is a waste management unit as defined in the Tri-Party Agreement Action Plan (Ecology et al., 1989b), Section 3.1.

f. Discovery: An initial classification status indicating evidence of a potential waste site; assessment is not yet complete. This is the classicization of a newly discovered WIDS site.

g. Rejected: A classification status indicating that a waste site does not require remediation under RCRA Corrective Action, CERCLA, or other cleanup standards based on qualitative information such as a review of historical records, photographs, drawings, walkdowns, ground penetrating radar scans, and shallow test pits. Such investigations do not include quantitative measurements.

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Table 3-4. Current Plan of Action for Remaining Accepted and Discovery Sites

Site Code	Site Type	Operable Unit	Site Names	Reclassification Status	Plan of Action
100-B-15	Radioactive Process Sewer	100-BC-1	100-B-15, 100-BC River Effluent Pipelines, 100-BC River Lines	Accepted	Removed from previous ESD; tentatively to be addressed in RCBRA and final ROD.
100-B-19	Unplanned Release	100-BC-1	100-B-19, 100-BC Stained Soil Sites, 100-BC Chemical Contaminated Surface Soil Areas	Accepted	RSVP Rev.0 scheduled to be issued in April 2010.
100-B-21	Process Sewer	100-BC-1	100-B-21, 100-BC Miscellaneous Pipelines	Accepted	See Subsite
100-B-21:4	Process Sewer	100-BC-1	100-B-21:4, Pipeline From 105-C Reactor East to 116-C-2B Sump	Accepted	RSVP Rev.0 scheduled to be issued in April 2010.
100-B-22	Dumping Area	100-BC-1	100-B-22, 100-B Water Treatment Facilities and Surrounding Soil	Accepted	See Subsite
100-B-22:2	Process Unit/Plant	100-BC-1	100-B-22:2, Water Treatment Facilities, Most of 183-B, 185-B, 190-B	Accepted	RSVP Rev.0 scheduled to be issued in April 2010.
100-B-25	Outfall	100-BC-1	100-B-25, 1904-B2 Spillway, Flume from Outfall Structures 132-B-6	Accepted	RSVP Rev.0 scheduled to be issued in March 2010.
100-B-27	Unplanned Release	100-BC-1	100-B-27, Sodium Dichromate Spill	Accepted	RSVP Rev.0 scheduled to be issued in February 2010.
100-B-28	Product Piping	100-BC-1	100-B-28, 183-C to 126-B-2 Sodium Dichromate Transfer Pipeline	Accepted	RSVP Rev.0 scheduled to be issued in April 2010.
100-B-31	Unplanned Release	100-BC-2	100-B-31, Garnet Sand at the 183-C Clearwell Pads	Accepted	RSVP Rev.0 scheduled to be issued in March 2010.
100-B-32	Unplanned Release	100-BC-1	100-B-32, SCA Associated With Legacy Waste	Accepted	RSVP Rev.0 scheduled to be issued in April 2010.
100-B-33	Unplanned Release	100-BC-1	100-B-33, SCA Area 2 Associated with Legacy Waste	Accepted	RSVP Rev.0 scheduled to be issued in March 2010.
118-B-8	Reactor	100-BC-1	118-B-8, 105-B Reactor Building, B Reactor (See Subsites)	Accepted	See Subsites

Table 3-4. Current Plan of Action for Remaining Accepted and Discovery Sites

Site Code	Site Type	Operable Unit	Site Names	Reclassification Status	Plan of Action
118-B-8:1	Reactor	100-BC-2	118-B-8:1, 105-B Reactor Building	Accepted	This waste site is associated with the B Reactor, there is no current plan in place for RTD. Characterization is planned.
118-B-8:2	French Drain	100-BC-2	118-B-8:2, 105-B French Drains	Accepted	This waste site is associated with the B Reactor, there is no current plan in place for RTD.
118-B-8:3	Radioactive Process Sewer	100-BC-2	118-B-8:3, 105-B Miscellaneous Pipeline Segments	Accepted	This waste site is associated with the B Reactor, there is no current plan in place for RTD.
132-B-2	Stack	100-BC-1	132-B-2, 116-B Reactor Exhaust Stack, 132-B-2 Stack	Accepted	This waste site is associated with the B Reactor, there is no current plan in place for RTD.
1607-B5	Septic Tank	100-BC-1	1607-B5, 1607-B5 Septic Tank System, 1607-B4, 1607-B4 Septic Tank System, 124-B-4, 1607-B4 Sanitary Sewer System	Accepted	This waste site requires remediation but it sits below an active transformer at the 181-B facility.
1607-B6	Septic Tank	100-BC-1	1607-B6, 1607-B6 Septic Tank System, 1607-B5, 1607-B5 Septic Tank System, 124-B-5, 1607-B5 Sanitary Sewer System	Accepted	This waste site is still active for the 182-B facility.
100-C-6	Radioactive Process Sewer	100-BC-2	100-C-6, 100-C Reactor Cooling Water Effluent Underground Pipelines (5 Subsites)	Accepted	See Subsite
100-C-6:5	Radioactive Process Sewer	100-BC-2	100-C-6:5, Pipelines Sections Under Export Water Line	Accepted	This site is a part of the EWL.
100-C-7	Dumping Area	100-BC-2	100-C-7, 183-C Head House Foundation and Stained Soil (100-C-7:1), 183-C Filter Building/ Pump room Facility Foundation and Stained Soil (100-C-7:2)	Accepted	RTD is planned at this site.

Table 3-4. Current Plan of Action for Remaining Accepted and Discovery Sites

Site Code	Site Type	Operable Unit	Site Names	Reclassification Status	Plan of Action
100-C-7:1	Unplanned Release	100-BC-2	100-C-7:1, 183-C Water Treatment Facility Head House Foundation and Stained Soil	Accepted	RTD is planned at this site.
118-C-3	Reactor	100-BC-2	118-C-3, 105-C Reactor Building (see subsites)	Accepted	See Subsite
118-C-3:1	Reactor	100-BC-2	118-C-3:1, 105-C Reactor Core and ISS Project	Accepted	This waste site is associated with the C Reactor, there is no current plan in place for RTD. Characterization is planned.

Notes:

ESD = Explanation of Significant Difference
ISS = Interim Safe Stored
RCBRA = River Corridor Baseline Risk Assessment
ROD = Record of Decision
RSVP = remaining site verification package
RTD = removal, treatment, and disposal
SCA = Soil contamination area

3.3.2 118-B-1 Solid Waste Burial Ground: Explanation of Significant Difference

The 118-B-1 burial ground has a site reclassification status of interim closed. Results of cleanup verification sampling indicate that all remedial action objectives (RAOs) were met except tritium concentrations in the vadose zone below the remediation footprint, which exceed the remedial action objective for the protection of groundwater. Because of this, an explanation of significant difference (ESD) was prepared to address tritium contamination remaining in the soil column (EPA et al., 2007, *Explanation of Significant Difference for the Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 200-KR-2 Operable Units [100 Area Burial Grounds] October 2007*). With consideration of various balancing factors (e.g., reduction of risk by decay, protection of human health and the environment, remediation cost), the ESD concluded that tritium-contaminated soil may remain in place with institutional controls that prohibit future irrigation to minimize further mobilization of residual tritium contamination to groundwater and the Columbia River (CVP-2007-00006).

3.3.3 100-B-15 River Effluent Pipelines

Between 1944 and 1967, cooling water from the 105-B and 105-C reactors was released to four pipelines that discharged into the Columbia River. The effluent entered the pipelines through three outfall structures (116-B-7, 132-B-6, and 132-C-2 waste sites). All three outfall structures have been remediated and interim closed out. Today, the inactive effluent pipelines (i.e., accepted waste site 100-B-15) remain in their original location on or beneath the Columbia River channel bottom. There are currently no plans to address the pipelines through interim remedial actions.

DOE/RL-2007-21, *Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment* (RCBRA), Vol. 2, Draft B, documents characterization data and human health and ecological risk evaluations associated with 100-BC River Effluent Pipelines as well as other area river effluent pipelines. The data are presented in BHI-01141, *100 Area River Effluent Pipelines Risk Assessment*, Tables 3, 4, 5, and 6.

For the evaluation, river sediment and pipe scale samples were selectively analyzed for Co-60, Cs-137, Eu-152, Eu-154, Eu-155, K-40, Ni-63, Pu-238, Pu-239/240, tritium, total uranium, inductively coupled plasma (ICP) metals, mercury, total organic carbon, gross alpha, gross beta, and total activity. Results of the risk evaluation of the pipelines under current conditions (in the river) indicate there were no unacceptable risks and, therefore, no requirement under CERCLA to remediate the river effluent pipelines. However, a supplemental risk evaluation performed in 2005 did determine that there may be elevated human health risk should portions of the river pipelines become dislodged and wash ashore. Final action to address the river effluent pipelines will be guided by the RCBRA in a final ROD. Therefore, no additional detail regarding river effluent pipelines is presented in this addendum.

3.3.4 High Volume Liquid Waste Sites

Field data from previous investigations indicate that contaminant concentrations at high volume, liquid waste sites (e.g., Cr(VI), lead, Cs-137, and Pu-239/240) were highest at the bottom of the disposal facility and generally decreased with depth. Soil samples collected and analyzed during interim remedial actions indicate residual contamination is generally located well above the water table and the periodically re-wetted zone. Waste sites that received small amounts of liquid were generally found to have soil contamination extending limited distances into the vadose zone beneath waste sites (i.e., burial grounds, some unplanned releases, and liquid sites). Table 2-4 and Figure 2-16 in Chapter 2 identify the high volume liquid waste sites.

Most of the high priority liquid waste sites in 100-BC were remediated by 2004, followed by the remediation of burial grounds and other site types. As of December 2009, all liquid waste sites, unplanned releases, and burial grounds considered for interim remedial action, with the exception of 100-C-7, either have been dispositioned according to the interim action record of decision (IROD) or TPA-MP-14, or are in the process of being reclassified (e.g., interim closed) pending regulatory approval.

To support interim closure of waste sites, soil samples are typically collected and analyzed from the exposed surface at the bottom and sidewalls of the excavation. Before 2005, samples were collected as composite samples, but the current methodology includes collection of grab samples. The sample methodology for verification samples is described in the associated SAPs. The resulting data are compared to RAGs and documented in cleanup verification packages (CVPs). The CVP data for the interim closed waste sites are summarized in Appendix B.

The primary statistical calculation to evaluate compliance with cleanup standards is the 95 percent upper confidence limit (UCL) on the arithmetic mean of the data. Maximum concentrations are also used to interim close waste sites. The data presented in Appendix B generally include the maximum concentrations and/or concentrations representing the 95 percent UCL of waste site COCs for both the shallow and deep zones (zero to 4.5 m [15 ft] and greater than 4.5 m [15 ft] bgs, respectively). These data also describe measured contamination levels and the extent of removed materials at interim closed waste sites.

After the implementation of remedial actions, contaminant inventories and impacts to the environment are significantly reduced. This mitigation occurs because contaminants encountered to the depth of remedial action are effectively removed from the waste site, treated as necessary, and disposed at an appropriate facility (e.g., ERDF). Any remaining contamination is the residual material below the depth of remediation. Therefore, it should be noted that information from previous investigations (presented in

UNI-946, 1978, and the LFI reports for the OUs) reflect contaminant concentrations measured in waste material that has since been removed during interim ROD remedial action.

The close-out verification data and background information on the waste sites are used in this addendum to support selection of waste sites for additional characterization based on residual concentrations remaining at the site. Characterization efforts planned in this addendum will be used to verify the distribution of remaining contamination, provide information to support modeling, and provide information to close CSM data gaps to support the final ROD.

3.3.5 Ongoing Investigation at Waste Site 100-C-7

The 100-C-7 waste site has been characterized to the water table, and soil has been removed from the waste site to a depth of 4.6 m (15 ft) bgs. Due to remaining Cr(VI) contamination levels at the base of the 100-C-7:1 excavation, a pothole was excavated into the bottom of the excavated waste site on April 5, 2005. The pothole had a starting elevation of 4.6 m (15 ft) bgs and was excavated an additional 5.5 m (18 ft), resulting in a total depth of 10 m (33 ft) bgs. Samples were collected to evaluate the vertical distribution of sodium dichromate contamination. Residual soil contamination was present at 10 m (33 ft) bgs with Cr(VI) concentrations of 1,620 mg/kg. Discolored soil indicating the presence of chromium was also observed in the sidewalls of the pothole.

In order to further evaluate the vertical distribution of contamination at this site, a characterization borehole (C4947) was drilled in August 2005 to collect soil and groundwater samples. The borehole was to be drilled in the location of the pothole; however, after placement of gravel to stabilize the site for mobilization of the drill rig, the actual borehole location was approximately 10 m (33 ft) northeast of the former pothole. No groundwater monitoring wells were located around the 183-C Water Treatment Facilities; therefore, a groundwater sample was collected prior to abandonment of the borehole to assist in future groundwater characterization. Groundwater sample results for Cr(VI) were 13.9 mg/L (13,900 μg/L) (filtered sample) and 46.9 μg/L (unfiltered sample).

In July 2007, eight characterization test pits (TP-1 through TP-8) were excavated at the bottom of the 100-C-7:1 excavation. In addition, one borehole, C5671 (BH-1 and Well 199-B8-7 [Appendix A, 100-BC Area and 100-BC-2/BC-6 Operable Unit Maps]), was drilled in the location of the original pothole. In August 2007, a borehole, C5672 (BH-2 and Well 199-B8-8), was drilled at the 100-C-7 (183-C Pump House) waste site. Samples were collected at various depths and analyzed for ICP metals (e.g., total chromium), Cr(VI), and pH. Toxicity Characteristic Leaching Procedure (TCLP) analyses were requested based on total chromium results. Characterization of TP-5 had the maximum Cr(VI) (concentration at 1,970 mg/kg) levels identified in 100-C-7. These results were from the 1 m (3 ft) depth of TP-5, approximately 5.6 m (18 ft) below the surrounding grade. Note that borehole C5672 had a starting elevation matching the surrounding grade. The pothole, test pits, and boreholes C4947 and C5671 had a starting elevation of 4.6 m (15 ft) below the surrounding grade due to the previous excavation activities performed at the 100-C-7:1 Site.

Hexavalent chromium concentrations exceed RAGs across the site, with concentrations of Cr(VI) ranging from less than 1 mg/kg to 1,970 mg/kg. The current levels of contamination at 100-C-7 warrant continued interim remedial action, which is expected to be removal, treatment, and disposal (RTD). Details of the 100-C-7 waste site investigation are presented in Blakley, 2008, "100-C-7 and 100-B-27 Test Pit and Borehole Data Summary Report."

3.4 Nature and Extent of Groundwater Contaminants

This section describes the nature and extent of groundwater contamination within the 100-BC Area. The annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66) present information on the groundwater within 100-BC that is more detailed.

The following subsections describe groundwater contaminant conditions focusing on the most recent sampling performed in fiscal year (FY) 2009. The 100-BC groundwater monitoring wells are shown in Appendix A. Wells in 100-BC are sampled for the COCs based on results of the data quality objectives (DQO) process (PNNL-14287).

Groundwater is sampled at various intervals (typically quarterly to biennially) for select contaminants of interest to describe the nature and extent of contamination at 100-BC. The sampling frequency was recommended in the groundwater SAP for this area (DOE/RL-2003-38, *100-BC-5 Operable Unit Sampling and Analysis Plan*, and in TPA-CN-293, *Change Notice for Modifying Approved Documents/ Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: 100-BC-5 Operable Unit Sampling and Analysis Plan, DOE/RL-2003-38 Rev 1 [as modified by TPA-CN-240, 12/08/2008]*) and as the result of the DQO process (PNNL-14287). Analytes included in the sampling vary by well, but include alkalinity, anions, metals, gross alpha, gross beta, Sr-90, tritium, Tc-99, and Cr(VI). The contaminants Sr-90, tritium, and Cr(VI) are the only three analytes detected above the water quality standards. Table 3-5 lists the areal extent of these plumes as of 2008. The extent of the plumes from 2009 data has not yet been calculated.

Groundwater samples generally are not filtered. Samples to be analyzed for metals currently are collected in filtered/unfiltered pairs. Between 2000 and 2007, only filtered metals samples were collected. Filtered metals samples represent dissolved materials and are less affected by particulate materials from the aquifer or well screen.

Water near the Columbia River is sampled annually (usually in the late fall) from aquifer tubes and from riverbank seeps. These water samples are analyzed for chromium, Cr(VI), gross beta, nitrate, specific conductance, Sr-90, and/or tritium. The results are documented in annual groundwater monitoring reports prepared for the Hanford Site (e.g., DOE/RL-2008-66). Groundwater monitoring has continued since the initial RI in 1993 (DOE/RL-93-37) and during waste site remedial actions.

Table 3-5. Plume Areas at 100-BC-5 Groundwater OU

Contaminant	Standard	Plume Area (km^2)	Plume Area (mi^2)
Cr(VI)[a]	20 µg/L [a]	0.82	0.32
Sr-90	8 pCi/L[b]	0.63	0.24
Tritium	20,000 pCi/L[b]	0.23	0.09

Notes:

Source: DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008.*

a Cleanup level based on ambient surface water quality criteria with 1:1 dilution applied (EPA/ROD/R10-96/134, *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington*). Cleanup level potentially applicable to 100-BC. Cr(VI) area based on dissolved total chromium analytical analyses (DOE/RL-2008-66).

b Federal Drinking Water Standard

3.4.1 Chromium

Hexavalent chromium contamination is of concern to salmon and other aquatic life. Fall Chinook salmon spawning areas have been recorded near 100-BC (Figure 3-4). Shoreline areas provide rearing habitat for young salmon and steelhead, as well as for many of the other species of fish in the river (DOE/RL-2005-40).

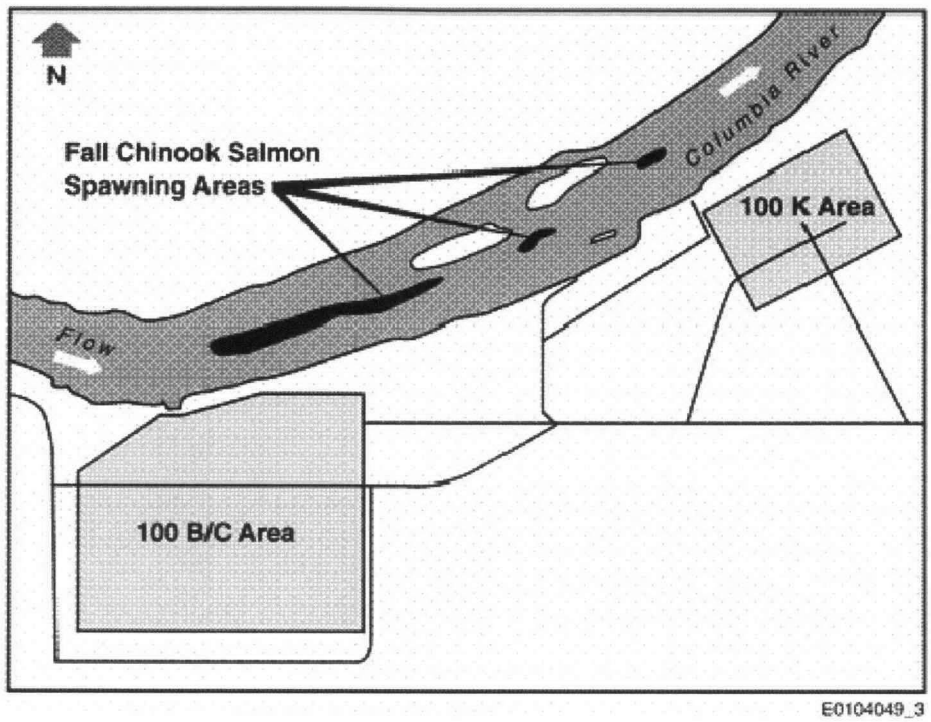

Figure 3-4. 100-BC Location with Respect to Mapped Salmon Redds (DOE/RL-2005-40)

Total chromium data from filtered samples and Cr(VI) data are discussed interchangeably in this section. Dissolved chromium in Hanford Site groundwater is virtually all found in its hexavalent form (WHC-SD-EN-TI-302, *Speciation and Transport Characteristics of Chromium in the 100-D/H Areas of the Hanford Site*), so filtered, total chromium data effectively represents Cr(VI) concentrations.

At other 100 Area locations, the Cr(VI) level protective of the river has been set at 20 μg/L or less at each compliance well to achieve the protective level of 10 μg/L at the river using the preliminary dilution factor of 1:1 (EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Benton County, Washington*). This aquatic protection level of 20 μg/L for Cr(VI) was exceeded in monitoring wells and aquifer tubes in the eastern half of 100-BC. Figure 3-5 presents the Cr(VI) plume based on average concentrations in 100-BC aquifer tubes and wells. Chromium concentrations in Well 199-B2-12, screened in the RUM Unit and located adjacent to 199-B3-47, range from below detection limits to 5 μg/L.

The Cr(VI) plume extends from the central region of 100-BC toward the Columbia River (Figure 3-5). The shape of the plume has not changed significantly in the past 10 years. Total chromium concentrations have been reported at less than federal DWS of 100 μg/L in recent years. Dissolved total concentrations (inferred to be representative of Cr(VI)) have exceeded the Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act—Cleanup," Method B concentration considered protective of ingestion of drinking water of 48 μg/L. The highest concentration of dissolved chromium detected in samples from 100-BC monitoring wells in 2009 was 56.1 μg/L in Well 199-B3-47, downgradient of the

116–B–11 Retention Basin. The average results for Well 199-B3-47 are within the range observed since 1999.

In the southern end of 100-BC, waste site investigations discovered Cr(VI) contamination in the vadose zone at the 100-C-7 Waste Site. Chromium concentrations for groundwater samples from Wells 199-B8-7 and 199-B8-8 initially were below 20 µg/L. The concentration increased to 49 µg/L in Well 199-B8-8 in July 2008 (Figure 3-6), but declined to below 20 µg/L in October 2008 and remained at that level in 2009.

Another waste site, 100-B-27 sodium dichromate spill located in the northwestern portion of 100-BC, had Cr(VI) contamination in the vadose zone. The DOE drilled a characterization borehole and collected a groundwater sample (WCH–225, *Sampling and Analysis Instruction for Evaluation of Residual Hexavalent Chromium Contamination in the Subsurface Soil at 100–B–27*). Chromium levels in groundwater were low (6.5 µg/L in a filtered sample). A new monitoring well is being installed downgradient of the site.

Figure 3-7 illustrates the distribution of Cr(VI) concentrations with depth for 100-BC aquifer tubes and nearby wells. In October 2009, the highest concentration in an aquifer tube was 45 µg/L in tube 06-M. In February 2009, two aquifer tubes had higher concentrations (78 µg/L in 05-S and 70 µg/L in C6231), but the concentrations declined in October 2009.

In fall 2009, researchers detected Cr(VI) in Columbia River pore water at concentrations higher than currently detected in groundwater. For example, one sample collected from approximately 0.3 m (1 ft) below the river bottom in the middle of the channel contained 112 µg/L Cr(VI). This finding suggests that Cr(VI) concentrations in groundwater may be higher in portions of the aquifer (horizontally or vertically) not monitored by existing wells. Alternatively, the high concentrations in pore water could represent residual contamination from historical groundwater conditions before most of the monitoring wells were installed. An upcoming report in 2010 will discuss the pore water data.

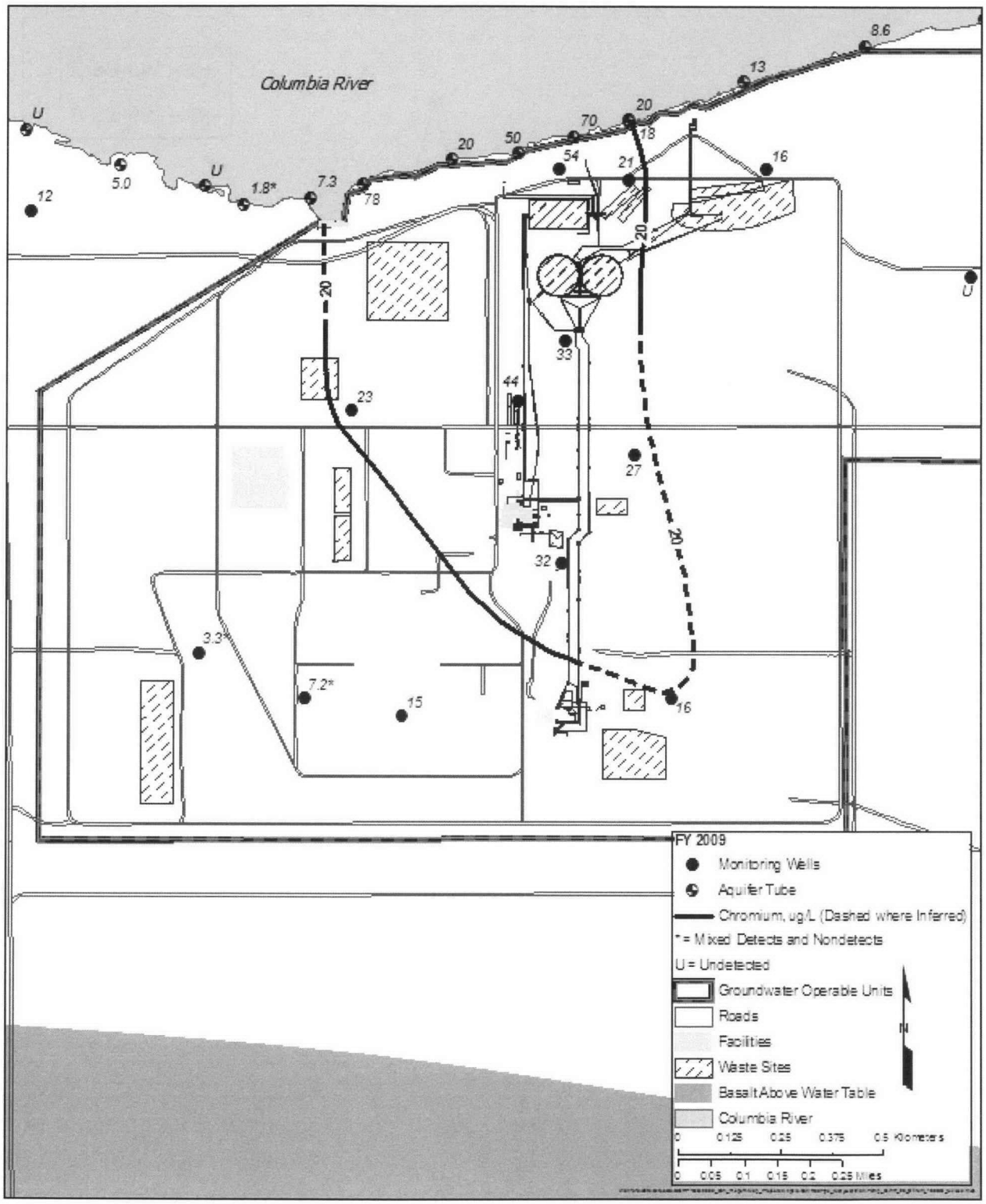

Figure 3-5. FY 2009 Average Chromium Concentrations in 100-BC, Upper Portion of the Unconfined Aquifer

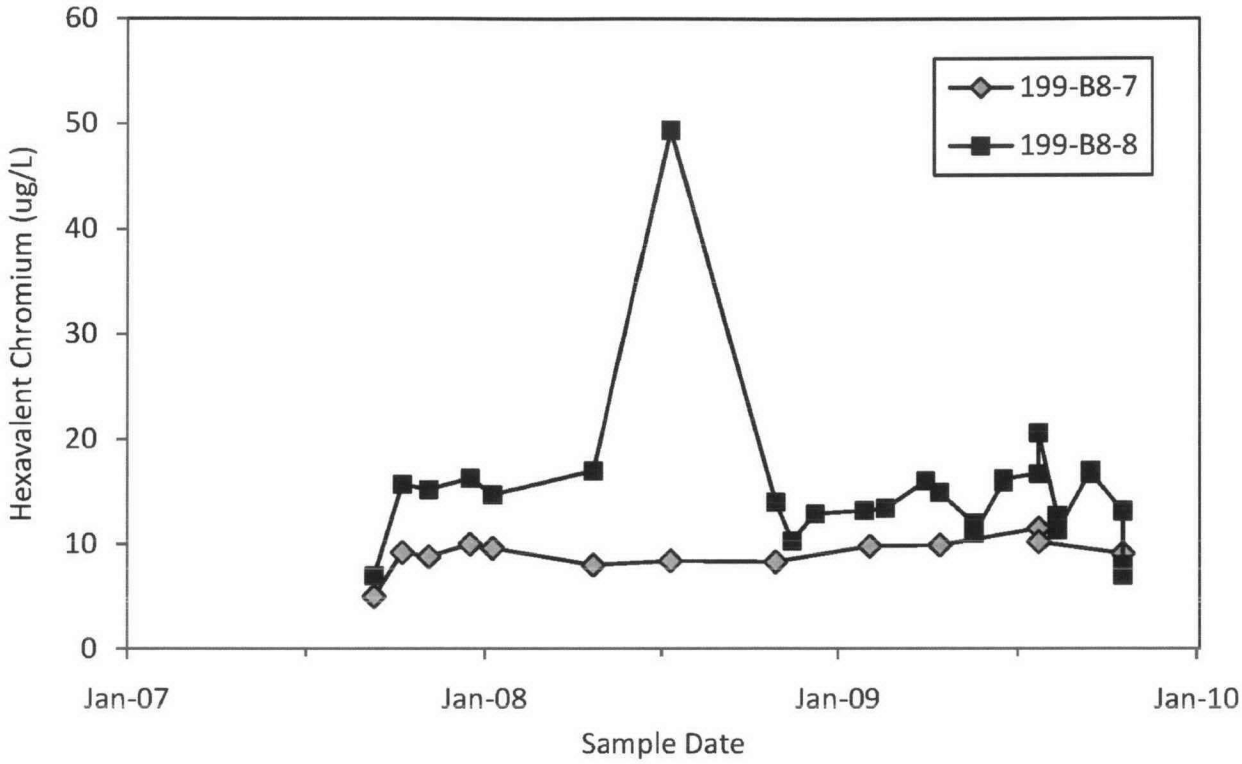

Figure 3-6. Dissolved Chromium Concentrations in Wells Near the 100-C-7 Waste Site

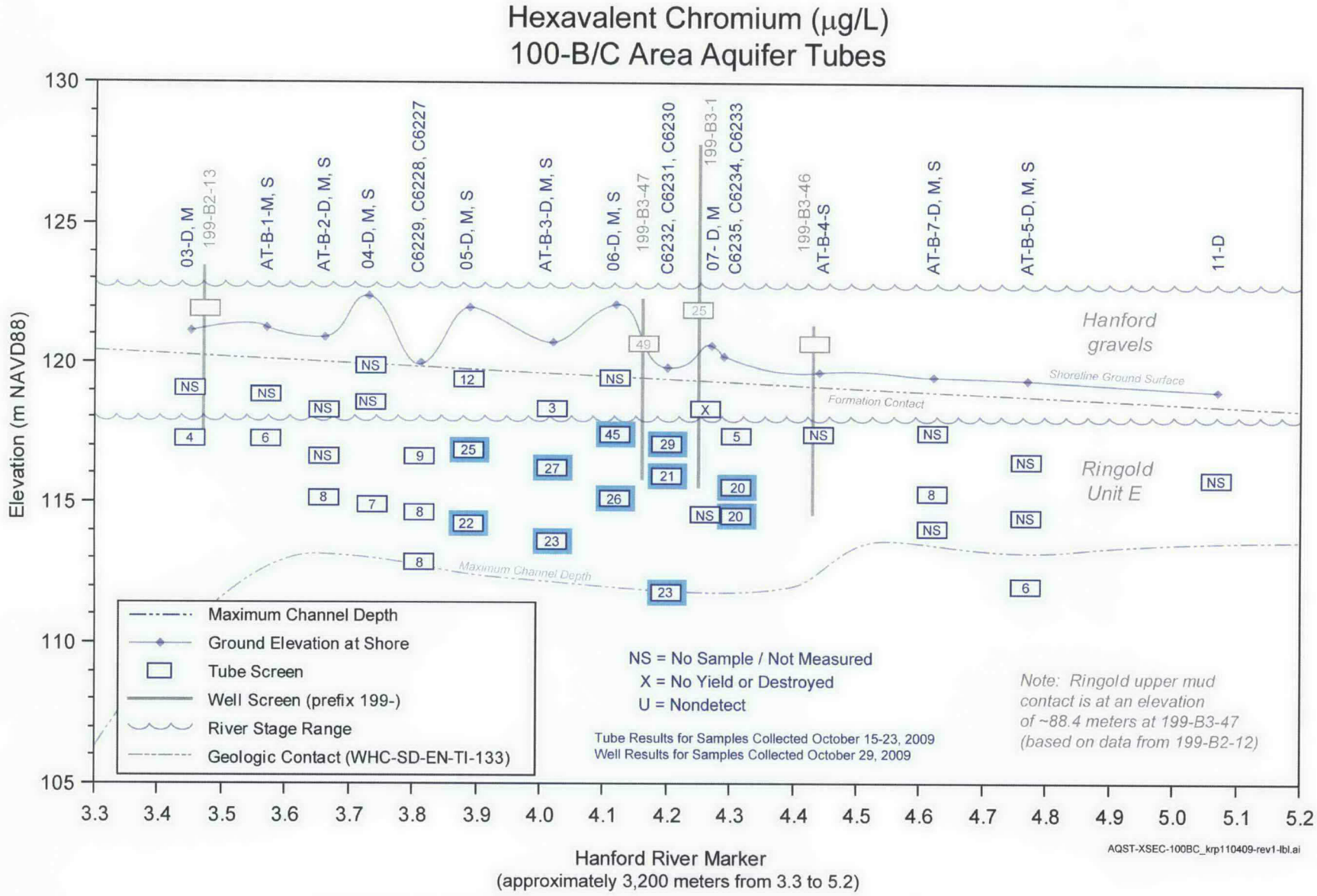

Figure 3-7. Cross Section of Chromium Concentrations and Screen Elevations in Wells and Aquifer Tubes in 100-BC

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3.4.2 Strontium-90

An Sr-90 plume extends from the central portion of 100-BC, north toward the river (Figure 3-8). The shape of the plume has not changed substantially in more than 10 years and covers approximately 0.63 km^2 (0.243 mi^2) at concentrations above 8 pCi/L DWS (DOE/RL-2008-66). Based on groundwater concentrations from 100-BC aquifer tubes, completed at different depths for monitoring groundwater within the unconfined aquifer, Sr-90 above the DWS appears to be limited to the upper portion of the unconfined aquifer. This is consistent with what has been seen elsewhere in the 100 Area. Deep Well 199-B2-12 consistently has no detectable Sr-90, while its shallow counterpart, Well 199-B3-47, has levels above the DWS. Similarly, deep aquifer tubes C6332, 05-D, and 06-D had undetectable Sr-90 concentrations, while their shallower counterparts had concentrations above the DWS (DOE/RL-2008-66). Wells downgradient of solid waste burial grounds detect little or no Sr-90. Well 199-B8-6, downgradient of the 118-B-1 Burial Ground, has never detected any Sr-90. Wells 199-B9-2 and 199-B9-3 monitor groundwater downgradient of the 1118-C-1 Burial Ground. Only one sample from 199-B9-2 detected Sr-90 (0.43 pCi/L in 2008).

Figure 3-9 shows Sr-90 concentration trends in wells near the 116-B-1 Trench, the 116-C-1 Trench, and cribs in the central area of 100-BC. The highest concentration in 2009 was 29 pCi/L in Well 199-B3-1, near the 116-B-1 Trench. Concentrations in 2009 were generally lower than those observed during several previous years.

Near-shore groundwater monitoring is conducted through sampling and analysis in aquifer tubes. In 2009, Sr-90 concentrations continued to exceed 8 pCi/L DWS in several aquifer tubes in 100-BC, with a maximum of 25 pCi/L in aquifer tube C6230. Concentration trends in the aquifer tubes are steady to gradually declining.

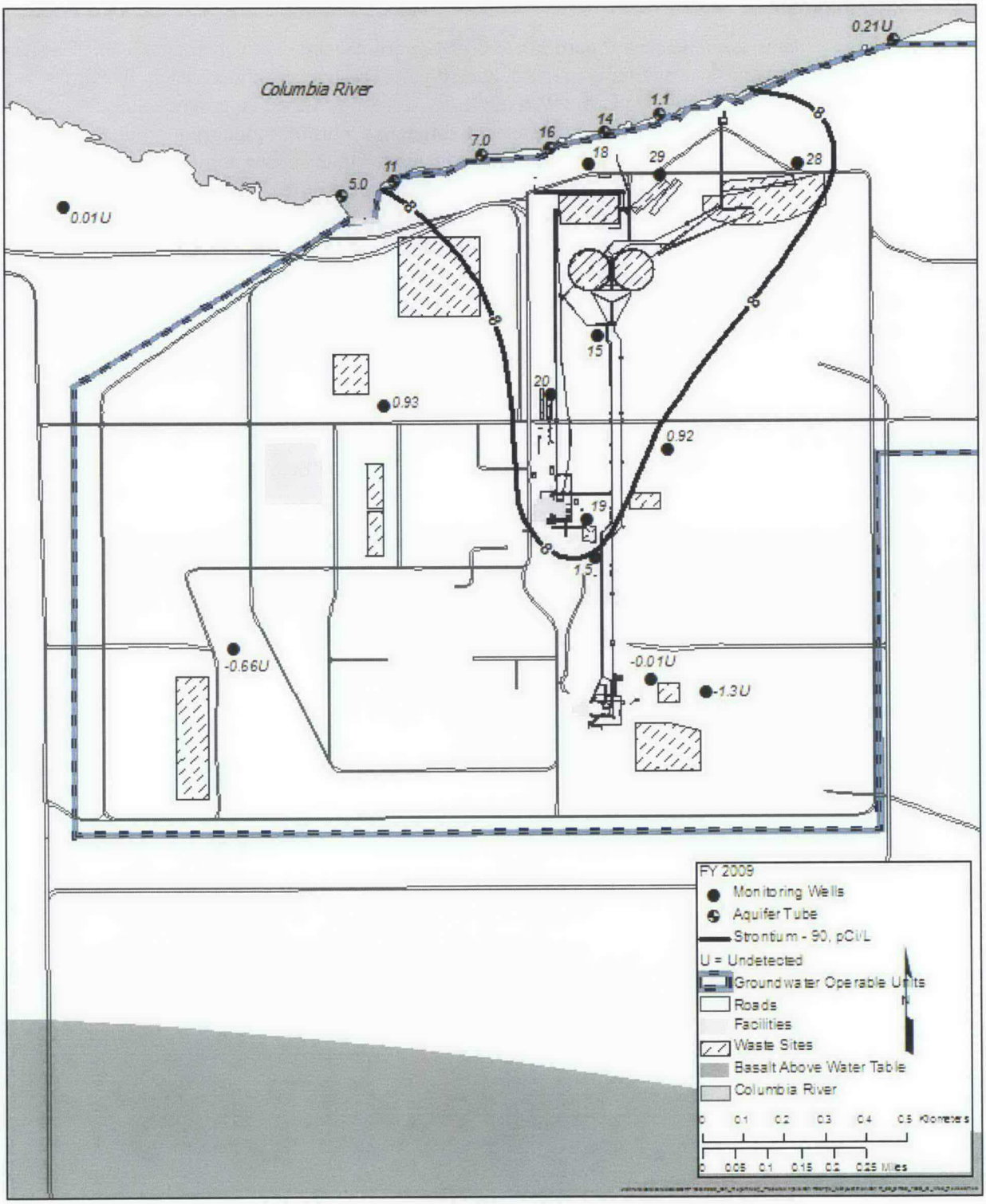

Figure 3-8. FY 2009 Average Sr-90 Concentrations in 100-BC, Upper Portion of the Unconfined Aquifer

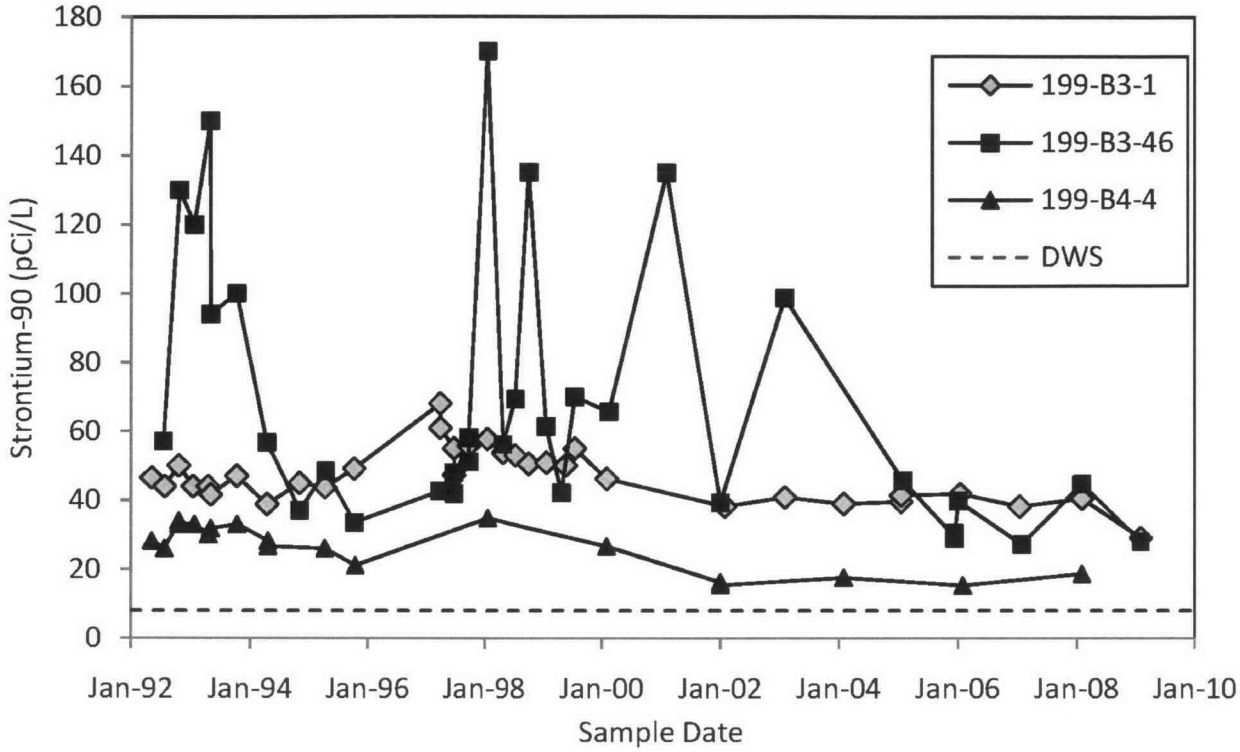

Figure 3-9. Sr-90 Concentration Trends in 100-BC Wells

3.4.3 Tritium

The upper part of the unconfined aquifer beneath 100-BC is contaminated with tritium at concentrations that exceed the DWS of 20,000 pCi/L in several wells (Figure 3-10). The area with tritium concentrations above 20,000 pCi/L covers an estimated 0.22 km^2 (0.085 mi^2) (DOE/RL-2008-66). The distribution of tritium currently is interpreted as three separate plumes (DOE/Rl-2008-66). In the northern plume, tritium concentrations exceeded the DWS from near the 116-B-11 Retention Basin to the Columbia River shoreline. Tritium within this plume has reached the river, as evidenced by detection in aquifer tubes. Although tritium spikes have been observed in downgradient Wells 199-B4-1 and 199-B5-2 in recent years, overall the 2009 concentrations were less than their peak values. Fluctuations and spikes in tritium concentrations have not been sufficiently explained (Figure 3-11). In 2009, Aquifer Tube 06-M had the highest concentration (29,000 pCi/L) in an aquifer tube. This level is lower than the historical values at this tube site, which ranged up to 66,000 pCi/L in 1998. Overall, concentrations of tritium have declined in the past 10 years in the tubes in this region.

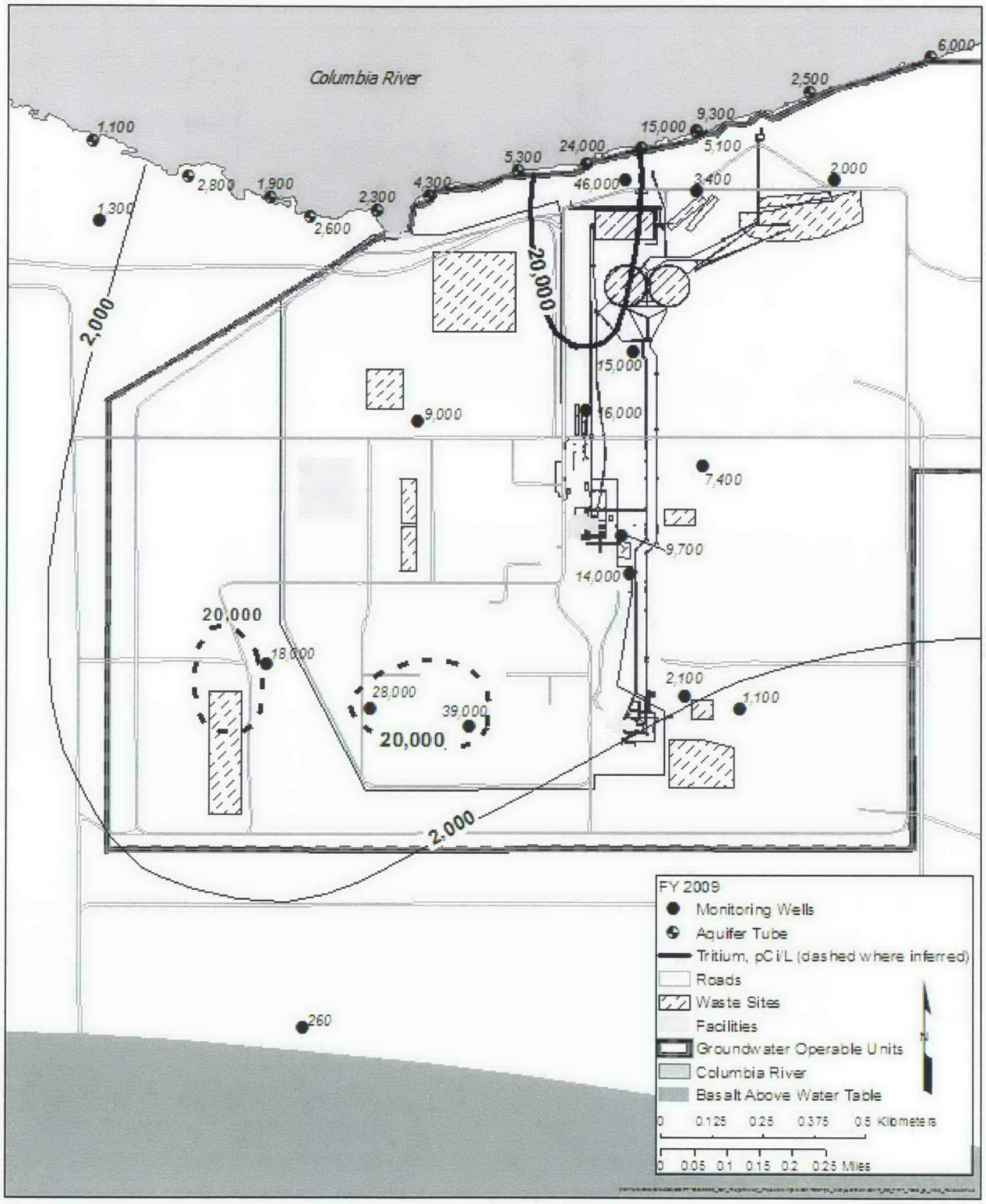

Figure 3-10. FY 2009 Average Tritium Concentration in 100-BC, Upper Portion of the Unconfined Aquifer

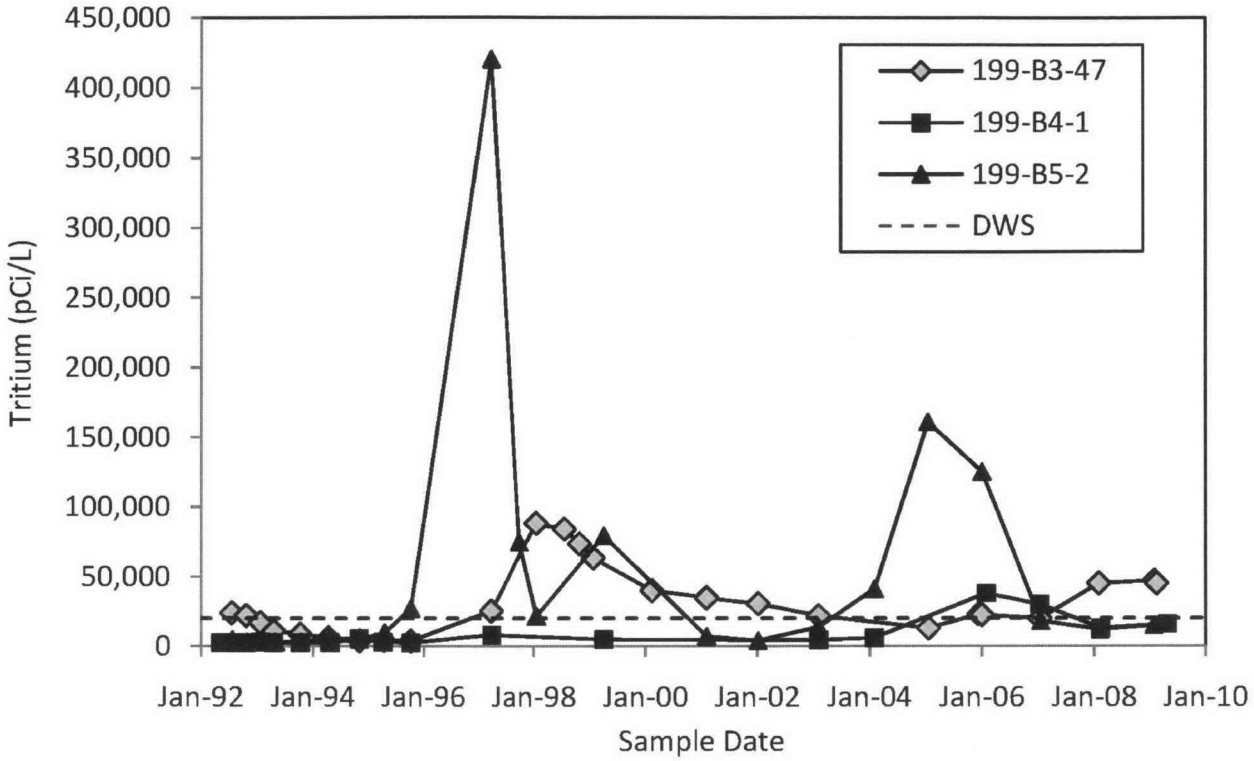

Figure 3-11. Tritium Concentration Trends in the Northern Portion of the 100-BC Wells

Tritium concentrations in three wells in the southern portion of 100-BC exceed the DWS (Figure 3-12). Because the area has only three monitoring wells, these plumes are not well defined. The two plumes on the southwest portion of 100-BC are interpreted as multiple plumes for the following reasons:

- Early tritium data from well 199-B8-7 were below the DWS, while concentrations of tritium in Wells 199-B8-6 and 199-B8-8 were above the DWS.
- Assuming the source for the western-most plume is the 116-B-1 Burial Ground, inferred groundwater flow directions in the area do not suggest eastward movement of the plume toward Wells 199-B8-7 and 199-B8-8.
- Well 199-B8-6 (near the 118-B-1 Burial Ground) had tritium concentrations of approximately 29,000 pCi/L from 2005 to 2008, but the concentration declined below the DWS in 2009.

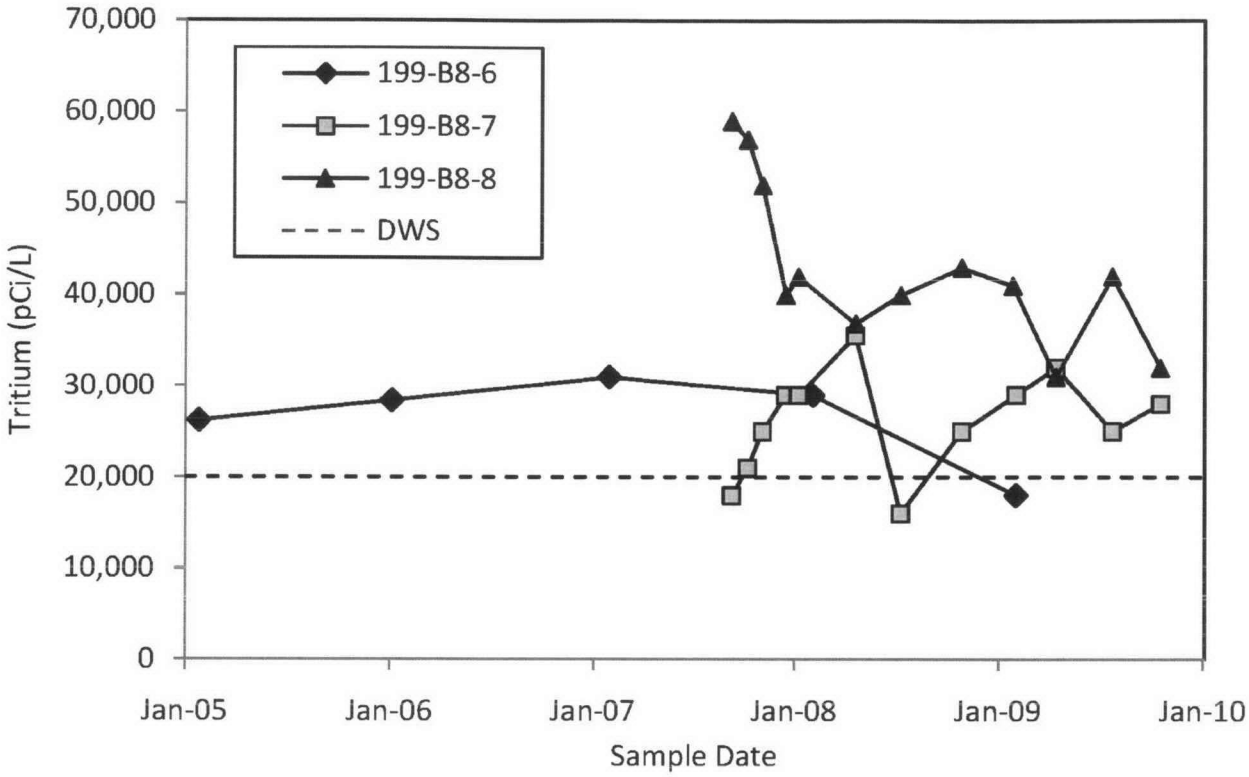

Figure 3-12. Tritium Concentration Trends in the Southern Portion of 100-BC

3.4.4 Other Contaminants

In 2003, DQOs were developed to guide the routine groundwater sampling for the 100-BC-5 groundwater OU (PNNL-14287). Groundwater samples collected from 1992 to 2002 were evaluated. Contaminants such as C-14, Tc-99, antimony, lead, cadmium, and mercury that never had been detected above DWS were not considered as COPCs for routine groundwater monitoring. However, the COCs for routine groundwater monitoring are not intended to represent the full range of COPCs for this RI/FS. Other contaminants such as aluminum, iron, and nickel no longer exceeded groundwater standards as of 1995 and were also not considered as COPCs.

Nitrate was identified as a COC in 1998 and 1999 based on its exceedance of the 45 mg/L DWS in Well 199-B3-47 (DOE/RL-2005-40). Concentrations have since decreased over time, but nitrate in groundwater continues to be routinely monitored as a supporting parameter (DOE/RL-2003-38).

The highest nitrate concentration in a well during 2008 or 2009 was 39.5 mg/L in Well 199-B3-47, observed at a 5-year increasing trend. Nitrate was detected at an elevated concentration of 44.7 mg/L (average of duplicates in October 2009) in nearby Aquifer Tube 06-M.

3.5 Contaminant Fate and Transport

This section discusses the fate and transport of contaminants in the vadose zone and groundwater within 100-BC. Contaminants remaining in the vadose zone may migrate to groundwater and ultimately to the Columbia River.

3.5.1 Contaminant Distribution in the Vadose Zone

The distribution of contaminants in the vadose zone beneath waste sites depends on many factors. The volume of effluent discharged, contaminant inventory, vadose zone thickness, stratigraphy, soil

partitioning coefficient (K_d), and natural recharge are the primary physical and chemical properties that influence contaminant distribution in the vadose zone.

The generalized contaminant distribution model for 100-BC is based on the observed distribution of contamination and information on recharge histories and contaminant chemical reactivity with subsurface sediments that are to some degree waste site specific. Effluent discharged to the soil column was the primary driving force for contaminant migration during operations. Where saturated conditions were maintained during operation, the extent of contamination is more extensive. Since cessation of waste discharges, only natural recharge and, in some cases, artificial sources of recharge (i.e., dust suppression water) are available to facilitate continued contaminant transport.

Waste sites that received enough liquid effluent to impact groundwater have contamination at varying levels throughout most of the vadose zone. Areas of high volumes of water resulted in increased potential for chemical transport to the groundwater, especially for the more mobile contaminants. Contaminants with low contaminant distribution coefficients (near zero) such as Cr(VI) have migrated through the vadose zone and into the groundwater when the waste sites were operational. The available data indicate residual concentrations of Cr(VI) remain in the vadose zone where remedial actions have been completed. However, few data are available to quantify total vadose zone Cr(VI) quantities and distribution. Data are also not available to evaluate the extent of other mobile contaminants such as tritium and nitrate across the thickness of the vadose zone. Concentrations of less mobile contaminants generally decrease with depth below the disposal structure.

Waste sites that received small amounts of dilute liquids are generally found to have soil contamination extending limited distances into the vadose zone beneath waste sites (i.e., burial grounds, reactor structures, and some unplanned releases). More than 60 target analytes are identified for soil waste sites. The master list of soil target analytes is provided in Chapter 4.

The CSM for waste sites incorporates the following:

- **High soil partitioning K_d contaminants:** The highest soil contaminant concentrations are expected within and near the point of release. Sufficiently high volumes of liquids discharged into a waste site can increase the vertical extent of contamination in the vadose zone. Where little or no liquid effluents were discharged to a waste site, soil contamination is expected to remain within and only slightly below the point of release.

- **Low soil partitioning K_d contaminants:** The highest levels of soil contamination are expected to be found near the point of release, but may also continue at elevated levels through the vadose zone to groundwater, depending on the discharge volume and infiltration rate. Soil contaminant levels generally decrease with depth, but contamination can be found at higher levels in lenses of fine materials. Limited data are available to evaluate vertical contaminant distribution behavior for several contaminants including nitrate, tritium, and Cr(VI).

Many facilities within 100-BC have undergone deactivation, decommissioning, decontamination, and demolition (D4), and the C-Reactor has been placed in ISS. Waste sites that are identified as part of the facility removal process are remediated using remedial action under interim action RODs. This process has resulted in limited characterization of soil beneath structures removed as part of the reactor ISS process or beneath the ISS reactor buildings. Because contaminants passed through reactor structures or were produced in reactor structures as part of operations, contaminants may be present beneath the structures at concentrations that are a risk to human health or ecological receptors. Insufficient data are available to assess the environmental risk of the contamination beneath or around the reactor structures.

Contaminated soil in the remediated portion of a waste site is below the RAGs. Empirical data and modeling results indicate the residual contaminants remaining in the soil at the bottom and sides of the excavated sites are protective of groundwater and the Columbia River. Soil samples have not been collected to the depth of the current water table to confirm this portion of the CSM at interim closed waste sites.

The continued search for additional waste sites is necessary to identify waste sites with a potential to adversely impact human health and the environment. An orphan site evaluation has been completed in the immediate vicinity of 100-BC. Orphan site evaluation is planned in the remaining portion of the area to identify waste sites with a potential to adversely impact human health and the environment. Although conducting orphan site evaluations are not within the scope of this addendum, the task will be completed by the River Corridor Contractor and incorporated into the RI/FS process as guided by TPA-MP-14. The evaluations are conducted according to WCH-218, *Orphan Sites Evaluation Project Execution Plan.*

3.5.2 Distribution of Contaminants in Groundwater

Both natural and anthropogenic hydrologic processes have influenced the distribution of contaminants in the subsurface via groundwater flow. Processes affecting contaminant migration continue (e.g., changing river stage), while the effect of local alterations to groundwater flow have diminished over time with the cessation of reactor operations (e.g., no more coolant water disposal).

Groundwater flow and elevations within 100-BC are influenced by fluctuating river stage. These changes are largely controlled by operation of the upgradient Priest River Dam. During the spring, the river surface rises because snowmelt requires more flow through the dam. The surface water rise displaces groundwater inland and causes water table rises throughout 100-BC. During this time, the hydraulic gradient is altered and less water flows into the river. Conversely, during the fall, the river surface declines and groundwater flow toward the river dominates once again.

In 100-BC, the primary historical local influences on groundwater flow patterns were chronic unintentional losses of fluids from retention basins and intentional discharges to cribs and trenches. The facilities that released large quantities of fluid, generally over long time periods, are summarized in Chapter 2, Table 2-4 and Figure 2-16. These long term discharges created groundwater mounds under the discharge facility that were 6 to 9 m (20 to 30 ft) above the nominal water table. Figure 3-13 provides locations and water table elevations over time for three groundwater monitoring wells that have long term records. Some groundwater contamination may have been directed inland because of the influence of the mounds, only to resume moving toward the river once groundwater mounds dissipated after termination of liquid waste discharge to the subsurface. Water mounding from leakage at these facilities during operations was considered the greatest factor in the widespread observation of groundwater Cr(VI), Sr-90, and tritium contamination at 100-BC in the subsurface.

In the past, groundwater mounds in the 200 Area pushed contaminant plumes north, through the gap between Gable Butte and Gable Mountain. The plumes can be traced from their sources in the 200 East Area to a region between the 100-BC and 100-K Areas. The historical transport of contaminants from the 200 Area is not currently impacting 100-BC groundwater above DWS.

All three wells in Figure 3-13 show the effects of groundwater mounding, particularly at Well 699-65-72 nearly 3.2 km (2 mi) inland from the retention basins where the record is most complete and seasonal variations from river stages provide little interference. At this well, the water table rose from the first measurement in February 1950 until it peaked in the spring of 1968.

Total elevation increase was about 5 m (16 ft) during this time. The timing of this trend coincides almost precisely with that of combined discharges of reactor coolant to the subsurface from leaking effluent pipes/retention basins and intentional discharges to the overflow trenches. Once discharges ceased, the

mound dissipated with preferential drainage into the Columbia River under the influence of the natural flow direction. Thus, the current conditions show essentially no remnant effects on groundwater flow resulting from the long groundwater mounding process that ended in 1968. Figure 2-4 in Chapter 2 shows a recent water table map for 100-BC.

Local effects of water leakage have also been observed within 100-BC. A leaking fire hydrant line close to Well 199-B5-1 in 2006 caused specific conductance and chromium concentrations to decline (Figure 3-14). Data are not available to assess whether a measurable groundwater mound was formed. After the leak was repaired, specific conductance measurements returned to preleak values.

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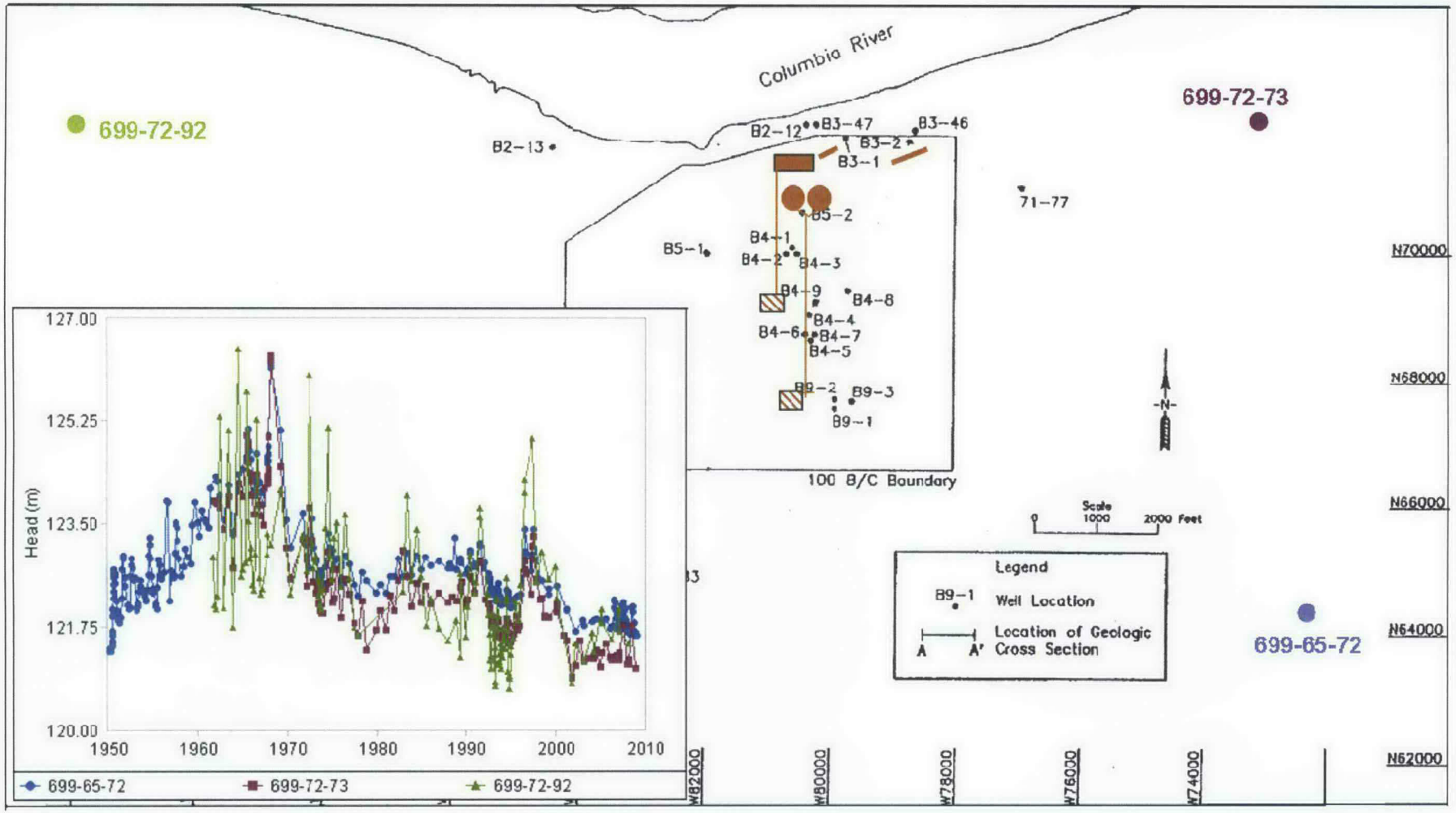

Figure 3-13. History of Water Table Elevations at 100-BC During Reactor Operations to the Present

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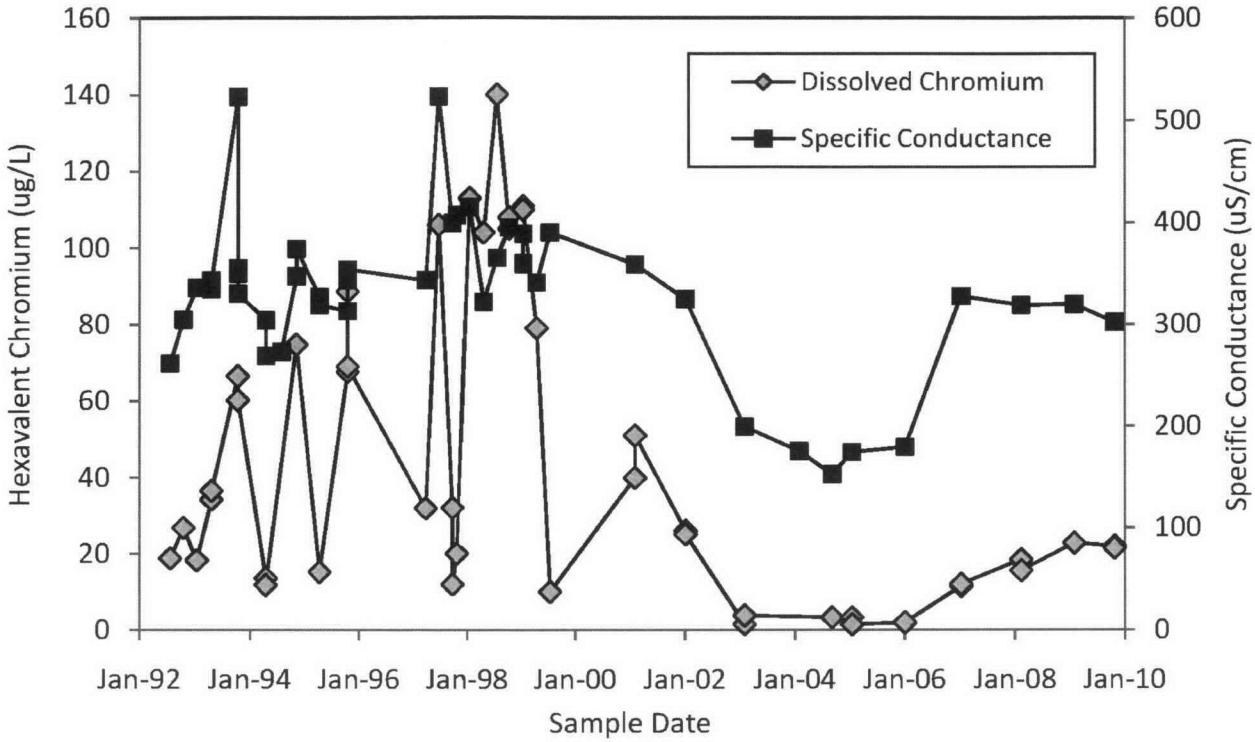

Figure 3-14. Chromium Concentration and Specific Conductance in Well 199-B5-1, Northwest Area of 100-BC

3.6 Human Receptors and Exposure Pathways

The EPA risk assessment guidance describes an exposure pathway as being the course that a contaminant takes from a source to a receptor (EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final*). Exposure pathways integrate information relating to sources and/or releases of contamination, contaminant transport pathways in the environment, exposure media, and exposure routes for receptors. Exposure pathways must contain all the following elements; otherwise, the pathway is not complete and does not present a risk or hazard (EPA/540/1-89/002 and EPA/540/1-89/001, *Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual: Interim Final*).

- Known and potential sources and/or releases of contamination
- Contaminant migration pathways
- Potential exposure scenarios
- Potential exposure media
- Potential exposure routes and receptors

Known and potential sources and/or releases of contamination include shallow-zone soil, deep-zone soil, sediment, and groundwater. Migration of contaminants from one source media may affect other media such as biota, air, groundwater, and surface water.

The analysis presented in Chapter 3 of the Integrated Work Plan (DOE/RL-2008-46) identifies a remaining data gap needed to address RCBRA uncertainty regarding groundwater risk to human receptors.

3.7 Ecological Receptors and Exposure Pathways

The Risk Assessment Work Plan (DOE/RL-2004-37) identifies and describes the ecological receptors and exposure pathways for the 100 Area. A remaining ecological exposure pathway uncertainty for 100-BC involves the discharge of contaminated groundwater to ecological receptors within the Columbia River. Columbia River pore water sampling in fall 2009, adjacent to 100-BC, detected levels of Cr(VI) above the aquatic standard of 10 μg/L. The Integrated Work Plan (DOE/RL-2008-46) presents the detailed description of ecological receptors and exposure pathways.

3.8 Conceptual Site Model Summary

The goal of the CSM is to synthesize knowledge to support project development needs and decisionmaking requirements, including the selection of a remedial action design. As the CSM evolves through the RI/FS process, the development and implementation of a remedy builds on the data collected and improved understanding of key uncertainties. The data and information requirements necessary to develop and implement the remedy come directly from the process of resolving the CSM uncertainties.

The following key elements of the CSM are discussed in the following sections.

- Past soil and groundwater sample data were evaluated and soil and groundwater samples will be analyzed for many COPCs. The lists of target analytes and COPCs for 100-BC OUs are provided in Chapter 4.
- The 100-C-7 waste site remains to be remediated. This waste site is part of an ongoing interim action and has not been fully characterized.
- The nature and extent of soil and groundwater contaminants is influenced by past waste disposal practices, historical groundwater flow patterns (e.g., groundwater mounding), natural influences on groundwater flow (e.g., river stage fluctuations), and geochemical conditions in the soil and groundwater.
- Uncertainty remains regarding the extent of contamination beneath select waste sites that have been interim closed out. Additional data collection is proposed to address this uncertainty as part of this RI.
- The known primary contaminants in the 100-BC groundwater are Cr(VI), Sr-90, and tritium. The nature and extent of groundwater contamination for some of the other groundwater COPCs is uncertain. Additional groundwater sample collection activities are proposed to address this uncertainty.

The following discussion postulates the evolution of contaminant distribution in the subsurface with emphasis on the hydrologic system characteristics and processes controlling contaminant distribution.

3.8.1 Conceptual Site Model for Hexavalent Chromium

The historical records show that dissolved Cr(VI) was primarily released into the environment in two types of solutions: the stock solutions used to make reactor coolant and the reactor coolant itself. The differences in solution chemistry, associated production facilities, and discharge locations have had a substantial effect on current chromium distribution in the subsurface. The total amount of Cr(VI) used during production is estimated to be 2.78 million kg (6.13 million lb). However, this quantity includes mass discharged to the river as well as mass remaining in the soil and groundwater. Based on reactor operations and liquid discharge history, it is estimated that a large portion of the mass has already discharged to the river.

For 100-BC, an estimated volume of 42,500 m^3/day (1,500,000 ft^3/day) of spent coolant infiltrated the soil column during operations at 116-B-11, as well as the other nearby high-volume locations (both waste sites and pipelines). Sodium dichromate that was used to treat the cooling water dissociated to create a concentration range between 700 μg/L to 800 μg/L of Cr(VI). At this infiltration volume and the lower

concentration threshold, approximately 30 kg/day (66 lbs/day) of Cr(VI) was released to the soil column, migrated downward, and reached groundwater (BHI-00917, *Conceptual Site Models for Groundwater Contamination at 100-BC-5, 100-KR-4, 100-HR-3, and 100-FR-3 Operable Units*). This value represents a conventionally accepted order of magnitude estimate.

Hexavalent chromium is very soluble and mobile in the subsurface. Beneath liquid waste facilities or spills, Cr(VI) contamination moved through the vadose zone into groundwater. Previously, it was believed that the highest concentrations of Cr(VI) in groundwater were near the top of the aquifer. Characterization data from new wells, however, indicate that in some locations the contamination is present at depth in the unconfined aquifer. Additional sampling is needed to develop a revised CSM for Cr(VI).

Chromium that reached the groundwater during reactor operations spread in a radial pattern because of large groundwater mounds (Section 3.4.2). After operations ceased and there was no longer the large scale infiltration from effluent discharges, the groundwater mounds dissipated and inland migration of chromium diminished. By the mid 1970s, the natural groundwater gradient was essentially reestablished with the seasonal impacts of high and low river stage controlling groundwater flow, but no long term trend with regard to Cr(VI) movement is observed. This behavior is indicated from comparing chromium (total/hexavalent) concentrations in monitoring wells (e.g., 199-B5-1, 199-B4-1, and 199-B3-1) from 1992 to 2009 as they have moved up and down within a narrow concentration interval during that time (DOE/RL-90-08).

The rapid formation of the groundwater mound shortly after discharges began suggests that Cr(VI) and other mobile contaminants migrated quickly through the vadose zone into the unconfined aquifer. The large quantities of coolant discharged changed the local groundwater gradient direction and relatively quick transport through the vadose zone occurred. Some portion of the source term discharged into the Columbia River and is no longer present in the subsurface. However, evidence of substantial infiltration along the river shore and farther inland indicates a widely dispersed contaminant source in the subsurface.

Some of the dissolved Cr(VI) was pushed inland by the growing groundwater mound. Water-level data from Well 599-65-72 suggests the hydraulic effects from the mound extended as much as 3.2 km (2 mi) inland. Low levels of total chromium (ranging from below detection limits to 13 μg/L) suggest that chromium contamination may have migrated to that well.

Hexavalent chromium contamination observed in groundwater at 100-BC is present in a broad plume at relatively low concentration (i.e., less than 60 μg/L), compared to 100-D where concentrations are over 6,000 μg/L in some areas. There are known releases of concentrated sodium dichromate to the soil at 100-BC (Section 2.2.4). For example, Cr(VI) concentrations up to 1,620 mg/kg were detected at 10 m (33 ft). Concentrations in soil below that depth generally decreased to a concentration of 2.9 mg/kg just above the water table. Groundwater concentrations in this area have been less than 20 μg/L except for a single sampling event when the concentration was approximately 50 μg/L (see Section 4.3.1). Hexavalent chromium was detected throughout the soil column to groundwater at another waste site, 100-B-27 (located in the northwestern portion of 100-BC), from a sodium dichromate spill (WCH-225).

3.8.1.1 Conceptual Site Model for Strontium-90

Strontium-90 is a moderately leachable fission product in ruptured fuel element debris, which is present in several waste sites (Section 2.2). Strontium-90 was also present in solid waste disposed at various burial grounds. The largest estimated inventories were at the 118-B-1 and 118-C-1 Solid Waste Burial Grounds (1.5 and 1.3 Ci) located east of the 105-B and 105-C Reactors, respectively. These are also possible sources of current aquifer contamination, although solid waste burial grounds are much less likely to contribute to Sr-90 in the aquifer compared to liquid discharge sites because the potential for infiltration

and vertical contaminant transport is limited from burial grounds. Strontium-90 has not been detected above the DWS in groundwater wells near the burial grounds.

A variety of waste sites and former facilities (Figure 2-19) are located within the estimated plume boundary, which could contribute to the persistence of Sr-90 observed and the configuration of the plume. Waste sites that received radioactively contaminated waste streams include 116-B-5 (108-B Crib) and 116-B-16 (111-B Fuel Examination Tank). Thus, the plume may be the result of several contributing locations gradually releasing contamination to the aquifer. The uncertainty regarding the quantity of Sr-90 disposed at these locations, principally from decontamination solutions and particularly contaminated reactor coolant or fuel storage basin liquid, is relatively high because of the presence of contaminated particles, which are far more challenging to measure in an effluent stream, compared to soluble Sr-90.

Although 116-C-2 is a potential contributing source with a significant inventory, it is not the most likely reason for the persistence of the Sr-90 plume. 116-C-2 worked as a sand filter, so Sr-90-contaminated particulates would have been present. However, the amount of waste discharged there was not large (7.5 million L [1.98 million gal]) when compared to the estimated infiltration that occurred during operations from the retention basins, and the filtering action of the sand would have minimized particulate movement.

Waste site 116-C-2 is not close to where groundwater mounding occurred, but it may have been impacted by the widespread inland infiltration resulting from leaking retention basins and other effluent disposal. When operations ended, the dissipation of the groundwater mound, reassertion of natural groundwater flow over time, and any alterations to the subsurface shaped the current configuration and behavior of the plume.

Thus, the impact and influence from effluent leakage 116-B-11, 116-B-1, 116-C-1, and 116-C-5 introduce several complicating factors in describing Sr-90 contaminant fate and transport. The current geochemistry does not appear to promote Sr-90 mobility, but during operations, the combination of acidic decontamination liquids and large volumes of hot, contaminated infiltrating liquid that temporarily saturated the vadose zone may have increased Sr-90 solubility. This increased mobility may have transported some Sr-90 from the near surface vadose zone deeper, toward the rewetted zone.

Source removal actions have reduced the amount of Sr-90 remaining at 100-BC. Several of the waste sites noted previously are now Interim Closed. Sr-90, being much less mobile than Cr(VI), did not migrate as far during the mounding/infiltration process during operations and likely did not disperse to the same degree as Cr(VI) since the end of reactor operations. However, there were processes at work that may have mobilized some Sr-90 deep into the vadose zone.

There does not appear to be a large Sr-90 inventory remaining at 100-BC (likely less than 100 Ci), but there is enough Sr-90 present for concentrations to exceed the DWS within the groundwater plume boundary. In addition, attenuation of Sr-90 from decay will continue in soil and groundwater (half-life is 28.8 years). Continued relatively slow dispersion and migration of Sr-90 in groundwater will occur because of its moderate adsorption to aquifer soil and the modest natural infiltration rate. Thus, the plume is anticipated to be persistent in groundwater due to widely distributed Sr-90 sorbed to soil within the deeper vadose zone and periodically re-wetted zone.

3.8.2 Conceptual Site Model for Tritium

The presence of tritium in the unconfined aquifer in 100-BC is not totally unexpected. However, its persistence and high concentration suggest a more concentrated source than is common at other 100 Area reactors. Tritium remains at elevated levels (greater than 20,000 pCi/L) in groundwater after almost five half-lives (one half-life is 12.3 years) after the end of the P-10 Tritium Separation Project process. At 100-BC, the 118-B-1, 116-B-9, and 118-B-6 waste sites are considered the most likely source for the tritium.

The 118-B-6 waste site was remediated in 2006. Since that time, the groundwater plume has migrated to the north (downgradient), which supports the theory that the 118-B-6 waste site was a tritium source. Based on the trend of decreasing concentrations since 2006, groundwater concentrations in this area are expected to continue to decrease.

3.8.3 Conceptual Site Model for Low Mobility Contaminants

Contaminants with high K_d are expected to be found at the greatest concentrations within and near the areas of discharge. When little or no liquid effluent was discharged to a waste site, soil contamination is expected to remain in the shallow sediment. Most of this shallow contamination has been removed during remediation activities. Sufficiently high volumes of liquids discharged into a waste site can modestly expand the depth of contamination in the vadose zone.

Groundwater samples currently are not routinely analyzed for low-mobility radionuclides (e.g., Cs-137, Co-60, Pu-238, Pu-239) or low-mobility metals (e.g. lead, mercury). Groundwater data from the early 1990s show few detections of these contaminants, supporting the interpretation that they did not migrate to groundwater in significant quantities.

3.8.4 RUM and Lower Hydrogeologic Units

Underlying the unconfined aquifer in 100-BC is the RUM (as described in Chapter 2). The RUM has been described as primarily clayey silt and silty clay, with lenses of silty sand and sandy silt. Only one well (199-B2-12) in 100-BC has been completed in the RUM (or hydrogeologic units beneath the RUM). Since only one well in 100-BC has been completed beneath the unconfined aquifer, groundwater flow directions and velocities are relatively undefined.

Groundwater in the RUM has been sampled for constituents that include organics, inorganics, and radionuclides from Well 199-B2-12, located downgradient of the 105-B and 105-C Reactors and relatively close to the shoreline, adjacent to shallow Well 199-B3-47. Concentrations of contaminants in groundwater samples from Well 199-B2-12 are near or below detection limits.

Based on current knowledge of the elevation of the RUM from wells and river bathymetry, the top of the RUM is more than 25 m (82 ft) below the bottom of the river channel (i.e., the top of the RUM does not intersect the river channel). Detailed bathymetric data are needed and have been collected, but not yet interpreted, to confirm that the Columbia River channel does not intersect the RUM at 100-BC. Also, the depth and continuity of the RUM are not well known because of a lack of boreholes that encounter it.

Because of the lack of wells completed beneath the upper aquifer in 100-BC, current discharge points for groundwater beneath the upper aquifer are not known. The RUM is not currently considered as a potential drinking water source. However, additional hydrogeologic data (e.g., hydraulic conductivity and hydraulic gradient information) are needed to confirm the preliminary CSM hypothesis that the RUM cannot support a drinking water resource.

3.8.5 Groundwater/River Interactions

Groundwater and river water mixing within the zone of interaction, and groundwater discharges into the river channel, are important to understanding the rate and magnitude of contaminants potentially entering the Columbia River. The working hypothesis is that mixing between groundwater and infiltrating river water during high river stage periods may cause the dilution of groundwater contamination to considerable depths within the aquifer.

Discharges to the river occur across the riparian zone as seeps and within the river channel substrate. Riverbank seepage creates a potential human health risk through exposure to groundwater contaminants and the potential introduction of contaminants to the food chain. Upwelling of groundwater into the

channel substrate poses a potential risk to river substrate biological communities and fish spawning habitat. Initial groundwater upwelling samples of the Columbia River channel have provided further insight regarding contaminant levels entering the river. The preliminary results from late 2009 indicate that Cr(VI) is present in the pore water at levels exceeding environmental standards.

Riverbank seep discharges to the river are visible during low river stage. Conversely, during high river stage, the seeps are submerged as river water infiltrates the riverbanks and forms either a layered system or a mixture during interaction with approaching groundwater. Data indicate riverbank storage water composition oscillates dramatically from nearly completely river water during high river stage to primarily groundwater during low river stage (PNNL-13674, *Zone of Interaction Between Hanford Site Groundwater and Adjacent Columbia River: Progress Report for the Groundwater/River Interface Task Science and Technology Groundwater/Vadose Zone Integration Project*). Figure 3-15 shows an illustrated model of the zone of interaction.

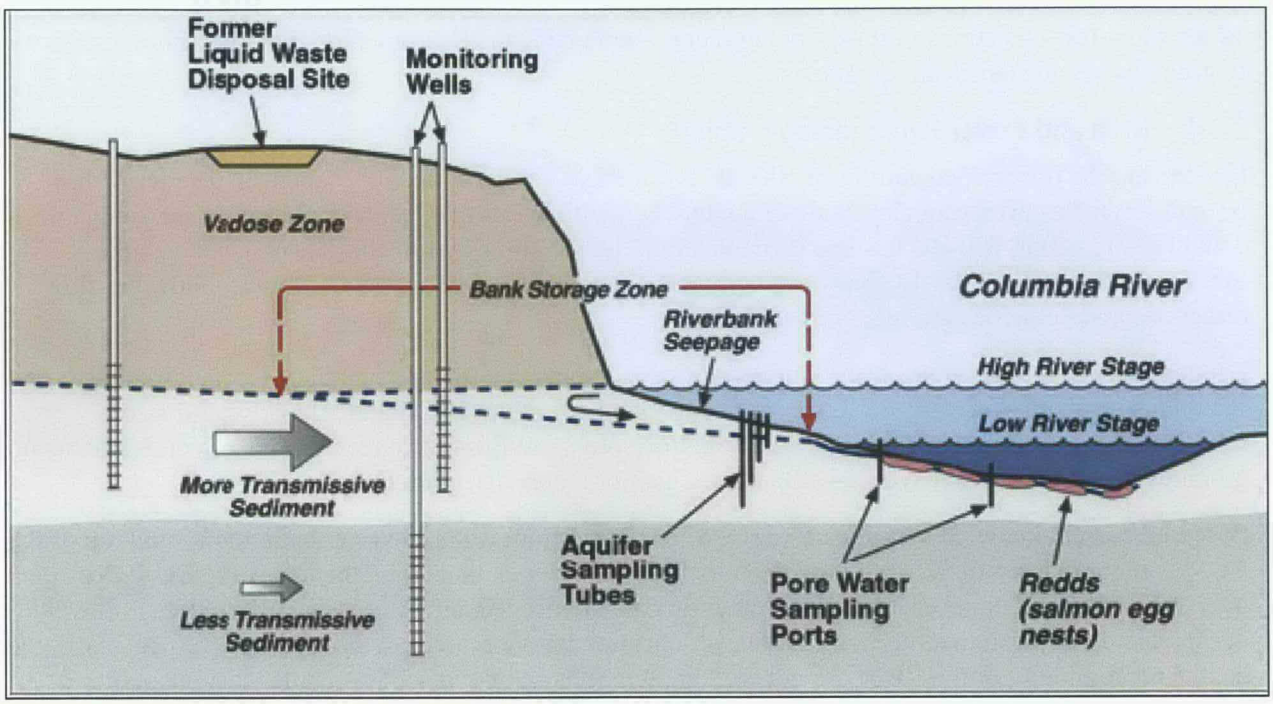

Figure 3-15. Principal Features and Monitoring Sites for Zone of Interaction (PNNL-13674)

In the channel substrate, sediment pore water may be influenced by the entrainment of river water and the gradual influx of groundwater that upwells from the underlying aquifer. Physical, chemical, and biological characteristics of this interface have been the focus of research in aquatic biology (e.g., Geist and Dauble, 1998, "Redd Site Selection and Spawning Habitat Use by Fall Chinook Salmon: The Importance of Geomorphic Features in Large Rivers," and Geist, 2000, "The Interaction of Ground Water and Surface Water Within Fall Chinook Salmon Spawning Areas in the Hanford Reach of the Columbia River"). Data indicate that physical processes dominate influences on contaminant concentrations and fluxes, where groundwater discharges into the free-flowing river. Chemical processes may render contaminants less mobile as they adsorb to sediment or precipitates. Zone of interaction biological activity may also capture contaminants and immobilize them, or introduce them into the food chain (PNNL-13674).

4 Work Plan Rationale and Tasks

This section identifies the process for target analyte list and COPC development, data gaps, and tasks to address uncertainties needed to refine the CSM and support decision making. Information is needed to fill these data gaps before decisions can be made regarding the remediation of the vadose zone and groundwater. Data gaps identified in this section will address uncertainties associated with nature and extent of contamination, fate and transport, and the hydrogeologic framework.

4.1 Approach

The Integrated Work Plan (DOE/RL-2008-46) includes a preliminary list of RAOs for the 100 Area (Table 4-1). The RAOs are refined through the RI/FS process during the RI, River Corridor Baseline Risk Assessment (RCBRA), and the detailed analyses of alternatives conducted in the FS; final RAOs are determined when the remedy is selected in the Record of Decision (ROD). The preliminary RAOs include media specific objectives for groundwater, surface water, soil, land use, and natural/cultural resources. The RAOs will be used to drive the remediation selection for 100-BC.

Table 4-1. Preliminary Remedial Action Objectives for the 100 Area Operable Units

RAO No.	Goal
	Groundwater
1	Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing nonradiological contaminant concentrations above federal and state standards.
2	Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing radiological contaminant concentrations above federal standards.
	Surface Water
3	Prevent unacceptable risk to human health and ecological exposure to surface water containing nonradiological contaminant concentrations above federal and state standards.
4	Prevent unacceptable risk to human health and ecological exposure to surface water containing radiological contaminant concentrations above federal standards.
	Soil
5	Prevent hazardous chemical contaminants from migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards for protection of surface and groundwater.
6	Prevent migration and/or leaching of radioactive contaminants through soil to groundwater in excess of federal standards.
7	Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil contaminated with nonradiological constituents at concentrations above the unrestricted land use criteria for human health or soil contaminant levels for ecological receptors.
8	Prevent unacceptable risk to human health and ecological receptors from exposure to upper 4.6 m (15 ft) of soils and to structures and debris contaminated with radiological constituents. Prevent exposure to radiological constituents at concentrations at or above a dose rate limit that causes an excess cancer lifetime risk threshold of 10^{-6} to 10^{-4} above background for the rural residential exposure scenario. An annual dose rate limit of 15 mrem/yr above background achieves EPA excess lifetime cancer risk threshold.
	Protect ecological receptors based on a dose rate limit of 0.1 rad/day for terrestrial wildlife populations, which is a "to-be-considered" criterion.

Table 4-1. Preliminary Remedial Action Objectives for the 100 Area Operable Units

RAO No.	Goal
	Land Use and Resource
9	Prevent adverse impacts to cultural resources, threatened or endangered wildlife, and ecological receptors using the Columbia River and prevent destruction of sensitive wildlife habitat.
10	Where it is not practicable to remediate levels that will allow for unrestricted use, ensure that appropriate institutional controls and monitoring requirements are established and maintained to protect future users of the remediated waste sites.

Notes:

EPA = U.S. Environmental Protection Agency
ft = foot/feet
m = meter(s)
mrem/yr = millirem per year
rad/day = radian per day

The preliminary remediation goals (PRGs) provide target cleanup levels for use in evaluating achievement of RAOs. They also provide preliminary risk reduction targets that a remedial alternative must meet to achieve the criteria set forth in Title 40 CFR Part 300.430(e)(9)(iii), "National Oil and Hazardous Substances Pollution Contingency Plan," "Remedial Investigation/Feasibility Study and Selection of Remedy." As additional information becomes available from site specific risk information, RI site characterization, and chemical specific applicable or relevant and appropriate requirements (ARARs), the PRGs will be developed and finalized in the RI/FS Report.

4.2 Development of Vadose Zone Soil Target Analyte Lists and Groundwater Contaminants of Potential Concern

A process has been developed to identify vadose zone soil target analytes for addressing uncertainties associated with the nature and extent of contamination in the vadose zone. Similarly, a process has been developed to identify groundwater COPCs for addressing uncertainties associated with the spatial and temporal distribution of groundwater contamination. This section summarizes that process, and provides tables of analytes for 100-BC. The Integrated Work Plan (DOE/RL-2008-46) provides additional detail on the process.

4.2.1 Vadose Zone Soil Target Analyte List

Remediation and characterization information was reviewed to develop an initial list of target analytes to represent potential contamination in the vadose zone. Information sources included focused feasibility studies, limited field investigation (LFI) reports, cleanup verification documents, technical baseline reports, and databases containing analytical data resulting from these activities.

After the initial target analyte list was compiled, the information underwent additional review steps to remove analytes, using generally accepted exclusion criteria (e.g., naturally occurring radionuclides; radionuclides with short half-lives; essential nutrients, and analytes with no toxicity values). The soil target analyte list was compared to the groundwater COPC list, and groundwater COPCs not found on the soil list were added to it to create the master soil target analyte list (Appendix D).

Next, appropriate analytical methods were determined for each analyte on the master list. Detection limits for each target analyte were evaluated to determine whether they could achieve the remedial action goals (RAGs) for direct exposure, groundwater protection, and Columbia River protection. Table 4-2 is the resulting master target analyte list for 100-BC.

The master target analyte list represents all potential target analytes that could be present in the vadose zone. Location specific target analytes were identified from the master list using the following approach:

- Identify the contaminants of concern for the specific waste sites from the applicable interim action ROD (which reflects information from LFIs and technical baseline reports) or from verification documentation, such as a Cleanup Verification Package (CVP) or remaining site verification package (RSVP). Include these analytes on the location specific target analyte list.
- Evaluate local groundwater data (wells located within waste site "zones of influence"). If the groundwater COPCs have been analyzed for but not detected, these analytes will not be included on the location specific target analyte list. If the groundwater COPCs have been analyzed for and have been detected, these analytes will be included on the location specific soil target analyte list. If the groundwater COPCs have not been analyzed for, an additional evaluation will be performed to determine if there is a data need. If there is a data need, these COPCs will be included on the waste site specific soil target analyte list.

Regulatory agency review of the target analyte lists allows for the adjustment/addition of sample locations and target analytes on a site specific basis. This adjustment has been agreed upon to ensure that regulator concerns regarding data gaps and uncertainties are addressed. When additional information needs are identified, the agencies will modify the characterization locations required and may adjust the location specific target analyte lists.

Location specific target analyte lists are provided in Chapter 2 of the 100-BC SAP (DOE/RL-2009-44).

Table 4-2. Master Soil Target Analyte List for the 100-BC OUs

Radionuclides	Non-radionuclides		
Americium-241	Butylbenzylphthalate	Lindane (Gamma-BHC) (1,2,3,4,5,6-hexachlorocyclo-hexane)	Nickel
Cobalt-60	Carbazole	Heptachlor	Selenium
Cesium-137	Dibenzofuran	Heptachlor epoxide	Silver
Europium-152	Diethylphthalate	Methoxychlor	Strontium
Europium-154	Di-n-octylphthalate	Technical chlordane (alpha and gamma)	Thallium
Europium-155	Isophorone	Acenaphthene	Tin
Carbon-14	Methylnaphthalene; 2-	Anthracene	Titanium
Nickel-63	Methylphenol; 4- (p-cresol)	Benzo(a)anthracene	Vanadium
Technetium-99	N-nitrosodiphenyl-amine	Benzo(a)pyrene	Zinc
Tritium	Pentachlorophenol	Benzo(b)fluoranthene	Benzene
Plutonium-238	Phenol	Benzo(k)fluoranthene	1,1-Dichloroethene
Plutonium-239/240	Trichlorobenzene; 1,2,4-	Benzo(g,h,i)perylene	1,1,2,2-Tetrachloroethane
Plutonium-241	Dalapon	Chrysene	Carbon tetrachloride

Table 4-2. Master Soil Target Analyte List for the 100-BC OUs

Radionuclides	Non-radionuclides		
Uranium-233/234	DB;2,4- [4-(2,4-dichlorophenoxy)butanoic acid] (Butoxone)	Dibenzo(a,h) anthracene	Chloroform
Uranium-235	Dicamba	Fluoranthene	Methyl isobutyl ketone (4-Methyl-2-pentanone)
Uranium-238	Dichlorophenoxy-acetic acid; 2,4-	Fluorene	Tetrachloroethene
Iodine-129	Dichloroprop	Indeno(1,2,3-cd)pyrene	Trichloroethene
Strontium-90	Dinoseb	Naphthalene	Toluene
	Picloram	Phenanthrene	Vinyl chloride
	TP-; 2,4,5-(2,4,5-Trichlorophenoxy) Propionic acid, 2]	Pyrene	Xylenes (total)
	Trichlorophenoxy-acetic acid; 2,4,5- (2,4,5-T)	Aluminum	Nitrate
	4,4'-Dichlorodiphenlydi-chlorethane	Antimony	Nitrite
	4,4-Dichlorodiphenyldi-chloro-ethylene	Arsenic	Asbestos
	4,4-Dichlorodiphenyltri-chloro-ethane	Barium	Chromium (hexavalent)
	Aldrin	Beryllium	Mercury
	Hexachlorocyclo-hexane; alpha (alpha-BHC, HCH)	Boron	Aroclor-1016 (PCB)
	Hexachlorocyclohexane; beta (beta-BHC, HCH)	Cadmium	Aroclor-1221 (PCB)
	Dieldrin	Chromium (total)	Aroclor-1232 (PCB)
	Endosulfan I	Cobalt	Aroclor-1242 (PCB)
	Endosulfan II	Copper	Aroclor-1248 (PCB)
	Endosulfan sulfate	Lead	Aroclor-1254 (PCB)
	Endrin	Lithium	Aroclor-1260 (PCB)
	Endrin aldehyde	Manganese	Total petroleum hydrocarbons
	Endrin ketone	Molybdenum	Uranium (total)

Notes:

BHC = Benzenehexachloride

HCH = Hexachlorocyclohexane

PCB = polychlorinated biphenyl

4.2.2 Groundwater Contaminants of Potential Concern

This process identified groundwater COPCs that will be carried forward and evaluated for nature and extent characterization and address RCBRA groundwater risk uncertainties. A COPC is a constituent identified as a potential threat to human health or the environment with data of sufficient quality for use in a baseline qualitative risk assessment. Action levels were derived from readily available sources of chemical specific ARARs, such as maximum contaminant levels (MCLs), ambient water quality criteria, or risk based PRGs using EPA health criteria and default exposure assumptions.

A groundwater data set was prepared for 100-BC to identify groundwater COPCs. Appendix D presents the process for selection of COPCs. Analytical data were obtained from the Hanford Environmental Information System database for all wells identified within the area. The analytical data set represents groundwater samples collected between 1992 and 2008 (approximately 16 years). This timeframe was selected because it captures analytical data collected during the LFI, which were used to prepare the qualitative risk assessment. In the early 1990s, groundwater samples were analyzed for a comprehensive set of constituents. Because many of the analytes were undetected, selected constituents were dropped from routine groundwater monitoring. Thus, some of the groundwater COPCs have only a short period of record. Results from unfiltered samples were selected, as these data represent total concentrations of the analyte. Because filtered sampling results may underestimate chemical and radiological concentrations in water from an unfiltered tap, they are not used for the COPC selection process.

After the initial COPC list was compiled, the information underwent additional review steps to remove analytes, using generally accepted exclusion criteria (e.g., naturally occurring radionuclides; radionuclides with short half-lives; essential nutrients, and water quality parameters that do not have available toxicological information and analytes without an action level). Analytes that were not detected in any of the groundwater samples were eliminated as groundwater COPCs. Analytical results that were rejected and flagged with an "R" qualifier were not considered reliable and not included as detection for that analyte. All constituents that were detected at least once were carried to the next step.

Maximum concentrations of analytes that are less than their action level were not identified as COPCs. Maximum concentrations of analytes detected in groundwater were compared to action levels to identify analytes that are likely to contribute to overall risk. Steps were taken to identify when an analyte was detected infrequently to determine if the results are reproducible or associated with localized contamination. Additionally, method detection limits were evaluated to determine if they are adequate for determining their presence at the action level. If the results of this comparison showed that the presence of an analyte was reproducible, then the analyte is identified as a groundwater COPC.

Next, groundwater COPCs were compared to the master target analyte list for soil. This step of the process is used to confirm that the target analytes identified for vadose zone soil are appropriately considered for groundwater. Based on the transport mechanism associated with the target analytes, it is a reasonable assumption that not all target analytes identified for vadose zone soil will be COPCs for groundwater. For example, contaminants that are not mobile in water, such as PCBs, are not included as a groundwater COPC.

Gross alpha and gross beta will be included in the analytical test suite. Gross alpha will be analyzed to confirm that the total of the individual alpha emitters do not exceed the overall standard of 15 pCi/L. Although numerous beta emitters will be analyzed for, gross beta will be measured separately to ensure that no significant beta emitters were overlooked.

Table 4-3 is the resulting groundwater COPC list for the 100-BC OUs. Regulatory agencies review the groundwater COPC list and can modify the list, as they do for soil target analyte lists.

Table 4-3. Groundwater COPCs for the 100-BC OUs

Radionuclides	Non-radionuclides	
Carbon-14	Antimony	Selenium
Cesium-137	Arsenic	Thallium
Cobalt-60	Beryllium	Zinc
Europium-155	Cadmium	1,1-Dichloroethene
Iodine-129	Chromium	1,1,2,2-Tetrachloroethane
Nickel-63	Cobalt	Benzene
Radium-228	Copper	Carbon Tetrachloride
Strontium-90	Hexavalent Chromium	Chloroform
Technetium-99	Lead	Tetrachloroethene
Tritium	Manganese	Trichloroethene
Uranium (total)	Mercury	Vinyl Chloride
	Nickel	Nitrate
		Total Petroleum Hydrocarbons (TPH) – Diesel range

4.3 Identification of Data Gaps

A product of the planning process is the identification of data gaps. Systematic planning identified eight data gaps to address uncertainties within the study area. The identified data gaps were selected to address uncertainties associated with nature and extent of contamination, fate and transport, and the hydrogeologic framework. Data gaps are identified in Table 4-4 with a description of data needs, planned efforts (i.e., drilling, sampling, and analysis) to address the uncertainty, and other background information. Additional background information and the rationale for planned efforts are presented in Sections 4.3.1 and 4.3.2. Figure 4-1 shows the locations of boreholes, wells, and waste sites described in this section. Table 4-5 identifies the number of field investigation locations for soil and water sampling. This includes the number of boreholes, wells, waste sites, and test pits to be drilled, excavated, and sampled. The specific sampling program, including the number of samples and analytical tests, are presented in the 100-BC SAP (DOE/RL-2009-44).

Table 4-4. 100-BC Data Gaps

Data Gap	Data Gap No.	Data Need	Description	Additional Data Collection Recommended?	Scope of Work	Justification
Verification data have not been collected from 100-C-7 according to the IROD.	1	Verification data are needed (after remediation) to complete interim remedial action at 100-C-7.	Collect verification samples and monitoring as applicable to assess impacts to groundwater and the Columbia River.	Yes	Conduct verification sampling and monitoring as applicable during the excavation of this waste site to the top of the unconfined aquifer.	100-C-7 has been characterized to the depth of the water table. Although this site has been remediated to the depth of 4.6 m (15 ft), soil concentrations exceed interim remedial action goals for protection of groundwater and the Columbia River.
Data are needed to refine the CSM of contaminant distribution beneath remediated waste sites.	2	Data are needed to assess the nature and vertical extent of contamination beneath select remediated waste sites.	Drill boreholes at select remediated waste sites. Excavate test pits into select remediated waste sites. Collect and analyze samples to assess the nature and vertical extent of contamination.	Yes	Drill boreholes into remediated waste sites as shown in Figure 4-1. Conduct test pit sampling at select remediated waste sites. Collect and analyze soil samples as described in the SAP (DOE/RL-2009-44). Waste sites with proposed boreholes are 100-B-5; 116-B-5; 116-B-14; 116-C-5; 118-B-6. Waste sites with proposed test pits are 118-B-8:3; 116-B-6B; 116-B-9. Conduct sampling to address data gap No. 7.	Characterization is needed to validate interim remedial action, including analysis for additional COPCs, and address uncertainty regarding the nature and extent of residual contamination in the vadose zone.
Data are needed to refine the CSM of contaminant distribution beneath and around reactor structures.	3	Data are needed to determine the nature and vertical extent of the contamination in the vadose zone around the 105-B and 105-C reactor structures.	Drill boreholes around 105-B and 105-C Reactor structures to assess the nature and vertical extent of contamination in the vadose zone.	Yes	Drill boreholes near the 105-B and 105-C reactors in locations shown in Figure 4-1. Collect and analyze soil samples as described in the SAP (DOE/RL-2009-44). Conduct sampling to address data gap No. 7.	The nature and extent of vadose zone contamination associated with the reactors has not been defined.
The nature and extent of contamination in the unconfined aquifer above cleanup standards has not been defined in select areas or for all COPCs.	4	Data are needed to identify groundwater contaminants and define the extent of contamination horizontally and vertically.	Cr(VI), tritium, and Sr-90 contamination has been detected at concentrations above water quality standards in the upper part of the unconfined aquifer in 100-BC. The extent of contamination has not been defined spatially in all locations. The vertical distribution of contamination has not been characterized. Not all groundwater COPCs are routinely monitored. Groundwater monitoring wells will be installed and monitored to define the extent of contamination.	Yes	Install six new groundwater monitoring wells (details provided in text). Well 1: A well to create a shallow/deep pair to characterize and monitor vertical distribution of contaminants. Well 2: A well to define the contaminant plumes near the river, to be placed southeast of the intake structure. Well 3: A well placed to provide information on chromium and Sr-90 distribution within the unconfined aquifer in a cluster with existing Wells 199-B3-47 (water table) and 199-B2-12 (RUM), and provide vertical hydraulic gradient data. The well will be placed where the chromium concentrations at the top of the aquifer are historically highest. Well 4: A well west of the C Reactor to define the western extent of contamination. Well 5: A well in the southeastern corner of 100-BC to define the southern extent of contamination. Well 6: A well screened in the first water bearing unit within the RUM and paired with Well C7665 to confirm the conditions of Well 199-B2-12, which is screened in the RUM and has no contamination. Sample new and existing monitoring wells for all groundwater COPCs. Details are found in the SAP (DOE/RL-2009-44).Conduct sampling to address data gap No. 7.	Analyzing samples from new and existing wells for all COPCs will provide data on the nature and extent of groundwater contamination. Groundwater quality data collected during drilling of new wells will determine how deep in the aquifer contamination is present.

Table 4-4. 100-BC Data Gaps

Data Gap	Data Gap No.	Data Need	Description	Additional Data Collection Recommended?	Scope of Work	Justification
The level of contamination entering the Columbia River is not well known.	5	Data are needed to confirm results of previous pore water sampling, to observe concentration trends over time, and to better define areas of contamination under the river. Data from the aquifer tube network are needed to monitor concentrations over time and with depth near the river.	Groundwater upwelling sampling and analysis in the Columbia River channel was performed in fall 2009, and follow-up sampling is planned for early 2010. It is expected these data will provide additional insight regarding contaminant levels entering the river and groundwater/river mixing ratio within the biotic zone (upper 30.5 cm; ~12 in. of substrate). Evaluate additional methods (e.g., new rounds of pore water samples in fall 2010, horizontal aquifer tubes in the biotic zone) in appropriate 100-BC locations to validate/update the pore water sampling.	Yes	Collect groundwater upwelling (pore water) samples in the Columbia River. Focus on sites where contamination was detected in previous pore water sampling and where specific conductance indicates groundwater upwelling (details provided in text and DOE/RL-2009-44). Continue routine sampling of existing aquifer tubes per DOE/RL-2000-59, *Sampling and Analysis Plan for Aquifer Sampling Tubes*, Rev. 1, or subsequent revisions. Install three new aquifer tube clusters to provide better coverage (details provided in text and DOE/RL-2000-59).	Additional sampling is needed to define the nature and extent of contamination in the hyporheic zone.
The fate and transport of contaminants beneath the unconfined aquifer has not been evaluated over a sufficiently large area of 100-BC.	6	Only one well has been completed within the RUM aquitard unit in 100-BC. Data are not available to evaluate the integrity of the aquitard unit, or fate and transport within the aquitard.	The RUM unit is currently considered an aquitard. The integrity of the aquitard unit and potential transport within the aquitard has not been evaluated in 100-BC. Groundwater monitoring wells will be installed to appropriate depths to determine the fate and transport characteristics of the aquitard.	Yes	Collect split spoon soil samples at total depth of 1.5 m (5 ft) into the RUM from the new proposed wells (data gap No. 4), and the four new wells (Wells C7505, C7506, C7507, and C7665) being installed per SAP DOE/RL-2009-61, *Sampling and Analysis Plan for Four Groundwater Monitoring Wells in the 100-BC Decision Unit.* Drill one well (Well No. 6 from data gap No. 4) into the RUM to the first water producing unit and collect soil and groundwater samples. Sampling details are listed in DOE/RL-2009-44.	These data are needed to confirm that the RUM is an aquitard beneath 100-BC and determine if water within the RUM is contaminated.
Data are needed for a better understanding of hydrogeological conditions, aquifer interactions, and Cr(VI) mobility through the vadose zone.	7	Geological characterization, physical, and hydraulic property data are needed to support modeling and analysis.	On select soil samples, estimate soil properties and hydraulic properties, determine level of contamination, and perform batch and column leach contact tests.	Yes	Drill and sample soil and groundwater from proposed groundwater wells and boreholes (data gap No. 4). Details are found in the SAP (DOE/RL-2009-44). Install one new well (Well No. 3) screened near the base of the unconfined aquifer near existing wells 199-B3-47 (water table) and 199-B2-12 (RUM). Collect soil and water samples throughout the thickness of the unconfined aquifer and the top of the RUM. Install pressure transducers in the three wells to obtain information about vertical hydraulic gradients. Install and monitor pressure transducers in selected other wells to determine horizontal hydraulic gradient and vertical gradient using wells installed as multi-depth pairs per data gap No. 4. Conduct batch and column leach tests from soil samples collected at 100-C-7.	Support fate and transport modeling and examine the persistence of contaminants.
Data are needed to reduce the uncertainty in spatial and temporal distribution of groundwater contamination.	8	Groundwater chemistry data are needed to reduce uncertainty in determining risks due to groundwater contamination.	Obtain data that are spatially representative of the area, representative of river stage influence, and inclusive of all COPCs.	Yes	Collect and analyze groundwater samples from 18 groundwater monitoring wells (see text) at three river stages (high, low, and transitional) to characterize the spatial and temporal extent of groundwater contamination. Details are found in the SAP (DOE/RL-2009-44).	Groundwater data are needed to address uncertainties associated with the RCBRA.

Notes:

DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/Feasibility Study.*

DOE/RL-2000-59, *Sampling and Analysis Plan for Aquifer Sampling Tubes*, Rev. 1.

DOE/RL-2009-61, *Sampling and Analysis Plan for Four Groundwater Monitoring Wells in the 100-BC Decision Unit.*

COPC = contaminant of potential concern
cm = centimeter(s)
Cr(VI) = hexavalent chromium
CSM = conceptual site model
ft = foot/feet
in. = inch(es)
IROD = interim record of decision
m = meter(s)
RCBRA = River Corridor Baseline Risk Assessment
RUM = Ringold Upper Mud
SAP = Sampling and Analysis Plan
Sr-90 = Strontium-90

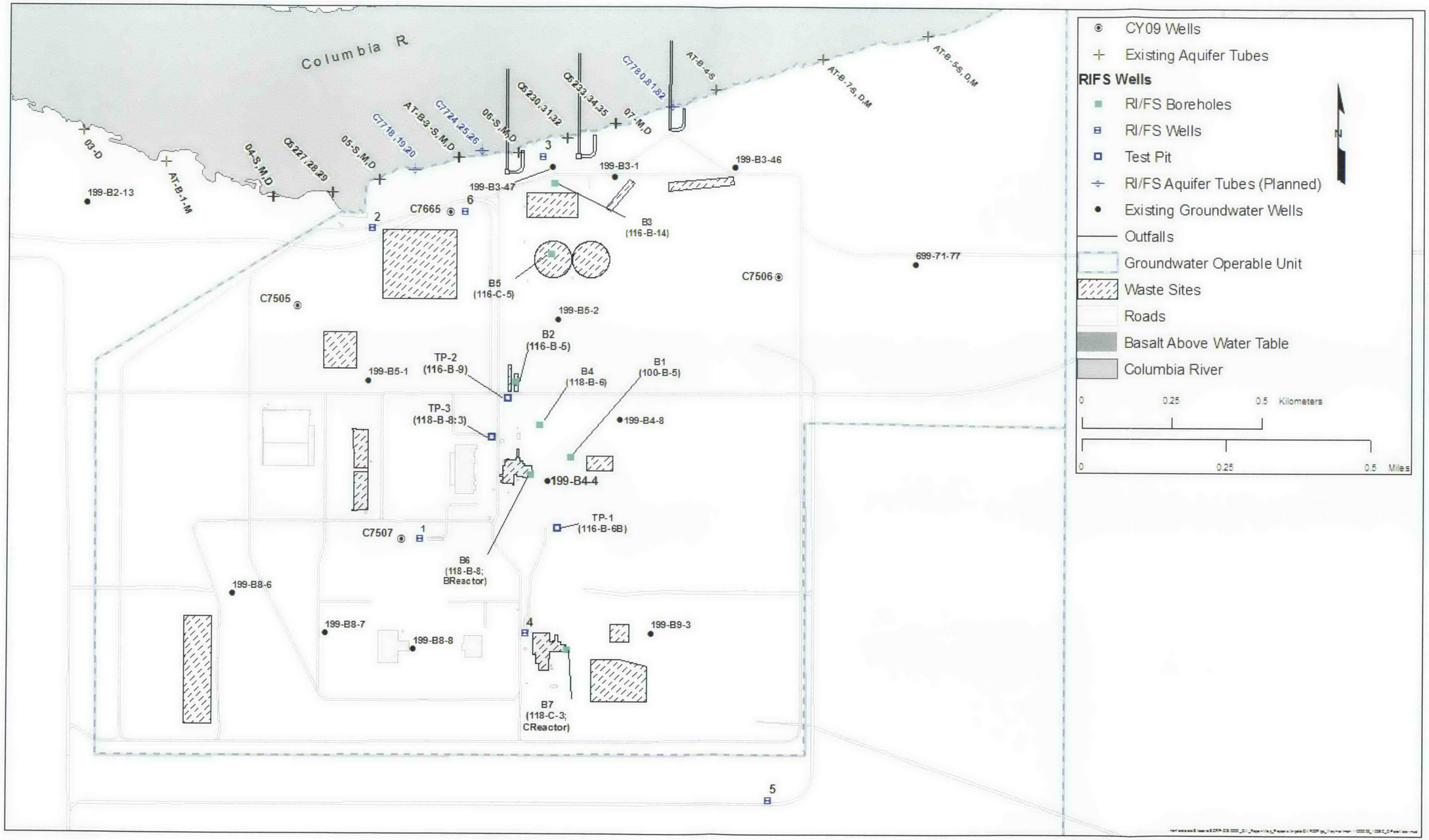

Figure 4-1. Proposed RI/FS Sampling Locations for Soil and Groundwater for 100-BC

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Table 4-5. Proposed 100-BC Field Characterization

Type	Number
To Be Remediated Source Sites[a]	1
New boreholes (vadose zone)	7
New Test Pits (vadose zone)	3
New wells (unconfined aquifer)	9[b]
New wells (screened the Ringold Upper Mud Unit)	1
Monitoring wells (sampling to support risk characterization)	18[c]

Notes:

a. This task is not within the scope of the SAP in this addendum. Accepted and Discovery sites are being evaluated, characterized, and/or remediated according to DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*

b. Four new wells will be installed as described in Sampling and Analysis Plan DOE/RL-2009-61, *Sampling and Analysis Plan for Four Groundwater Monitoring Wells in the 100-BC Decision Unit,* and five new wells will be installed in FY10 as part of this RI as described in Sampling and Analysis Plan DOE/RL-2009-44, *Sampling and Analysis Plan for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units Remedial Investigation/ Feasibility Study* (Section 4.8.2).

c. The 18 wells to be sampled to support risk characterization include 14 existing monitoring wells and 4 new wells to be installed as described in the SAP, DOE/RL-2009-61 (Section 4.8.2).

RI = Remedial Investigation

SAP = Sampling and Analysis Plan

4.3.1 100-BC Data Gaps – Vadose Zone

There are 150 waste sites in 100-BC (including sub-sites). Remediation of these sites began in 1996 under the remedial action authority of an interim action ROD. As of January 2010, 124 of the 150 waste sites have been characterized, remediated, and interim closed or evaluated (i.e., rejected or not accepted as waste sites) in accordance with an interim action ROD or other regulatory guidance. The remaining 26 waste sites have an accepted site status. Many of these waste sites have been remediated and interim close out is expected in spring 2010. The extent of remaining contamination within the vadose zone is unknown in several areas within 100-BC, as discussed in data gaps No. 1 through No. 3.

Data Gap No. 1: Verification data are not sufficient or available to interim close 100-C-7 according to the Interim Record of Decision (IROD).

Background and Justification: With the exception of the 100-C-7 waste site and the pending approval of nine waste site close-out packages under review by EPA, interim remedial actions in 100-BC have been completed. The 100-C-7 site has been characterized to the depth of the water table and remediated to a depth of 4.6 m (15 ft) bgs. Current information indicates that contaminant concentrations in the soil column exceed RAGs for protection of groundwater and the Columbia River. Continued remedial action (such as removal, treatment, and disposal [RTD]) and verification sampling are planned at 100-C-7. Activities associated with this task are guided by the interim action ROD; DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*; DOE/RL-96-22, *100 Area Remedial Action Sampling and Analysis Plan*; and DOE/RL-2001-35, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan.* As such, sampling and analysis requirements for data gap No. 1 are not directed by the 100-BC addendum and SAP.

Scope of Work: Continue excavation and RTD activities, and perform verification sampling at the 100-C-7 waste site. Due to the levels of Cr(VI) present at 100-C-7, this site is an excellent source to support planned leach testing. During or prior to remedial activities and sampling, a soil sample will be collected within the waste site, in an area with high levels of Cr(VI) contamination, to support leach testing described in data gap No. 7. In addition, approved close-out documentation shall be obtained from the regulators on nine waste sites. Closeout documentation should indicate achievement of interim remedial action goals. If interim closed-out approval is not obtained, additional remediation may be required.

Data Gap No. 2: Data are needed to refine the conceptual site model of contaminant distribution beneath remediated waste sites.

Background and Justification: To determine those waste sites that may require further characterization to address CSM uncertainties regarding nature and extent of contamination and fate and transport, all of the area waste sites were placed into three general categories based on current site status. Site status provides an indicator of the cleanup progress and future evaluation that may be required.

- Category 1 includes sites with a status of no action or not accepted. No further characterization is typically required at these sites because the areas of concern meet applicable cleanup standards or closure requirements, do not require remedial action based on quantitative data, or were determined not to be a waste site according to RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)." Forty-nine sites have a status of no action, or not accepted (Table 3-3). As additional remediation and characterization are not required at Category 1 sites, no additional effort is planned in this RI.

- Category 2 includes sites with a status of accepted or discovery. This category includes sites that generally have not been remediated and interim closed or otherwise have not been addressed according to the IROD; it also includes sites that are active (e.g., in use as a septic system) and two reactor sites With exception of the waste sites located below the reactor buildings (118-B-8 and 118-C-3), the 118-B-8:3/100-B-14:1 process sewer, and the 100-C-7 waste site, accepted and discovery sites will be characterized and evaluated (as applicable) through the efforts of other programs such as the River Corridor Field Remediation Project or remain in use. Table 3-4 identifies the plan of action for the accepted and discovery sites. Only the two reactor sites, a process sewer, and the 100-C-7 waste site in this category were considered for additional characterization in this addendum.

- Category 3 includes waste sites with a status of closed and interim closed (i.e., site has been remediated according to the IROD). There are 75 waste sites in this category that are considered for additional characterization in the 100-BC OU RI/FS.

Further analysis and evaluation was then conducted to determine which sites might need further characterization. Those sites that were identified for further characterization in the RI were selected because of characterization deficiencies (i.e., COPCs were not analyzed) or the existence of other conditions. These conditions include the presence of residual contamination, amount of data available, and the volume of liquid at the waste site, among others. The process for this evaluation is described below.

Step 1: The first step was to eliminate sites that had a rejected or not accepted reclassification status, were part of an active facility, or were undergoing active remediation (Table 4-6).

Table 4-6. Waste Sites Dropped from Further Consideration by Step 1

100-B-4	100-B-30	100-C-2	132-B-2
100-B-7	100-B-31	100-C-4	600-33
100-B-17	100-B-32	100-C-5	600-34
100-B-19	100-B-33	100-C-6:5	600-56
100-B-21:4	118-B-7	100-C-7	600-67
100-B-22:2	126-B-4	100-C-7:1	600-231
100-B-25	128-B-1	100-C-7:2	600-252
100-B-27	1607-B5	100-C-8	600-253
100-B-28	1607-B6	124-C-4	600-264
100-B-29			

Step 2: Review available site data (WIDS, CVPs, RSVPs, LFI) for sites with a no action, interim closed out, or closed out reclassification status to identify sites with potential data missing for primary risk driver COPCs. This includes consideration of missing analyses and exceedances of applicable PRG values. Sites that were eliminated at this step are shown in Table 4-7.

Table 4-7. Waste Sites Dropped from Further Consideration by Step 2

100-B-1	100-B-21:2	118-B-2	1607-B11
100-B-2	100-B-21:3	118-B-3	100-C-3
100-B-3	100-B-22:1	118-B-4	100-C-9:1
100-B-10	100-B-26	118-B-5	100-C-9:2
100-B-11	116-B-2	126-B-2	100-C-9:3
100-B-12	116-B-3	128-B-3	100-C-9:4
100-B-14:1	116-B-4	132-B-3	116-C-3
100-B-14:3	116-B-6A	132-B-4	116-C-6
100-B-14:4	116-B-12	132-B-5	118-C-2
100-B-14:5	116-B-13	1607-B3	132-C-1
100-B-14:7	116-B-15	1607-B4	132-C-3
100-B-21:1	116-B-16	1607-B7	600-230

Step 3: From the list of remaining waste sites, those waste sites that had exceedances of PRG values for contaminants with high soil-partitioning affinity, and that had little or no liquid use were eliminated from further evaluation. These sites are presented in Table 4-8:

Table 4-8. Waste Sites Dropped from Further Consideration by Step 3

100-B-16	132-B-1
100-B-18	132-B-6
100-B-20	1607-B1
100-B-23	1607-B8
100-B-24	1607-B9
100-B-31	1607-B10
116-B-10	118-C-1
118-B-9	118-C-3:3
118-B-10	118-C-4
120-B-1	128-C-1
126-B-1	600-232
126-B-3	600-233
128-B-2	

Step 4: From the list of remaining waste sites, those sites that already have sufficient vertical characterization data from interim remediation or other characterization data were eliminated from further evaluation. Table 4-9 lists those sites and indicates the type of characterization data that was collected.

Table 4-9. Waste Sites Dropped from Further Consideration by Step 4

100-B-15	River outfall pipelines – numerous existing samples
118-B-1	Previous characterization test pits and borehole
116-C-1	Previous characterization test pit to groundwater
116-C-2A	Previous characterization borehole

The remaining waste sites requiring additional characterization are presented in Table 4-10. The existing contaminant data collected from the vadose zone was obtained from depths no greater than 9.1 m (30 ft) bgs, with a few exceptions. The available data indicate the need to better characterize the vadose zone beneath select waste sites and assess the vertical extent of vadose zone contamination. Characterization is needed to validate interim remedial action and address uncertainty regarding the nature and extent of residual contamination in the vadose zone. Additional information on each waste site and a detailed description for each is provided under the associated data gap.

Table 4-10. Remaining Waste Sites for Further Characterization

Waste Site	Planned Characterization
100-B-5	Selected for RI borehole
100-B-8:1	Data gap addressed by 100-B-5 borehole

Table 4-10. Remaining Waste Sites for Further Characterization

Waste Site	Planned Characterization
100-B-8:2	Data gap addressed by 100-B-5 borehole
100-B-14:2	Localized residual contamination sufficiently characterized
100-B-14:6	Data gap addressed by 118-B-8:3 test pit
116-B-1	Analogous to 116-C-1
116-B-5	Selected for RI borehole
116-B-6B	Selected for RI test pit
116-C-9	Selected for RI test pit
116-B-7	Data gap addressed by 100-B-5 and 116-C-5 boreholes
116-B-11	Analogous to 116-C-5
116-B-14	Selected for RI borehole
118-B-8:1	Selected for RI borehole
118-B-8:2	Analogous to 118-C-3:3
118-B-8:3	Selected for RI test pit (chemical process sewer component—pipeline discharging to former 100-B-14:1 sewer)
118-B-6	Selected for RI borehole
132-B-6	Data gap addressed by 100-B-5 and 116-C-5 boreholes
1607-B2:1 and 1607-B2:2	Sufficient existing characterization of residual contaminant concentrations
100-C-6:1	Data gap addressed by 100-B-5 borehole
100-C-6:2	Data gap addressed by 100-B-5 borehole
100-C-6:3	Data gap addressed by 100-B-5 borehole
100-C-6:4	Data gap addressed by 100-B-5 borehole
116-C-2B	Data gap addressed by previous 116-C-2A borehole
116-C-2C	Data gap addressed by previous 116-C-2A borehole
116-C-5	Selected for RI borehole
118-C-3:1 and 118-C-3:2	Selected for RI borehole
132-C-2	Data gap addressed by 100-B-5 and 116-C-5 boreholes

Notes:

RI = Remedial Investigation

Scope of Work: Five boreholes will be drilled and three test pits will be excavated to fill this data gap and obtain the data needed to refine the CSM. Soil samples will be collected during drilling and analyzed to assess vertical extent of contamination in the vadose zone beneath select waste sites. Test pits will be excavated to the depth of previous remediation at two locations. Soil samples will be collected and

analyzed to assess the nature of contamination immediately below the depth of remedial action. An additional test pit will be excavated to provide access to contaminant material in and beneath a pipeline (process sewer). This scope of work will also be used to gather data identified in data gap No. 7. Soil samples will be collected and analyzed as described in the SAP (DOE/RL-2009-44). The locations of the boreholes and waste sites of interest are shown in Figure 4-1 and described in Table 4-11. Boreholes for this data gap are identified as B2 through B6, and test pits are identified as TP-1 through TP-3.

Table 4-11. Borehole and Test Pit Locations and Justification for Data Gap No. 2

Waste Site	Site Status	Characterization Description	Justification for Inclusion
100-B-5 Trench	Interim Closed	Borehole B1	The 100-B-5 Trench was selected for characterization because mercury and total chromium are above screening levels for groundwater protection at a depth of 8.5 m (28 ft) below surface. No other contaminants were above screening levels for protection of groundwater. Although Sr-90 and Cr(VI) were detected below screening for groundwater protection, this site is selected because of its location with respect to the two groundwater plumes. Portions of the 100-B-8 and 100-C-6 effluent pipelines are located adjacent to this site; therefore, data will be provided to characterize process pipelines.
116-B-5 Crib	Interim Closed	Borehole B2	The 116-B-5 Trench was selected for characterization because the list of COCs analyzed was limited and tritium, mercury, and barium were identified above screening levels for groundwater protection at a depth of approximately 4.8 m (16 ft) bgs. This site is also located relative to the tritium, Cr(VI), and Sr-90 groundwater plumes and the site is a likely source of the tritium groundwater contamination. Process information indicates that 10 million L (2.64 million gal) of tritiated effluent containing hundreds of gallons of mercury along with solvents and degreasers such as carbon tetrachloride, methyl alcohol, and trichloroethylene were released to the soil column. The volume of effluent release was sufficient to affect the entire vadose zone beneath the waste site. No organics or Cr(VI) were part of the original close out data.
116-B-14 Sludge Trench	Interim Closed	Borehole B3	This site received sludge from the 116-B-11 Retention Basin. There is no history of this site receiving a high volume liquid waste stream. This site is being characterized to support CSM development of a low-volume liquid site; there is also a lack of PCB data at this site. Site is located relative to the Cr(VI), tritium, and Sr-90 groundwater plumes adjacent to the Columbia River.
118-B-6 Burial Ground	Interim Closed	Borehole B4	The 118-B-6 Burial Ground is selected for characterization because the list of COCs analyzed was limited and tritium levels in the soil column at a depth of 7.0 m (23 ft) is approximately 200 times the soil concentration that is protective of groundwater. This site is also located relative to the Sr-90 and Cr(VI) groundwater plumes.
116-C-5 Retention Basin	Interim Closed	Borehole B5	This site was selected for characterization because Cr(VI), total chromium, lead, mercury, and nickel-63 exceed remedial action goals in the deep zone. The site is also located relative to the Cr(VI), tritium, and Sr-90 groundwater plumes adjacent to the Columbia River.

Table 4-11. Borehole and Test Pit Locations and Justification for Data Gap No. 2

Waste Site	Site Status	Characterization Description	Justification for Inclusion
116-B-6B Crib	Interim Closed	Test Pit TP1	The 116-B-6B Crib was selected for characterization because it received 100 kg of sodium dichromate in 4,000 L (1,056 gal) of effluent. Based on the soil column pore volume of 198 m^3 (6,992 ft^3), the volume discharged was not sufficient to affect groundwater. Thus, the volume of effluent discharged to the soil column remains in the vadose zone and may be a future source of groundwater contamination. This site is also selected because the depth of remedial action 4.6 m (15 ft) is equal to the depth to the engineered structure 4.6 m (15 ft); lead was the only contaminant of concern analyzed for during closeout sampling. The site was also selected due to its location relative to the Sr-90 and Cr(VI) groundwater plumes.
116-B-9 French Drain	Interim Closed	Test Pit TP2	This site was selected for characterization because data are not available to evaluate the concentration and distribution of tritium at this site. The site was part of the P-10 project and tritium was not included in the analysis list for the close out data.
118-B-8:3/ 100-B-14:1 Process Sewer	Accepted	Test Pit TP3	This site was selected for characterization because the pipeline is located near the 118-B-8 Reactor. Samples will be collected from inside and below the pipe mainly to evaluate risk and contaminant level below the 105-B reactor museum.

Notes:

bgs	=	below ground surface	kg	=	kilogram(s)
COCs	=	contaminants of concern	L	=	liter(s)
Cr(VI)	=	hexavalent chromium	m	=	meter(s)
CSM	=	conceptual site model	m^3	=	cubic meters
ft	=	foot/feet	PCB	=	polychlorinated biphenyl
ft^3	=	cubic feet			

Borehole samples will be screened in the field for radiological contamination and Cr(VI). Radiological screening will be conducted with field instruments. Screening for Cr(VI) will be performed visually and assumed present, as indicated by soil staining. Groundwater samples will also be collected and analyzed for COPCs as outlined in the SAP (DOE/RL-2009-44).

Soil samples from boreholes will be collected for chemical and radiological analysis at 1.5 m (5-ft) intervals from the bottom of the waste site (or the maximum depth of remedial action). Continuous sampling will be performed within 3 m (10 ft) of the water table. A soil and filtered water sample will also be collected 1.5 m (5 ft) into the aquifer. Opportunistic groundwater samples will be collected from borings as described under Task No. 1, in Section 4.3.3. Additional samples may be collected at the discretion of the geologist or sampler, based on field screening results. Specific sample intervals and COPCs are defined in the SAP (DOE/RL-2009-44). Boreholes will be decommissioned after sample collection.

Test pit samples will also be screened in the field for radiological contamination and Cr(VI). Radiological screening will be conducted with field instruments. Screening for Cr(VI) will also be performed visually and assumed present, as indicated by soil staining. Sample intervals and COPC are defined in the SAP (DOE/RL-2009-44). The test pits will be backfilled after sampling.

- The 116-B-6B Crib and 116-B-9 French Drain sampling will commence at the maximum depth of remedial action or when native soils are encountered. Sampling will be conducted from each test pit as described in the SAP (DOE/RL-2009-44).
- The 118-B-8:3/100-B-14:1 Process Sewer shall be sampled inside of the pipeline/process sewer (sediment, soil, and/or sludge). A soil sample will also be collected beneath the pipeline.

Data Gap No. 3: Data are needed to refine the conceptual site model of contaminant distribution beneath and around reactor structures.

Background and Justification: There are two inactive reactors at 100-BC. As previously discussed, the 105-B Reactor is slated for historical conservation and the 105-C Reactor has been placed into ISS. The reactor structures, thick reinforced concrete floors, and associated pipelines have inhibited the ability to characterize the area below the reactors. Little or no contaminant data have been collected in and around the 105-B Reactor. The nature and extent of vadose contamination associated with the reactors is not well defined.

Borehole drilling and sampling are planned at the 105-B and 105-C Reactor Fuel Storage Basins. Historical information indicates that each basin leaked in the past and contained pool water (reactor cooling water), spent fuel, and sludge. Soil at the fuel storage basins may be contaminated.

Scope of Work: Boreholes B6 and B7 will be drilled to fill this data gap and obtain the data needed to refine the CSM. Borehole samples will be collected and analyzed mainly to assess vertical extent of contamination in the vadose zone beneath and around the reactor fuel storage basins. The locations of the boreholes and waste sites of interest are shown in Figure 4-1 (Boreholes B6 and B7) and described in Table 4-12. Soil samples will be collected and analyzed as described in the SAP (DOE/RL-2009-44). This task will also be performed to gather data identified in data gap No. 7.

Borehole samples from the reactors will also be screened in the field for radiological contamination and Cr(VI). Radiological screening will be conducted with field instruments. Screening for Cr(VI) will be performed visually and assumed present, as indicated by soil staining. Sampling at the 105-B Reactor will start at the surface, with sampling at 105-C Reactor starting at the depth of 4.6 m (15 ft), which is the depth of previous RTD activities. Soil samples will generally be collected for chemical and radiological analysis at 1.5 m (5-ft) intervals. Continuous sampling will be performed within 3 m (10 ft) of the water table. A soil and filtered water sample will also be collected 1.5 m (5 ft) into the aquifer. Additional samples may be collected at the discretion of the geologist or sampler based on field screening results. Specific sample intervals and COPCs are defined in the SAP (DOE/RL-2009-44). The boreholes will be decommissioned after sample collection.

Table 4-12. Borehole Locations and Justification for Data Gap No. 3

Waste Site	Site Status	Characterization Description	Justification for Inclusion
118-B-8 Reactor	Accepted	Borehole B6	This site is selected because little or no data have been collected in the immediate vicinity of the reactor. The reactor fuel storage basin is known to have leaked and contained fuel pool water, spent fuel, and sludge. The site is also located relative to the Cr(VI) and Sr-90 groundwater plumes adjacent to the Columbia River. Data are needed to evaluate the vertical extent of contamination at the 105-B reactor museum.

Table 4-12. Borehole Locations and Justification for Data Gap No. 3

Waste Site	Site Status	Characterization Description	Justification for Inclusion
118-C-3 Reactor	Accepted	Borehole B7	This site is selected because the reactor fuel storage basin is known to have leaked and contained fuel pool water, spent fuel, and sludge. Data are needed to evaluate the vertical extent of contamination at the reactor.

Notes:

Cr(VI) = hexavalent chromium

Sr-90 = Strontium-90

4.3.2 100-BC Data Gaps – Groundwater

Data gaps specific to groundwater are identified and described in this section. Data gaps include analytical data (e.g., laboratory sample results), other quantitative data (e.g., hydrogeologic, geochemical parameters), and qualitative data (e.g., decision data needs, policy data needs, and information data needs). Proposed groundwater monitoring wells are summarized in Table 4-4, and discussed in the following data gap descriptions.

Data Gap No. 4: The nature and extent of contamination in the unconfined aquifer above cleanup standards has not been defined in select areas or for all COPCs.

Background and Justification: Knowledge of the nature and extent of contamination across 100-BC is limited due to the depth, location, and number of existing monitoring wells. While previous investigations have taken place, as discussed in Chapter 3, data from these investigations were often limited in the number of contaminants analyzed and the frequency of sampling. In addition, analytical testing methods have changed over the many years of investigation.

Hexavalent chromium, tritium, and Sr-90 contamination have been detected at concentrations above the water quality standards in the upper part of the unconfined aquifer of 100-BC. The extent of contamination has not been defined spatially in all locations and the vertical distribution of contamination has not been characterized. In addition, not all groundwater COPCs are routinely monitored.

EPA expects to return usable groundwater to beneficial use wherever practical, within a period that is reasonable given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practical, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction (40 CFR 300.430[a][1][iii][F]).

Groundwater plume movement must also be evaluated to assess whether there will be impacts to surface water. If impacts are occurring or might reasonably be expected to occur in the future, human exposure to surface water and aquatic protection must be evaluated. The results of the RCBRA will be used to support comparisons of remedial action scope and cost estimates for the FS.

Analyzing samples from new and existing wells for COPCs will provide data on the nature and extent of groundwater contamination. Groundwater quality data collected during drilling of new wells will determine how deep in the aquifer contamination is found. In addition, groundwater elevation data will be used to evaluate groundwater and plume flow direction.

Scope of Work: Install six new groundwater monitoring wells as follows:

- Well 1: A well to create a shallow/deep pair to characterize and monitor vertical distribution of contaminants. This well will be paired with Deep Well C7507 to create a shallow/deep pair.
- Well 2: A well to define the contaminant plumes near the river, to be placed southeast of the intake structure. The well will be drilled and sampled to the RUM and screened at the depth of maximum chromium concentrations.
- Well 3: A well placed to provide information on Cr(VI), Sr-90, and tritium distribution within the unconfined aquifer and provide vertical hydraulic gradient data. The well will be placed where the chromium concentrations at the top of the aquifer are historically highest. The location is adjacent to Wells 199-B2-12 (screened in the RUM) and 199-B3-47 (screened at the water table). The well will be drilled to the top of the RUM for characterization, and screened at the depth of peak chromium concentration, unless that is at the top of the aquifer. If the maximum chromium concentrations are at the top of the aquifer or if contamination is vertically homogeneous, Well 3 will be screened at the bottom of the unconfined aquifer. This well will provide information on Cr(VI), Sr-90, and tritium distribution within the unconfined aquifer and provide vertical hydraulic gradient data.
- Well 4: A well west of the C Reactor to define the western extent of chromium contamination. The well will be drilled to RUM and screened at depth of greatest chromium contamination. If no significant contamination or if contamination is vertically homogeneous, the well will be screened at the top of the aquifer.
- Well 5: A well in the southeastern corner of 100-BC to define the southern extent of contamination. The well will be drilled to the RUM and screened at the depth of greatest chromium contamination. If no significant contamination is present, or if contamination is vertically homogeneous, the well will be screened at the top of the aquifer.
- Well 6: A well screened in the first water bearing unit within the RUM and paired with Well C7665, to obtain additional information on the potential for contamination in the RUM.
- New and existing monitoring wells (including the four wells installed during FY 2009 (DOE/RL-2009-61) will be sampled for all groundwater COPCs (Table 4-2). Details are found in the SAP (DOE/RL-2009-44).
- Further sampling of Wells 1 through 6 after well completion will be evaluated for inclusion into *100-BC-5 Operable Unit Sampling and Analysis Plan* (DOE/RL-2003-38, Rev. 1).

During well installation, the following data will be collected:

- Soil data (split spoons) above the unconfined aquifer, within the aquifer, prior to entering the RUM, and after entering the RUM.
- Water samples within the unconfined aquifer to determine vertical distribution of contamination.
- Soil and groundwater characterization are not required in Well 1 because data are available from adjacent Well C7507. Soil and groundwater characterization through the unconfined aquifer are not required in Well 6 because data are available from adjacent Well C7665. Details are provided in the SAP.

Data Gap No. 5: The level of contamination entering the Columbia River is not well known.
Background and Justification: The near-shore groundwater conditions are directly affected by river stage. Limited data have been available to understand groundwater flow paths, contaminant migration,

and mixing in the near-shore area adequately. A wide range of mixing ratios has been observed (SGW-39305, *Technical Evaluation of the Interaction of Groundwater with the Columbia River at the Department of Energy Hanford Site, 100-D Area*) between upwelling water at the bottom of the river and groundwater at near-shore locations. This mixing ratio represents a continuum from pure groundwater to pure river water, depending on where in the groundwater pathway measurement is taken. The current dilution factor allowed by the interim action ROD is 1:1. Appendix D, Milestone M-016-110-T01 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b) requires compliance with cleanup standards in the hyporheic zone. Thus, more data from near-shore wells and aquifer tubes will be gathered to quantify groundwater-river water mixing behavior, addressing this uncertainty in establishing remediation goals.

Scenarios for plume discharge to the river vary widely because of seasonality and dynamic conditions in the zone of interaction. The greatest contaminant flux and highest concentrations at exposure locations are postulated to occur during periods of low river stage conditions, when the hydraulic gradient toward the river is steepest and mixing between river water and groundwater is minimal. Additional physical, chemical, and biological process data and ongoing monitoring information may be needed to understand the features and transport processes associated with the zone of interaction and their potential impact to aquatic receptors, as well as to support remedy decisions.

Groundwater upwelling sampling and analysis in the Columbia River channel was performed in fall 2009, and follow up sampling is planned for early 2010. The fall sampling at 100-BC focused on delineating areas of suspected groundwater plume upwelling. This activity included in situ pore water measurements of specific conductance, temperature, and Cr(VI). The follow up sampling in 2010 is anticipated to concentrate on those areas where Cr(VI) was detected, and include analysis for metals, uranium, nitrate, radionuclides, Sr-90, and field parameters as outlined in DOE/RL-2008-11, *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River*.

It is expected that these data will provide further insight regarding contaminant levels entering the river and groundwater/river mixing ration within the biotic zone (upper 30.5 centimeters [12 inches] of the substrate). Additional sampling is needed to define the nature and extent of contamination approaching the river and in the pore water (i.e., entering the accessible river environment).

Additional sampling (e.g., new rounds of pore water samples, horizontal aquifer tubes in the biotic zone) will be evaluated in appropriate 100-BC locations to validate/update the pore water sampling conducted in 1995, 2009, and 2010 as it relates to both the appropriate mixing ratio and further information on upwelling contaminant concentrations.

Scope of Work: Groundwater upwelling (pore water) samples will be collected in the Columbia River. Samples will be collected from established upwelling locations, with the focus on sites where contamination was detected in previous pore water sampling conducted under the *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* (DOE/RL-2008-11). At a minimum, sampling will be attempted under this RI/FS at all ten of the 100-BC locations selected for Phase III sampling under DOE/RL-2008-11. Exact sample locations will be identified in the field using the procedures for identifying favorable flow conditions relating to temperature and conductivity, as outlined in DOE/RL-2008-11. Any additional sampling locations will be determined through a collaborative process with DOE and EPA.

Laboratory analysis will include, at a minimum, Cr(VI) and total Cr. Additionally, those contaminants detected above either aquatic protection levels or drinking water standards (whichever is most restrictive) during the spring 2010 Phase III sampling, conducted under DOE/RL-2008-11, will be sampled for from selected locations as indicated by the Phase III results. This need for additional analytes will be determined through a collaborative process with DOE and EPA.

Continue routine sampling of existing aquifer tubes per DOE/RL-2000-59, Rev. 1, or subsequent revisions. Install three new aquifer tube clusters to provide better coverage along the riverbank (DOE/RL-2009-59).

Data Gap No. 6: The fate and transport of contaminants beneath the unconfined aquifer has not been evaluated sufficiently over a larger area of 100-BC.

Background and Justification: Only one well in 100-BC currently monitors the RUM, Well 199-B2-12. The well is screened in sand and silty sandy gravel 4.6 m (15 ft) beneath the top of the RUM. An adjacent monitoring well that is screened at the top of the unconfined aquifer (199-B3-47) detects some of the highest concentrations of Cr(VI) and Sr-90 in 100-BC. In the deeper well (199-B2-12), Cr(VI) is near or below detection limits (≤5 μg/L) and Sr-90 is undetected.

The RUM unit is currently considered an aquitard. The continuity and integrity of the aquitard and potential transport within the RUM have not been fully evaluated in 100-BC. Additional data collection from soil borings and wells is proposed to evaluate the continuity of the RUM, its hydrologic properties, and contamination concentrations. These data are needed to confirm that the RUM is an aquitard beneath 100-BC and determine what, if any, contamination exists in the RUM.

Soil samples within the RUM will be analyzed for physical, chemical, and hydraulic properties and for the presence and leachability of contamination. Leach testing will be conducted as described in data gap No. 7. The SAP (DOE/RL-2009-44) provides details of sampling and analyses requirements for the groundwater and soil samples collected during drilling.

Scope of Work: Samples of RUM sediment (split-spoon) will be collected from the RUM and at a depth of approximately 1.5 m (5 ft) into the RUM in the wells proposed for data gap No. 4. In addition, these data are being collected for the four wells installed under DOE/RL-2009-61. Well 6 will be drilled and screened deeper in the RUM, in the first water-bearing unit. Split-spoon soil samples will be collected at changes in lithology within the RUM and at final depth. A water sample from the first water-bearing unit in the RUM will also be collected during drilling.

Data Gap No. 7: Data are needed for a better understanding of hydrogeological conditions, aquifer interactions, and Cr(VI) mobility through the vadose zone.

Background and Justification: Geological characterization and hydraulic property data are needed to support modeling and analysis, including developing a better understanding of how the groundwater moves through the aquifers, the connections between the different aquifers, and the hydrogeologic conditions of the aquifers. These data will provide a better understanding of the groundwater flow and, therefore, the fate and transport of contaminants.

The fate and transport of Cr(VI) is largely dependent on the effluent volume discharge and its contaminant K_d. Hexavalent chromium typically has a very low contaminant K_d (near zero). Thus, the contaminant moves through the vadose zone with the effluent discharged to the soil column. Studies also indicate that this constituent can be retarded in the environment, depending on the source of the contaminant and available iron in the vadose zone.

In addition to release of contaminants to the environment associated with effluent during operations, contaminants are affected by the changes in groundwater level. The periodically rewetted zone is the area where the water level in a well fluctuates throughout the year. Adjacent to 100-BC, river stage changes relatively rapidly on various time scales (e.g., hourly, daily, and seasonally). Groundwater levels in the upper aquifer and the RUM respond to changes in river stage. The water table in the aquifer responds to changing river stage up to several hundred meters inland, including areas where the highest Cr(VI) concentrations have been detected in 100-BC. During high river stage and, therefore, high groundwater table, contaminants such as Cr(VI) suspended in the periodically rewetted zone can be remobilized to

groundwater at unknown rates and concentrations, which may be a continuing source of the relatively high concentrations of chromium observed in groundwater. Conversely, during low river stage, contaminants in groundwater are left suspended on the soil matrix and are likely dissolved within residual soil moisture.

Soil and water analyses are needed to determine the potential for each unit to contain sufficient contamination to be a continuing source of groundwater contamination. Multiple hypotheses have been proposed to explain the persistent nature of Cr(VI) and Sr-90 found in groundwater.

An uncertainty exists as to whether persistent inland Cr(VI) in groundwater is the result of the following.

- Continuing vadose zone sources from beneath waste sites
- Vadose zone contamination (mass) within the periodically rewetted zone
- Contamination within the unconfined aquifer
- Contamination within or even below the RUM
- A combination of some or all of the above

The contaminant K_d of Cr(VI) should be verified to support assessments of contaminant fate and transport in the environment. In addition, the K_d of the final COPCs should be evaluated. Specific field values for soil properties are needed to support input parameters for fate and transport calculations and modeling.

Scope of Work: Drill and sample soil and groundwater from proposed groundwater wells and boreholes (data gap No. 4). Details are found in the SAP (DOE/RL-2009-44). Estimate soil and hydraulic properties necessary for modeling on soil samples (split spoons) collected during drilling.

Install one new well (Well 3) near existing Wells 199-B3-47 (water table) and 199-B2-12 (RUM). Drill to the top of the RUM for characterization and screen at the depth of peak chromium concentration, unless that is at the top of the aquifer. If the maximum chromium concentrations are at the top of the aquifer or if contamination is vertically homogeneous, screen Well 3 at the bottom of the unconfined aquifer. Collect soil and water samples throughout the thickness of the unconfined aquifer and the top of the RUM. Install pressure transducers in the three wells to obtain information about vertical hydraulic gradients. Install and monitor pressure transducers in selected other wells to determine horizontal hydraulic gradient and vertical gradient.

To determine the K_d for Cr(VI), batch and column leach tests will be conducted at the 100-C-7 waste site. This site was selected because it is the only remaining waste site where high levels of Cr(VI) are still present and accessible in the near surface to conduct an accurate leach test.

Sampling from new wells (as described in data gap No. 4 and No. 6) is proposed to explain the persistent nature of Cr(VI) and Sr-90 found in groundwater. This includes determining the Kd for Cr(VI). Soil data will be collected and analyzed for leachable chromium from the following locations:

- Above the unconfined aquifer
- Within the aquifer
- Above the RUM
- Immediately on entering the RUM
- Within the RUM

The SAP (DOE/RL-2009-44) contains a detailed description of the analyses planned. Analyses for wells are the same as those listed previously for boreholes.

Data Gap No. 8: Data are needed to reduce the uncertainty in spatial and temporal distribution of groundwater contamination.

Background and Justification: To determine human health risk uncertainties associated with the RCBRA, the RI process requires the groundwater be sampled, providing representative data of aquifer conditions, both spatially and temporally. It is required the groundwater be sampled throughout the area without regard to the location of surface facilities or known groundwater plumes. If there are temporal changes in groundwater conditions, samples must be collected to capture these varying stages to properly delineate risk to receptors.

Sampling well locations must be identified for a spatial representation of the area, regardless of facility or known contaminant plume locations. These sampling networks should represent locations where human or ecological receptors could potentially encounter groundwater. Any discussion of potential residential use of the land at this location is solely for the purpose of analyzing risk and planning a sampling program. The primary pathway for human exposure is through direct contact with groundwater obtained from residential or community water wells. Identification of sampling locations to assess the direct exposure pathways is based on the assumption that the land will be developed for future human habitation.

Based on remedial action goals for the interim action ROD (DOE/RL-96-17), the assumption for future habitation is a rural residential scenario, which assumes that families will live on the land, grow a garden, and raise livestock to provide approximately 25 percent of the family's food requirements. This land usage places specific state and daily water requirements for each residence. The remedial action goals are based on groundwater restored to drinking water standards. It is also assumed at least a 5-acre plot per unit is necessary to raise livestock. Thus, each residence in the following scheme assumes a family plot size of 5 acres.

To provide the number of sampling points for a monitoring well network, the average groundwater yields are used to determine the number of residences supported on one supply well. Thus, the grid size specific to each area is determined. Use of a random grid generator provides approximate locations for sampling points based on the final number of sampling points and the total area.

In addition to determining the maximum number and location of potential exposure pathways, additional wells were added to networks to define the risk associated with known contaminant plumes. Current monitoring wells were chosen to provide data on maximum contaminant levels and to define plume extents.

Scope of Work: Three rounds of groundwater samples will be collected for analysis of all COPCs to support the remedial investigation for each contaminant. A sampling round, or event, will be conducted for each seasonal high, low, and transition river stages, totaling three samples per well. Each round of monitoring in the network of wells for this area will be completed within 30 consecutive calendar days to minimize statistical variability in water levels.

Groundwater samples will be collected so that they chemically, radiologically, spatially, and temporally represent the groundwater in the area. Eighteen monitoring wells, including fourteen existing monitoring wells (Figure 4-1) and four new wells to be installed per the SAP (DOE/RL-2009-61 for Wells C7505, C7506, C7507, and C7665) will be sampled and analyzed for this purpose.

4.3.3 100-BC – Additional Scope of Work

The following tasks will be conducted as part of the scope of work under this RI/FS. These tasks are not specifically related to a data gap or need, but will enhance the understanding of the site and potential remediation options.

Task 1: Opportunistic groundwater sampling will be conducted at borehole locations.
Boreholes will be installed in various locations within 100-BC as part of this RI/FS. The purpose of these boreholes is to characterize the vadose zone and to satisfy specific soil related data gaps. Groundwater sampling from these boreholes may be possible during drilling. In order to maximize the amount of data available for decision making, groundwater samples will be collected from boreholes whenever possible. Conditions that may limit sampling include limited groundwater production or borehole collapse during sampling. Sampling will be conducted as outlined in the SAP, with a full suite of COPCs collected from each borehole. Samples will be collected in the order of priority, as described in the SAP, due to the possibility of limited water availability. Data resulting from such sampling will be used to increase the understanding of contaminant distribution within 100-BC.

Task 2: Develop potential remedial technologies.
Currently, the number of effective remedial technologies for the COCs is limited. Development of additional potential technologies will provide greater flexibility when accessing remediation techniques. This is not specific to 100-BC, but will be addressed as part of the work plan in preparation for the feasibility study and evaluation of remediation alternatives.

Groundwater contamination above aquatic standards and drinking water MCLs has been detected in 100-BC. No interim remedial actions are currently in operation. Remedy and remedial technology comparisons are needed to support the FS. Mitigating exposure to environmental receptors from contaminated groundwater is a critical element of the remedial action.

As part of the RI/FS process, a comparison of potential groundwater remediation technologies will be necessary if groundwater contamination above applicable cleanup and/or risk levels remains after completion of the RI. EPA expects to return usable groundwater to beneficial use wherever practical, within a period that is reasonable given the particular circumstances of the site. Thus, the list of likely potential remedial technologies should be drafted and groundwater data and information necessary to support a comparison of potential remedies should be collected.

Soil samples from new boreholes and wells will be archived so future soil analysis can be performed to support specific data needed for technology and remedy comparison. Data collected during the RI, including soil physical properties and groundwater data, will be used to support remedy comparisons. In addition, the remedial process optimization activity for 100-D/H has evaluated potentially applicable remediation technologies for Cr(VI). Evaluations related to Sr-90 and tritium has been completed for the 100-NR-2 and the 200-ZP-1 Groundwater OUs. These evaluations will be used during preparation of the 100-BC Operable Units FS.

Task 3: Update bathymetric data for the river adjacent to100-BC to support calculations of contaminant transport to the river and ecological receptors.
The preliminary evaluation of the geology of near-river wells indicates that the top of the aquitard (RUM) lies more than 15 m (49 ft) beneath the bottom of the Columbia River (i.e., the top of the RUM does not intersect the Columbia River).

Ecological receptors (e.g., salmon redds) have been identified within the river. In order to evaluate flow paths of contaminants to receptors (particularly from beneath the unconfined aquifer), updated and accurate bathymetric data for the river are needed. The bathymetric data will be combined with groundwater fate and transport analysis to evaluate contaminant risks to specific ecological receptors and related portions of the river.

Bathymetric data adjacent to 100-BC have been collected, but not yet evaluated. Preliminary evaluation of the top of the RUM surface using near-river wells indicates the top of the RUM does not intersect the

Columbia River; therefore, no new data collection is proposed for the area. However, the existing data should be evaluated to better define the river bathymetry.

5 Project Schedule

Figure 5-1 is the project schedule for activities discussed in this addendum. This schedule will serve as the baseline for the planning process and will be used to measure the implementation progress of this process. Any updates to the project schedule will be reflected in the annual work planning process and are not anticipated to require a revision to this addendum.

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RI/FS and Proposed Plan for 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units (Calendar Year)[1]

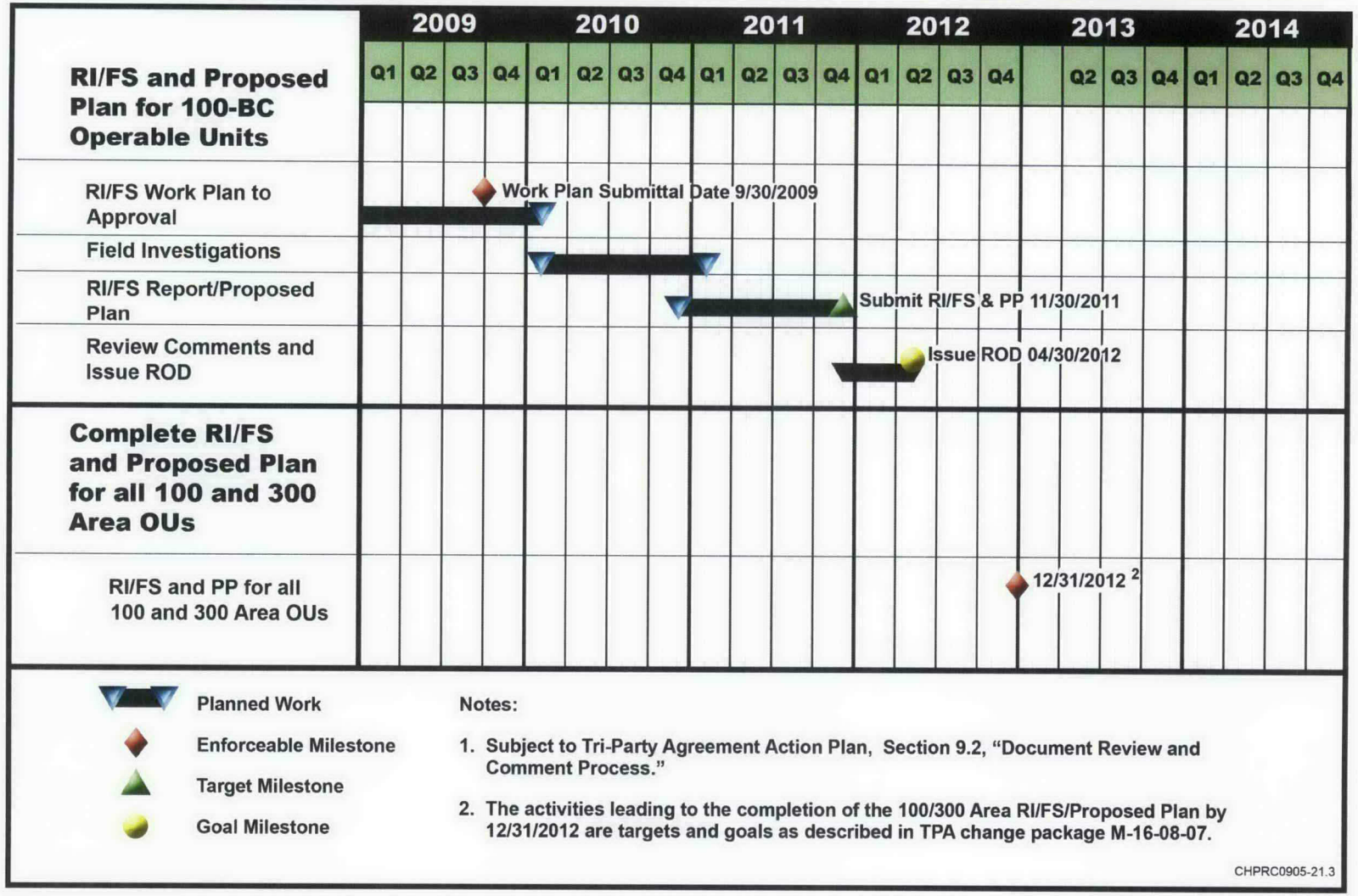

Figure 5-1. 100-BC Project Schedule

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6 References

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Appendix A

100-BC-1, 100-BC-2, and 100-BC-5 Operable Unit Maps

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A1 Introduction

Maps showing the facilities and waste sites located in the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units are provided.

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Appendix B

100-BC Waste Sites Description and History

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B1 Introduction

Table B-1 provides a summary of the codes, types, and status of waste sites in 100-BC. Table B-1 also provides physical dimensions, dates of operation, a brief history for each site, and relevant decision/ remedial action information, if available. Data presented are current as of December 3, 2009.

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Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-1	Dumping Area	100-BC-2	303 x 296 x 1.86	100-B-1, Surface Chemical and Solid Waste Dumping Area, Laydown Yard	Interim Closed Out	WSRF-2006-003	6/9/2003	5/12/2005	51,099	4	bis(2-Ethylhexyl)phthalate	0.045	\	0.045	\
											Di-n-butylphthalate	0.024	\	0.024	\
											Diethylphthalate	0.048	\	0.048	\
100-B-2	Trench	100-BC-1	70.1 x 6.1 x 3.05	The site is a trench that was constructed to receive backwash filter backflush from the 181-B Pumphouse. Based on the review of the historical data and facility information, no sampling is necessary to confirm the status of this site because the vertical thimble that was buried in 1952 was removed before 1956, and contamination remaining in the excavation when the thimble was removed was short-lived radionuclides (less than 5.27 years). After 10 half-lives have elapsed, a radionuclide is considered to have decayed away. The geophysics over a large area, including the site, showed no evidence of a remaining buried thimble or the conclusive location of an old burial site.	No Action	WSRF-2004-101	N/A							
100-B-3	Burial Ground	100-BC-1	Not Documented	The site was described as a trench where a highly radioactive vertical control thimble was buried. No sampling was necessary to confirm the status of this site because original documentation explained that the vertical thimble was buried in 1952 and removed before 1956. Also, the contamination remaining in the excavation when the thimble was removed was short-lived radionuclides, all with half-lives of less than 5.27 years.	No Action	WSRF-2003-08	N/A							
100-B-4	Spoils Pile/Berm	100-BC-1	8.5 x 13.1 x 0.3	The site was possibly associated with farming or some type of military activity. The authors of the 100B Technical Baseline Report believe the site may be the remains of a building foundation.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A							

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-5	Trench	100-BC-1	30.5 x 3 x 3	The site was the result of leakage that occurred at a junction box. The site was believed to be located east of the 105-B Reactor Building, west of the 100-C Reactor effluent pipeline, north of the 100-B Reactor effluent crosstie pipeline, and north of the junction box where the east-west 100-B Effluent Pipeline joined the north-south 100-C Effluent Pipeline. The junction box (part of site 100-C-6, 100-C Reactor Cooling Water Effluent Underground Pipelines, but pertinent to this site) was a concrete structure. Two sides of the structure were double-walled, providing the structure with two chambers.	Interim Closed Out	CVP-2003-00014	May-03	May-03	16,320	8.5	Americium-241	0.168	0.332	0.15	0.452
											Cesium-137	0.15 U	22.4	0.0507	20.3
											Cobalt-60	0.1 U	1.46	0.0457	1.5
											Europium-152	0.25 U	15.3	0.102	14.8
											Europium-154	0.37 U	1.44	0.136	1.38
											Europium-155	0.25 U	0.61 U	0.103	0.292
											Plutonium-238	0 U	0.264	0.0291	0.233
											Plutonium-239/240	0.352	3.4	0.0954	3.08
											Strontium-90	0.034 U	1.93	-0.00252	1.86
											Uranium-238	0.804	0.749	0.616	0.732
											Lead	9.4	8.2	8.2	8.4
											Mercury	0.02	5	0.02	4.5
											Chromium	15	300	13	280
											Chromium VI	0.43 U	1.9	0.43	1.8
100-B-7	Product Piping	100-BC-1	Not Documented	The site encompasses the clean water upstream pipelines for the 100-B Area, including underground pipelines used to transport raw, fire, export, and sanitary water from the river pumphouse to the water treatment facilities and to 100-B Area facilities and fire hydrants. The 100-B Service Water Pipelines pumped reactor cooling water from the Columbia River; the water was settled and treated to remove minerals, and pumped to the reactor core at a rate of 1.93E+05 L (51,000 gal) to 2.69E+05 L (71,000 gal) per minute.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
100-B-8	Radioactive Process Sewer	100-BC-1	See subsites	The site encompassed the underground 100-B Reactor Cooling Water Effluent Pipelines. These included the effluent pipelines that transported 118-B-8 (105-B Reactor) cooling water from the reactor core to the 116-B-11 (107-B) Retention Basin, and from the basin to the 116-B-7 (1904-B) Outfall Structure.	Interim Closed Out	See subsites	See subsites								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-8:1	Radioactive Process Sewer	100-BC-1	466.9	This subsite includes the underground effluent pipelines surrounding the 105-B Reactor (excluding a 7.6 m [25-ft] buffer zone) of the reactor foundation, and running north from the reactor to B Avenue.	Interim Closed Out	CVP-2003-00022	9/9/2002	11/7/2003	79,339	8.5	Americium-241	0.229 U	0.442	0.0342	0.183
											Cesium-137	1.15	20.7	0.188	8.95
											Cobalt-60	0.085 U	0.308	0.0189	0.12
											Europium-152	0.854	5.03	0.1	2.09
											Europium-154	0.28 U	0.354	0.0617	0.152
											Europium-155	0.17 U	0.18 U	0.051	0.0599
											Plutonium-238	0.064 U	0.071 U	0.0126	0.0198
											Plutonium-239/240	0.037	0.745	0.0178	0.36
											Strontium-90	0.316	3.5	0.0218	2.12
											Uranium-238	1	0.877	0.546	0.556
											Lead	250	12	22	7.3
											Mercury	0.33	0.51	0.33	0.18
											Chromium	46.5	94.7	15.9	53.6
											Chromium VI	0.36	1.1	1.3	0.95
100-B-8:2	Radioactive Process Sewer	100-BC-1	2,791.47	This subsite includes the 105-B Reactor Effluent Pipelines from B Avenue north to the 116-B-11 Trench, the pipelines from the 116-B-11 Trench to the 116-B-7 Outfall, and the east-west connecting pipeline from 100-B-8:2 to the diversion box for the 100-C-6 Pipelines, which is just south of the 116-C-5 Retention Basins. It also includes the pipeline connecting to the 116-C-5 Retention Basin; this pipeline (the part outside of the excavation/ sampling area footprint) was removed as part of the 116-C-5 Remedial Action but not sampled for cleanup verification at that time.	Interim Closed Out	CVP-2003-00019	2/26/2001	2/6/2003	244,656	7.5	Americium-241	0.374 J	1.11	0.0521	0.193
											Cesium-137	4.15	7.94	0.378	7.55
											Cobalt-60	0.174	0.728	0.0335	0.276
											Europium-152	1.83	9.85	0.292	3.19
											Europium-154	0.382	1.28	0.0937	0.449
											Europium-155	0.23 U	0.33 U	0.0549	0.0881
											Plutonium-238	0.081 U	0.128 U	0.0142	0.0392
											Plutonium-239/240	0.359 J	3.12	0.0367	0.567
											Strontium-90	2.67	6.32	0.201	1.7
											Uranium-238	0.943 J	0.733	0.551	0.518
											Lead	15	6	5.4	3.7
											Mercury	0.05	0.17	0.05	0.13
											Chromium	44	140	16	45
											Chromium VI	3.4	3.5	1.8	1.8

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-10	Unplanned Release	100-BC-1	Not Documented	This is not a site where wastes have been disposed or spilled, but was the place where groundwater contaminated from the 116-B-11 Retention Basin exited the riverbank. This spring no longer exists and the precise location is unknown. The groundwater that fed the spring is a separate OU (100-BC-5).	No Action	WSRF-2001-021	N/A								
100-B-11	Storage Tank	100-BC-1	1.2 m^2	The site was a steel pipe structure (caisson) about 1.2 m (4 ft) in diameter and 1.5 m (5-ft) deep with a bottom and a steel plate placed over the top. The site was self-contained without any incoming or outgoing piping. Its original purpose is not known, but it was located just outside of Dryer Room No. 1 of the 115-B/C Facility. The no-action decision for the 100-B-11 Site is supported based on reviews of site history, field observations, and characterization results. The maximum detected results from underlying soil samples collected at locations suspected of having the greatest potential for residual contamination levels were shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection.	No Action	WSRF-2004-003	9/2003 (confirmatory samples	N/A	N/A	N/A	Strontium-90	0.247	\	\	\
											Antimony	1.4	\	\	\
											Arsenic	4.9	\	\	\
											Barium	74.4	\	\	\
											Boron	5.7	\	\	\
											Cadmium	0.224	\	\	\
											Chromium	11.6	\	\	\
											Cobalt	8.1	\	\	\
											Copper	20.5	\	\	\
											Lead	11.6	\	\	\
											Manganese	318	\	\	\
											Molybdenum	0.551	\	\	\
											Vanadium	55	\	\	\
											Zinc	65	\	\	\
100-B-12	Storage	100-BC-1	289.59 m^2	The site was a filter box radiological materials area with four metal boxes containing filters, resting on shoring that sat on the bare soil. An additional six filter frames, marked as having fixed contamination, rested directly on the soil. These came from the 100-N Area in the 1980s. The basis for reclassification was the disposal of all contaminated filter frames at the ERDF. Because the frames were solid waste, no releases to the soil were expected. A radiation survey was completed at the site after the frames were removed to document that the radiological materials area could be downposted; the survey results met the requirement for downposting a radiological materials area.	Interim Closed Out	WSRF-2001-016	N/A								

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-14	Process Sewer	100-BC-1	See Subsites	The 100-B-14 Waste Site, in its entirety, which encompasses the underground process pipelines and process and sanitary sewers associated with the 100-B Area Pre-Reactor Cooling Water Treatment Facilities. For confirmatory sampling efforts, the 100-B-14 Site was administratively divided into seven subsites. The seven subsites are as follows: • 100-B-14:1 Main Process Sewer Collection Pipeline • 100-B-14:2 Sanitary Sewer Pipelines • 100-B-14:3 West Process Sewer Feeder Lines (182-B and 183-B) • 100-B-14:4 190-B/105-B Cooling Water Tunnel Pipelines • 100-B-14:5 Sodium Dichromate And Sodium Silicate Pipelines • 100-B-14:6 184-B Powerhouse Pipelines • 100-B-14:7 185-B/190-B Sump and Process Sewer Pipelines	Interim Closed Out	See subsites	See subsites								
100-B-14:1	Process Sewer	100-BC-1	1,599.53	Main Process Sewer Collection Pipeline.	Interim Closed Out	WSRF-2004-005	Jan-05	Sep-06	Not Documented	7.6	Carbon-14	258	1.1 U	0.16	0.49
											Cesium-137	0.061	0.23	0.159	0.493
											Cobalt-60	0.061 U	0.050 U	0.021	0.018
											Europium-152	0.15 U	0.13 U	0.044	0.042
											Europium-154	0.46 U	0.16 U	0.07	0.057
											Europium-155	0.21 U	0.16 U	0.06	0.053
											Tritium	0.721 U	0.0183 U	\	0.83
											Chromium VI	2.6	0.350 U	0.91	0.21
100-B-14:2	Process Sewer	100-BC-1	1,389.52	115-B Gas Recirculation Sanitary Sewer Pipelines.	Interim Closed Out	WSRF-2006-055	Jan-05	Jul-06	Not Documented	2.5		Area 2 (Shallow)	Area 5 (Shallow)	Area 4 (Shallow)	
											Cesium-137	0.107	\	0.107	\
											Strontium-90	0.311	2.1	0.181	\
											Tritium	0.151 U	0.296	\	\
											Antimony	0.5 UJ	0.47	0.64	\
											Arsenic	7.5	3.8	4.1	\
											Barium	998	141	163	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Beryllium	0.5	0.55	0.5	\
											Boron	5	3.6	4.7	\
											Cadmium	1.5	0.21	0.43	\
											Chromium	67.8	12.8	11.2	\
											Chromium VI	0.74	0.98	0.74	\
											Cobalt	8.8	9.2	8.5	\
											Copper	102	18.1	34	\
											Lead	279	26.1	27.1	\
											Manganese	388	351	362	\
											Mercury	7.2	0.47	0.47	\
											Molybdenum	1.7	0.6	0.8	\
											Nickel	34	12.5	15.8	\
											Strontium	118	57.1	57	\
											Tin	13.5	1.3	1.3	\
											Titanium	1860	1490	1637	\
											Vanadium	53.6	47.4	48.6	\
											Zinc	223	49.6	82	\
											Aroclor-1254	0.33	0.0062	0.33	\
											Aroclor-1260	0.0067	0.011	0.0067	\
											bis(2-Ethylhexyl)phthalate	1.6	1.1	1.6	\
											2-Methylnaphthalene	0.034	\	0.034	\
											Chrysene	1.1	0.26	1.1	\
											Di-n-butylphthalate	0.07	0.08	0.07	\
											Diethylphthalate	\	0.018	\	\
											Di-n-octylphthalate	0.095	\	0.095	\
											Dibenz(a,h)anthracene	0.66	\	0.66	\
											Dibenzofuran	0.082	\	0.082	\
											Fluoranthene	10.4	0.032	10.4	\
											Fluorene	0.13	\	0.13	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Indeno(1,2,3-cd)pyrene	0.9	0.087	0.9	\
											Naphthalene	0.055	\	0.055	\
											Phenanthrene	3	0.42	3	\
											Pyrene	9.1	0.71	9.1	\
											Phenol	0.017	0.027	0.017	\
											alpha-Chlordane	0.00087	\	0.00087	\
											alpha-BHC	\	0.002	\	\
											beta-BHC	0.0019	0.0043	0.0019	\
											4,4'-DDD	0.0021	\	0.0021	\
											4,4-DDE	0.018	0.00044	0.018	\
											4,4'-DDT	0.017	0.016	0.017	\
											Dieldrin	\	0.0007	\	\
											Endosulfan I	0.0069	\	0.0069	\
											Endosulfan II	0.0034	\	0.0034	\
											Endosulfan sulfate	0.0033	\	0.0033	\
											Endrin	0.0013	\	0.0013	\
											Endrin aldehyde	0.0074	0.0022	0.0074	\
											Endrin ketone	0.0011	\	0.0011	\
											Heptachlor epoxide	0.0006	\	0.0006	\
											gamma-Chlordane	0.0013	\	0.0013	\
											Methoxychlor	0.049	\	0.049	\
											Anthracene	\	0.39	\	\
											Benzo(a)anthracene	1.2	1.6	1.2	\
											Benzo(a)pyrene	1.1	1.5	1.1	\
											Benzo(b)fluoranthene	0.8	1.3	0.8	\
											Benzo(g,h,i)perylene	0.8	1.2	0.8	\
											Benzo(k)fluoranthene	0.9	1.3	0.9	\
											Carbazole	0.25	\	0.25	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-14:3	Process Sewer	100-BC-1	1,227.37	Process Sewer Feeder Pipelines from 182-B and 183-B, West Process Sewer Pipelines. The sample results demonstrated that the subsite has achieved the RAOs and remedial action goals.	No Action	WSRF-2004-007	10/2003 (confirmatory samples)	N/A	N/A	N/A	Arsenic	2.4	\	\	\
											Barium	59.8	\	\	\
											Beryllium	0.31	\	\	\
											Boron	1.4	\	\	\
											Chromium	5.6	\	\	\
											Chromium VI	0.42	\	\	\
											Cobalt	9.9	\	\	\
											Copper	15.1	\	\	\
											Lead	3.9	\	\	\
											Manganese	355	\	\	\
											Mercury	0.01	\	\	\
											Molybdenum	0.53	\	\	\
											Nickel	8.5	\	\	\
											Silver	0.5	\	\	\
											Vanadium	64.4	\	\	\
											Zinc	45.9	\	\	\
											Sulfate	6.2	\	\	\
											bis(2-Ethylhexyl)phthalate	0.046	\	\	\
100-B-14:4	Process Sewer	100-BC-1	365.7	Cooling Water Pipelines and Tunnels from 190-B. The 100-B-14:4 Pipelines were removed and the tunnels collapsed in 1993 during D&D of the 190-B Pumphouse. There is no history of radiological contamination associated with the 100-B Reactor cooling water tunnels and no radiological contamination was detected during decommissioning of the tunnels.	No Action	WSRF-2004-008					Chromium VI	0.18			

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-14:5	Process Sewer	100-BC-1	928.89	Sodium Dichromate and Sodium Silicate Pipelines. The sample results demonstrated that the subsite has achieved the RAOs and remedial action goals.	No Action	WSRF-2004-009	10/2003 (confirmatory samples)	N/A	N/A	N/A	Antimony	0.31	\	\	\
											Arsenic	3.3	\	\	\
											Barium	82.1	\	\	\
											Beryllium	0.36	\	\	\
											Boron	4.4	\	\	\
											Cadmium	0.19	\	\	\
											Chromium	16.5	\	\	\
											Cobalt	9.9	\	\	\
											Copper	17.7	\	\	\
											Lead	7.3	\	\	\
											Manganese	395	\	\	\
											Molybdenum	0.56	\	\	\
											Nickel	11.6	\	\	\
											Silver	0.09	\	\	\
											Vanadium	69.4	\	\	\
											Zinc	76.2	\	\	\
100-B-14:6	Process Sewer	100-BC-1	453.86	Process Sewer Feeder Pipeline from 184-B and 184-B Ash Slurry Line. The waste site evaluation for 184-B Powerhouse Pipelines sample results demonstrated that the site has achieved the RAOs and remedial action goals.	No Action	WSRF-2004-010	2003 (confirmatory samples)	N/A	N/A	N/A	Arsenic	3.8	\	\	\
											Barium	364	\	\	\
											Beryllium	0.47	\	\	\
											Boron	5.8	\	\	\
											Cadmium	0.25	\	\	\
											Chromium	49.1	\	\	\
											Cobalt	9.6	\	\	\
											Copper	16.7	\	\	\
											Lead	10.8	\	\	\
											Manganese	446	\	\	\
											Mercury	1.4	\	\	\
											Molybdenum	0.94	\	\	\
											Nickel	25.1	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Silver	0.09	\	\	\
											Vanadium	53.9	\	\	\
											Zinc	57	\	\	\
100-B-14:7	Process Sewer	100-BC-1	143.92	Process Sewer Feeder Pipeline from 185-B and 190-B. The waste site evaluation for 184-B Powerhouse Pipelines sample results demonstrated that the site has achieved the RAOs and remedial action goals.	No Action	WSRF-2004-011	10/2003 (confirmatory samples)	N/A	N/A	N/A	Antimony	0.79	\	\	\
											Arsenic	5.4	\	\	\
											Barium	128	\	\	\
											Beryllium	0.43	\	\	\
											Boron	5.4	\	\	\
											Cadmium	0.52	\	\	\
											Chromium	25.4	\	\	\
											Cobalt	9.6	\	\	\
											Copper	22.1	\	\	\
											Lead	13.6	\	\	\
											Manganese	408	\	\	\
											Mercury	0.08	\	\	\
											Molybdenum	0.76	\	\	\
											Nickel	22.7	\	\	\
											Zinc	88.3	\	\	\
100-B-15	Radioactive Process Sewer	100-BC-1	643 x 0.01	This site includes the 100-B/C Area river effluent pipelines (river lines) that extend from each of the three outfalls into the main channel of the Columbia River. All three outfall structures have been remediated; however, the river pipelines remain in place.	Accepted	Not Documented	N/A								
100-B-16	Dumping Area	100-BC-1	927.52 m^2	The site consisted of four surface piles of debris. The exact history of this site is unknown. The surface debris materials consisted of telephone poles (grouped mostly together) and associated utility debris in piles adjacent to the telephone poles.	Interim Closed Out	WSRF-2005-009	Nov-04	Mar-05	774 BCM	3	Arsenic	3.3	\	\	\
											Barium	226	\	\	\
											Cadmium	0.36	\	\	\
											Chromium	15.4	\	\	\
											Lead	8.7	\	\	\
											Mercury	0.03	\	\	\
											Silver	1.5	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Phenanthrene	0.06	\	\	\
											Fluoranthene	0.15	\	\	\
											Pyrene	0.12	\	\	\
											Chrysene	0.11	\	\	\
											Benzo(b)fluoranthene	0.06	\	\	\
											Benzo(k)fluoranthene	0.05	\	\	\
											Benzo(a)pyrene	0.02	\	\	\
											Benzo(a)anthracene	0.03	\	\	\
											Aroclor-1260	0.02	\	\	\
100-B-17	Dumping Area	100-BC-1	24.38 x 9.14	The site is an old dumping area. The waste is a mixture of material ranging from corrugated transite, fire brick, milk bottles, concrete form fittings, small rebar, pipe fittings, chunks of vitrified clay, nuts, and bolts. The source of the debris is unknown.	Not Accepted	Not Documented	N/A								
100-B-18	Dumping Area	100-BC-1	30 x 15	The site consists of a debris pile containing miscellaneous demolition waste from the decommissioning activities of the 184-B Power House. Demolition, including the smoke stacks, was completed by 1983. All the aboveground structures were removed, leaving the foundation slabs, footprints, tunnels, pits, and other associated concrete structures at or near grade level. During 1988, the foundation and the other below-grade features were demolished to at least 0.9 m (3 ft) below grade, backfilled with rubble, and buried in situ.	Interim Closed Out	WSRF-2007-020	Jun-07	Jul-07	70 bank cubic meters	Not documented	Antimony	9.3	\	\	\
											Arsenic	4.1	\	\	\
											Barium	1300	\	\	\
											Beryllium	0.64	\	\	\
											Boron	34.2	\	\	\
											Cadmium	13.2	\	\	\
											Chromium	11.3	\	\	\
											Cobalt	8.2	\	\	\
											Copper	18.9	\	\	\
											Lead	25.3	\	\	\
											Manganese	356	\	\	\
											Mercury	2.2	\	\	\
											Molybdenum	0.96	\	\	\
											Nickel	12.1	\	\	\
											Selenium	0.73	\	\	\
											Vanadium	46.5	\	\	\
											Zinc	77.6	\	\	\
											TPH	194	\	\	\
											Aroclor-1260	0.095	\	\	\

Table B-1. 100-BC Waste Sites Description and History

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Acetone	0.018	\	\	\
											Acenapthene	0.17	\	\	\
											Acenaphylene	0.079	\	\	\
											Anthracene	0.55	\	\	\
											Benzo(a)anthracene	0.25	\	\	\
											Benzo(a)pyrene	0.3	\	\	\
											Benzo(b)fluoranthene	0.24	\	\	\
											Benzo(g,h,i)perylene	0.15	\	\	\
											Benzo(k)fluoranthene	0.1	\	\	\
											Chrysene	0.27	\	\	\
											Dibenzo(a,h)anthracene	0.03	\	\	\
											Fluoranthene	0.3	\	\	\
											Fluorene	0.53	\	\	\
											Indeno(1,2,3-cd)pyrene	0.19	\	\	\
											Napthalene	0.44	\	\	\
											Phenanthrene	0.12	\	\	\
											Pyrene	0.51	\	\	\
100-B-19	Unplanned Release	100-BC-1	Area 1: 3 x 5 Area 2: 5 m dia. Area 3: 3 x 6 Area 4: 27.20 m dia. Area 5: 13.6 x 4 Area 6: 2 m dia.	The site consists of six areas of disturbed soil with little or no vegetation and/or discoloration. The soil sites have a visible yellow or red-to-purple surface discoloration seen at analogous sites in the locations in the 100 Area. The red-purple staining is possibly garnet grit, which was commonly used in grit-blasting operations to clean the surface of metal components of rust, paint, or contamination. The garnet material itself is not a hazardous substance, but there is a potential for contamination from the surface material that was cleaned by grit blasting. Yellow stains on soil in this area may be due to spills of concentrated sodium dichromate solution Cr(VI) and/or concentrated sulfuric acid used at the water treatment plants for reactor coolant water cleaning and for corrosion control.	Accepted	OSR-2007-0001	N/A								

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-20	Maintenance Shop	100-BC-1	16.31 x 12.19 x 5.49	The site is the 1716-B Maintenance Garage Underground Tank. The shop was built in 1944 and provided automotive repair, light vehicle maintenance, and lubrication service for 100-BC Area vehicles (du Pont, 1945) until deactivation of the 105-B Reactor in 1968.	Interim Closed Out	WSRF-2006-019	Jan-06	Jan-06	Not Documented	2.1	Arsenic	2.8	\	\	\
											Barium	72.7	\	\	\
											Beryllium	0.32	\	\	\
											Boron	3.7	\	\	\
											Chromium	12.1	\	\	\
											Cobalt	11.2	\	\	\
											Copper	43.3	\	\	\
											Lead	20.9	\	\	\
											Manganese	354	\	\	\
											Mercury	0.33	\	\	\
											Molybdenum	0.6	\	\	\
											Nickel	10.8	\	\	\
											Selenium	0.44	\	\	\
											Vanadium	53.9	\	\	\
											Zinc	326	\	\	\
											Aroclor-1260	0.0085	\	\	\
											Benzo(a)anthracene	0.029	\	\	\
											Benzo(a)pyrene	0.032	\	\	\
											Benzo(b)fluoranthene	0.035	\	\	\
											Benzo(g,h,i)perylene	0.023	\	\	\
											Benzo(k)fluoranthene	0.035	\	\	\
											Chrysene	0.031	\	\	\
											Di-n-butylphthalate	0.15	\	\	\
											Fluoranthene	0.043	\	\	\
											Indeno(1,2,3-cd)pyrene	0.021	\	\	\
											Pyrene	0.04	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-21	Process Sewer	100-BC-1	See Subsites	The site consists of a variety of underground pipelines uncovered during removal of effluent pipelines and soils. The subsites associated with this site have been separated into like groups of piping.	Accepted	See subsites	See subsites								
100-B-21:1	Process Sewer	100-BC-1	11.47	The site is potentially contaminated soil and two pipeline segments.	No Action	WSRF-2005-052	1/7/2003 (confirmatory samples)	9/24/2003 (confirmatory samples)	N/A	1.5 (depth of samples)	Arsenic	13.9 (<BG)	\	\	\
											Barium	37.8 (<BG)	\	\	\
											Cadmium	0.24 (<BG)	\	\	\
											Chromium	26.4	\	\	\
											Lead	48.4	\	\	\
											Mercury	0.05 (<BG)	\	\	\
100-B-21:2	Process Sewer	100-BC-1	1.5 (length) 2.5 cm (diameter)	The subsite is potentially contaminated soil and a pipeline segment. This is an approximately 1.5 m (5-ft) asbestos-wrapped, 2.5 cm (1-in.) metal pipeline protruding from the ground. The history of the 100-B-21:2 Pipeline, before its discovery in 2003, is unknown. The location and orientation of the pipeline suggests that it was associated with the 116-B-11 Retention Basin and discharged to the river embankment. It is smaller than most drain lines, suggesting it was a pressurized water pipe, though the exact purpose remains unknown.	Interim Closed Out	WSRF-2008-003	6/11/2007	6/18/2007	91	0.3		Shallow Soil	Over-burden	Shallow Soil UCL	
											Cesium-137	\	0.048	0.048	\
											Arsenic	7.9	4.8	5.9	\
											Barium	107	89.8	89.4	\
											Beryllium	0.19	0.19	0.19	\
											Boron	2.7	-	2.4	\
											Cadmium	0.31	0.33	0.31	\
											Chromium	19.7	15.8	16	\
											Chromium VI	0.32	0.26	0.26	\
											Cobalt	8.6	8.6	7.9	\
											Copper	24	20.6	20.9	\
											Lead	7.2	6.5	6.3	\
											Manganese	371	363	355	\
											Molybdenum	2.5	0.83	2.5	\
											Nickel	18.3	17.8	16.4	\
											Silver	0.39	-	0.39	\
											Vanadium	59.4	17.8	51	\
											Zinc	48.7	48.7	43.6	\
											Di-n-butylphthalate	0.022	-	0.022	\
											Pyrene	0.021	-	0.021	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-21:3	Process Sewer	100-BC-1	Not Documented	Asbestos-Wrapped Steel Pipeline.	Interim Closed Out	Not Documented	N/A								
100-B-21:4	Process Sewer	100-BC-1	91.87	Pipeline from 105-C Reactor East to 116-C-2B Pump.	Accepted	Not Documented	N/A								
100-B-22	Dumping Area	100-BC-1	See Subsites	This site consists of the 100-B Area Water Treatment Facilities, soils associated with these facilities, and any remaining piping not already associated with existing sites.	Accepted	See subsites	See subsites								
100-B-22:1	Process Sewer	100-BC-1	1841.42	Piping between 183-B and 185-B/ 195-B. The pipelines in this waste site were uncovered during the removal of effluent pipelines and soils. As pipeline removal progressed, an effort was made to photograph, accurately locate, and in some cases perform limited chemical and radiological investigations of the pipelines. The basis for no-action determination was process history, which indicates the only additive to the process water in the pipelines came from the 183-B Facility. Chemicals added at the 183-B Facility included chlorine, sulfuric acid, alum, ferric sulfate, separan (a coagulant), and lime. Trace contamination from the sulfuric acid that was added to adjust the pH of the water, would be diluted in the cooling water. There was no evidence to suggest that the pipelines were ever a source of human-health risk due to the addition of sulfuric acid.	No Action	WSRF-2006-042	N/A								
100-B-22:2	Process Unit/ Plant	100-BC-1	Not Documented	Most of 183-B, 185-B, and 195-B Water Treatment Facilities.	Accepted	Not Documented	N/A								
100-B-23	Dumping Area	100-BC-2	Varies between sites	The 100-B-23 waste site, located in the 100-BC-1 OU of the Hanford Site, consisted of multiple locations of surface debris and chemical stains that were identified in 2004 as part of an Orphan Site Evaluation of the 100-BC Area.	Interim Closed Out	WSRF-2008-027	Jun-07	Feb-08	680	Varies between sites	Antimony	0.27	\	\	\
											Arsenic	4.4	\	\	\
											Barium	118	\	\	\
											Beryllium	0.45	\	\	\
											Boron	14.1	\	\	\
											Cadmium	1.7	\	\	\
											Chromium	14	\	\	\
											Cobalt	7.7	\	\	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Copper	21.6	\	\	\
											Lead	73.8	\	\	\
											Lithium	8.6	\	\	\
											Manganese	352	\	\	\
											Mercury	8.2	\	\	\
											Molybdenum	0.71	\	\	\
											Nickel	13.6	\	\	\
											Selenium	0.57	\	\	\
											Strontium	25.1	\	\	\
											Tin	3.2	\	\	\
											Vanadium	42.9	\	\	\
											Zinc	1310	\	\	\
											TPH	173	\	\	\
											Aroclor-1254	0.0054	\	\	\
											Aroclor-1260	0.021	\	\	\
											Acenapthene	0.2	\	\	\
											Anthracene	1.9	\	\	\
											Benzo(a)anthracene	0.49	\	\	\
											Benzo(a)pyrene	0.22	\	\	\
											Benzo(b)fluoranthene	0.27	\	\	\
											Benzo(g,h,i)perylene	0.05	\	\	\
											Benzo(k)fluoranthene	0.29	\	\	\
											Bis(2-ethylhexyl)phthalate	0.21	\	\	\
											Butylbenzylphthalate	0.02	\	\	\
											Carbazole	0.37	\	\	\
											Chrysene	1.4	\	\	\
											Di-n-butylphthalate	0.031	\	\	\
											Dibenzo(a,h)anthracene	0.05	\	\	\
											Dibenzofuran	0.22	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Fluoranthene	1.6	\	\	\
											Indeno(1,2,3-cd)pyrene	0.083	\	\	\
											Phenanthrene	2.4	\	\	\
											Pyrene	1.2	\	\	\
100-B-24	Outfall	100-BC-1	126.19 x 3.66 x 2.7	The 1904-B1 Spillway (Flume) was an alternate discharge point for the 116-B-7 Outfall Structure. The spillway was to have been used for an emergency effluent release or if the river effluent pipelines (100-B-15) were blocked, damaged, or undergoing maintenance. There is no corroborated physical or historical evidence that the spillway was ever used.	No Action	WSRF-2006-051	1/17/2006 (confirmatory samples)	N/A	N/A	N/A	Cesium-137	0.419	\	\	\
											Cobalt-60	0.108	\	\	\
											Europium-152	0.182	\	\	\
											Nickel-63	3.78	\	\	\
											Uranium-233/234	0.713	\	\	\
											Uranium-238	0.479	\	\	\
											Antimony	6.4	\	\	\
											Arsenic	31.6	\	\	\
											Barium	133	\	\	\
											Beryllium	0.59	\	\	\
											Boron	15.1	\	\	\
											Cadmium	0.29	\	\	\
											Chromium	13.8	\	\	\
											Cobalt	10.2	\	\	\
											Copper	38.4	\	\	\
											Lead	14.9	\	\	\
											Manganese	326	\	\	\
											Mercury	0.02	\	\	\
											Molybdenum	1.9	\	\	\
											Nickel	12.1	\	\	\
											Vanadium	52.9	\	\	\
											Zinc	228	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-25	Outfall	100-BC-1	37 x 3.66 x 1.5	The 1904-B2 Spillway was an alternate discharge point for the 132-B-6 Outfall Structure. It was planned to be used only if the 100-B-15 River Effluent Pipelines were blocked, damaged, or undergoing maintenance. The upper portion of the spillway was removed in 2001 as part of remediation of the 132-B-6 Outfall Structure, and the remainder of the spillway and riprap has been backfilled with clean soil. Based on results of the 2002 and 2003 GPERS field radiological survey measurements, the 100-B-25 Site was determined to contain radiological contamination at levels above the remedial action goals. Based on this determination, remedial action was recommended for the site.	Accepted	EPA/ROD/ R10-99/039	N/A								
100-B-26	Outfall	100-BC-1	14.2 x 3.05 x 3	The spillway was an alternate discharge point for the 132-C-2 Outfall Structure. It was planned to be used as an alternate for effluent only if the 100-B-15 River Effluent Pipelines were blocked, damaged, or undergoing maintenance. There is no historical information that the spillway was ever used.	No Action	WSRF-2006-052	1/17/2006 (confirmatory samples)	N/A	N/A	N/A	Cesium-137	3.14	\	\	\
											Uranium-233/234	1.44	\	\	\
											Uranium-238	1.18	\	\	\
											Arsenic	5.2	\	\	\
											Barium	84.7	\	\	\
											Beryllium	0.44	\	\	\
											Boron	1.8	\	\	\
											Cadmium	0.5	\	\	\
											Chromium	39.3	\	\	\
											Chromium VI	2	\	\	\
											Cobalt	6.4	\	\	\
											Copper	20.2	\	\	\
											Lead	17.6	\	\	\
											Manganese	262	\	\	\
											Mercury	0.02	\	\	\
											Molybdenum	0.21	\	\	\
											Nickel	16.5	\	\	\
											Selenium	0.51	\	\	\
											Vanadium	33.7	\	\	\
											Zinc	108	\	\	\

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-27	Unplanned Release	100-BC-1	10.67 x 7.62 Depth uncertain	The site is an unplanned release of sodium dichromate that was discovered while removing the western staging pile associated with the cleanup of the 126-B-3 Coal Pit. About 1.2 m (4 ft) of below grade ash was scraped off during the removal of the staging pile. A stained soil area was observed in the middle of the north one-third of the staging pile area. Because the contamination was unrelated to disposal or remediation staging activities at the 126-B-3 Waste Site, and because the extent of contamination was unknown, this area was classified as a new site and subsequently designated as the 100-B-27.	Accepted	EPA/AMD/R10-97/044	N/A								
100-B-28	Product Piping	100-BC-1	600.46 7.6 cm (diameter)	The 183-C to 183-B Sodium Dichromate Transfer Pipeline. Sodium dichromate solids and concentrated solutions were received, stored, and mixed with the reactor cooling water as a corrosion inhibitor for the reactor fuel and piping. Initially, granular sodium dichromate was mixed with water to prepare a 15% weight solution that was metered into the volute of the primary pumps in the 190-B Pump House to provide a 2-ppm concentration of sodium dichromate in the reactor cooling water. Later, the solid sodium dichromate feedstock was replaced with a concentrated (70% by weight) sodium dichromate solution that was metered into the cooling water to produce the 2-ppm concentration of sodium dichromate.	Accepted	Not Documented	N/A								
100-B-29	Dumping Area	100-BC-1	3 (length) 0.15 (diameter)	While excavating 100-B-28 in February 2009, a pipeline was uncovered that matched the pipe remnant lying on the surface. The northwesterly end was jagged metal suggesting that it may have been severed during an excavation.	Not Accepted	137127, Four Discovery Sites in the 100-B/C Area	N/A								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-B-30	Product Piping	100-BC-2	4 (length) 0.08 (diameter)	The waste is a single segment of pipe. There is no evidence of staining or any additional pipe or piping systems in the area, and is located in an area of other scattered surface debris outside the 100-BC perimeter fence. The pipe is believed to be surficial debris only.	Not Accepted	137127, Four Discovery Sites in the 100-B/C Area	N/A								
100-B-31	Unplanned Release	100-BC-2	134.11 x 121.92 x 0	The site is a garnet sand release. The exact process that caused the garnet sand to be located at the 183-C Clearwell Pads is unknown. However, garnet sand (grit) was used in sandblasting operations.	Accepted	137127, Four Discovery Sites in the 100-B/C Area	N/A								
100-B-32	Unplanned Release	100-BC-1	Not Documented	The site is a surface contamination area. Contamination at this location is matrixed with the asphalt and is believed to be a legacy of past practices and operations.	Accepted	137127, Four Discovery Sites in the 100-B/C Area	N/A								
100-B-33	Unplanned Release	100-BC-1	150 m^2	The site is a surface contaminated area. The waste is contaminated soil. The site was discovered during the surface soil surveys of the northeast quadrant of the 100-B/C Area in July through August 2007. The readings found showed an elevated area averaging 15,000 cpm over a 150 m^2 (5,297-ft^2) area with a maximum reading of 93,000 cpm.	Accepted	Not Documented	N/A								
116-B-1	Trench	100-BC-1	112.78 x 15.24 x 4.57	The site received effluent from the 107-B Retention Basin at times of high activity due to fuel element failures. The fission products of 54 fuel ruptures were routed to this site.	Interim Closed Out	CVP-99-00012	10/6/1998	1/6/1999	43,033	4.6	Americium-241	0.086 J	0.065 U	0.047	0.042
											Cesium-137	0.25	3.16	0.15	0.163
											Cobalt-60	0.106	0.196	0.053	2.89
											Europium-152	1.41	8	0.69	6.35
											Europium-154	0.177	0.487	0.11	0.453
											Nickel-63	2.25 U	2.81 U	4	8.56
											Plutonium-238	0.023 U	0 UJ	0.039	0.06
											Plutonium-239/240	0.031 J	0.179	0.037	0.158
											Strontium-90	0.066 U	1.55	0.16	1.23
											Uranium-238	0.84 J	1.06	0.74	0.91
											Chromium	14.6	17	12.4	16.1
											Chromium VI	1.7	7.1	1.18	0.363

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-B-2	Trench	100-BC-1	22.86 x 3.05 x 4.57	The 105-B Storage Basin Trench was only used once in 1946 to receive contaminated basin water after a fuel element was accidentally cut in half in the 105-B Fuel Storage Basin.	Interim Closed Out	CVP-99-00015	2/17/1999	6/24/1999	9,393	4.9	Cesium-137	1.22	47.2	0.967	44
											Europium-152	0.098 U	0.87	0.0821	0.643
											Europium-154	0.084 U	0.079 U	0.0743	0.0789
											Strontium-90	0.323 J	11.5	0.28	7.22
											Uranium-238	0.707 J	0.67 J	0	0
											Uranium-233/234	0.603 J	0.78 J	0	0
											Chromium VI	0.42 U	0.42 U	0.42	0.42
116-B-3	Crib	100-BC-1	3.05 x 3.05 x 6.10	The 105-B Pluto Crib received 105-B Cooling Water Wastes that had been contaminated by cladding ruptures of fuel elements. Cooling water diversion occurred when a fuel element rupture was detected within a process tube. The water was diverted from the affected process tube through a valve on the rear of the reactor face known as a "pluto valve" and through rubber hose to the crib. The wooden crib was buried so that its upper surface was approximately at grade. A hatch on the upper surface was opened to receive the rubber hose and the crib was allowed to flood.	Closed Out	CVP-99-00013	2/17/1999	5/12/1999	244	4.6	Cesium-137	0.061	19.7 J	0.0423	17.8
											Strontium-90	0.157 J	3.16	0.0495	2.85
											Uranium-233/234	0.745 J	0.558	0	0
											Chromium VI	0.42 U	0.42 U	0.42 U	0.42 U
116-B-4	French Drain	100-BC-1	2.27 m^2 4.57 (depth)	The 105-B Dummy Decontamination French Drain received spent acid rinse water from the 105-B Dummy Decontamination Facility, which was used for the decontamination of fuel element spacers and other reactor hardware. The French drain was fed by a single, underground stainless steel pipe. Acids were neutralized within the 105-B Dummy Decontamination Facility before discharge to the French drain.	Interim Closed Out	CVP-99-00014	7/11/1995	4/4/1999	8,700	4.6	Cesium-137	0.049 J	372.16	0.0437	39.9
											Cobalt-60	0.027 UJ	23.803	0.024	5.4
											Europium-152	0.056 UJ	315.36	0.0518	77
											Europium-154	0.091 UJ	37.886	0.0791	9.02
											Europium-155	0.075 UJ	0.527	0.0595	0.241
											Plutonium-239/240	0.353 J	0.011 U	0.244	0.0502

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-B-5	Crib	100-BC-1	27.03 x 2.44 x 2.70	The 116-B-5 Crib began operations in 1950 to receive liquid waste from the 108-B Building P-10 Project. The P-10 Project was initially a pilot-plant tritium separations project to derive tritium products for the U.S. Nuclear Weapons Program. It was estimated that hundreds of gallons of mercury were disposed of to the 116-B-5 Crib along with solvents and degreasers, such as carbon tetrachloride, methyl alcohol, and trichloroethylene. After the tritium project ended in 1951, portions of the facility were used for destructive examination of ruptured fuels and damaged irradiated process tube examinations. These laboratory examinations likely generated chemical wastes common to decontamination of radioactive components. These chemicals included oxalic and nitric acids, sodium hydroxide, and solvents such as acetone, methyl ethyl ketone, carbon tetrachloride, and methyl and ethyl alcohols. The 108-B Facility also housed a photographic darkroom at its north end that may have discharged waste to the crib.	Interim Closed Out	WSRF-98-064	6/26/1995	Not Documented	300m^3	5	Cesium-137	1.82	\	0.23	\
											Cobalt-60	1.032	\	0.17	\
											Europium-152	10.7	\	1.26	\
											Europium-154	0.882	\	1.02	\
											Tritium	680	\	48.48	\
											Mercury	16	\	2.17	\
											Barium	1000	\	407.62	\
116-B-6A	Crib	100-BC-1	3.66 x 2.44 x 4.57	The 116-B-6A Crib received radioactive liquid wastes from equipment decontamination performed in the 111-B Building, as well as from the decontamination of fuel element spacers.	Closed Out	CVP-99-00011	Not Reported	5/12/1999	5,072	4.6	Cesium-137	37.1	2.04	2.92	1.84
											Cobalt-60	0.046 U	0.022	0.032	0.023
											Europium-152	0.19 U	0.061 U	0.1	0.065
											Europium-154	0.13 U	0.078 U	0.099	0.079
											Strontium-90	3.77	21.1	1.81	10.8
											Uranium-233/234	1.38	0.586 J	0.867	0.506
											Uranium-238	0.662 J	0.639 J	0.529	0.524
											Mercury	0.11	0.02 U	0.08	0.02 U
											Chromium VI	0.42 U	0.41 U	0.42 U	0.41 U
116-B-6B	Crib	100-BC-1	3.66 x 2.44 x 4.57	The 111-B Crib No. 2 was an unlined crib that received radioactive wastes from equipment decontamination performed in the 111-B Decontamination Station, as well as liquid wastes from the decontamination of fuel element spacers.	Interim Closed Out	CVP-99-00017	3/11/1999	3/12/1999	263	3	Lead	7.9	\	5.48	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-B-7	Outfall	100-BC-1	8.23 x 4.27 x 6.4	The 1904-B-1 Outfall Structure was an open, reinforced-concrete structure that directed the water either through the river discharge pipelines or through spillways. The spillways were concrete flumes used when the river pipelines were blocked, damaged, or undergoing maintenance. The cooling water discharged into the upper chamber of the concrete outfall structure, flowed through a bar grillwork, and fell about 6 m (20 ft) to the lower chamber of the outfall structure. The cooling water then overflowed from the lower chamber into the discharge pipe to the river.	Interim Closed Out	CVP-2002-00003	Jun-01	Jan-02	17,233	8.3	Americium-241	0.076 U	0	0.028	0.022
											Cesium-137	1.2	3.5	0.31	3.2
											Cobalt-60	0.25	0.18	0.072	0.16
											Europium-152	1.9	1.4	0.4	1.3
											Europium-154	0.21	0.33 U	0.12	0.15
											Europium-155	0.23 U	0.23 U	0.079	0.11
											Nickel-63	3.6	3.3 J	0.59	3.1
											Plutonium-238	0 U	0 U	0.011	0
											Plutonium-239/240	0 U	0 U	0.06	0.068
											Tritium	0.072 U	0.039 U	0.072	0.016
											Strontium-90	0.18	0.4 J	0.15	0.4
											Uranium-234	0.9 J	1.1 J	0.64	0.92
											Uranium-235	0.05 J	0.097 J	0.2	0.097
											Uranium-238	0.92 J	1.1 J	0.69	0.67
											Lead	11	8.8	7.1	8.8
											Mercury	0.24	0.75	0.24	0.67
											Chromium	25	25	19	21
											Chromium VI	0.81	2.1	0.81	2.1
116-B-9	French Drain	100-BC-1	2.32 m^2	The 104-B-2 French Drain was in the 104-B-2 Building, which was associated with the P-10 Project that involved tritium production. The 104-B-2 Building was used to store casks containing irradiated lithium targets for tritium production and product tritium. The facility contained an inspection laboratory and an annex on the east end that contained air-sampling equipment.	Interim Closed Out	CVP-99-00009	3/10/1999	3/11/1999	Not Documented	2.44	Cesium-137	0.028 U	\	0.0252	\
											Cobalt-60	0.023 U	\	0.0221	\
											Europium-152	0.053 U	\	0.047	\
											Strontium-90	0.115 U	\	0.17	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-B-10	Sump	100-BC-1	3.68 m^2 0.91 (Diameter)	The 108-B Dry Well Quench Tank was used to collect liquid decontamination wastes from the 108-B Tube Examination and Experimental Facility.	Interim Closed Out	CVP-99-00010	3/10/1999	5/19/1999	692	2.44	Cesium-137	0.034	\	0.028	\
											Cobalt-60	0.08	\	0.0597	\
											Europium-152	0.053	\	0.0601	\
											Europium-154	0.094 U	\	0.0854	\
											Strontium-90	0.146 U	\	0.196	\
											Uranium-233/234	0.687 J	\	0	\
											Uranium-238	0.713 J	\	0	\
											Mercury	0.3 J	\	0.92	\
											Chromium VI	0.42 U	\	0.42 U	\
116-B-11	Retention Basin	100-BC-1	142.34 x 70.1 x 6.10	The 116-B-11 Retention Basin was constructed to hold cooling water effluent from the 105-B Reactor to allow for thermal cooling and radioactive decay before release to the Columbia River. This unit was a concrete-lined basin with wooden baffles. The basin was divided lengthwise into two halves designed to operate independently. The floor and walls consist of concrete slabs; their joints were originally closed with neoprene water seals. The unit was backfilled with soil to a depth of almost 1.2 m (4 ft).	Interim Closed Out	CVP-99-00001	11/26/1997	10/28/1998	165,178	5	Americium-241	0.0944 J	14.2	0.064	6.54
											Strontium-90	0.02 U	0.106 U	0.206	0.149
											Cesium-137	1.27	238	0.815	165
											Cobalt-60	0.401	94.9	0.211	80
											Europium-152	3.37	844	1.76	532
											Europium-154	0.473 U	104	0.111	70.8
											Europium-155	0.0947 U	3.49	0.078	5.66
											Nickel-63	22.4 J	6140 J	11.5	4816
											Plutonium-238	0.0104 U	1.35 J	0.023	1.63
											Plutonium-239/240	0.102	51.3	0.067	28
											Strontium-90	0.236 J	7.15	0.204	5.17
											Uranium-238	1.49	2.8 J	1.28	1.42
											Lead	7.5 B	21.5	5.3	13.1
											Mercury	0.19	14.5	0.1	11.2
											Chromium	19.1	449	13.3	314
											Chromium VI	1.67	2.03	1.67	1.23

Table B-1. 100-BC Waste Sites Description and History

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-B-12	Crib	100-BC-1	28.04 x 18.9 x 3.05	The 117-B Seal Pit Crib received drainage from the confinement system seal pits in the 132-B-4 Air Filtration Ventilation Building.	Interim Closed Out	CVP-99-00008	2/17/1999	3/5/1999	8696	4.6	Uranium-238	7.23 J	5.85 J	0	0
											Chromium VI	0.42 U	0.86	0.42 U	0.809
116-B-13	Trench	100-BC-1	30.48 x 9.14	The unit received low-level sludge waste from the bottom of 116-B-11 (107-B Retention Basin). During maintenance cleanout operations, sludge was disposed of to the trench. There is no indication from available records that this site directly received any regular and/or high-volume effluent wastes.	Interim Closed Out	CVP-99-00002	8/7/1998	11/6/1998	6,340	4.3	Americium-241	0.493	\	0.419	\
											Cesium-137	0.0492	\	0.066	\
											Cobalt-60	0.0172 U	\	0.042	\
											Europium-152	0.138	\	0.098	\
											Europium-154	0.043 U	\	0.118	\
											Europium-155	0.0401 U	\	0.066	\
											Plutonium-238	0.0107 UJ	\	0.032	\
											Plutonium-239/240	0.0398	\	0.036	\
											Strontium-90	0.407 J	\	0.308	\
											Uranium-238	0.991 J	\	0	\
											Lead	4.4	\	2	\
											Mercury	0.02 J	\	0.02	\
											Chromium	4.1 J	\	5	\
											Chromium VI	0.84 U	\	0.03	\
116-B-14	Trench	100-BC-1	36.58 x 3.05 x 3.05	The unit received low-level sludge waste from the bottom of 116-B-11 (107-B Retention Basin). During maintenance cleanout operations, sludge was disposed of to the trench. There is no indication from available records that this site directly received any regular and/or high-volume effluent wastes. After its use, the waste site was covered with about 1.8 m (6 ft) of soil.	Interim Closed Out	CVP-99-00003	5/27/1998	9/17/1998	3,795	6	Americium-241	0.263	0.008	0.182	0.036
											Cesium-137	1.14	5.88	0.785	5.37
											Cobalt-60	0.043	0.034 J	0.057	0.028
											Europium-152	4.43	1.34	1.31	1.21
											Europium-154	0.191 U	0.117	0.164	0.631
											Europium-155	0.087	0.0417 U	0.109	0.081
											Plutonium-238	0.0554	0.008 U	0.027	0.038
											Plutonium-239/240	0.37	0.101	0.267	0.068

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Strontium-90	1.55	1.6	1.14	1.35
											Lead	20	5.3	18.7	5
											Mercury	0.03 J	0.018	0.03	0.02
											Chromium	33.6 J	18.6	31.2	17.9
											Chromium VI	0.297	0.252	0.253	0.231
116-B-15	Pond	100-BC-1	30.48 x 15.24 x 1.83	During the cleaning of the 105-B Fuel Storage Basin, the radiologically contaminated shielding water was processed through a system that used ion exchange columns. Before the water was discharged to the 105-B Fuel Storage Basin Cleanout Percolation Pit (105-B Pond), composite samples were taken to ensure that radionuclide concentrations were below release criteria.	No Action	WSRF-2003-052	8/8/2003 (confirmatory samples)	N/A	N/A	N/A	Nickel-63	20.8	\	\	\
											Radium-228	1.22	\	\	\
											Uranium-233/234	0.672	\	\	\
											Uranium-238	0.666	\	\	\
											Arsenic	6.8	\	\	\
											Barium	89	\	\	\
											Chromium	14.4	\	\	\
											Lead	9.3	\	\	\
											Mercury	0.02	\	\	\
											Selenium	0.5	\	\	\
116-B-16	Storage Tank	100-BC-1	3.25 x 1.75 x 2.74	The 116-B-16 Fuel Examination Tank was a low-level liquid waste disposal site that was operational during the lifetime of the 111-B Metallurgical Examination Building. The tank received liquid wastes from the decontamination of fuel element spacers and other equipment as well as from other 111-B Building activities.	Closed Out	CVP-99-00011	See 116-B-6A								

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
118-B-1	Burial Ground	100-BC-2	740 x 90 x 6.1	The original 105-B Burial Ground contained six to eight trenches, but was expanded over its operational lifetime to 23 trenches. The site was to have received general reactor waste from the B Reactor including the following: aluminum tubes, lead bricks, thermocouples, vertical and horizontal aluminum thimbles, stainless-steel gun barrels, and expendables (e.g., plastic, wood, and cardboard). Spline silos were also constructed at the burial ground, which were vertical metal culverts, 3 to 3.7 m (10 to 12 ft) in diameter, built presumably to receive reactor poison splines and other metal wastes. In 1952, the burial ground received contaminated tritium pots, irradiated process tubing, contaminated fuel spacers (perfs), solid tritium wastes, and high-level liquid tritium wastes that were sealed in a 7.6 cm (3-in.) -diameter iron pipe. In 1956, the second extension to the burial ground was added and was used for the burial of contaminated yokes from B Reactor. In the mid-1960s, the third extension was added to the north side of the original burial ground. Historical data on the contents of these trenches are not as detailed as with earlier extensions but are presumed to include "general" reactor and construction waste from modifications to the B Reactor. Waste materials from the Tritium Separation (P-10) Project were also buried here, including lithium-aluminum alloy, lead, mercury, aluminum cladding, and palladium.	Interim Closed Out	CVP-2007-00006	2/2/2004	6/7/2007	120,000	10	Carbon-14	3.44	2.46 U	1.93	\
											Cesium-137	3.6	0.478	2.4	0.159
											Cobalt-60	0.049	0.164	0.039	0.05
											Europium-152	1.24	0.143	0.695	0.068
											Strontium-90	4.42	0.412	2.56	0.12
											Tritium	239	7.32	158	\
											Uranium-233/234	0.718	0.874	0.671	0.564
											Uranium-235	0.055	0.167	0.051	0.039
											Uranium-238	0.756	0.715	0.725	0.587
											Arsenic	4.5	4.8	4.1	3.7
											Barium	145	75.4	132	60.8
											Beryllium	0.66	0.62	0.64	0.56
											Boron	18.1	2.9	13.7	1.8
											Chromium	9.59	9.5	8.9	8.1
											Chromium VI	0.33	0.36	0.29	0.24
											Cobalt	14.5	10.9	10.2	9.2
											Copper	25.7	17.2	22.2	15.9
											Lead	12.9	6.5	11	5.1
											Manganese	411	418	381	366
											Mercury	2	0.03	1.3	0.03
											Molybdenum	2.1	0.5	2.1	0.43
											Nickel	19	12.5	15.9	11.1
											Selenium	0.68	1	\	1
											Vanadium	68.7	54.2	54.5	48.8
											Zinc	49.1	45	45.8	41.4
											Aroclor-1254	0.08	0.047 J	0.08	\
											bis(2-Ethylhexyl)phthalate	0.6	0.28	0.41	0.08
											Butylbenzylphthalate	0.024	0.34 U	0.024	\
											2-Methylnaphthalene	0.026	0.34 U	0.026	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Di-n-butylphthalate	0.084	0.049	0.16	0.13
											Diethylphthalate	0.025	0.019	0.025	0.019
											4-Methyl-2-pentanone	0.008	0.007	0.006	0.007
											Naphthalene	0.019	0.34 U	0.019	\
											Phenol	0.026	0.027	0.17	0.034
											Toluene	0.005 U	0.001	\	0.001
											Xylenes	0.010 U	0.001	\	0.001
											Acetone	0.023	0.02	0.017	0.02
											Carbon tetrachloride	0.017	0.032	0.016	0.011
											Methylene chloride	0.026	0.018	0.019	0.014
											alpha-Chlordane	0.012	0.0013 U	0.012	\
											beta-BHC	0.0078	0.0022	0.0078	0.0022
											4,4'-DDE	0.016	0.0013 U	0.016	\
											4,4'-DDT	0.0013 U	0.0016	\	0.0016
											Aldrin	0.0013 U	0.017 U	0.0005	\
											Dieldrin	0.0038	0.0013 U	0.0038	\
											Endosulfan I	0.0013 U	0.0049	\	0.0049
											Endosulfan sulfate	0.0022	0.0084	0.0022	0.00084
											Endrin	0.0015	0.0017 U	0.0015	\
											Endrin aldehyde	0.0055	0.0015	0.0055	0.0015
											Endrin ketone	0.0078	0.0014	0.0078	0.0014
											Heptachlor	0.0017 U	0.00043	\	0.00043
											gamma-Chlordane	0.0025	0.017 U	0.0025	\
											Methoxychlor	0.0091	0.0053	0.0091	0.0053
											2,4-D	0.062	0.081 U	0.062	\
											2,4-DB	0.043	0.0098	0.043	0.0098
											2,4,5-TP	0.012	0.020 U	0.012	\
											Dalapon	0.048	0.048	0.037	0.048
											Dicamba	0.013	0.013	0.013	0.013

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Dichloroprop	0.19	0.21	0.14	0.21
											Pentachlorophenol	0.014	0.017 U	0.014	\
											Picloram	0.014	0.017 U	0.014	\
118-B-2	Burial Ground	100-BC-2	18.29 x 9.14 x 3.05	The Minor Construction Burial Ground No. 1 received dry waste from the 107-B Basin repairs and from the 115-B Gas Recirculation Facility alterations. Operation of the unit began in 1952 and ended in summer 1956.	Interim Closed Out	CVP-2005-00001	4/19/2004	6/24/2004	9,525	4.6	Cesium-137	0.182	0.1 U	0.094	\
											Cobalt-60	0.19 U	0.11 U	0.068	\
											Europium-152	2.47 UJ	0.21 U	0.16	\
											Europium-154	0.026 U	0.32 U	0.15	\
											Europium-155	0.026 U	0.21 U	0.091	\
											Nickel-63	0.095 U	0.807 UJ	1.8	\
											Plutonium-238	11.5	0.029 U	0.0086	\
											Plutonium-239/240	.3 J	0 U	0.0086	\
											Strontium-90	5.2	0.03 U	0.05	\
											Chromium	0.02 U	12.7	10	11
											Chromium VI	\	0.322 J	0.3	0.32
											Lead	0.1 U	6.7	4.9	6.5
											Mercury	0.25	0.02 U	0.02	0.02 U
118-B-3	Burial Ground	100-BC-2	106.68 x 83.82 x 6.10	The Construction Burial Ground No. 2 was in operation from summer 1956 until 1960 and was used for disposal of solid waste from effluent pipeline modifications and for disposal of reactor-generated solid waste during various modification programs.	Interim Closed Out	CVP-2005-00001	See 118-B-2 Data								
118-B-4	Burial Ground	100-BC-2	15.24 x 9.14 x 4.57	The unit was used for disposal of fuel spacers dummies. The 105-B Spacer, or 105-B Dummy Burial Ground, received irradiated aluminum fuel spacers from the 105-B Reactor.	Interim Closed Out	CVP-2004-00002	11/14/2003	12/22/2003	3,171	3.9	Cobalt-60	0.054 U	\	0.054	\
											Chromium VI	0.87 U	\	0.25	\
118-B-5	Burial Ground	100-BC-1	15.24 x 15.24 x 6.10	The Ball 3X Burial Ground received irradiated equipment and metallic wastes removed from the 105-B Reactor during the Ball 3X Project. The 118-B-5 (Ball 3X) Burial Ground contained one trench, which was covered with 1.5 m (5 ft) of soil after its use was discontinued. The site appeared as a vegetation-free "L" shaped mound of cobbles, about 0.9 m (3-ft) high, that was surrounded by permanent concrete markers and was outside the reactor exclusion area.	Interim Closed Out	CVP-2004-00003	Nov-03	Dec-03	5,046	4.8	Carbon-14	241 J	\	0.0465	\
											Cobalt-60	7.7	\	0.023	\
											Nickel-63	0.08	\	0.51	\

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
118-B-6	Burial Ground	100-BC-2	4.57 x 3.05 x 6.10	The 108-B Solid Waste Burial Ground No. 2 was used for disposal of wastes from the "metal line" of the P-10 Tritium Separation Project. One of the pipes was filled with waste and capped, and the other was partially filled with waste and capped. Finally, both pipes were capped with a concrete pad.	Interim Closed Out	CVP-2006-00002	Nov-04	Jun-05	577	7	Tritium	241 J	2780 J	160	1996
											Lead	7.7	5.1	6.7	4.9
											Mercury	0.08	0.035 U	0.08	0.02 U
118-B-7	Burial Ground	100-BC-1	2.44 x 2.44 x 2.44	The 111-B Solid Waste Burial Site received decontamination materials and assorted equipment from the 111-B Decontamination Facility and workshop from 1951 to 1968. After researching photos and documentation of the area, a GPS survey was conducted. Verification sampling indicated that contaminants were at or below background levels.	Rejected	EPA/ROD/R10-00/121	N/A								
118-B-8	Reactor	100-BC-1	3,866.08 m^2	The site is an inactive plutonium production reactor. The unit consists of a reactor block with associated shielding and controls, an irradiated fuel storage basin, and contaminated portions of the reactor building.	Accepted	Not Documented	N/A								
118-B-8:1	Reactor	100-BC-2		The reactor rested on a 7.0 m (23-ft) -thick concrete foundation topped with cast-iron blocks that served as a thermal shield. The building walls consisted of reinforced concrete in the lower portions and concrete blocks in the upper portions with thickness varying from 0.9 to 1.5 m (3 to 5 ft). The roof was composed of precast concrete roof tiles, except for the discharge area enclosure and inner horizontal rod room where the roof was composed of 1.8 m (6-ft) -thick reinforced concrete. The reactor was known as a "single-pass" reactor due to the once-through nature of its light water cooling systems. Known as "piles" in the 1940s, the reactor drew cooling water from the river, and pumped it through a series of filtration, chemical treatment, and storage buildings and tanks. The water then was passed directly through long, horizontal tubes in the reactors, where the solid, Al-Si-jacketed uranium fuel rods underwent active neutron bombardment.	Accepted									

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
				From there, the water was pumped out the back of the piles, left for a brief time (30 minutes to 6 hours) in retention basins to allow for short-term radioactive decay, and then returned to the Columbia River. The core of each reactor was a series of graphite blocks (stack) that fitted together. The graphite served as the "moderator" to slow and absorb extraneous neutrons from the basic nuclear chain reaction. The "lattice," or pattern of process channel configuration was a simple rectangle, with only the corners of the core bearing no penetrations. Each reactor's graphite core was surrounded by thick thermal and biological shields. The core and shields formed the reactor "block," and each block was enclosed in a welded steel box that functioned to confine a gas atmosphere. The atmosphere of the earliest reactors was composed of helium, an inert gas selected for its high heat removal capacity. The reactor core consisted of a graphite "stack" that measured 8.5 m (28 ft) from front to rear, 11.0 m (36 ft) from side to side, and 11.0 m (36 ft) from top to bottom. The stack was pierced front to rear by 2,004 process channels that held the fuel elements. Nine horizontal channels for control rods entered from the left side and 29 vertical channels for safety rods entered from the top. Test holes extended from the right side of each Hanford pile for the irradiation of experiments and special samples. Horizontal channels for control rods (HCRs) entered from the left side of each reactor, and vertical channels for safety rods (VSRs) entered from the top. The control and safety systems functioned simply to absorb neutrons, thus slowing and eventually stopping the controlled chain reaction of neutron exchange between the uranium fuel elements. The horizontal control rod (HCR) and vertical safety rod (VSR) channels, as well as the test holes, were lined with a thin sheet of aluminum known as a "thimble."											

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
118-B-9	Storage	100-BC-1	104-B-1 tritium vault: 3.96 x 3.05 104-B-2 tritium laboratory: 7.32 x 3.66	The site consisted of two concrete masonry facilities identified as 104-B-1 Tritium Vault and 104-B-2 Tritium Laboratory. Both structures were demolished and their associated foundations removed to 1 m (3 ft) below grade in 1996. The Tritium Laboratory contained 63 special cells recessed in the laboratory floor. These were used to store the vacuum casks, which contained the irradiated target elements for the P-10 Project. The sample results demonstrate that the site achieves RAOs and remedial action goals.	No Action	WSRF-2004-004	Sep-03	N/A	N/A	N/A	Antimony	0.695	\	\	\
											Arsenic	4.9	\	\	\
											Barium	141	\	\	\
											Beryllium	0.177	\	\	\
											Boron	9.7	\	\	\
											Cadmium	0.435	\	\	\
											Chromium	15.7	\	\	\
											Cobalt	9.5	\	\	\
											Copper	20.5	\	\	\
											Lead	26.9	\	\	\
											Manganese	354	\	\	\
											Mercury	0.225	\	\	\
											Molybdenum	0.4	\	\	\
											Nickel	14.8	\	\	\
											Vanadium	71.6	\	\	\
											Zinc	250	\	\	\
118-B-10	Storage Tank	100-BC-1	14.63 x 5.49	The waste is a radioactive metal storage tank used to store radioactive boron balls from the ball 3X system.	Interim Closed Out	CVP-2004-00004	12/1/2003	12/2/2003	266	3.21	Cobalt-60	0.31	\	\	\
											Nickel-63	81.1	\	\	\
120-B-1	Sump	100-BC-1	6.47 m^2	The 120-B-1 Battery Acid Sump is a standard limestone acid neutralization pit with metal cover plates at grade. It was used from approximately 1944 to 1969 to neutralize the spent sulfuric acid from lead cell batteries of emergency power packs and the emergency lighting system.	Interim Closed Out	WSRF-2006-057	6/1/2006	6/13/2006	32 BCM	3	Arsenic	5	\	\	\
											Barium	135	\	\	\
											Beryllium	0.31	\	\	\
											Boron	8.1	\	\	\
											Chromium	273	\	\	\
											Chromium VI	0.38	\	\	\
											Cobalt	9.1	\	\	\
											Copper	19.8	\	\	\
											Lead	15.4	\	\	\
											Manganese	336	\	\	\
											Mercury	0.09	\	\	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Molybdenum	2.3	\	\	\
											Nickel	13.8	\	\	\
											Silver	0.23	\	\	\
											Vanadium	55.9	\	\	\
											Zinc	72.2	\	\	\
											Sulfates	5,960	\	\	\
											Aroclor-1221	0.0098	\	\	\
											Aroclor-1260	0.17	\	\	\
126-B-1	Coal Ash Pit	100-BC-1	200 x 200	Coal ash from the 184-B Powerhouse was mixed with raw river water and sluiced in slurry form to the ash pit via a 20 cm (8-in.) ashcolite pipe. Coal ash from analogous sites has been analyzed using the extraction procedure toxicity test in accordance with WAC 173-303, and no hazardous materials were found.	Rejected	Not Documented	N/A								
126-B-2	Dumping Area	100-BC-1	228.9 x 41.15 x 5.18	The site consists of two underground concrete reservoirs, or clearwells, separated in the center by the remains of a demolished pump room. A concrete piping structure remains above ground at the southeast corner of the clearwell site. The 126-B-2, 183-B Clearwells waste site is limited to the clearwells themselves. The remainder of the 183-B Facility (i.e., head house, flocculation and sedimentation basins, and pump house) and the pipelines around the original 183-B Facility are all part of the 100-B-22 Waste Site, the 100-B-14 Waste Site, or the 100-B-28 Waste Site, and are not addressed in this site. The basis for reclassification to no action is process knowledge, historical documents, and historical drawings. Under the original and final configurations of the water treatment facilities, sodium dichromate was added to the process water in the 190-B Facility, which is downstream of the 126-B-2 Clearwells. Therefore, water in the 126-B-2 Clearwells would not have been expected to contain Cr(VI) or radionuclides, even at low concentrations.	No Action	WSRF-2007-004	N/A								

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
126-B-3	Dumping Area	100-BC-1	152.4 x 79.25 x 4.57	The 126-B-3, 184-B Coal Pit received coal that was crushed and sized for use in the 184-B Power House Boilers. Following shutdown of the reactors and beginning in the early to mid-1970s, the coal pit was used to dump demolition debris from decommissioned 100-B Facilities. In May 1985, demolition D&D of the 108-B Building were completed and the clean rubble and debris were disposed to the 184-B Coal Pit (126-B-3). Radioactively contaminated debris was sent to the 200 Area burial grounds.	Interim Closed Out	WSRF-2005-028	Sep-03	Sep-03	43,100 BCM	7	Arsenic	12	\	5.9	\
											Barium	163	\	93.4	\
											Beryllium	0.76	\	0.56	\
											Boron	7.8	\	4.9	\
											Chromium	20.7	\	12.2	\
											Cobalt	15.6	\	11.6	\
											Copper	36	\	23.4	\
											Lead	18.1	\	8.3	\
											Manganese	689	\	467	\
											Mercury	0.03	\	0.03	\
											Molybdenum	1.4	\	1.4	\
											Nickel	26.2	\	15.9	\
											Vanadium	76.1	\	66.9	\
											Zinc	84.4	\	62.4	\
											Aroclor-1260	0.017	\	0.017	\
											1,2,4-Trichlorobenzene	0.052	\	0.052	\
											2-Methylnaphthalene	0.39	\	0.39	\
											Acenaphthene	0.055	\	0.055	\
											Anthracene	0.15	\	0.15	\
											Benzo(a)anthracene	0.35	\	0.35	\
											Benzo(a)pyrene	0.27	\	0.27	\
											Benzo(b)fluoranthene	0.19	\	0.19	\
											Benzo(g,h,i)perylene	0.17	\	0.17	\
											Benzo(k)fluoranthene	0.24	\	0.24	\
											Carbazole	0.075	\	0.075	\
											Chrysene	0.37	\	0.37	\
											Dibenzofuran	0.099	\	0.099	\
											Dibenz(a,h)anthracene	0.088	\	0.088	\
											Fluorene	0.071	\	0.071	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Fluoranthene	0.73	\	0.73	\
											Indeno(1,2,3-cd)pyrene	0.16	\	0.16	\
											N-nitrosodiphenylamine	0.1	\	0.1	\
											Naphthalene	0.12	\	0.12	\
											Phenanthrene	0.62	\	0.62	\
											Pyrene	0.7	\	0.7	\
126-B-4	Sump	100-BC-1	15.19 m^2	The salt-dissolving pits and brine pump pit were part of a single below-grade concrete structure that provided brine for the 184-D Powerhouse. The structure has been demolished and buried in situ. No evidence of the site remains at the surface. Before demolition, the pits were surveyed for radiological and nonradiological hazardous materials. The water analysis from the salt-dissolving pits indicated no radioactivity above background, no reportable concentrations of heavy metals, and a sodium chloride concentration less than 1%.	Rejected	Not Documented	N/A								
128-B-1	Burn Pit	100-BC-1	30.48 x 30.48	The site has been described as a burn pit. During a field investigation on October 17, 1995, it was noted that the area is covered with cheatgrass and appears undisturbed with no evidence of burning.	Not Accepted	Not Documented	N/A								
128-B-2	Burn Pit	100-BC-1	100 x 60 x 3.05	The site received nonradioactive, combustible materials. Old paint cans and sandblast sand can still be seen at the site. Office waste, paint waste, chemicals, and solvent were burned at this site. It appears that clean fill material has been added to the site, indicating that the site may have also been used as a solid waste landfill.	Interim Closed Out	WSRF-2005-038	Nov-04	Apr-05	5,627 BCM	3.5	Radium-226	0.674	\	0.461	\
											Uranium-233/234	0.891	\	0.658	\
											Uranium-238	0.953	\	0.792	\
											Arsenic	3.1	\	\	\
											Barium	83.5	\	59.9	\
											Beryllium	1.3	\	1.11	\
											Boron	4.9	\	\	\
											Chromium	35.8	\	10.7	\
											Cobalt	9.1	\	8.9	\
											Copper	19.3	\	16.6	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Lead	77.7	\	11.3	\
											Manganese	397	\	362	\
											Molybdenum	1.7	\	\	\
											Nickel	12.7	\	12.2	\
											Vanadium	60.7	\	52.9	\
											Zinc	61.9	\	47.4	\
											Aroclor-1260	0.022	\	\	\
											Bis(2-ethylhexyl)phthalate	0.62	\	\	\
											Di-n-butylphthalate	0.018	\	\	\
											Toluene	0.004	\	\	\
128-B-3	Burn Pit	100-BC-1	17046.55 m^2	The 128-B-3 Coal Ash and Demolition Waste Site is an area where dumping and burning of waste material has occurred. No markers or signs are present at the site. The site is visible in a 1968 aerial photo and appears to have been divided into a construction debris dumping area to the south and a combustible waste burning area to the north.	Interim Closed Out	WSRF-2006-058	Nov-04	May-06	21,000 BCM	Not Documented	Arsenic	22.4	\	3.5 <BG	\
											Barium	264	\	88.3 <BG	\
											Beryllium	0.4	\	0.35 <BG	\
											Boron	9.3	\	2.8	\
											Chromium (Total)	70.6	\	13.6 <BG	\
											Chromium IV	1.8	\	1.3	\
											Cobalt	9.1	\	6.5 <BG	\
											Copper	52.3	\	16.7 <BG	\
											Lead	464	\	5.6 <BG	\
											Manganese	1230	\	309 <BG	\
											Mercury	0.64	\	0.07 <BG	\
											Nickel	26.4	\	13.4 <BG	\
											Vanadium	48	\	34.9 <BG	\
											Zinc	132	\	40.5 <BG	\
											Petroleum Hydrocarbons	291	\	157	\
											Aroclor-1254	0.014 U	\	0.19	\
											Endrin	0.0014 UD	\	0.0024	\
											Benzo (a) anthracene	0.350 U	\	0.024	\
											Benzo (a) pyrene	0.350 U	\	0.017	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
132-B-1	Process Unit/ Plant	100-BC-1	45.11 x 9.25	Also known as the 108-B Tritium Separation Facility, which was converted to a tritium recovery processing facility and was used as such until 1954. After the tritium recovery processing facility was closed down, operational activity was limited to the first floor. The tube examination hot cell and laboratory rooms located there were used until the early 1970s. All hazardous material was removed and disposed of separately during the decommissioning process. Post-decommissioning contamination levels were at or near background. The contamination exists in a thin layer on the inner concrete surfaces of the building. Based on data collected to support release and demolition of other 100 Area buildings, the contamination penetration depth is expected to be less than 1 cm (0.4 in.). The release surveys indicated that residual contamination levels do not present unacceptable risk to the maximally exposed individual, and RESidual RADioactivity(RESRAD) modeling indicates they are protective of groundwater and the Columbia River.	No Action	WSRF-2003-44	N/A							
132-B-2	Stack	100-BC-1	60.96 (length)	The unit is part of the 105-B Reactor Gas and Exhaust Air System. The unit is still standing and constructed of reinforced concrete with a base diameter of approximately 4.9 m (16 ft).	Accepted	Not Documented	N/A								
132-B-3	Burial Ground	100-BC-1	76.2 x 9.14 x 5.5	The site consisted of a trench, which was used to bury low-level contaminated rubble from the demolition of the 108-B Ventilation Exhaust Stack, also known as the 108-B Tritium Pilot Facility Ventilation Exhaust Stack. The stack foundation was found to be free of contamination. It was destroyed separately, buried in place, and covered with clean fill material.	No Action	WSRF-2003-11	N/A							

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
132-B-4	Process Unit/ Plant	100-BC-1	16.76 x 7.01 x 11.0 2.4 m above grade	The Ventilation Exhaust Filter Building housed blowers and particulate filters used to treat the ventilation exhausted from the B Reactor Building. Included in this site were the 117-B Building, the intake ventilation duct from the 105-D Reactor Building, and the exhaust ventilation ducts to the 116-B Reactor Exhaust Stack. Historical radiological survey and sampling data indicate that the majority of the contamination for the 117-B Filter Building and inlet/outlet ducts was found upstream of the filter cells. The highest level of contamination is below 4.6 m (15 ft) and does not pose a direct exposure risk. The contamination is not present in the concrete, but in a thin paint layer, and RESRAD evaluation indicates residual contamination levels are protective of groundwater and the Columbia River.	No Action	WSRF-2003-010	N/A							
132-B-5	Process Unit/ Plant	100-BC-1	51.21 x 29.87 x 3.35	The 115-B/C Gas Recirculation Facility filtered and recirculated the inert gas that surrounded the core of the reactors. The recirculation cycle included cooling, drying, and filtering of the large gas volumes before re-entry into the reactors. The 110-B Pressurized Gas Storage Facility provided the source gas for the recirculation facility. A no-action decision is supported based on reviews of the facility information, historical data, and allowable residual contamination level and RESRAD modeling results. Contaminated process equipment and materials were removed from the facility during decommissioning and packaged for disposal as radioactive or hazardous waste, as applicable. Residual contamination, present in a thin 1 cm (0.4-in.) layer on concrete surfaces and within sealed process piping, were shown in RESRAD results to not present an unacceptable level of risk to the maximally exposed individual, and are protective of groundwater and the Columbia River.	No Action	WSRF-2003-27	N/A							

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
132-B-6	Outfall	100-BC-1	8.23 x 4.27	The 1904-B2 Outfall was built in 1954 to supplement the 116-B-7 Outfall, which was no longer adequate to receive 100-B Reactor effluents after the completion of Project CG-558. It was an open, reinforced-concrete sump, with a new 168 cm (66-in.) effluent line that ran from the downcomer to the outfall and extended 137 m (450 ft) into the Columbia River.	Interim Closed Out	CVP-2002-00003	See 116-B-7 data								
1607-B1	Septic Tank	100-BC-1	4.27 x 2.13 x 3.35	The waste site includes a septic tank, drain field, and associated connecting pipelines and influent sanitary sewer lines that serviced the former 1701-B Badgehouse, 1720-B Patrol Building/Change Room, and 1709-B Fire Headquarters. The septic tank was constructed of reinforced concrete and has a 125-person capacity (132 L [35 gal] per capita) with an average detention period of 24 hours. The results of the confirmatory sampling show that residual contaminant concentrations do not preclude any future uses and allow for unrestricted use of shallow zone soils. The current site conditions achieve the RAOs and the corresponding remedial action goals established in EPA/ROD/R10-99/039.	No Action	WSRF-2007-015	5/21/2007 (confirmatory samples)	N/A	N/A	3.7 (Depth of confirmatory sample)	Cesium-137	0.122	\	\	\
											Arsenic	4.2	\	\	\
											Barium	138	\	\	\
											Beryllium	0.27	\	\	\
											Boron	2.4	\	\	\
											Cadmium	0.12	\	\	\
											Chromium VI	0.3	\	\	\
											Chromium	9.6	\	\	\
											Cobalt	8.9	\	\	\
											Copper	20.2	\	\	\
											Lead	8.6	\	\	\
											Manganese	304	\	\	\
											Mercury	0.23	\	\	\
											Molybdenum	0.57	\	\	\
											Nickel	11.6	\	\	\
											Vanadium	42.2	\	\	\
											Zinc	93.9	\	\	\
											Aroclor-1260	0.011	\	\	\
											alpha-BHC	0.00052	\	\	\
											4,4'-DDD	0.001	\	\	\
											4,4'-DDT	0.021	\	\	\
											Bis(2-ethylhexyl)phthalate	0.098	\	\	\
											Di-n-butylphthalate	0.026	\	\	\
											Pyrene	0.021	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
1607-B2	Septic Tank	100-BC-1	See Subsites	The site includes a septic tank and drain field. This unit received sanitary sewage from the 100-B/C Area office buildings, the 105-B Reactor Building, and the 190-B Pumphouse. All office buildings have been removed; however, the sewer lines to the respective buildings still exist.	Interim Closed Out	WSRF-2006-055	See subsites								
	Septic Tank	100-BC-1	3159.9 m^2 (Drain Field)	The 1607-B2 Septic System included a large-capacity (59,620-L [15,750-gal]) septic tank and drain field located north of the 105-B Reactor Building. The system was initially designed to support waste loading from 450 users at a rate of 133 L (35 gal) per capita per day with a 24-hour cell retention time. The 1607-B2 Waste Site has been administratively divided into two subsites for the purposes of verification sampling: the drain field is designated as the 1607-B2:1 Subsite, and the collection main, septic tank, and discharge line to the drain field are collectively designated as the 1607-B2:2 Subsite.	Interim Closed Out	1607-B2:1	Jan-05	Jul-06	Not Documented	4	Antimony	0.49	\	0.58	\
											Arsenic	5.3	\	7.2	\
											Barium	101	\	258	\
											Beryllium	0.47	\	0.8	\
											Boron	2.3	\	8.3	\
											Cadmium	0.13	\	0.13	\
											Chromium	14.6	\	19.8	\
											Chromium VI	0.24	\	0.33	\
											Cobalt	8	\	12.9	\
											Copper	17.5	\	29.6	\
											Lead	6.6	\	10.2	\
											Manganese	357	\	588	\
											Mercury	\	\	0.02	\
											Molybdenum	0.61	\	1.2	\
											Nickel	14.4	\	21.2	\
											Silver	0.09	\	0.2	\
											Vanadium	40	\	54.9	\
											Zinc	42.5	\	69	\
											4,4'-DDD	\	\	0.0017	\
											Dieldrin	\	\	0.0017	\
											Endrin aldehyde	\	\	0.0022	\
											2,4-D	\	\	0.11	\
											2,4-Db	\	\	0.25	\
											2,4,5-T	0.049	\	0.041	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											2,4,5-Tp (Silvex)	\	\	0.023	\
											Dinoseb	\	\	0.027	\
											2-Methylnaphthalene	\	\	0.15	\
											Di-n-butylphthalate	\	\	0.021	\
											Dibenzofuran	\	\	0.034	\
											Diethylphthalate	\	\	0.026	\
											Indeno(1,2,3-cd)pyrene	\	\	0.024	\
											Naphthalene	\	\	0.11	\
											Phenanthrene	\	\	0.037	\
											Acetone	0.009	\	0.01	\
1607-B2:2	Septic Tank	100-BC-1	10.77 x 4.01 x 4.40 (Septic Tank)	The 1607-B2 Septic System included a large-capacity (59,620-L [15,750-gal]) septic tank and drain field located north of the 105-B Reactor Building. The system was initially designed to support waste loading from 450 users at a rate of 133 L (35 gal) per capita per day with a 24-hour cell retention time. The 1607-B2 Waste Site has been administratively divided into two subsites for the purposes of verification sampling: the drain field is designated as the 1607-B2:1 Subsite, and the collection main, septic tank, and discharge line to the drain field are collectively designated as the 1607-B2:2 Subsite.	Interim Closed Out	WSRF-2006-055	Jan-05	Jun-06	Not Documented	4	Cesium-137	\	\	0.107	\
											Strontium-90	2.1	\	0.181	\
											Antimony	0.47	\	0.51	\
											Arsenic	3.6	\	4.1	\
											Barium	91	\	112	\
											Beryllium	0.39	\	0.44	\
											Boron	2.8	\	4.7	\
											Cadmium	0.1	\	0.43	\
											Chromium	12.8	\	10.5	\
											Chromium VI	0.28	\	0.35	\
											Cobalt	8.2	\	8.5	\
											Copper	16	\	34	\
											Lead	8.9	\	10.1	\
											Lithium	7.7	\	8.3	\
											Manganese	340	\	362	\
											Mercury	0.14	\	0.92	\
											Molybdenum	0.36	\	0.37	\
											Nickel	12.5	\	12.5	\
											Strontium	31	\	48.2	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Titanium	1330	\	1509	\
											Vanadium	46.6	\	46.4	\
											Zinc	49.6	\	51.5	\
											Aroclor-1254	0.0062	\	0.33	\
											Aroclor-1260	0.011	\	0.0067	\
											alpha-Chlordane	\	\	0.00087	\
											beta-BHC	\	\	0.0019	\
											4,4'-DDE	0.00044	\	0.018	\
											4,4'-DDT	0.016	\	0.017	\
											Endosulfan I	\	\	0.0069	\
											Endosulfan II	\	\	0.0034	\
											Endosulfan sulfate	\	\	0.0005	\
											Endrin aldehyde	0.0022	\	0.0074	\
											Endrin ketone	\	\	0.0011	\
											gamma-Chlordane	\	\	0.00043	\
											Heptachlor epoxide	\	\	0.0006	\
											Methoxychlor	\	\	0.015	\
											2-Methylnaphthalene	\	\	0.019	\
											Benzo(a)anthracene	\	\	0.041	\
											Benzo(a)pyrene	\	\	0.033	\
											Benzo(b)fluoranthene	0.018	\	0.041	\
											Benzo(g,h,i)perylene	\	\	0.03	\
											Benzo(k)fluoranthene	\	\	0.035	\
											Bis(2-ethylhexyl)phthalate	1.1	\	1.6	\
											Chrysene	\	\	0.064	\
											Di-n-butylphthalate	0.08	\	0.07	\
											Dibenz(a,h)anthracene	\	\	0.022	\
											Fluoranthene	0.032	\	0.079	\
											Indeno(1,2,3-cd)pyrene	\	\	0.028	\

Table B-1. 100-BC Waste Sites Description and History

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Naphthalene	\	\	0.017	\
											Phenanthrene	\	\	0.046	\
											Phenol	0.027	\	0.017	\
											Pyrene	0.026	\	0.066	\
1607-B3	Septic Tank	100-BC-1	2.9 x 1.37 x 3.17	The site is a closed-out septic system that includes a septic tank, tile field, and associated piping. This unit received an unknown amount of sanitary sewage from the 184-B Powerhouse. The site is no longer apparent and appears as a cobble-covered field with natural vegetation growing on its surface. The septic tank was demolished and buried in situ between January and March 1988. According to WIDS, before demolition, the contents of the tank were sampled, and no significant radioactivity was found above background, and there were no reportable concentrations of heavy metals.	Closed Out	WSRF 2001-015	N/A								
1607-B4	Septic Tank	100-BC-1	1.83 x 0.91 x 2.54	The site is a closed-out septic system associated with the 151-B Substation. This unit received sanitary sewage from the 151-B Electrical Distribution Facility. The flow rate to the unit was estimated at less than 132 L (35 gal) per day. Closure of the septic tank was completed in 2000. According to WIDS, the tank contents were sampled and analyzed for radiological contaminants, with results lower than detection limits. The tank contents were pumped out and the tank was filled with clean material. A letter was sent to notify the Washington State Department of Health of the abandonment.	Closed Out	WSRF 2000-121	N/A								
1607-B5	Septic Tank	100-BC-1	1.22 x 0.61 x 2.54	The 1607-B5 Septic Tank System received sanitary sewage from the 181-B/C Pumphouse.	Accepted	DOE/RL-94-61, Appendix N	N/A								

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
1607-B6	Septic Tank	100-BC-1	2.44 x 1.22 x 2.54	This system includes the feed pipeline from the 183-B Filter House, the septic tank, and the drain field. This unit receives 130 L/day (35 gal/day) of sanitary sewage from the 182-B Pump Station and cooling water and leakage from pumps located in the 182-B Facility. It also received sewage from the 183-B Headhouse, which was decommissioned in 1987.	Accepted	DOE/RL-94-61, Appendix N	N/A								
1607-B7	Septic Tank	100-BC-1	1.83 x 0.91 x 2.51	The 1607-B7 Septic Tank System had a 12-person capacity (130 L [35 gal] per capita) with an average detention period of 24 hours. This unit received an unknown amount of sanitary sewage from the 183-B Water Treatment Plant.	Interim Closed Out	CVP-2003-00004	Mar-03	Mar-03	198	3.5	Cesium-137	0.3 U	\	0.0428	\
											Cobalt-60	0.2 U	\	0.0464	\
											Europium-152	0.42 U	\	0.103	\
											Europium-154	55	\	0.129	\
											Europium-155	0.0021	\	0.0903	\
											Chromium VI	0.12	\	0.42	\
											Lead	0.13 U	\	27	\
											Beta-BHC	0.19 U	\	0.0021	\
1607-B8	Septic Tank	100-BC-2	7.27 m^2	The site consisted of a septic tank and tile field. The vertical tank was constructed of steel and had a 1,325-L (350-gal) capacity. The tile field was oriented north-south and was located to the south of the septic tank. The tile field was constructed of 20 cm (8-in.) vitrified clay pipe laid with open joints. This unit received an unknown quantity of sanitary sewage from the 190-C Pumphouse.	Interim Closed Out	CVP-2003-00005	Mar-03	Mar-03	361	2.5	Cesium-137	0.26 U	\	0.0602	\
											Cobalt-60	0.2 U	\	0.0446	\
											Europium-152	0.43 U	\	0.0949	\
											Europium-154	170	\	0.129	\
											Europium-155	0.027	\	0.0997	\
											Chromium VI	0.38	\	0.43	\
											Lead	0.0264	\	118	\
											DDT	0.16 U	\	0.0194	\
											Aroclor-1254	0.23 U	\	0.273	\
1607-B9	Septic Tank	100-BC-2	4.27 x 0.91	The site was a septic tank and tile field. This unit received an unknown amount of sanitary sewage from the 105-C Reactor Building. The system tank had a 9,085-L (2,400-gal) capacity. Effluent from the tank was routed a short distance (about 16 m [52 ft]) through a pipeline to the tile field. The tile field located southeast of the tank was constructed of 20 cm (8-in.) -diameter vitrified clay pipe laid with open joints.	Interim Closed Out	CVP-2003-00006	Apr-03	May-03	3,060	3.5	Cesium-137	0.29 U	\	0.0551	\
											Cobalt-60	0.2 U	\	0.0586	\
											Europium-152	0.41	\	0.0989	\
											Europium-154	15	\	0.125	\
											Europium-155	0.0046	\	0.0868	\
											Chromium VI	0.054	\	0.44	\
											Lead	0.074 U	\	10.3	\
											Dieldrin	0.17 U	\	0.0046	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
1607-B10	Septic Tank	100-BC-2	74.85 m^2	The site consisted of a septic tank and tile field. The unit received only sanitary sewer wastes from the headhouse of the 183-C Water Treatment Plant. There were no known discharges of hazardous chemicals or radionuclides.	Interim Closed Out	CVP-2003-00007	Mar-03	Mar-03	328	2.5	Cesium-137	0.21 U	\	0.042	\
											Cobalt-60	0.22 U	\	0.0356	\
											Europium-152	0.61	\	0.0755	\
											Europium-154	18	\	0.0957	\
											Europium-155	0.38	\	0.0978	\
											Chromium VI	25	\	0.42	\
											Lead	0.0045	\	18	\
											Mercury	0.057	\	0.29	\
											Chromium	25	\	20	\
											DDT	0.0045	\	0.0041	\
											Aroclor-1254	0.057	\	0.047	\
1607-B11	Septic Tank	100-BC-2	74.58 m^2	The site consisted of a septic tank and drain field. There were no known discharges of hazardous chemicals or radionuclides into the unit. The unit received only sanitary sewer wastes from the 183-C Filter Building and Pump Room (183-C Water Treatment Plant).	Interim Closed Out	CVP-2003-00008	Mar-03	Mar-03	146	3	Cesium-137	0.0308	\	0.0426	\
											Cobalt-60	0.1 U	\	0.0465	\
											Europium-152	0.21 U	\	0.0961	\
											Europium-154	0.27 U	\	0.127	\
											Europium-155	0.19 U	\	0.0951	\
											Lead	10.3	\	9.4	\
											Chromium VI	0.38	\	0.42	\
											bis(2-Ethylhexyl)phthalate	0.68	\	0.68	\
100-C-2	Foundation	100-BC-2	1.83 x 1.83	The site is the foundation of a general monitoring station (614 Structure). Its function was to house the environmental monitoring equipment that sampled airborne process wastes.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
100-C-3	French Drain	100-BC-2	0.61 m^2	The 119-C Sample Building French Drain was a 0.61 m (2-ft) -diameter gravel-filled pit that received effluent from the 119-C Sample Building. The 119-C Sample Building was built in 1960 and contained water-cooled air sample monitoring equipment. Effluent from the sampling equipment, the building's swamp cooler, and possibly janitorial waste would have been disposed to the 100-C-3 French Drain.	Interim Closed Out	CVP-2003-00009	3/19/2003	3/19/2003	49	3	Cesium-137	0.147	\	0.113	\
											Cobalt-60	0.092 U	\	0.0396	\
											Europium-152	0.19 U	\	0.0874	\
											Europium-154	0.29 U	\	0.121	\
											Europium-155	0.18 U	\	0.0755	\
											Chromium VI	0.42 U	\	0.42	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-C-4	Valve Pit	100-BC-2	1.8 x 1.8	The site is a valve pit located along the export water line. The export water line distributes clean river water from 100-B Area to the 200 Area. The site was identified in the 100-B Area Technical Baseline Report as a "Hazardous Site," by which the authors meant that the site was a safety hazard due to its disrepair. The site has not been used for waste management activities.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
100-C-5	Product Piping	100-BC-2	10567.33	The site encompasses the clean water upstream pipelines for the 100-C Area, including underground pipelines used to transport raw, fire, export, and sanitary water from the river pumphouse, to the water treatment facilities and to 100-C Area facilities and fire hydrants.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
100-C-6	Radioactive Process Sewer	100-BC-2	See subsites	The waste was contaminated steel piping, concrete, and soil. The site includes the underground 105-C Reactor cooling water effluent pipelines. These include those effluent pipelines that transported 105-C Reactor cooling water from the reactor to the 116-C-5 (107-C Retention Basin), and from the basin to the 132-B-6 and 132-C-2 Outfall Structures and/or to the 116-C-1 Liquid Waste Disposal Trench (see subsites).	Accepted	See subsites	N/A								
100-C-6:1	Radioactive Process Sewer	100-BC-2	Not Documented	100-C Area South Effluent Pipelines	Interim Closed Out	CVP-2003-00022	See 100-B-8:1								
100-C-6:2	Radioactive Process Sewer	100-BC-2	Not Documented	100-C Area North Effluent Pipelines	Interim Closed Out	CVP-2003-00019	See 100-B-8:2								
100-C-6:3	Radioactive Process Sewer	100-BC-2	Not Documented	100-C Retention Basin to Outfalls Effluent Pipelines	Interim Closed Out	CVP-2003-00019	See 100-B-8:2								
100-C-6:4	Radioactive Process Sewer	100-BC-2	700.91	100-BC Pipelines Discovery Areas	Interim Closed Out	CVP-2003-00019	See 100-B-8:2								
100-C-6:5	Radioactive Process Sewer	100-BC-2	30.5	Pipelines Sections Under Export Water Lines	Accepted	EPA/ROD/R10-95/126	N/A								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-C-7	Dumping Area	100-BC-2	92.96 x 88.16	Also known as 183-C Filter Building/ Pumproom Facility Foundation and Demolition Waste. One of the purposes of the 183-C Pumproom was to treat the cooling water with sodium dichromate, a rust inhibitor, before storage in the four exterior 1.89E+07 L (5E+06 gal) tanks (183-C Clearwells). Water was drawn from the 183-C Filter Building clearwells and injected with sodium dichromate in the pumproom before being pumped to the four, large tanks for storage. During past practices, the sodium dichromate was stored, mixed, and spilled in various locations throughout the building.	Accepted	EPA/ROD/R10-99/039	N/A								
100-C-7:1	Unplanned Release	100-BC-2	Not Documented	The stained soil was observed in early April 2002. It is located north of the 183-C Head House and adjacent to the northwest corner of the 183-C Sedimentation Basins. Discussions with project personnel concerning the past use of this area indicate that the appearance of the stain is consistent with sodium dichromate. It is believed that a railroad spur was used to deliver water treatment supplies to the 183-C Head House. One of these chemicals was sodium dichromate, a corrosion inhibitor, used to treat the reactor cooling water. The Final Decommissioning Report for the 183-C Filter Building/Pumproom Facility (BHI-01005) states that the sodium dichromate was stored, mixed and spilled in various locations throughout the 183-C Pump Room Facility, where it was then pumped into the four large exterior tanks and stored for the 190-C Process Pump House. It is unclear as to how the Sodium Dichromate was transferred from the Head House, west of the sedimentation basins, to the Pump Room Facility, east of the basins. The stained area may be a result of this transfer process.	Accepted									
100-C-7:2	Unplanned Release	100-BC-2	Not Documented		Discovery										

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-C-8	Unplanned Release	100-BC-2	Not Documented	An excavator broke a main hydraulic line while dismantling a concrete pad at 105-C. A large area was sprayed due to the hydraulic system being under pressure. The exact quantity was not known at the time of the hose failure and was believed to be below the DOE reportable threshold of 160 L (42 gal). The hydraulic oil is not designated as a hazardous substance.	Not Accepted	WSRF 2002-01	N/A								
100-C-9	Process Sewer	100-BC-2	See Subsites	The 100-C-9 Waste Site includes the underground sanitary and process sewers and process pipelines associated with the 100-C Area pre-reactor water treatment facilities. The waste site was administratively divided into four subsites based on the intended use of the pipes (e.g., sanitary or process sewer), expected sources of contamination, and potential differing remedial action requirements. The four 100-C-9 subsites are as follows: 1. 100-C-9:1 Main Process Sewer Collection Line 2. 100-C-4:2 Sanitary Sewers 3. 100-C-9:3 Clearwell Pipes 4. 100-C-9:4 Cooling Water Transfer Pipelines and Tunnels	Interim Closed Out	See Subsites	See Subsites								
100-C-9:1	Process Sewer	100-BC-2	2,066.11	100-C Main Process Sewer Collection Line	Interim Closed Out	WSRF-2004-012	11/22/2004	4/19/2006	20,490	0.3		Excavation Footprint	Over-burden	Excavation Footprint UCL	
											Arsenic	9.1	5.3	5	\
											Antimony	0.62	1.4	0.62	\
											Barium	102	78.1	75.9	\
											Beryllium	0.48	1.8	0.4	\
											Boron	2.2	1.8	1	\
											Cadmium	0.26	0.26	0.26	\
											Chromium	60.6	15.4	15.9	\
											Chromium VI	1.8	0.39	1.8	\
											Cobalt	12.5	11.5	9.7	\
											Copper	21.1	26.5	18	\
											Lead	10.7	6.8	6.4	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Manganese	497	390	400	\
											Mercury	8.8	0.04	22.7	\
											Molybdenum	0.32	0.8	0.42	\
											Nickel	17	14.9	12.8	\
											Selenium	0.46	\	0.47	\
											Vanadium	77	65	48.9	\
											Zinc	57.9	65.1	48.2	\
100-C-9:2	Process Sewer	100-BC-2		100-C-9:2, 100-C Sanitary Sewer Lines. Subsite 100-C-9:2 is a collection of the feeder pipelines for the former 1607-B8, 1607-B9, 1607-B10, and 1607-B11 Septic Systems. Each of the systems consisted of a septic tank, vitrified clay sanitary sewer pipe, and a drain field.	Interim Closed Out	WSRF-2004-013	Early 2005	9/29/2006	3,701	1607-B8: 2m 1607-B9: 3.5m 1607-B10: 9m 1607-B11: 4m		1607-B8 Feed Line	1607-B9 Overburden	1607-B9 Feed Line	
											Arsenic	4.4	2.4	2.9	\
											Antimony	0.97	\	\	\
											Barium	74.1	56.7	64.3	\
											Beryllium	0.51	0.48	0.46	\
											Boron	5.1	\	\	\
											Cadmium	0.5	0.17	0.24	\
											Chromium	16.5	7.2	8.7	\
											Chromium VI	0.83	0.27	0.28	\
											Cobalt	8.9	7.6	7.7	\
											Copper	17.6	14.6	15.6	\
											Lead	152	8.8	12.8	\
											Lithium	7.2	5.1	7	\
											Manganese	456	345	343	\
											Mercury	0.85	\	0.04	\
											Molybdenum	1.9	0.38	0.42	\
											Nickel	22	10	10.9	\
											Strontium	32.7	20.6	22.7	\
											Titanium	1,960	1,720	1,570	\
											Vanadium	58.4	50.3	47.5	\
											Zinc	111	43.6	162	\
											Aroclor-1254	0.12	0.039	0.028	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											4,4-DDE	0.014	0.0007	0.0012	\
											4,4'-DDD	0.0035	\	\	\
											4,4-DDT	0.0051	\	\	\
											Dieldrin	\	0.0099	0.0017	\
											Endrin	0.0036	\	\	\
											Endrin aldehyde	0.0029	\	0.00097	\
											Endrin ketone	0.00074	\	\	\
											gamma-Chlordane	0.0016	\	\	\
											Endosulfan I	0.00064	\	\	\
											Endosulfan sulfate	0.0037	\	\	\
											Benzo(a)anthracene	\	\	0.041	\
											Benzo(a)pyrene	0.022	0.018	0.048	\
											Benzo(b)fluoranthene	0.073	\	0.041	\
											Benzo(g,h,i)perylene	0.023	0.018	0.037	\
											Benzo(k)fluoranthene	0.023	\	0.045	\
											bis(2-Ethylhexyl)phthalate	0.25	\	\	\
											Chrysene	0.082	0.02	0.055	\
											Di-n-butylphthalate	0.04	\	\	\
											Fluoranthene	\	0.024	0.081	\
											Indeno(1,2,3-cd)pyrene	\	\	0.03	\
											Methoxychlor	0.0073	\	\	\
											Phenanthrene	\	\	0.056	\
											Pyrene	\	\	0.094	\
100-C-9:3	Process Sewer	100-BC-2	1,657.66	This sub-unit includes the process sewer pipes surrounding the 183-C Clearwells (demolished) to the point of junction with the main process sewer collection line. The confirmation sampling results from scale and soil samples support no-action reclassification of the 100-C-9:3 Site.	No Action	WSRF-2004-014	10/2003 (confirmatory samples)	N/A	N/A	N/A	Arsenic	6.5	\	\	\
											Antimony	2.1	\	\	\
											Barium	66.7	\	\	\
											Beryllium	0.33	\	\	\
											Boron	1.3	\	\	\
											Cadmium	0.2	\	\	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Chromium	12.8	\	\	\
											Chromium VI	0.61	\	\	\
											Cobalt	9.2	\	\	\
											Copper	19.6	\	\	\
											Lead	6.3	\	\	\
											Manganese	412	\	\	\
											Molybdenum	0.64	\	\	\
											Nickel	14.5	\	\	\
											Silver	0.14	\	\	\
											Vanadium	63.9	\	\	\
											Zinc	54.9	\	\	\
											4-Methylphenol (cresol, p-)	1.1	\	\	\
											Acenaphthene	6.8	\	\	\
											Anthracene	1.3	\	\	\
											Benzo(a)anthracene	20	\	\	\
											Benzo(a)pyrene	13	\	\	\
											Benzo(b)fluoranthene	11	\	\	\
											Benzo(g,h,i)perylene	5.4	\	\	\
											Benzo(k)fluoranthene	12	\	\	\
											Carbazole	7.3	\	\	\
											Chrysene	20	\	\	\
											Dibenzofuran	3	\	\	\
											Dibenz(a,h)anthracene	22	\	\	\
											Fluorene	5.8	\	\	\
											Fluoranthene	52	\	\	\
											Indeno(1,2,3-cd)pyrene	5.6	\	\	\
											Isophorone	0.28	\	\	\
											Naphthalene	2.1	\	\	\
											Phenanthrene	46	\	\	\
											Pyrene	35	\	\	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
100-C-9:4	Process Sewer	100-BC-2	895.45	This sub-unit includes the cooling water transfer lines located in tunnels between the 190-C Pump House and the 105-C Reactor Building. Confirmatory sample collection at the waste site was not possible because the existing structures were sealed to prevent entry following previous D&D activities. The data from the 105-B Valve Pit Feedwater Valves were used to close the 100-C-9:4 site, as it was considered an analogous site.	No Action	WSRF-2004-015	N/A								
116-C-1	Trench	100-BC-1	152.4 x 15.24 x 6.10	The 107-C Liquid Waste Disposal Trench was a former process effluent disposal trench (unlined) that received 700 million L (184 million gal) of contaminated cooling water from the 100-BC Area Retention Basins after ruptured fuel elements were detected in the reactors. The 116-C-1 Site continued to receive contaminated cooling water until reactor operations ceased in 1968. An additional 40 billion L (more than 10 billion gal) of high-temperature reactor cooling water was discharged to the site during a 150-day infiltration test in 1967. After the soil plume excavation was completed, a test pit was excavated down to groundwater to further characterize the subsurface. The test pit was centered at an area of elevated activity (identified by radionuclide field surveys) near the 116-C-1 Inlet Pipes. Soil samples were taken from each quadrant of the test pit and composited for each of the eight 1 m (3-ft) test pit lifts.	Interim Closed Out	CVP-98-00006	7/15/1996	11/15/1996	97,515	5	Americium-241	0.0469	52.4	0.024	17.3
											Cesium-137	2.07	2030	0.803	625
											Cobalt-60	0.0741	63.8	0.074	24.2
											Europium-152	1.62	434	0.643	185
											Europium-154	0.258	59.9	0.258	25.3
											Europium-155	0.0837	2.53	0.084	2.53
											Nickel-63	3.08	1540	1.54	645
											Plutonium-238	0.033	3.31	0.017	1.19
											Plutonium-239/240	0.215	89.9	0.215	31
											Strontium-90	0.689	135	0.345	44.1
											Uranium-238	0.913	12.5	0.793	0.853
											Lead	5	38.5	4.41	16.4
											Mercury	0.03 B	3.1	0.03	1.44
											Chromium	14.2	159	12.3	67.5
											Chromium VI	0.115 UJ	0.246 J	0.058	0.246
116-C-2A	Crib	100-BC-2	6.78 x 4.66 x 5.10	This was the largest of the 100 Area Pluto Cribs and was unique in that effluents passed through a settling tank and sand filter before being discharged to the crib. The Pluto Crib was constructed of concrete ties that were notched and stacked in a log cabin formation. Walls of concrete ties were constructed to divide the crib into 12 sections. Spaces between the ties were filled with sand. The crib was covered over by concrete roof slabs.	Interim Closed Out	CVP-99-00019	3/3/1999	5/7/1999	15,939	9.15	Americium-241	0.026 U	0.71 J	0.073	0.607
											Cesium-137	0.58	25.3	0.404	20.4
											Cobalt-60	0.227	12.2	0.0887	10.4
											Europium-152	0.484	29.6	0.211	24.5
											Europium-154	0.087 U	3.29	0.0785	2.68
											Europium-155	0.059 U	0.25 U	0.0504	0.204
											Plutonium-238	0 U	0.332 J	0.0805	0.126

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Plutonium-239/240	0.1 J	3.99 J	0.0652	1.24
											Strontium-90	1.85	6.18	0.725	4.38
											Uranium-238	0.599 J	0.75 J	0.444	0.445
											Chromium VI	0.41 U	0.848	0.41 U	0.0308
116-C-2B	Pump Station	100-BC-2	3.05 x 2.94 x 9.14	This unit was a rectangular-shaped, concrete sump. The unit received waste from the 105-C Reactor and pumped it into the 116-C-2C (105-C Pluto Crib Sand Filter).	Interim Closed Out	CVP-99-00019	See 116-C-2A data								
116-C-2C	Sand Filter	100-BC-2	12.65 x 5.49 x 5.49	The structure was an open-bottom concrete box placed in a sand and gravel pit. It was covered with concrete shielding slabs. Contaminated water was spread over the surface of the sand filter media by distribution trays. The site included the underground pipelines from the 105-C Pluto Crib Sand Filter to the 116-C-2A Pluto Crib. Effluent passed through the 105-C Pluto Crib Sand Filter before being discharged to the soil column of the 116-C-2 Crib.	Interim Closed Out	CVP-99-00019	See 116-C-2A data								
116-C-3	Storage Tank	100-BC-2	Each tank was 10.9 m in length, 3.5 m in diameter and 3.4 m below grade	The 116-C-3 Chemical Waste Tanks consisted of two below grade chemical waste storage tanks designed to receive mixed waste from the 105-C Reactor Metal Examination Facility dejacketing process. This process consisted of immersing irradiated the fuel slugs in a 50% sodium hydroxide solution, draining the resulting solution, and rinsing the dejacketed slugs with water. The slugs were then cleaned with a 10% nitric acid solution, followed with multiple water rinses. These solutions were discharged into the 116-C-3 Tank System.	Interim Closed Out	WSRF-2008-002	Feb-07	Dec-07	3,767	8.5		Northern Tank	Southern Tank	Over-burden	
											Americium-241	0.273	\	\	\
											Cesium-137	14.1	0.084	0.091 <BG	\
											Plutonium-239/240	0.912	\	\	\
											Strontium-90	18.2	\	\	\
											Tritium	4.02	\	3.89	\
											Uranium-233/234	0.901 <BG	0.873 <BG	0.684 <BG	\
											Uranium-235	0.042 <BG	\	0.048 <BG	\
											Uranium-238	0.860 <BG	0.788 <BG	0.695 <BG	\
											Arsenic	6.4 <BG	5.2 <BG	2.6 <BG	\
											Barium	196	106 <BG	68.5 <BG	\
											Beryllium	0.42 <BG	0.71 <BG	0.25 <BG	\
											Boron	24.3	2.4	1.8	\
											Cadmium	0.36 <BG	\	\	\
											Chromium (Total)	26.4	18.1 <BG	10.4 <BG	\

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Chromium IV	1.5	\	1.7	\
											Cobalt	6.7 <BG	7.7 <BG	7.3 <BG	\
											Copper	20.4 <BG	15.3 <BG	15.3 <BG	\
											Lead	9.1 <BG	7.5 <BG	6.3 <BG	\
											Manganese	346 <BG	328 <BG	319 <BG	\
											Molybdenum	1.1	\	\	\
											Nickel	18.1 <BG	18.2 <BG	13.6 <BG	\
											Vanadium	42.4 <BG	38.6 <BG	39.1 <BG	\
											Zinc	49.5 <BG	51.4 <BG	42.4 <BG	\
											Nitrate (As nitrogen)	2.8	0.48 <BG	16.5	\
116-C-5	Retention Basin	100-BC-1	7946.0 m^2	The 116-C-5 Retention Basins were constructed to hold cooling water effluent from the 105-C Reactor to allow for thermal cooling and radioactive decay before release to the Columbia River. When in operation, the retention basins were two circular, 3.8E+07 L (1.0E+07 gal), open-topped tanks. Each tank had a diameter of 100 m (330 ft), a depth of 4.9 m (16 ft), and had internal baffles to prevent water from channeling across the tanks into the discharge lines. The tanks were constructed of welded carbon steel and were set on a reinforced-concrete foundation with a crushed rock subfloor.	Interim Closed Out	CVP-99-00004	9/21/1996	3/21/1998	224,709	4.6	Americium-241	0.456 J	7.24 J	0.256	5.11
											Cesium-137	1.75	209	1.12	114
											Cobalt-60	0.197	55.7	0.145	21.4
											Europium-152	2.36	303	1.59	135
											Europium-154	0.359	41.7	0.244	23.8
											Europium-155	0.0947 U	1.93	0.066	0.71
											Nickel-63	8.89 J	1790	7.52	677
											Plutonium-238	0.0083 U	0.42	0.029	0.19
											Plutonium-239/240	0.15	16.5	0.192	5.1
											Strontium-90	0.696 J	22	0.37	5.11
											Uranium-238	1.13	1.2	0.927	0.94
											Lead	11.2	49.2	7.3	20.9
											Mercury	0.04	6.2	0.04	1.47
											Chromium	16.2	78.8	12.9	43.2
											Chromium VI	0.239	2	0.239	2.28

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
116-C-6	Process Pit	100-BC-2	30.48 x 30.48 x 1.83	The 105-C Fuel Storage Basin Cleanout Percolation Pit was constructed to receive liquid from the clean out of the 105-C Fuel Storage Basin. The radiologically contaminated shielding water in the basin was processed through an ion exchange column and filter system. After being sampled to determine if the radioactivity was below release criteria, the water was discharged to the pit. Chemical analysis for hazardous substances was not a standard practice and there was no evidence that it was performed. The water percolated into the soil as fast as it was discharged to the site.	Interim Closed Out	WSRF-2003-34	3/2004 (confirmatory samples)	Not Documented	Not Documented	Not Documented	Americium-241	0.642	\	\	\
											Cesium-137	1.9	\	\	\
											Europium-152	0.251	\	\	\
											Nickel-63	5.35	\	\	\
											Plutonium-239/240	0.528	\	\	\
											Total strontium	0.463	\	\	\
											Radium-228	0.603	\	\	\
											Uranium-233/234	0.535	\	\	\
											Uranium-235	0.041	\	\	\
											Uranium-238	0.523	\	\	\
											Arsenic	3.4	\	\	\
											Barium	44.7	\	\	\
											Chromium	6.7	\	\	\
											Lead	4.3	\	\	\
118-C-1	Burial Ground	100-BC-2	155.45 x 121.92 x 6.10	The 118-C-1, 105-C Burial Ground, is the primary burial ground for general wastes from the operation of the 105-C Reactor. It received process tubes, aluminum fuel spacers, control rods, reactor hardware, and soft wastes.	Interim Closed Out	CVP-2006-00011	2/2/2004	5/27/2006	75,300	5	Cesium-137	1.19	0.437	0.81	0.352
											Carbon-14	11.7	0.472 U	8	\
											Cobalt-60	1.48	0.04 U	0.99	\
											Europium-152	0.281	0.1 U	0.199	\
											Nickel-63	35.8	0.29 U	26.1	\
											Strontium-90	0.323	2.1	0.268	1.41
											Uranium-233/234	1.09	0.575	0.83	0.523
											Uranium-235	0.027	0.02 U	0.084	\
											Uranium-238	0.825	0.508	0.666	0.505
											Tritium	7.71	2.09 U	4.76	\
											Arsenic	33.9	2.3	4.5	2.4
											Barium	286	58.4	206	55.2
											Beryllium	0.93	0.69	0.88	0.68
											Boron	4.9 J	2.1 U	3.4	\
											Cadmium	0.12	0.21 U	0.12	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Chromium	9.2	6.8	8.7	6.5
											Cobalt	13.1	7.8	8.8	8.7
											Copper	286	15.8	13.7	15
											Lead	130	5.2	18.6	5
											Manganese	362	329	349	340
											Molybdenum	54.9	0.85 U	4.5	\
											Nickel	13	9.6	12	9.9
											Vanadium	62.7	45.7	51.6	51.6
											Zinc	296	37.5	74.8	41
											Aroclor-1254	0.062	4.9 J	0.054	0.013
											Benzo(a)anthracene	0.18 J	0.038 J	0.18	0.13
											Benzo(a)pyrene	0.12 J	0.024 J	0.12	0.083
											Benzo(b)fluoranthene	0.14 J	0.033 J	0.14	0.11
											Benzo(g,h,i)perylene	0.051 J	0.330 U	0.051	0.037
											Benzo(k)fluoranthene	0.14 J	0.029 J	0.14	0.092
											Butylbenzylphthalate	0.038 J	0.330 U	0.038	\
											bis(2-Ethylhexyl)phthalate	0.4 B	0.330 U	0.28	0.017
											Chrysene	0.21 J	0.052 J	0.21	0.17
											Di-n-butylphthalate	0.063 J	0.330 U	0.13	0.026
											Fluoranthene	0.32 J	0.11 J	0.32	0.33
											Indeno (1,2,3-cd)pyrene	0.046 J	0.330 U	0.046	0.035
											Phenanthrene	0.097 J	0.330 U	0.097	0.097
											Pyrene	0.35	0.037 J	0.35	0.35
											Benzene	0.001 J	0.012 J	0.001	0.001
											Xylenes	0.001 J	0.006 J	0.001	0.001
											Acetone	0.013 J	0.012 J	0.012	0.012
											Methylene chloride	0.014 B	0.013 B	0.014	0.014

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
118-C-2	Storage Tank	100-BC-2	26.9 m^2	Operation of the 105-C Ball Storage Tank (Ball 3X Storage Tank) began in 1969, coinciding with the Ball 3X Project work. The project operation ended that same year. During Ball 3X Project work with a prototype-contaminated ball sorter, the tank received highly radioactive, irradiated, nickel-plated boron-steel, and carbon-steel balls. The tank served as temporary storage until the balls decayed radiologically before burial. The storage box had a slope with vents at each end. One vent was used to put the balls into the tank and the other was used to remove them (following a cool down period). Approximately 9,070 kg (20,000 lb) of highly activated balls remained in the storage tank. Approximately 70% of the balls remaining are boron-steel and 30% are carbon-steel.	Interim Closed Out	CVP-2004-00005	11/10/2003	12/3/2003	470	3.14	Cobalt-60	0.1	\	0.044	\
											Nickel-63	78.9 B	\	70.9	\
118-C-3	Reactor	100-BC-2	5,528 m^2	The site is an inactive plutonium production reactor that has been placed in ISS. The original facility consisted of the reactor block, which included the graphite core, biological and thermal shields, pressure tubes, and the safety and control systems. The irradiated fuel storage basin was constructed below grade.	Accepted	EPA/ROD/ R10-95/126	N/A								
118-C-3:1	Reactor	100-BC-2	Not Documented	The 105-C Reactor Facility was a water-cooled, graphite-moderated nuclear reactor that irradiated uranium fuel rods. The plutonium byproduct was extracted from the irradiated rods in the 200 Area Fuel Separations plants.	Accepted	EPA/ROD/ R10-95/126	N/A								
118-C-3:2	Reactor	100-BC-2	Not Documented	The remedial action involved the D&D of associated structures and soils at the 105-C Reactor to the extent required leaving only the reactor core to be placed in interim safe storage status. Remediation included the removal of hazardous and radiologically contaminated material from below grade rooms, tunnels, and contaminated soils.	Closed Out	CVP-98-00009	Not Documented	Not Documented	15,600 tons	15	Americium-241	\	31.1	\	\
											Cesium-137	\	1.4	\	\
											Cobalt-60	\	6.2	\	\
											Europium-152	\	3.3	\	\
											Europium-154	\	3	\	\
											Europium-155	\	125	\	\
											Nickel-63	\	4,026	\	\
											Plutonium-238	\	37.4	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Plutonium-239/240	\	33.9	\	\
											Strontium-90	\	4.5	\	\
											Uranium-234	\	1.1	\	\
											Uranium-235	\	1	\	\
											Uranium-238	\	1.1	\	\
											Chromium VI	\	2.2	\	\
											Lead	\	353	\	\
											Mercury	\	24	\	\
											PCBs	\	1	\	\
118-C-3:3	French Drain	100-BC-2	Not Documented	The 118-C-3:3 Site is a collection of four French drains roughly located at the four corners of the 105-C Reactor Building. The 118-C-3:3 French drains were likely condensate drains from the sealed steam heating system that would not have been subject to contamination from within the reactor building. However, the exact history of the 118-C-3:3 Drains is unknown. Excavation at the four French drain locations found three of the four drains partially intact. The fourth drain, No. 4 to the southeast, was not found in the excavation. The three French drains found were excavated and sampled just below the bottom of the drain. The southeast location was excavated to 4.6 m (15 ft) below ground surface and sampled at the bottom of the excavation.	Interim Closed Out	WSRF-2006-016	1/4/2006 (confirmatory samples)	Not Documented	Not Documented	4.6	Uranium-233/234	0.625	\	\	\
											Uranium-235	0.051	\	\	\
											Uranium-238	0.676	\	\	\
											Arsenic	3.4	\	\	\
											Barium	80	\	\	\
											Beryllium	0.69	\	\	\
											Boron	1.4	\	\	\
											Chromium	16.4	\	\	\
											Chromium VI	0.54	\	\	\
											Cobalt	7.4	\	\	\
											Copper	38.3	\	\	\
											Lead	7.9	\	\	\
											Manganese	297	\	\	\
											Mercury	0.8	\	\	\
											Nickel	14.4	\	\	\
											Selenium	0.37	\	\	\
											Vanadium	48.7	\	\	\
											Zinc	50.2	\	\	\
											Aroclor-1254	0.0051	\	\	\
											Aroclor-1260	0.0065	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Benzo(a)anthracene	0.075	\	\	\
											Benzo(a)pyrene	0.073	\	\	\
											Benzo(b)fluoranthene	0.059	\	\	\
											Benzo(g,h,i)perylene	0.059	\	\	\
											Benzo(k)fluoranthene	0.068	\	\	\
											Chrysene	0.1	\	\	\
											Fluoranthene	0.16	\	\	\
											Indeno (1,2,3-cd)pyrene	0.052	\	\	\
											Phenanthrene	0.11	\	\	\
											Pyrene	0.17	\	\	\
											bis(2-Ethylhexyl)phthalate	0.065	\	\	\
											Di-n-butylphthalate	0.026	\	\	\
118-C-4	Storage	100-BC-2	12.19 x 7.62	The 105-C Horizontal Control Rod Storage Cave included tunnels used for temporary storage of control rods, and possibly miscellaneous equipment, to allow radioactive decay before disposal. Three French drains were located along the center of the structure floor for the removal of precipitation runoff that could potentially percolate and collect between the tunnels.	Interim Closed Out	CVP-2003-00015	Mar-03	Mar-03	453	0.85	Americium-241	0.169	\	0.045	\
											Cesium-137	0.034 U	\	0.015	\
											Cobalt-60	0.033 U	\	0.0151	\
											Europium-152	0.076 U	\	0.0338	\
											Europium-154	0.12 U	\	0.519	\
											Europium-155	0.095 U	\	0.0446	\
											Plutonium-238	0.06 U	\	0.0397	\
											Plutonium-239/240	0.0726 U	\	0.0238	\
											Strontium-90	0.004 U	\	0.00245	\
											Uranium-234	0.835	\	0.55	\
											Uranium-235	0.054 U	\	0.0463	\
											Uranium-238	0.936	\	0.59	\
											Arsenic	2.5	\	2.5	\
											Barium	45	\	44	\
											Cadmium	0.51 U	\	0.4	\
											Chromium	7.8	\	7.5	\
											Chromium VI	0.44 U	\	0.44	\

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Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Lead	20	\	16	\
											Mercury	0.034	\	0.02	\
											Selenium	0.51 U	\	0.42	\
											Silver	0.0084 B	\	0.12	\
124-C-4	Sanitary Sewer	100-BC-2	Not Documented	This site was assigned based on the information from Bechtel Hanford, Inc., D&D in the 1995 RARA Summary Report. D&D could not identify the site location nor could the Bechtel Hanford, Inc., historian. The site is thought to be either 1607-B10 or 1607-B11 as they are the only remaining septic systems in the 100-B Area that have a 124 alias assigned to them. If a determination can be made that it is one of above-referenced septic systems, the 124-C-4 will be added to the site as an alias. This site reference (as a separate site) will then be removed from the database.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
128-C-1	Burn Pit	100-BC-2	150 x 110 x 4.6	The 100-C Burning Pit was a vegetation and ash-covered field strewn with pieces of green, clear, and bright blue glass; small glass bottles; metallic wastes such as rusted cans, auto parts, and assorted scrap metal; chunks of concrete; and pieces of asbestos transite. The site was divided into four areas for evaluation, with a total of three trenches and three test pits excavated.	Interim Closed Out	WSRF-2005-019	Sep-04	Feb-05	8,750 BCM	1.8 - 4.6	Arsenic	7.2	\	4.4	\
											Antimony	2.7	\	\	\
											Barium	82.3	\	62.4	\
											Beryllium	1.1	\	0.8	\
											Boron	22.9	\	6.9	\
											Cadmium	2.3	\	0.6	\
											Chromium	37.7	\	18.5	\
											Cobalt	10.2	\	7.3	\
											Copper	114	\	51.2	\
											Lead	73.5	\	35	\
											Lithium	8.9	\	6.9	\
											Manganese	395	\	313	\
											Mercury	0.1	\	0.07	\
											Molybdenum	1.9	\	\	\
											Nickel	17.5	\	11.7	\
											Selenium	1.3	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Silver	6.6	\	\	\
											Vanadium	58.5	\	40.9	\
											Zinc	170	\	69.5	\
											Aroclor-1254	0.54	\	0.12	\
											Aroclor-1260	0.011	\	\	\
											Benzo(a)anthracene	0.029	\	\	\
											Benzo(a)pyrene	0.031	\	\	\
											Benzo(b)fluoranthene	0.032	\	\	\
											Benzo(g,h,i)perylene	0.024	\	\	\
											Benzo(k)fluoranthene	0.03	\	\	\
											bis(2-Ethylhexyl)phthalate	3.1	\	\	\
											Chrysene	0.038	\	\	\
											Di-n-butylphthalate	0.053	\	0.099	\
											Fluoranthene	0.059	\	\	\
											Indeno (1,2,3-cd)pyrene	0.021	\	\	\
											Phenanthrene	0.033	\	\	\
											Pyrene	0.047	\	\	\
132-C-1	Burial Ground	100-BC-2	60.96 x 9.14 x 5.49	This site was a burial area that contained rubble from the 105-C Reactor Stack, also known as the 116-C Reactor Exhaust Stack. A no-action decision is supported based on reviews of the facility information, historical data, and allowable residual contamination level and RESRAD modeling results. Residual contamination, present in a thin layer not more than 1 cm (0.4-in.) thick, was shown in RESRAD results to not present an unacceptable level of risk to the maximally exposed individual, and is protective of groundwater and the Columbia River.	No Action	WSRF-2003-26	N/A								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
132-C-2	Outfall	100-BC-1	16 x 8.2	The 132-C-2 Outfall is located north of the 107-B Retention Basin and downstream from the 116-B-7 Outfall. In addition to two steel pipelines that discharged at the center of the Columbia River, it was designed with a concrete overflow flume that spilled effluent water onto a large basalt boulder riprap flume that extended to the river shoreline. In 1979, the outfall was reduced to near grade and backfilled.	Interim Closed Out	CVP-2002-00003	See 116-B-7 data								
132-C-3	Process Unit/Plant	100-BC-2	16.86 x 7.01	The 117-C Filter Building began operation in 1961 to filter 105-C Reactor exhaust air before it was routed to the 116-C Exhaust Stack. The building was shut down in 1969. A no-action decision is supported based on reviews of the facility information, historical data, and allowable residual contamination level and RESRAD modeling results. Low-level radioactive waste removed from the facility was packaged and shipped to the 200 West Area burial grounds for disposal. No asbestos, mercury, or any other nonradioactive hazardous materials were found in the 117-C Facility. Residual contamination, present in a thin 1 mm (04-in.) paint layer, was shown in RESRAD results to not present an unacceptable level of risk to the maximally exposed individual, and is protective of groundwater and the Columbia River.	No Action	WSRF-2003-24	N/A							
600-33	Burial Ground	100-BC-2	12.2 x 6.1 x 3.0	The waste site was a burial site for the 105-C Reactor Test Loop. The selected design for the test loop was a tube within a tube (annular design). The outer tube was a 3.8 cm (1.5-in.) inside diameter Schedule 160 stainless steel tubing. The inner tube was 2.5 cm (1-in.) inside diameter with 0.17 cm (0.065-in.) wall thickness within a 12 m (40-ft) carbon steel shield tube. The test loop was inserted into the south side of the C Reactor core (one of the channels) and was used to test the effects of ionization on various chemicals being considered for reactor process tube scaling and cleaning.	Rejected	EPA/ROD/ R10-00/121	N/A							

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												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
600-34	Dumping Area	100-BC-1	300 x 150 x 4.6	The site is a dumping area used for disposal of miscellaneous waste. Visible wastes include wood (timbers and ties), piles of a silt-like material, sheet metal, cardboard, roofing material, concrete, electrical insulators, and a 10-L (5-gal) plastic bucket. Pre-Hanford Site waste is also evident including barbed wire, what appears to be old farm equipment, and remnants of wire-wrapped wooden irrigation pipe.	Rejected	Not Documented	N/A								
600-56	Dumping Area	100-BC-1	Not Documented	The site is the abandoned waste from what appears to be a pre-Manhattan Engineering District farm. The site is identifiable by scattered debris, piles of rocks, and an excavated pit.	Rejected	Not Documented	N/A								
600-67	Storage	100-BC-1	33.83 x 14.02	The Bruggemann's Warehouse site is the remaining one-story warehouse, associated foundations, piping, and debris surrounding the site. The building is considered culturally significant because of its good condition and use of native materials for construction. It is in the process (as of January 2001) for listing on the National Register of Historic Places.	Rejected	Not Documented	N/A								
600-230	Dumping Area	100-BC-1	15.24 x 6.1	The RCRA General Inspection 200WFY97 Item No. 4 Historic Disposal Site is believed to be a pre-Manhattan Project dump that represents an opportunistic event to dispose of primarily unwanted household items. The location of the dump near the edge of the upper terrace above the Columbia River indicates someone dumped garbage near the edge of the terrace and over time some of the items have moved downslope. The basis for reclassification to no action is a cultural resource review that concluded the site was the result of pre-Hanford Site dumping activities. The only noted suspect hazardous material, a single battery, was removed from the site and disposed. Residual material (debris, soil) at the site achieves the established RAOs and corresponding remedial action goals.	No Action	WSRF-2006-041	N/A								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
600-231	Dumping Area	100-BC-1	12.19 x 3.05	The site contains pre-Hanford Site debris, including several rusty metal food containers, empty paint cans, buckets, glass, small pieces of concrete, cable, barbed wire, sheet metal, and a rubber tire.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
600-232	Dumping Area	100-BC-2	24772.23 m^2	The site has several weathered utility poles in various conditions ranging from poor to good. The treated wood ends of the utility poles are categorized as dangerous waste. The site also contained various electrical utility materials such as steel cable, aluminum high-voltage wire, aluminum beams, aluminum poles, and insulators.	Interim Closed Out	WSRF-2004-066	2/19/2004	4/16/2004	9,005	0.3	Arsenic	2.4	\	\	\
											Barium	68.2	\	\	\
											Cadmium	0.1	\	\	\
											Chromium	9.8	\	\	\
											Lead	4.9	\	\	\
											Mercury	0.02	\	\	\
											Aroclor-1254	0.023	\	\	\
											bis(2-Ethylhexyl)phthalate	0.036	\	\	\
											Carbazole	0.028	\	\	\
											Chrysene	0.24	\	\	\
											Di-n-octylphthalate	0.028	\	\	\
											Dibenz[a,h]anthracene	0.018	\	\	\
											Fluoranthene	0.52	\	\	\
											Indeno (1,2,3-cd)pyrene	0.043	\	\	\
											Pentachlorophenol	0.15	\	\	\
											Phenanthrene	0.14	\	\	\
											Pyrene	0.54	\	\	\
											Total petroleum hydrocarbons	10.9	\	\	\
600-233	Storage Tank	100-BC-2	First pipe: 1.7 (depth) 6.4 cm (diameter) Second pipe: 1.9 cm (diameter)	These pipes were identified during the Ecology RCRA inspection at 100-B. They appear to be old water supply pipes. A search of old pipeline drawings of the 100-B/C Area shows no known pipelines in this area. There are no facilities other than the railroad near this location, so it is likely the pipes are an extension of the fire control system and used for the railroad and laydown area.	Interim Closed Out	WSRF-2005-041	Not Documented	Not Documented	Not Documented	0.5	Barium	51.2	\	\	\
											Beryllium	0.41	\	\	\
											Boron	1.5	\	\	\
											Cadmium	0.28	\	\	\
											Chromium	7.9	\	\	\
											Cobalt	6.3	\	\	\
											Copper	11.5	\	\	\
											Lead	4.9	\	\	\
											Manganese	270	\	\	\

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
											Nickel	8.3	\	\	\
											Selenium	3	\	\	\
											Vanadium	37	\	\	\
											Zinc	33.8	\	\	\
											Anthracene	0.047	\	\	\
											Benzo(a)anthracene	0.29	\	\	\
											Benzo(a)pyrene	0.18	\	\	\
											Benzo(b)fluoranthene	0.22	\	\	\
											Benzo(k)fluoranthene	0.18	\	\	\
											Butylbenzylphthalate	0.028	\	\	\
											Chrysene	0.34	\	\	\
											Dibenz[a,h]anthracene	0.061	\	\	\
											Fluoranthene	0.69	\	\	\
											Indeno (1,2,3-cd)pyrene	0.11	\	\	\
											Phenanthrene	0.34	\	\	\
											Pyrene	0.51	\	\	\
600-252	Dumping Area	100-BC-2	2.44 1.07 (diameter)	The site is an old, rusty, corrugated steel tank lying on its side. The site was visited on September 26, 2000, with a cultural resource specialist familiar with the history of the farms in this area. The tank was identified as a water tank because of the lack of any oil staining inside of or below the tank, and the cuts for the pipes fit irrigation piping but not typical oil heating or storage systems.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								
600-253	Depression/Pit (nonspecific)	100-BC-1	Not Documented	Gravel Pit No. 24 is a large excavated area that is actively used as a source of gravel and sand material. Because the bottom of the pit reached groundwater, a wetland was deliberately created in 1999 by excavating a little deeper and contouring the bottom to form islands and different depths of water. There is no evidence of hazardous or radioactive wastes disposed at this site.	Not Accepted	Site Closed using TPA-MP-14 WIDS Discovery Site Evaluation checklist approved by the Regulators.	N/A								

Table B-1. 100-BC Waste Sites Description and History

Site Code	Site Type	Operable Unit	Site Dimensions (m)	Site History	Reclassification Status	Closure Document	Remedial Action Start Date	Remedial Action End Date	Contaminated Waste Volume to ERDF (metric tons)	Maximum Depth of Remedial Action (m)	COC	Max Concentration (pCi/g, mg/kg)		95% UCL (pCi/g, mg/kg)	
												Shallow[a]	Deep[b]	Shallow[a]	Deep[b]
600-264	Dumping Area	100-BC-1	8.9 x 7.5	The site consisted of a 55-gal drum lying on its side, surrounded by orchard smudge pots. The drum was removed from the old orchard site to a DynCorp 90-Day Waste Accumulation Area on April 18, 2000. The oil-crusted soil around the drum was removed on June 28, 2001, as a voluntary DOE cleanup action.	Rejected	Not Documented	N/A								

Notes:

a. Shallow zone: soil above 4.6 m below ground surface

b. Deep zone: soil below 4.6 m below ground surface

4,4'-DDD = Dichlorodiphenyldichloroethane
4,4'-DDT = Dichlorodiphenyltrichloroethane
4,4-DDE = Dichlorodiphenyldichloroethylene
BCM = bank cubic meter
BG = background
BHC = Benzenehexachloride
COC = contaminant of concern
cpm = counts per minute
CVP = Cleanup Verification Package
D&D = decontamination and decommissioning
DOE = Department of Energy
ERDF = Environmental Restoration Disposal Facility
GPERS = Global Positioning Environmental Radiological Surveyor
GPS = global positioning system
HCR = horizontal control rod
ISS = Interim Safe Storage
N/A = not applicable
OSR = orphan site report
OU = operable unit
ppm = parts per million
RAO = remedial action objective
RARA = radiation area remedial action
RCRA = *Resource Conservation and Recovery Act of 1976*
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
VCR = vertical control rod
VSR = vertical safety rod
WAC = Washington Administrative Code
WIDS = Waste Information Data System
WSRF = Waste Site Reclassification Form
/ = no data collected

Appendix C

Summary of 100-BC Facilities

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C1 Introduction

Table C-1 provides a summary of the buildings/facilities that have existed in 100-BC. Many of these buildings/facilities have been demolished or are no longer used. Table C-1 also provides physical dimensions and a brief history for each building/facility.

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Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
103-B	Storage	100-BC-1	17.68 × 8.23 × 5.18	Demolished	1943	1996	The 103-B Fresh Metal Storage Building is located just north of 105-B. This rectangular-shaped building consists of one storage room and a loading platform, and was used for pallet storage of fuel elements before use in the reactor. In 1985, it was decontaminated and cleaned out. More recently, it was used as a rigger's loft for storing rigging equipment.
104-B1	Storage	100-BC-1	12.2 m^2	Demolished	1950	1996	The 104-B1 Tritium Vault was constructed to support the P-10 Project. The vault contained storage racks on the north and south walls, and the storage racks were used to hold shipping flasks containing tritium gas.
104-B2	Laboratory	100-BC-1	47.9 m^2	Demolished	1950	1996	The 104-B2 Tritium Laboratory was constructed to support the P-10 Project (the irradiation of lithium-aluminum fuel targets). The facility had 63 special cells recessed in the laboratory floor, used to store vacuum casks that contained the irradiated target elements.
105-B	Reactor	100-BC-1	75 × 55	Inactive	1943	Not Available	The B Reactor provided housing for the nuclear reactor and equipment directly associated with the reactor operations. The two main components are the reactor block and the storage basin. The reactor block is located near the center of the building. When facing the reactor front face, the horizontal control rod penetrations are on the left side of the reactor block, and the safety rod penetrations are on the top of the reactor. Fuel discharge and storage areas are located adjacent to the rear face of the reactor block. Experimental test penetrations are on the right side. The reactor block consists of a graphite moderator stack encased in cast iron thermal shielding and a biological shield rests on a massive concrete foundation. The fuel storage basin served as a collection, storage, and transfer facility for the irradiated fuel elements discharged from the reactor. Irradiated fuel elements were sorted in the pickup area, transferred to buckets, transported by monorail to the storage area, and held to allow decay of short-lived radionuclides before reprocessing. Following storage, the buckets of fuel elements were moved to the transfer area, placed in lead-shield casks, and moved into compartmented, water-filled railroad well cars for transport to the chemical processing facilities. A wash pad, which was used for equipment decontamination, and an underwater inspection facility are also in the storage basin area. The B Reactor, the first full-size reactor in the world, was the first reactor built on Hanford Site. It has received several national awards as a Nuclear and Mechanical Engineering Landmark, and is listed on the National Register of Historic Places. A community effort is currently under way to use the B Reactor as a museum.
105-C	Reactor	100-BC-2	105.5 × 45.7 × 36.6 and 45.7 × 27.4 × 6.1	Inactive	1952	ISS -1998	The C Reactor provided housing for the nuclear reactor and equipment directly associated with the reactor operations. The two main components are the reactor block and the storage basin. The reactor block is located near the center of the building. When facing the reactor front face, the horizontal control rod penetrations are on the left side of the reactor block, and the safety rod penetrations are on the top of the reactor. The reactor block consists of a graphite moderator stack encased in cast iron thermal shielding, a biological shield consisting of alternating layers of masonite and steel on the four sides, and a heavy aggregate poured shield on top. The entire block rests on a massive concrete foundation. The fuel storage basin served as an underwater collection, storage, and transfer facility for the irradiated fuel elements discharged from the reactor. Irradiated fuel elements were sorted and placed in storage containers in the pickup area, transported by monorail to the storage area, and held to allow decay of short-lived radionuclides before reprocessing. Following storage, the buckets of fuel elements were moved to the transfer area, placed in lead-shield casks, and moved into a railroad well car for transport to the chemical processing facilities. A wash pad, which was used for equipment decontamination, and an underwater inspection facility are also in the storage basin area.
105-CA	Storage	100-BC-2	24.84 × 6.32	Demolished	1996	Not Available	The 105-CA facility was a small addition on the southwest side of the 105-C Reactor Building. The east wall was the existing concrete wall of the 105-C building, while the other walls of the structure were concrete block. The roof of the facility was gravel surfaced asphalt. The area immediately north of 105-CA was used as a loading dock, and a ramp was located along the west side of the structure. Utilities serving the building included a ventilation unit, steam, and a 10 cm (4-in.) floor drain.
106-B	Storage	100-BC-2	15 × 5.7 × 3.6	Demolished	1943	Not Available	The 106-B Contaminated Equipment Storage Building was a galvanized iron Quonset hut with a plywood floor. During the historical research for 100-BC, the exact location of the 106-B Building was not discovered. A review of construction drawings and historical photographs did not support its existence. Although not confirmed, this building may not have been constructed.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
107-B	Retention Basin	100-BC-1	70 × 142	Demolished	1944	1954	The purpose of the retention basin was to retain reactor cooling water to allow for decay of short-lived radionuclides and cooling of water before its return to the river. It discharged to an outfall at the river and had a crosstie to 107-C. Because of a crack in the basin in 1954, extensive leaks occurred to the soils in the area, ending operations of the facility.
107-C	Retention Basin	100-BC-1	2 tanks, ea. 101 m dia.	Demolished	1952	1999	The 107-C Retention Basin consisted of two circular open-topped tanks with a capacity of 37.9 million L (10 million gal). The facility held effluent water from the B and C Reactors for cooling and decay before its release into the Columbia River.
108-B	Process Unit/Plant	100-BC-1	40 × 10 × 12	Demolished	1944	1985	The intended use of this facility was for the chemical mixing and addition to the reactor cooling water; however, it was soon determined this function could be better performed elsewhere in the cooling water supply system. The 108-B Building was then converted to a tritium recovery processing facility. The tritium separation facility was designed to support reactor operations by recovering tritium from irradiated lithium-aluminum target elements.
110-B	Storage Tank	100-BC-1	2 tanks, ea. 2.4 m dia. 2 tanks, ea. 0.6 m dia.	Demolished	1944	Not Available	The 110-B Gas Storage Tanks held the helium and carbon dioxide used for the reactor atmosphere. The tanks were supported by concrete cradles. Pipe extended from the tanks to the circulation system and equipment in the 115-B Building.
111-B	Laboratory	100-BC-1	24 × 19 × 4.4	Demolished	1944	1984	The 111-B Metal Examination Facility was a one-story, wood frame "L"-shaped building built on a concrete floor slab. The facility served as a failed fuel inspection facility. Irradiated fuel pieces were stored and examined in two below grade stainless steel-lined concrete tanks filled with water for shielding purposes. The facility was demolished to slab-on-grade in 1984 and the slab and below grade tanks removed in 1999.
115-B	Process Unit/Plant	100-BC-1	1413 m^2	Demolished	1944	1989	The 115-B Gas Recirculation Facility filtered and recirculated the inert gas that surrounded the core of the reactors. The recirculation cycle included cooling, drying, and filtering of the large gas volumes before reentry into the reactors.
116-B	Stack	100-BC-1	height: 61; dia. 5	Inactive	1943	Not Available	The unit is part of the 105-B Reactor Gas and Exhaust Air System. Following completion of the confinement project in 1960, the air was diverted via an above-ground aluminum duct and an underground, reinforced-concrete duct to the 117-B Filter Building. After flowing through the filters, the air flowed through a below grade concrete duct and an above grade aluminum duct into the exhaust stack.
116-C	Stack	100-BC-2	height: 61; dia. 5	Demolished	1952	1983	Exhaust air flowed through concrete ducts from the 105-C Building directly out the exhaust stack. Following completion of the confinement project in the 1950s, the air was diverted via underground, reinforced-concrete ducts to the 117-C Filter Building. After flowing through the filters, the air went through below and above-grade concrete ducts into the exhaust stack.
117-B	Process Unit/Plant	100-BC-1	17 × 11 × 10.6	Demolished	1960	1988	This building was a below grade, bermed (earth and gunite) structure with large steel hatch covers that served as the roof. The building was 2.4 m (7.8 ft) above grade, 8.2 m (26 ft) below grade, 17 m (56 ft) long, and 11 m wide. The building filtered ventilation air from the confinement zone of the B Reactor Building through HEPA and activated charcoal filters, before its discharge to the atmosphere through the 116-B Stack.
117-C	Process Unit/Plant	100-BC-2	17 × 11 × 10.6	Demolished	1960	1988	The building received exhaust fan discharge through an inlet duct from the C Reactor Building and discharged the filtered air (HEPA and activated charcoal filters) through a discharge duct and out the 116-C Stack.
119-B	Laboratory	100-BC-1	25.8 m^2	Inactive	1960	Not Available	The purpose of the 119-B Sample Building was to monitor the air quality of the exhaust that was released through the 116-B Stack. A small stream of air was diverted from the main flow and routed to this building for sampling. Two separate detectors were used to measure the quality of airborne iodine-131, including a fog-spray scintillation chamber detector and a halogen charcoal sampler system. An automatic filter sampler was used to measure the radiation levels in airborne particulate matter. Additional equipment was provided for monitoring the radiation and pressure conditions in the 117-B Filter Building.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
119-C	Laboratory	100-BC-2	21.9 m^2	Demolished	1960	Not Available	The purpose of the 119-C Sample Building was to monitor the air quality of the exhaust that was released through the 116-C Stack. A small stream of air was diverted from the main flow and routed to this building for sampling. Two separate detectors were used to measure the quality of airborne iodine-131, including a fog-spray scintillation chamber detector and a halogen charcoal sampler system. An automatic filter sampler was used to measure the radiation levels in airborne particulate matter. Additional equipment was provided for monitoring the radiation and pressure conditions in the 117-C Filter Building.
151-B	Substation	100-BC-2	12,667 m^2	Active	1944	NA	The 151-B Primary Substation supplies electrical power for the pumping facilities in 100-B and electricity for 100-B standby facilities. The substation was expanded in 1951 to support the C Reactor. This facility is needed as long as the 200 Area needs water service from 100-B.
152-B	Substation	Not Documented	62.2 m^2	Demolished	1944	Not Available	There were 10 secondary substations located in 100-B.
152-C	Substation	Not Documented	Not Available	Demolished	1952	Not Available	For the construction of the C Reactor, additional substations were built to support the 183-C, 190-C, and 105-C Buildings.
153-B	Substation	Not Documented	Not Available	Demolished	Not Available	Not Available	There were eight distribution stations located in the B Reactor area. Each distribution substation was constructed as an open wood pole structure surrounded by a picket fence.
1131-AB	Storage	100-BC	89.2 sq m	Removed	Not Available	Not Available	The 1131-AB building (also listed as 1131-A) was a hutment type structure in 100-BC. The unusual name suggests that this facility may have originated in the 1100 Area and then was relocated to 100-BC. The 1131-AB facility was likely removed in the 1970s, although the exact date could not be determined.
1605-B	Guard Towers	Not Documented	11 towers ea. 4.4 × 4.4 × 3.9	Demolished	1944	Not Available	There were 11 guard towers in 100-BC, located along the perimeter fence on the east, south, and west sides of the area, and along the river to the north.
1608-B	Pump Station	100-BC-1	5.18 × 6.10 × 4.22	Inactive	1944	NA	The 1608-B facility consisted of two components, a small wooden shack and a below grade concrete structure. The shack was a wood frame building with composition roof. It was used as an instrumentation hut and contained controls for making minor modifications to the gas pressure within the system. The concrete structure measured 5.2 m (17 ft) by 6.1 m (20 ft) and extended to 4.2 m (13.8 ft) below grade. It contained two large cylindrical tanks, each measuring 3.25 m (10.7 ft) long with a diameter of 1.8 m (6 ft). One tank served as a vacuum seal tank, while the other was used as a pressure seal tank. Since the cover gas system was specifically designed to prevent water from reaching the reactor, water seals could not be used. Instead the seal pit relied on oil seals, due to the fact that oil is much less volatile than water. At least one above-ground tank was also associated with the facility. It was constructed in 1944.
1614-B	Monitoring Station	Not Documented	3.8 m^2	Demolished	Not Available	Not Available	There were three environmental monitoring stations, used to house the equipment that sampled airborne process wastes.
1621-B	Substation	Not Documented	1.5 × 2.9 × 3.4	Demolished	Not Available	Not Available	Three emergency generators were built for 100-B. Each one contained a gasoline-powered electrical generator designed to automatically activate in the case of a power failure. Fuel was stored outside of the building in tanks placed on tall concrete saddles for gravity feeding.
1701-B	Office	100-BC-2	12 × 6.7 × 7	Demolished	1944	Not Available	The 1701-B Badge House provided entrance into the exclusion area and was later used as a lunchroom and restroom facility. The facility was designed to house personnel who verified employee identification entering the work area. The facility contained a guard, equipment, clock alley, laboratory, storage, office, and restrooms.
1701-BA	Office	100-BC-1	6.1 × 6.1 × 3.7	Demolished	1966	1996	This facility was constructed in 1966 to replace the 1702-B Gate House during the fence relocation project. It provided a shelter for a security checkpoint before entrance to the exclusion area.
1702-B	Office	100-BC-1	6.1 × 6.1 × 3.7	Demolished	1944	1966	The facility provided entrance to the 105-B Exclusion Area. The building was replaced in 1966 by the 1701-BA Building.
1702-C	Office	100-BC-1	19.5 m^2	Demolished	Not Available	1997	The facility provided entrance to the 105-C Exclusion Area.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
1703-B	Office	100-BC-1	367.5 m^2	Demolished	1950	Not Available	The facility was located near the 108-B Facility, and is believed to have been an office building built to house personnel for the C Reactor, or to support the tritium project in 108-B.
1704-B	Office	100-BC-1	45 × 35 × 8	Demolished	1944	NA	The one-story 1704-B Office Building was used as a supervisor's office and a laboratory. The facility was later moved to the 200 Area in the 1970s.
1707-B	Office	100-BC-1	9 × 20 × 5	Demolished	1944	Not Available	The 1707-B Building was originally used as a change house and lunchroom and later as office space located along the main gatehouse road.
1707-BA	Office	100-BC-1	170.7 m^2	Demolished	1944	Not Available	The 1707-BA Building provided locker space, shower facilities, and a lunchroom.
1709-B	Office	100-BC-1	331 m^2	Demolished	1944	Not Available	The 1709-B Fire Headquarters Building was located near the main gate entrance to the B Reactor area. The facility was designed to provide living quarters for firefighters and included truck storage.
1713-B	Storage	100-BC-1	23.5 × 16 × 5	Removed	Not Available	Not Available	The one-story 1713-B Building was used for storeroom and warehouse space. All 100-B supplies were received and dispersed from this building. Later it was converted to an instrument and development testing facility.
1713-BA	Storage	100-BC-1	24.4 × 63.4 × 4.3	Demolished	Not Available	Not Available	The 1713-BA Essential Materials Storage building was converted from the Temporary Construction Receiving and Warehouse Building.
1713-BB	Storage	100-BC-1	4.6 × 39.3 × 3	Demolished	Not Available	Not Available	The 1713-BB Facility was converted from the Temporary Construction TC-30 Division Engineer's Office.
1713-C	Storage	100-BC-1	3.8 × 3.8	Demolished	1952	Not Available	The 1713-C Solvent Storage Building was located east of the 108-B Building.
1714-C	Storage	100-BC-2	3.7 × 5.5	Demolished	1952	1996	The 1714-C Building was located south of 105-C, near 117-C, and was used as an oil house to store miscellaneous oil and solvents.
1715-B	Storage	100-BC-1	13 × 4.2 × 5.5	Demolished	Not Available	Not Available	The 1715-B Oil and Paint Storage building was one-story tall with a concrete foundation.
1716-B	Maintenance Shop	100-BC-1	16 × 12 × 5.5	Demolished	Not Available	Not Available	The 1716-B Automotive Repair Building was equipped for service station function and light maintenance of vehicles.
1717-B	Maintenance Shop	100-BC-1	46 × 24 × 7.6	Removed	Not Available	Not Available	The one-story 1717-B Maintenance Shop was located along the main entrance road and contained a large machine, carpenter, pipe, sheet metal, electric and forge shops, a tool room, several offices, and a restroom.
1719-B	Office	100-BC-1	9.7 × 7.8 × 5.9	Demolished	Not Available	Not Available	The 1719-B First Aid Station was a one-story structure located near the center of the process area. It contained a first aid room, cot room, laboratory, office, and restrooms.
1720-B	Office	100-BC-1	24 × 9.7 × 4.6	Demolished	Not Available	NA	The 1720-B Building was a one-story building originally used as the area patrol headquarters and later for office space.
1722-B	Maintenance Shop	100-BC-1	12 × 9.1 × 4.6	Demolished	Not Available	Not Available	The 1722-B Paint Shop was a one-story building that contained a rigger's loft and paint storage room.
1722-BA	Maintenance Shop	100-BC-1	12.2 × 29 × 3	Demolished	Not Available	Not Available	This facility was originally the TC-30 Electrical Shop. In 1945, it had telephone, lighting, water, and heating utilities.
1729-B	Storage	100-BC-1	669 m^2	Demolished	Not Available	Not Available	The 1729-B Storage Building was used to house extra machinery. It was converted from the TC Pipe Storage Warehouse.
1734-B	Storage	100-BC-1	22.3 m^2	Demolished	Not Available	Not Available	The 1734-B Gas Cylinder Storage Building contained four small cylinder storage spaces, one for oxygen storage, one for hydrogen and acetylene storage, and two for empty cylinder storage.
1735-B	Office	100-BC-1	21.34 × 7.62	Removed	Not Available	Not Available	The 1735-B Building was located in the 100-B in the late 1950s and early 1960s, north of the 108-B Building and west of the 108-B crib (waste site 116-B-5). The type of construction used for the facility is unknown, although it was likely a temporary wood frame structure.
1736-B	Storage	100-BC-1	6.1 × 12.2	Removed	Not Available	Not Available	The 1736-B Building was used to store maintenance tools and equipment.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
1736-C	Storage	100-BC-1	74.3 m^2	Removed	Not Available	Not Available	The 1736-C Building may not have ever have been constructed; however, there is some evidence to support the location of 1736-B as being next to the B Reactor, and it can be supposed that this building may have been located adjacent to 105-C. If so, it was likely used to store maintenance tools and equipment.
1784-B	Office	100-BC-1	9.3 m^2	Demolished	Not Available	Not Available	The building is the 1784-B Coal Handlers' Office.
181-B	Pump Station	100-BC-1	75 × 15 × 6	Active	1944	NA	The facility supported both B and C Reactors by pumping raw river water to water treatment plants. This facility had 10 electric-driven pumps with a capacity of about 40,000 L/min (10,570 gal/min).
181-C	Pump Station	100-BC-1	15.2 × 5.5 × 5.5	Inactive	1952	Not Available	The facility provided raw river water to the 182-B Reservoir and the 183-C Filter Plant Headhouse. This facility was actually an addition to the 181-B River Pump House with a concrete intake and trash rack running along the north side, and a pipe tunnel 2.7 by 34.4 m (8.8 by 1,12.8 ft) running along the south side of the building. The addition included a lighting system, power system, motor control center, the 181-B Substation, and the necessary building service, together with the piping system and pumping equipment to support a 272,550-L/min (72,021-gal/min) pumping rate. It had 12 pump bays, two of which were designed for future planned expansion.
182-B	Process Unit/Plant	100-BC-1	147 × 94 × 12	Active	Not Available	NA	The reservoir and pumphouse provided reserve water for reactor cooling and raw export water for the 100 Area and 200 Area. The river pumphouse (181-B) supplied water to the two storage reservoirs, and the reservoir capacity was 9.5 million L (25 million gal). Seven pumps were located in the pump room, each capable of pumping 23,000 L/min (6,077 gal/min). Water was treated to reduce corrosion and film formation in the water cooling tubes and the canned uranium slugs in the reactor.
183-B	Process Unit/Plant	100-BC-1	73 × 114 × 6	Demolished	Not Available	1988	The 183-B Filter Plant contained water treatment and filtering facilities and served as a reservoir for treated water. The facility consisted of a head house and chemical building, flocculation and sedimentation basins, filter building, and clearwell storage with pump room. The filter plant contained the chemical feeding equipment, mechanical mixing and flocculating chambers, gravity filters, sedimentation basins, and a 38 million-L (13 million-gal) clearwell used for the storage of filtered water. The filter plant was designed to remove suspended materials from the water by mixing chemicals followed by a sedimentation period and filtration through a bed of Anthrafilt, sand, and gravel. Chemicals used for water treatment in the facility included lime, aluminum or ferric sulfate, activated carbon, chlorine, and Calgon. The total capacity of the 183-B Pumping Facility was 439,000 L/min (116,006 gal/min).
183-C	Process Unit/Plant	100-BC-1	64.6 × 23.8 × 24.4	Demolished	1952	1982	The 183-C Facility was a complete chemical storage and handling facility (head house) with flocculation and sedimentation basins, mixers, sample and analyses facilities, flow control devices, and four steel clearwell tanks with the capacity for 11.4 million L (3 million gal) of storage. It supplied treated water to the C Reactor.
184-B	Process Unit/Plant	100-BC-1	64.6 × 23.8 × 24.4	Demolished	1943	1983	The building was called the Power House, but was primarily a Boiler House, containing only a small turbine generator for emergencies, capable of supplying building lights and motors that must be maintained in continuous service. The building consisted of the following structures: Main Power House, two 91 m (300-ft) reinforced-concrete smoke stacks, coal-handling conveyor system, including crusher house, two transfer houses and track hoppers, an open coal storage pit, salt dissolving pit, and brine pump house. The 184-B-Building Powerhouse provided steam and emergency electrical power for the secondary coolant system located in 181-B. It also supplied office heat and other heating needs through overhead steam lines that looped throughout 100-B.
185-B	Process Unit/Plant	100-BC-1	94 × 15 × 18	Demolished	1944	Not Available	The 185-B Deaeration Facility (i.e., 185-B Water Treatment Plant) was designed to receive filtered water from underground clearwells, remove the dissolved gases and entrained air, and pump the deaerated water to steel storage tanks in the 190-B Process Pumphouse. Although originally constructed as a deaeration facility, it was never used for this purpose. The facility provided coolant water for the B Reactor and was later used to store resin for the N Reactor.
187-B1	Storage Tank	100-BC-1	height: 12; dia. 12.5	Removed	1944	1982	The 187-B1 Storage Tank was one of two elevated process water tanks in the B Reactor area. The tanks were located near and on opposite sides of the 105-Reactor. The tanks were of identical design and constructed of 0.95 cm- (0.37-in.-) thick steel plate.
187-B2	Storage Tank	100-BC-1	height: 12; dia. 12.5	Removed	1944	1982	The 187-B2 Storage Tank was one of two elevated process water tanks in the B Reactor area. The tanks were located near and on opposite sides of the 105-Reactor.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
187-C1	Storage Tank	100-BC-2	37	Demolished	Not Available	Not Available	The 187-C1 Storage Tank was made of steel and mounted on a 37 m- (121-ft-) high tower. Its capacity was 1,100,000 L (290,675 gal).
187-C2	Storage Tank	100-BC-2	37	Demolished	Not Available	1996	The 187-C2 Storage Tank was made of steel and mounted on a 37 m- (122-ft-) high tower. Its capacity was 1,100,000 L (290,657 gal).
188-B	Coal Ash Pit	100-BC-1	97.5 × 103.6 × 3.5	Demolished	1943	1969	188-B is an open rectangular-shaped pit and dike-type basin that was dug or constructed for the disposal of ashes from the 184-B Power House. The powerhouse was equipped with automated removal of ash by pumping ash directly from the sluice pit in the power house to the Ash Disposal Basin by a 20.3 cm (8-in.) chrome-iron alloy (ashcolite) underground pipeline, which was abandoned in place. The ash pit was filled with ash, covered over with dirt and cobble, and abandoned in place.
190-B	Pump Station	100-BC-1	139 × 56	Demolished	1944	1993	The 190-B Pump House provided primary coolant water to the B Reactor Building. It contained four large steel water tanks. Each one was capable of storing 26.5 million L (7 million gal) of treated water. There were also 12 pumping units, each containing a steam-driven primary and an electrically driven secondary. Together, the two pumps in one unit operated at 1,135 L/min (299 gal). The 190-BA Annex was constructed to increase the capacity of the 190-B Main Pump House and thus provide additional cooling water to the B Reactor. It contained eight electrically driven 39,368-L/min (10,403-gal/min) pumps, of which seven were needed to reach the desired flow rate.
190-C	Pump Station	100-BC-2	48.6 × 18.3 × 9.8	Demolished	Not Available	1999	The 190-C Facility pumped water to the C Reactor as part of the reactor-cooling process after the water was treated/filtered in the 183-C Filter Building/Pump Room. The building contained approximately 380 linear m (1,246 linear ft) of asbestos-lagged pipes and valves. Ten pumping stations were located on the main floor with a 37,800-L/min (9,988-gal) capacity each, electrical switchgear room, control room, survey room, lunchroom, change room, bathroom, shop area, and filter storage area. The basement contained cooling water, compressed air and steam piping, fluid coupling heat exchanger, solids injection system, valve pits, and the entrances to the 105-C Water Tunnels. Each tunnel contained the piping used to supply water to C Reactor and a steam supply pipe to 190-C. The tunnels are located at the northeast and southeast corners of the building and are approximately 3.0 by 36 by 150 m (9 by 12 by 492 ft) long.
1901-B	Storage Tank	100-BC-1	36.6	Demolished	Not Available	Not Available	The 1901-B Soft Water Tank was an elevated cylindrical storage tank with a conical roof used to store water that was then used as feed water for the power house boilers. The total height of the structure was approximately 36.6 m (120 ft), with the steel tank itself accounting for about 7.5 m (24 ft). The capacity of the tank was 283,900 L (48,596 gal).
1902-B	Storage Tank	100-BC-1	36.6	Demolished	Not Available	Not Available	The 1902-B Sanitary Water Tank was an elevated cylindrical storage tank with a conical roof used to store backup water for the fire system in the B Area. The total height of the structure was approximately 36.6 m (120 ft), with the steel tank accounting for about 7.5 m (24 ft). The capacity of the tank was 283,900 L (48,596 gal).
1904-B1	Outfall	100-BC-1	Not Available	Demolished	Not Available	Not Available	The 1904-B1 Outfall was located north of the 107-B Building, and was used to direct reactor-cooling water into the river through either the discharge pipeline or the spillway. Water from 107-B discharged into the outfall structure, then into the discharge pipe to the river. The spillway was a concrete flume used to release the water when the discharge pipelines were out of service.
1904-B2	Outfall	100-BC-1	Not Available	Demolished	Not Available	Not Available	The 1904-B2 Outfall was located north of the 107-B Building, and was used to direct reactor-cooling water into the river through either the discharge pipeline or the spillway. Water from 107-B discharged into the outfall structure, then into the discharge pipe to the river. The spillway was a concrete flume used to release the water when the discharge pipelines were out of service.
1904-C	Outfall	100-BC-1	261 m^2	Demolished	Not Available	Not Available	The 1904-C Outfall was used to direct reactor-cooling water into the river through either the discharge pipeline or the spillway. Water from 107-C discharged into the outfall structure, then into the discharge pipe to the river. The spillway was a concrete flume used to release the water when the discharge pipelines were out of service.
1908-C1	Monitoring Station	100-BC-1	13.3 m^2	Demolished	Not Available	Not Available	The 1908-C1 Monitoring House was used to monitor the cooling water as it was being discharged to the river.
1908-C2	Monitoring Station	100-BC-1	13.3 m^2	Demolished	Not Available	Not Available	The 1908-C2 Monitoring House was used to monitor the cooling water as it was being discharged to the river.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
CT0013	Change House	100-BC-2	3.05 × 12.19	Demolished	2005	2008	CT-0013 was a 2005 Pacific Mobile trailer that was located in 100-BC. It had sheetrock interior and was heated with a wall mounted heat pump. The CT-0013 facility was brought onsite by FE&C to support specialty sub-tier work in 100-BC in 2006 and 2007. It was used as a change room for 100-BC personnel until it was relocated to 100-H in 2009.
CT0015	Storage	100-BC-1	2.44 × 13.72	Active	1982	NA	CT0015 was a 1982 Dorsey semi-trailer that was used for storage in 100-BC. The interior of the facility was wood paneling. A dirt and gravel ramp was used to provide access to the double doors of the trailer.
CT0024	Storage	Unknown	3.35 × 7.47	Active	2000	NA	The CT-0024 facility was a 2000 Whitley-Evergreen semi-trailer that was located in 100-BC. CT-0024 was used as a storage facility. It had previously been located in 100-H but was relocated to 100-BC in January 2009.
MO-390-C	Office	100-BC-2	3.1 × 9.8	Removed	1997	NA	The MO-390 Building was relocated to 100-BC in 1997, to a site west of the C Reactor. It was used as the RCT office during the ISS Project for the C Reactor.
MO-417-C	Office	100-BC-2	8.5 × 20.1	Removed	1996	NA	The MO-417 Building was a double-wide mobile office that was located near the C Reactor. It was used as an office facility during the ISS Project for the 105-C Reactor Building. The building was later moved to 100-F.
MO-474	Office	100-BC-1	234 m^2	Active	Not Available	NA	The MO-474 Building is a double-wide mobile trailer serving as the primary field trailer in 100-BC. The building has been in place in 100-BC since at least 1996.
MO-474A	Office	100-BC-1	Not Available	Removed	2002	NA	The MO-474A Building was a single-wide mobile trailer used to house offices for the subcontractor RCI Environmental. The building was removed in 2002.
MO-474B	Office	100-BC-1	Not Available	Removed	2002	NA	The MO-474B Building was a single-wide mobile trailer serving used to house offices for RCT personnel in 100-BC. The building was removed in 2002.
MO-761	Office	100-BC-1	7.3 × 18.3	Removed	2002	Not Available	The MO-761 Building was a double-wide mobile office facility located in 100-BC near the MO-474 Central Support Facility. The building was used to house offices for RCT personnel.
MO-762	Office	100-BC-1	19.5 × 8.5	Removed	2002	Not Available	The MO-762 Building was a double-wide mobile office facility located in 100-BC near the MO-474 Central Support Facility. The building was used to house offices for RCT personnel.
MO-763	Change House	100-BC-1	3 × 12	Removed	2004	NA	The MO-763 Building was a single-wide trailer used as a change house in 100-BC. The building was removed from 100-BC in September 2004.
MO-764	Change House	100-BC-1	9.1 × 3.7	Removed	2005	Not Available	The MO-764 Facility is a restroom trailer in support of the 100-BC Administration trailers that is located in 100-BC near the MO-474 Facility. It has two external structures associated with it, including an above ground portable water tank to the north, and an underground septic holding tank to the west. Underground piping connected the MO-764 Building to both structures.
MO-769	Change House	100-BC-2	3 × 12	Removed	2004	NA	The MO-769 Building was a single-wide trailer that served as a change house while in 100-BC. The building was moved to 100-D in 2004.
MO-770	Office	100-BC-2	4.9 × 20.1	Removed	2007	NA	The MO-770 Building was a mobile office facility located near the C Reactor used by RCT personnel during the 100-B/C Area Remaining Pipelines and Sewers Project. The building had been removed by 2007.
MO-771	Office	100-BC-2	7.9 × 20.1	Removed	2007	NA	The MO-771 Building was a mobile office facility located near the C Reactor used by Bechtel Hanford, Inc., personnel during the 100-B/C Area Remaining Pipelines and Sewers Project. The building had been removed by 2007.
MO-772	Office	100-BC-2	18.3 × 6.1	Removed	2007	NA	The MO-772 Building was a mobile office facility located near the C Reactor used by Federal Engineers and Constructors personnel during the 100-B/C Area Remaining Pipelines and Sewers Project. It contained offices and a lunchroom. The building had been removed by 2007.
MO-773	Change House	100-BC-2	3.1 × 12.2	Removed	2007	NA	The MO-773 Building was a restroom trailer located near the C Reactor that supported nearby trailers during the 100-B/C Area Remaining Pipelines and Sewers Project. An underground septic holding tank was located to the east of this facility. The building had been removed by 2007.

Table C-1. Summary of 100-BC Facilities

Facility Code	Facility Type	Operable Unit	Site Dimensions (m)	Facility Status	Construction Date	Demolition Date	Facility Description
MO-829-C	Office	100-BC-2	8.5 × 18.3	Removed	1998	NA	MO-829 was a double-wide mobile office located west of the C Reactor. It served as an administrative office during the ISS Project at the C Reactor. The building was removed from 100-BC in 1998.

Notes:

Data Correct as of January 7, 2010.

FE&C = Federal Engineers and Constructors Inc.

M = meters

NA = not applicable

HEPA = high-efficiency particulate air

ISS = Interim Safe Storage

RCI = RCI Environmental

RCT = Radiological Control Technician

Appendix D

Implementation of Constituents of Potential Concern and Target Analyte List for 100-BC

This appendix implements the process defined in the Integrated 100 Area Work Plan (DOE/RL-2008-46, Rev. 0) for determining the contaminants of potential concern (COPCs) and target analyte lists (TALs) for the 100-BC operable units. The COPC and TALs were developed using the respective companies' quality standards and have undergone a vigorous check and review. Throughout the process, the Tri-Parties provided input. The list for the 100-BC operable units incorporates OU-specific input that has been provided from EPA.

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D1 Identification of Contaminants of Potential Concern for Groundwater Portion of the 100-BC Remedial Investigation/ Feasibility Study Work Plan

Environmental Calculation Cover Page

Calculation No.: ECF-100BC5-10-0288 Revision No.: 0

Project: Soil and Groundwater Remediation Date: 3/8/10

Calculation Title & Description: Identification of Contaminants of Potential Concern (COPC) for Groundwater Portion of the Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units.

This calculation brief describes the selection of contaminants of potential concern for defining the nature and extent of groundwater contamination at the 100-BC-5 Groundwater Operable Unit.

Revision History:

Revision No.	Description	Date	Affected Pages
0	Groundwater COPC selection process prepared to support DOE/RL-2008-46-Add 3, Rev.0	3/8/10	All

Document Review & Approval:

Originator: Kristin Singleton/Risk Assessor

Name/Position

Signature — Date: 3-9-10

Senior Reviewer: Donna Morgans/Senior Risk Assessor

Name/Position

Signature — Date: 3-8-10

Responsible Manager: Alaa Aly/ Modeling and Risk Integration Manager

Name/Position

Signature — Date: 9 MAR 2010

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D1.1 Purpose

This memorandum describes the method for selecting groundwater COPCs in support of developing the 100-BC RI/FS Work Plan documents. A secondary objective of this memorandum is to identify the appropriate analytical methods for the COPCs. The recommended analytical methods for radiological and nonradiological COPCs are based on their ability to achieve their respective action level.

The list of COPCs identified with this procedure will be used for planning future risk assessment activities for 100-BC. These COPCs also will be used in the nature and extent characterization for 100-BC. The identified COPCs can be used to develop a more focused list of analytes for sampling and analysis plans, such as remedial process optimization.

The source of analytical data and selection criteria for identifying COPCs are described in Section D1.2, Methodology. A COPC is a constituent suspected of being associated with site-related activities that represents a potential threat to human health or the environment, and constituent data are of sufficient quality for use in a quantitative baseline risk assessment. COPCs will be carried into the Sampling and Analysis Plan for characterization for developing baseline conditions through sampling and analysis by approved analytical methods.

D1.2 Methodology

The evaluation methodology involves a sequence of two steps-extracting and processing an OU-specific analytical data set and screening the data for the entire groundwater OU to select analytes that qualify as initial COPCs for inclusion in the SAP.

D1.2.1 Analytical Data Processing

The data set obtained from the Hanford Environmental Information System (HEIS) includes the following types of information:

- Filtered and unfiltered analytical results
- Data qualification and data validation flags, including rejected results
- Results reported by more than one analytical method
- Parent, field duplicate, and field split samples

As a result of these database qualities, the analytical data obtained from the HEIS database are processed to identify one set of results per sampling location and time of collection. The following describes the data processing steps taken prior to the selection of groundwater COPCs. Figure D1-1 presents the analytical data processing requirements associated with the groundwater COPC selection process and the number of records associated with each of the processing steps.

Unfiltered Sample Results. Only unfiltered nonradiological and radiological results are used for selecting COPCs. Use of unfiltered sampling results represents total concentrations of the analyte. Because filtered sampling results may underestimate chemical and radiological concentrations in water from an unfiltered tap, they are not used for the COPC selection process.

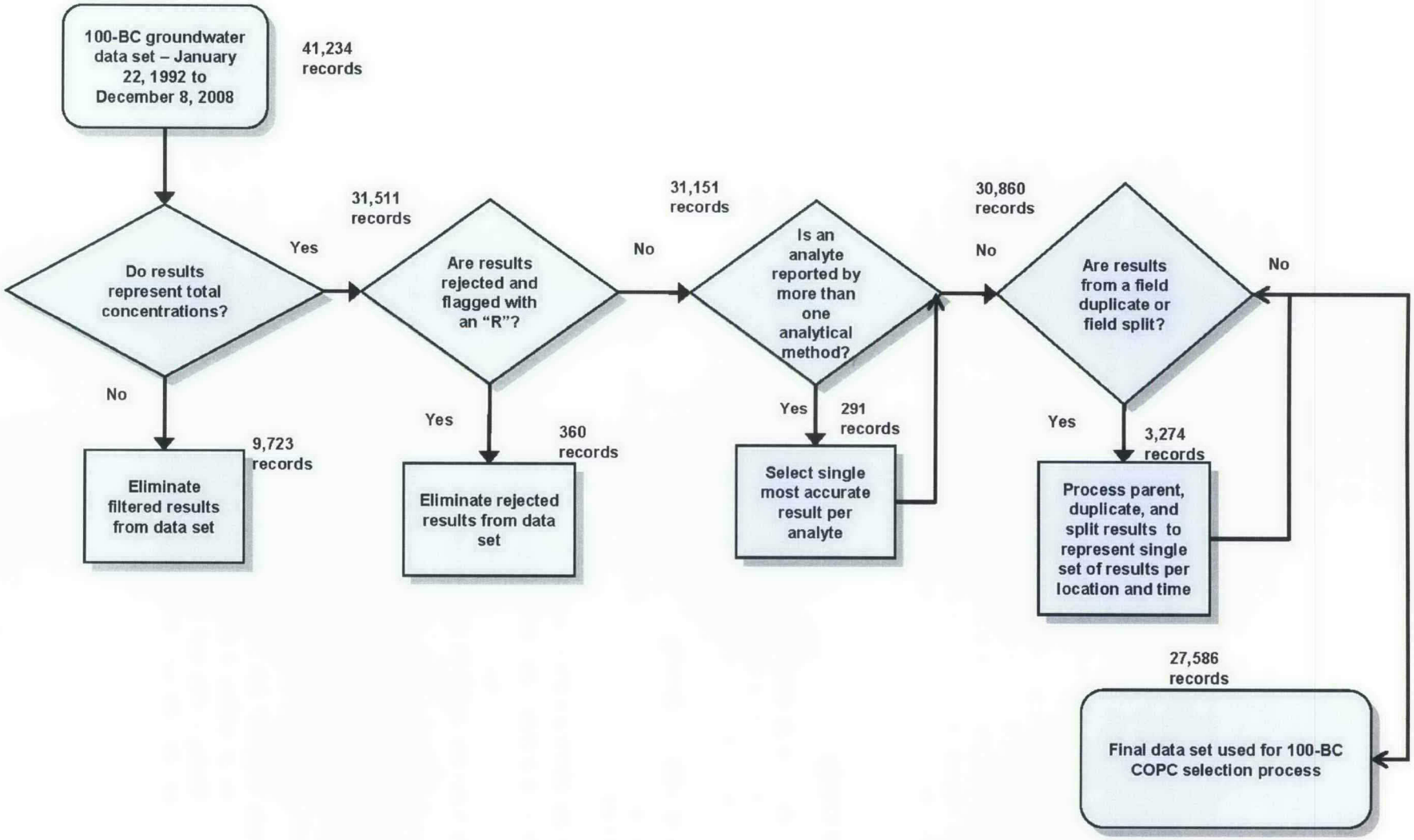


Figure D1-1. Analytical Data Processing for COPC Selection Process

Field Duplicate and Split Results. Field quality control samples (field duplicates and field splits) are collected in the field and analyzed by the laboratory as unique samples. The parent sample and quality control samples are collected from the same location (i.e., monitoring well), resulting in more than one sample per location. The following criteria were used to reduce multiple sample results from one location to a single result.

- If two or more detections exist, the maximum concentration will be used.
- If one detection and one nondetection exist, the detected concentration will be used.
- If two or more nondetections exist, the lowest detection limit will be used.

Laboratory and Data Validation Flags. After receiving analytical data with data qualification flags from the laboratory, validation qualifiers are assigned during the data validation process. The following rules are applied to determine how the sample results can be used for selecting COPCs.

- All sample results flagged with a "U" qualifier or combination of qualifiers that include a "U," such as a "UJ," are considered a nondetected concentration.
- All sample results without a "U" qualifier are considered detected concentrations, including results without a qualifier or with a "J" qualifier.
- No sample data rejected and flagged with an "R" are used for selecting COPCs.

Analytes Reported by Numerous Analytical Methods. An analyte can often be reported by more than one analytical method resulting in multiple results for the same analyte from the same location. When analytes are reported by more than one analytical method, results will be processed to select the method that provides the most reliable results.

D1.2.2 Identify Action Levels

Action levels are derived from readily available sources of chemical-specific ARARs or risk-based PRGs developed using EPA health criteria and default exposure assumptions. Table D1-1 identifies all sources of chemical-specific ARARs and PRGs for each of the 226 analytes reported. The action level represents the lowest of the available values for each analyte evaluated. A description of the sources of available chemical-specific ARARs and PRGs follows. A description of how the action levels are used in the COPC selection process is provided in Section D1.5.

D1.2.2.1 Applicable or Relevant and Appropriate Requirement-Based Remediation Goals

Potential chemical-specific ARARs include concentration limits set by federal environmental regulations such as MCLs, secondary MCLs, and non-zero maximum contaminant level goals established under the *Safe Drinking Water Act of 1974 (*42 USC 300j-9(i); ambient water quality criteria established under the *Clean Water Act of 1977* (33 USC 1251 et seq.); and Washington State regulations (WAC 173-340-720, "Ground Water Cleanup Standards;" WAC 173-340-730 "Surface Water Cleanup Standards;" and WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington").

Uranium isotopes are not identified as COPCs because the MCL for uranium (metal) is considered protective of kidney toxicity and carcinogenicity. The following excerpt is taken from the National Primary Drinking Water Regulations to describe the basis for the uranium MCL:

> "*Exposure to uranium in drinking water may cause toxic effects to the kidney. In 1991, EPA proposed an MCL of 20 μg/L, which was determined to be as close as feasible to the maximum contaminant level goal (MCLG). Based on human kidney toxicity data collected since that time*

and on its estimate of the cost and benefits of regulating uranium in drinking water, EPA determined that the benefits of a uranium MCL of 20 μg/L did not justify the costs. Instead, EPA determined that 30 μg/L is the appropriate MCL, because it maximizes the net benefits (benefits minus costs) while being protective of kidney toxicity and carcinogenicity with an adequate margin of safety."

D1.2.2.2 Risk-Based Preliminary Remediation Goals

The risk-based concentration table for residential tap waters is used as the source of PRGs. These values are obtained from the "Regional Screening Levels for Chemicals Contaminants at Superfund Sites" website (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). The PRGs for chemicals with carcinogenic effects correspond to a 10^{-6} incremental risk of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen from all significant exposure pathways for a given medium. The PRGs for chemicals with noncancerous effects corresponds to a hazard index of one, which is the level of exposure to a chemical from all significant exposure pathways in a given medium below which it is unlikely for even sensitive populations to experience adverse health effects. The direct contact exposure pathway for groundwater considers exposure from ingestion, inhalation of vapors, and dermal contact. The residential tap waters value is used only when a chemical-specific ARAR is not available.

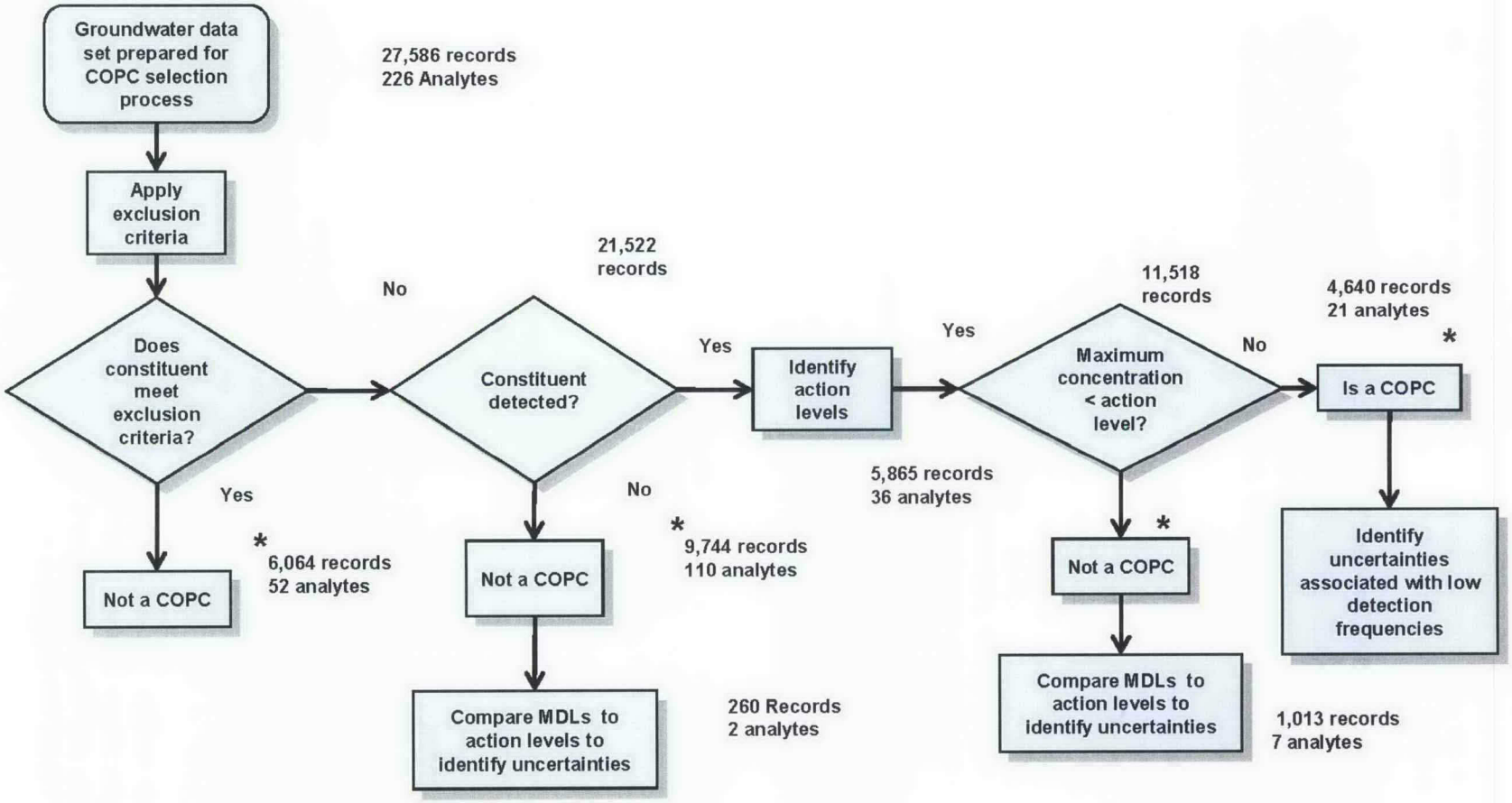
D1.2.3 Identify Groundwater COPCs

The following process is used to select COPCs for 100-BC. This process is used to identify COPCs in support of developing the 100-BC RI/FS Work Plan documents. The steps used in the COPC selection process are as described below. A flowchart presenting the COPC selection process and the number of records associated with each of the COPC selection process steps is shown in Figure D1-2.

D1.2.3.1 Apply Exclusion Criteria

Analytes that meet exclusion criteria are eliminated as COPCs. Analytes that do not meet the exclusion criteria are carried forward into the next step of the process.

- Naturally-occurring radionuclides associated with background radiation
- Radionuclides with half-lives of less than 3 years and do not have "significant daughter product"
- Essential nutrients (minerals)
- Common laboratory contaminants
- Water quality parameters
- Analytes without no known toxicity information



*Review vadose zone soil target analytes to determine if groundwater COPCs should be added.

*Review vadose zone soil target analytes to determine if groundwater COPCs should be added.

Figure D1-2. COPC Selection – A Multi-Step Process

D1.2.3.2 Identify Nondetected Analytes

Analytes that have been collected from appropriate locations, that have adequate detection limits, and that have not been detected in any of the groundwater samples for an operable unit are eliminated as COPCs. All analytes detected at least once are carried forward to the next step of the process.

D1.2.3.3 Analytes with Maximum Detected Concentrations Less than Action Levels

Maximum concentrations of analytes detected in groundwater are compared to action levels to identify analytes that are not likely to contribute significantly to overall risk. If the maximum detected concentration of an analyte is less than its action level, the analyte is eliminated as a COPC unless the uncertainty analysis indicates otherwise.

Uncertainty Analysis. An additional evaluation was performed on those analytes that were detected at concentrations slightly less than their respective action level (i.e., the maximum detected concentration is at least one-tenth the action level or within one order of magnitude). The purpose of this evaluation is to determine if there is the potential for underestimating cumulative effects when concentrations of analytes are near but do not exceed the action level. Additionally, minimum and maximum method detection limits (MDLs) associated with these analytes are evaluated to determine adequacy for confirming presence at their respective action levels. If the MDLs are greater than the action level and the analyte is identified as a soil target analyte, then it will be identified as a COPC.

D1.2.3.4 Identify Analytes with Maximum Detected Concentrations Greater than Action Levels

Maximum concentrations of analytes detected in groundwater are compared to action levels to identify analytes that are likely to contribute to overall risk. If the maximum detected concentration of an analyte is greater than its action level, the analyte is identified as a COPC unless the uncertainty analysis indicates otherwise.

Uncertainty Analysis. An additional evaluation was performed to distinguish those analytes that were detected infrequently and are not reproducible from those analytes that could be associated with a potential hot spot or localized area of contamination near a monitoring well.

D1.2.3.5 Final Evaluation of Groundwater COPCs

The final step is used to confirm the list of groundwater COPCs is consistent with what is known about Hanford Site operations and is compared to the vadose zone soil target analyte list and DOE/RL-2007-21.

D1.3 Assumptions and Inputs

D1.3.1 Groundwater Set Used for COPC Selection

The analytical data set used in this evaluation was extracted from the HEIS database. Groundwater data for this analysis were obtained from monitoring wells and compliance wells. Although groundwater data collected from injection wells, extraction wells, and aquifer tubes can be used with monitoring and compliance data for purposes such as remedy selection and design, these other data are not used for risk assessment.

The U.S. Department of Energy monitors groundwater at the Hanford Site to fulfill a variety of state and federal regulations, including the *Atomic Energy Act of 1954* (AEA), the *Resource Conservation and Recovery Act of 1976*, the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, and WAC 173-340, "Model Toxics Control Act -- Cleanup." Data collected to fulfill monitoring

requirements provide a comprehensive data set for identifying contaminants of potential concern (COPCs) in groundwater.

Although it can be used for risk assessment, monitoring data do have associated uncertainties. The uncertainties associated with the groundwater data set are described in DOE/RL-2007-21, *Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment*, Volume 2. Specifically, the analytes, sampling frequencies, and method detection limits (or reporting limits) are used to meet different regulatory program requirements. Additionally, quality assurance and quality control requirements can vary between programs. As a result, data may be flagged for suitability during validation and these flags may limit the use of the data. Because of these differences, a consistent chemical "snapshot" of current groundwater conditions is needed.

The groundwater data set used for COPC selection consists of sampling and analysis data collected from 32 monitoring wells from the 100-BC-5 Groundwater OU. Table D1-2 provides a list of the monitoring wells used in this evaluation. The sampling and analysis data were collected between January 22, 1992 and December 8, 2008. This groundwater data set includes groundwater samples collected since 1992 and reported in the limited field investigation for the 100-BC-5 Groundwater OU (DOE/RL-93-37, *Limited Field Investigation Report for the 100-BC-5 Operable Unit*). These data also were used for the ecological component of the qualitative risk assessment (WHC-SD-EN-RA-006, 1994, *Qualitative Risk Assessment for the 100-BC-5 Groundwater Operable Unit*). As stated previously, the data collected to fulfill monitoring requirements provide a comprehensive data set for identifying COPCs in groundwater. A total of 41,234 records were obtained from the HEIS database, and 226 analytes are represented in this data set.

Table D1-2. Summary of Groundwater Monitoring Wells in the 100-BC-5 Groundwater Operable Unit

Well Name	
199-B2-12	199-B8-1
199-B2-13	199-B8-6
199-B3-1	199-B8-7
199-B3-46	199-B8-8
199-B3-47	199-B9-1
199-B4-1	199-B9-2
199-B4-2	199-B9-3
199-B4-3	699-63-90
199-B4-4	699-65-72
199-B4-5	699-65-83
199-B4-6	699-66-103
199-B4-7	699-67-86
199-B4-8	699-68-105
199-B4-9	699-71-77
199-B5-1	699-72-73
199-B5-2	699-72-92

D1.4 Software Applications

Software used for this analysis included the HEIS database, Microsoft Access[1] database software, and Microsoft Excel[2]. The HEIS database is a central repository for storing and maintaining access to environmental data collected and analyzed for the Hanford Site. Microsoft Access was used to query and sort the data downloaded from the HEIS database. Microsoft Excel was used to present the groundwater data and information in spreadsheets. No statistical calculations were performed.

D1.5 Calculation

This section summarizes the outcome of the methodology described for identification of groundwater COPCs for 100-BC groundwater. Tables referenced in this section are located at the back of the document.

D1.5.1 Apply Exclusion Criteria

Identified Excluded Contaminants

Table D1-3 lists the 52 of the 226 analytes that meet the exclusion criteria. Sampling dates, minimum and maximum detected concentrations, minimum and maximum MDLs, and the basis for their exclusion are also provided in Table D1-3. The following define the exclusion criteria that are applied:

- **Background Radiation.** Naturally-occurring radionuclides associated with background radiation (potassium-40, radium-226, thorium-228, and thorium-232) were measured in groundwater from 100-BC and are eliminated as COPCs.
- **Radionuclides with a Half-Life of Less than Three Years and Do Not Have Significant Daughter Products.** Radioisotopes with half-lives less than or equal to three years are eliminated from further consideration because only a small fraction of activity remains after 30 years of decay. The 16 radioisotopes that met this exclusion criterion are eliminated from further consideration as COPCs. Only antimony-125 and ruthenium-106 were reported with measureable concentrations in groundwater. Neither of these radioisotopes is a significant daughter product of decay chain; thus, neither is identified as a groundwater COPC.
- **Essential Nutrients.** Essential nutrients are those constituents considered essential for human nutrition. Essential nutrients (calcium, magnesium, potassium, and sodium) were measured in groundwater and are excluded from further consideration as COPCs.
- **Water Quality Parameters.** Water quality parameters that represent physical and biological characteristics, such as temperature, pH, or turbidity, are eliminated as COPCs. In all cases, water quality parameters do not have available toxicological information and cannot be evaluated for exposure purposes. Eleven water quality parameters were measured in groundwater from 100-BC and are eliminated from further consideration as COPCs.
- **Common Laboratory Contaminants.** Methylene chloride, acetone, and bis(2-ethylhexyl) phthalate are considered by EPA to be common laboratory contaminants. Common laboratory contaminants are introduced as a result of laboratory analysis procedures after the sample collection and are not related to the Hanford Site. Methylene chloride, acetone, and bis(2-ethylhexyl) phthalate were detected in

[1] Access is a trademark of Microsoft Corporation, Redmond, Washington.

[2] Excel is a trademark of Microsoft Corporation, Redmond, Washington.

groundwater at concentrations that would indicate they are common laboratory contaminants, therefore they are eliminated from further consideration as COPCs.

Analytes without Action Levels. Analytes without an action level are eliminated as COPCs because a promulgated chemical-specific ARAR is not published from the list of sources. Seventeen analytes are eliminated because an action level is not available. The analytes that do not have action levels represent some analytes that have been detected in groundwater and other that have not been detected. Eight analytes without an action level have not been detected (two pesticides, three semi-volatile organic compounds [SVOCs], and three volatile organic compounds [VOCs]). The remaining eight analytes (four radioisotopes and four wet chemistry parameters) were detected at least once.

With the exception of the uranium isotopes, gross beta, and two pesticides (endrin ketone and delta-benzenehexachloride [delta-BHC]), the analytes eliminated as COPCs are water quality parameters.

The uranium isotopes were detected at concentrations ranging from 0.038 to 1.6 picocuries per liter (pCi/L). Uranium isotopes are not identified as COPCs because the MCL for uranium (metal) is considered protective of kidney toxicity and carcinogenicity.

All uranium isotope concentrations are below the proposed MCL value of 20 pCi/L. However, total uranium (metal) has been identified as a COPC for 100-BC because of a lack of available data to confidently determine if it is present in groundwater at concentrations above the MCL.

Endrin ketone and delta-BHC have not been detected and do not have an action levels. Endrin and endrin aldehyde are structurally similar to endrin ketone and have action levels. Endrin and endrin aldehyde have not been detected in groundwater and their minimum MDLs were either less than their action level or slightly above. Gamma-BHC is structurally similar to delta-BHC and has an action level. Gamma-BHC has not been detected in groundwater and the minimum MDL was slightly greater than the action level. Based on these comparisons, endrin ketone and delta-BHC are not present in groundwater at levels at or near a similar action level and are not identified as COPCs.

D1.5.2 Identify Nondetected Analytes

Of the 226 analytes, 112 analytes have not been detected in 100-BC and are listed in Table D1-4. Table D1-4 also provides sampling dates, minimum and maximum MDLs, the action level, basis of the action level, and the level of exceedance. The minimum MDL is divided by the action level to determine the level of exceedance. The purpose of determining the minimum level of exceedance is to identify those analytes with MDLs that have not met the action level to date versus those analytes with MDLs that have met the action level at least some of the time.

One metal, seven polychlorinated biphenyls (PCBs), 19 pesticides, six radioisotopes (europium-152, europium-154, europium -155, nickel-63, plutonium-239, and radium-228), 54 SVOCs, total petroleum hydrocarbon-diesel range, 23 VOCs, and one wet chemistry parameter were analyzed, but were not detected and are not considered COPCs.

Uncertainty Analysis. Fifty-seven analytes were reported with minimum MDLs greater than their respective action levels. The analytical method selected is unable to detect the analyte at or below the action level.

Europium-152, europium-154, europium-155, nickel-63, plutonium-239, and radium-228 were not detected in any groundwater sample. Europium-152 and europium-154 were analyzed in greater than 90 samples suggesting the absence of these radioisotopes. Plutonium-239 was analyzed in two samples and reported in combination with plutonium-239/240 (see Table D1-5). Plutonium-239/240 was analyzed

in 87 groundwater samples with one detection; these results suggest the absence of this isotope in groundwater. Europium-155 was analyzed in six samples, nickel 63 was analyzed in two samples, and radium-228 was analyzed in one sample. Europium-155, nickel-63, and radium-228 are identified as groundwater COPCs due to the lack of available data to determine the presence or absence of these isotopes in groundwater.

Twenty-four SVOCs were reported with MDLs greater than their action levels. With the exception of polynuclear aromatic hydrocarbons (PAHs), the remainder of the SVOCs are not known or suspected to be associated with Hanford Site operations. Seven of the 13 PAHs reported have not been detected in groundwater, but their minimum MDLs are 2,600 times greater than their respective action levels. EPA Method 8270 (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*) currently is used to analyze for PAHs in groundwater. A comparison of MDLs between the historic and current analytical methods shows no difference in MDLs. This indicates that the current analytical method cannot attain MDLs at the action level and would not reduce the uncertainties associated with the ability to confirm the analytes' absence or presence at or below action levels. Generally, PAHs are immobile in soil and are not expected to migrate from vadose zone into groundwater. However, lower molecular weight PAHs such as acenaphthene, anthracene, fluorine, and naphthalene have the potential to be more mobile than higher molecular weight PAHs. Additionally, PAHs can form hydrophobic bonds to collocated organic, which also creates the potential to mobilize PAHs. The fact that 7 of the 13 PAHs reported achieved MDLs less than their respective action level suggests the overall absence of PAHs in groundwater; therefore, PAHs are not expected to be present in groundwater and are not identified as COPCs.

Eight VOCs were reported with MDLs greater than their respective action level. With the exception of 1,1-dichloroethene and vinyl chloride, the analytes reported are not known or suspected to be associated with Hanford Site operations. 1,1-Dichloroethene and vinyl chloride are potential breakdown products of trichloroethylene and could be present in groundwater. All MDLs associated with 1,1-dichloroethene and vinyl chloride are greater than the action levels of 0.0729 μg/L and 0.025 μg/L, respectively. 1,1-Dichloroethene and vinyl chloride are identified as groundwater COPCs to determine if nondetected concentrations are less than action levels.

Seven PCBs were reported with MDLs greater than their respective action levels. PCBs have been associated with some Hanford Site operations. PCB MDLs ranged from approximately 15,600 to 31,250 times greater than their respective action levels. EPA Method 8082 currently is used to analyze for PCBs in groundwater. A comparison of MDLs between historic and current analytical methods shows little to no difference in MDLs. This indicates that current analytical method cannot attain MDLs at the action level and would not reduce the uncertainties associated with the ability to confirm the analytes' presence at or below action levels. Generally, PCBs are immobile in soil and are not expected to migrate from soil into groundwater; therefore, PCBs are not expected to be present in groundwater and are not identified as COPCs.

Sixteen pesticides were reported with MDLs greater than their respective action levels. Pesticides have been applied to areas within the 100 Area. Pesticide MDLs ranged from slightly greater than 1 to approximately 25,000 times greater than their respective action levels. EPA Method 8081 currently is used to analyze for pesticides in groundwater. A comparison of MDLs between historic and current analytical methods shows little to no difference. This indicates that current analytical methods cannot attain MDLs at the action level and would not reduce the uncertainties associated with the ability to confirm the analytes' presence at or below action levels; therefore, pesticides are not identified as COPCs.

Sulfide was reported with an MDL greater than its action level. This analyte is not known to be persistent in the environment. Sulfide's MDLs range from 50 to 500 times greater than its action level. EPA Method 9030 is currently used to analyze sulfides in groundwater. A comparison of the MDL between the historical and current analytical methods shows no difference. Because this analyte is not known to be persistent in the environment and is not suspected to be present in groundwater, sulfide is not identified as a COPC.

Total petroleum hydrocarbon (TPH) –diesel range was reported with an MDL greater than its action level. A comparison of the MDL between historical and current analytical methods indicates that a lower MDL can be attained. However, because TPH–diesel range was only analyzed three times and is identified as a vadose zone soil target analyte, TPH–diesel range is identified as a COPC.

D1.5.3 Analytes with Maximum Detected Concentrations Less than Action Levels

Table D1-5 presents a summary of the analytes with maximum detected concentrations less than their respective action level. Thirty-four analytes were detected at least once, but their maximum detected concentrations are less than their respective action levels. The level the maximum detected concentration did not exceed the action level associated with this group of analytes ranged from 0.94 to 5.47E-05. The maximum detected concentration is divided by the action level to determine the level of amount the action level was not exceeded. An additional consideration for inclusion as a COPC is the abundance of analytical results to determine the presence of an analyte or radioisotope.

D1.5.3.1 Uncertainty Analysis

The analytes with maximum detected concentrations greater than one-tenth of their respective action level are barium, carbon-14, chloride, chloroform, fluoride, gross alpha, nitrite, silver, sulfate, technetium-99, and vanadium. Chloroform is reported with maximum MDLs greater than their respective action levels.

Barium. Barium was detected in 272 of 278 samples (98 percent frequency) collected between 1992 and 2008. Although barium is identified as a vadose zone target analyte, all detected concentrations and MDLs are consistently below the action level. Based on the results of this evaluation, barium is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Carbon-14. Carbon-14 was detected in 20 of 204 samples (10 percent frequency) collected between 1992 and 1995. All detected concentrations and MDLs are consistently below the action level. Carbon-14 is identified as a vadose zone soil target analyte, but is not expected to be present in soil or groundwater.

Chloride. Chloride was detected in all water samples collected between 1992 and 2008. All detected concentrations are consistently below the action level. Based on the results of this evaluation, chloride is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Chloroform. Chloroform was detected in 23 of 157 samples (15 percent frequency) collected between 1992 and 2001. One hundred five MDLs are greater than the 5.7 μg/L action level, the remaining 29 MDLs are less than the action level. Although chloroform is not identified as a vadose zone target analyte, many of the MDLs are greater than the action level and are not adequate for confirming the absence of this analyte in groundwater; therefore, chloroform is identified as a groundwater COPC.

Fluoride. Fluoride was detected in 402 of 427 samples (94 percent frequency) collected between 1992 and 2008. All detected concentrations and MDLs are consistently below the action level. Based on the

results of this evaluation, fluoride is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Gross Alpha. Gross alpha was detected in 96 of 288 samples (33 percent frequency) collected between 1992 and 2008. Gross alpha is frequently analyzed in groundwater samples as an indicator parameter to confirm that individual alpha emitting isotopes do not exceed the overall standard. All gross alpha concentrations and MDLs are less than the action level of 15 pCi/L. However, several alpha emitting isotopes (Am-241, Pu-238, and Pu-239/240) were detected in the past on an infrequent basis and at concentrations less than their respective MCL. To confirm that the gross alpha MCL is not exceeded it will be analyzed to confirm that individual alpha emitters do not exceed the overall standard.

Nitrite. Nitrite was detected in four of 215 samples (2 percent frequency) collected between 1992 and 2008. All concentrations and MDLs are consistently below the action level. Based on the results of this evaluation, nitrite is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Silver. Silver was detected in 14 of 278 samples (5 percent frequency) collected between 1992 and 2008. All detected concentrations and MDLs are consistently below the action level. Based on the results of this evaluation, silver is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Sulfate. Sulfate was detected in all water samples collected between 1992 and 2008. All detected concentrations are consistently below the action level. Based on the results of this evaluation, sulfate is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Vanadium. Vanadium was detected in 210 of 278 samples (76 percent frequency) collected between 1992 and 2008. Although vanadium is identified as vadose zone soil target analyte, all detected concentrations and MDLs are consistently below the action level. Based on the results of this evaluation, vanadium is eliminated from consideration as a COPC and its exclusion would not likely underestimate overall cumulative effects.

Total uranium and beta-emitting isotopes have been detected in the past, but do not have adequate spatial coverage within the operable unit and do not have enough recent analytical data to determine their concentrations. Total uranium (metal) was only analyzed in 11 groundwater samples between 1993 and 1994. Total uranium (metal) is identified as a groundwater COPC because additional data are needed to determine its concentration in groundwater.

Carbon-14, cesium-137, cobalt-60, iodine-129, and technetium-99 are beta emitting isotopes that have been detected in groundwater. Most of the isotopes do not have current analytical results for this OU; therefore, these radioisotopes are identified as groundwater COPCs to determine their contribution to the 4mem/yr standard for beta emitters.

D1.5.4 Identify Analytes with Maximum Detected Concentrations Greater than Action Levels

Twenty-eight of the 226 analytes were detected at least once and their maximum detected concentrations are greater than their respective action levels. Table D1-6 provides a summary of the analytes with maximum detected concentrations greater than their respective action level. An uncertainty analysis was performed to distinguish analytes that are infrequently detected and are not reproducible from those that could be associated with a potential hot spot or localized area of contamination near a monitoring well.

D1.5.4.1 Uncertainty Analysis

Eight analytes (1,1,2,2-tetrachloroethane, antimony, benzene, cadmium, carbon tetrachloride, cyanide, hydrazine, and tetrachloroethene) are detected at low frequencies (i.e., less than five percent).

1,1,2,2-Tetrachloroethane. 1,1,2,2-Tetrachloroethane was detected in two of 93 samples (2.2 percent frequency) collected between 1992 and 1993. 1,1,2,2-Tetrachloroethane was detected in Well 199-B3-46 (B070J7) in July 1992 at a concentration greater than its action level. The analyte was analyzed four times between 1992 and 1993 at Well 199-B3-46 (B070J7) with only one detection. Similarly, 1,1,2,2-tetrachloroethane was analyzed four times at Well 199-B4-8 (B07ZL7) with only one detection between 1992 and 1993. All MDLs are greater than the action level. Although 1,1,2,2-tetrachloroethane is not identified as a vadose zone target analyte, all of the MDLs are greater than the action level and are not adequate for confirming the absence of this analyte in groundwater; therefore, 1,1,2,2-tetrachloroethane is identified as a groundwater COPC.

Antimony. Antimony was detected in seven of 278 samples (2.5 percent frequency) collected between 1992 and 2008. All detected concentrations are greater than the action level. A total of 258 MDLs are greater than the action level of 5.6 μg/L, while the remaining 13 MDLs are less than the action level. Antimony is identified as a vadose zone soil target analyte. Based on the results of this evaluation, antimony is identified as a groundwater COPC.

Benzene. Benzene was detected in eight of 160 samples (5.0 percent frequency) collected between 1992 and 2001. Benzene was detected in six different monitoring wells at concentration greater than the action level 0.795 μg/L Benzene was detected in wells 199-B4-1 (B01MJ5), 199-B4-4 (B01MJ7), 199-B4-5 (B07ZK7), 199-B4-7 (B07ZL2), 199-B9-1 (B01MJ9), and 699-65-72 (B07QZ9) at concentrations ranging between 1 and 5 μg/L.

Ninety MDLs are greater than the action level, the remaining 62 MDLs are less than the action level. Benzene is identified as a vadose zone target analyte. Based on the results of this evaluation, benzene is identified as a COPC.

Cadmium. Cadmium was detected in 13 of 278 samples (4.7 percent frequency) collected between 1992 and 2008. All detected concentrations are greater than the 0.25 μg/L action level. A total of 262 MDLs are greater than the action level, the remaining three MDLs are less than the action level. Cadmium is identified as a vadose zone target analyte. Based on the results of this evaluation, cadmium is identified as a COPC.

Carbon Tetrachloride. Carbon tetrachloride was detected in three of 157 samples (1.9 percent frequency) collected between 1992 and 2001. One hundred thirty-eight MDLs are greater than the 0.23 μg/L action level, the remaining 16 MDLs are less than the action level. Carbon tetrachloride is identified as a vadose zone target analyte. Based on the results of this evaluation, carbon tetrachloride is identified as a COPC.

Cyanide. Cyanide was detected in four of 101 samples (4.0 percent frequency) collected between 1992 and 1995. Cyanide was detected once in Monitoring Wells 199-B4-4, 199-B4-5, 199-B4-7, and 199-B5-2. Cyanide was analyzed four times between 1992 and 1993 at Well 199-B4-4 with only one detection. Similarly, cyanide was analyzed five times at Well 199-B4-5, five times at Well 199-B4-7, and five times at Well 199-B5-2 between 1992 and 1995. Although all MDLs are greater than the 5.2 μg/L action level cyanide is not identified as a vadose zone soil target analyte and is not expected to be present in soil or groundwater. The results of this evaluation suggest that the presence of cyanide in these four wells is anomalous and it is not identified as a COPC.

Hydrazine. Hydrazine was detected in one of 34 samples (2.9 percent frequency) collected between 1992 and 1993. Hydrazine was detected at Well 199-B4-9 (B05XZ8) and was not detected in the subsequent round in 1993. Although all MDLs are greater than the 0.0146 µg/L action level, hydrazine is not identified as a vadose zone soil target analyte and is not expected to be present in soil or groundwater. Based on the results of this evaluation, hydrazine is not identified as a COPC.

Tetrachloroethene. Tetrachloroethene was detected in one of 159 samples (0.63 percent frequency) collected between 1992 and 2001. Tetrachloroethene was detected once in Well 199-B3-46 (B0HTL6) in 1996; however, it was not detected in the six previous or two subsequent sampling rounds. One hundred fifty-four MDLs are greater than the 0.081 µg/L action level, the remaining four MDLs are less than the action level. Although tetrachloroethene is not identified as a vadose zone soil target analyte, many of the MDLs are greater than the action level and are not adequate for confirming the absence of this analyte in groundwater, therefore tetrachloroethene is identified as a groundwater COPC.

D1.5.5 Final Evaluation of Groundwater COPCs

Twenty-eight analytes are reported with maximum detected concentrations greater than their respective action levels. The final step is used to confirm the list of groundwater COPCs is consistent with what is known about Hanford Site operations and is compared to the vadose zone soil target analyte list and DOE/RL-2007-21.

Aluminum and Iron. Aluminum and iron were analyzed for and detected in groundwater samples collected from 1992 through 2008. Although maximum detected concentrations of aluminum and iron are greater than their action levels, which are secondary MCLs, the presence of these metals likely are naturally occurring.

Iodine-129. Iodine-129 was not identified as a groundwater COPC because it was not detected in groundwater concentration above the action level of 1 pCi/L. However, iodine-129 is identified as a soil target analyte and only seven samples were analyzed for this analyte. Therefore, iodine-129 was added as a groundwater COPC.

D1.6 Results

D1.6.1 Summary of Final COPCs

Table D1-7 identifies the COPCs for 100-BC groundwater, proposed analytical methods, their contract required detection limits, action levels, and action level basis.

Thirty-six analytes have been identified as COPCs for groundwater at 100-BC. This list reflects the analytes most likely to contribute to overall risk within 100-BC. The groundwater data set represents a comprehensive data set for defining the COPCs, as it includes groundwater data collected between 1992 and 2008. The groundwater COPCs have been compared to the target analytes identified for vadose zone soil in 100-BC and to the groundwater contaminants of concern identified in DOE/RL-2007-21.

A selection process for target analytes in vadose zone soil has been conducted in coordination with this process for selecting COPCs in groundwater. The target analytes identified for vadose zone soil is based on an approach that was developed during 100-D/H systematic planning effort by Uncertainty Team No. 1 with participation from the Washington Department of Ecology, Fluor Hanford, and Washington Closure Hanford. The target analytes selection process relies on the review of remediation and characterization information (historic and current) and the identification of appropriate information

sources, such as limited field investigation reports, interim action records of decision, and cleanup verification documents (Cleanup Verification Packages and Remaining Sites Verification Packages).

DOE/RL-2007-21,Volume 2 includes a baseline risk assessment for each of the groundwater operable units in the 100 and 300 Areas. The results of this risk assessment identified several uncertainties associated with the groundwater data set. DOE/RL-2007-21, Volume 2 is currently a draft document. Hexavalent chromium, nitrate, strontium-90, tritium, and zinc are identified as COPCs for the 100-BC-5 Groundwater OU. The results of this COPC selection process also identify these analytes as COPCs. This draft report includes chloroform as an uncertainty because a conclusion about COPC status was considered unsupportable and the data were suspect and inadequate to support risk assessment calculations.

D1.7 References

Atomic Energy Act of 1954, 42 USC 2011, et seq.

Clean Water Act of 1977, 33 USC 1251, et seq. (NOTE: see *Federal Water Pollution Control Act of 1972*.)

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

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WAC 173-340-730, "Surface Water Cleanup Standards," *Washington Administrative Code,* Olympia, Washington.

WAC 173-340-720, "Ground Water Cleanup Standards," *Washington Administrative Code*, Olympia, Washington.

WAC 173-340-720(3), "Method A Cleanup Levels for Potable Ground Water," *Washington Administrative Code*, Olympia, Washington.

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WHC-SD-EN-RA-010, Rev. 0, 1994, *Qualitative Risk Assessment for the 100-KR-4 Groundwater Operable Unit*, Westinghouse Hanford Company, Richland, Washington.

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
7429-90-5	Aluminum	Metal	µg/L	3.70E+04	5.00E+01	--	8.70E+01	--	1.60E+04	--	5.00E+01	Federal MCL
7440-36-0	Antimony	Metal	µg/L	1.50E+01	6.00E+00	--	--	5.60E+00	6.40E+00	1.04E+03	5.60E+00	Human Health Water + Organism
7440-38-2	Arsenic	Metal	µg/L	4.50E-02	1.00E+01	1.90E+02	1.50E+02	1.80E-02	5.83E-02	9.82E-02	1.80E-02	Human Health Water + Organism
7440-39-3	Barium	Metal	µg/L	7.30E+03	2.00E+03	--	--	1.00E+03	3.20E+03	--	1.00E+03	Human Health Water + Organism
7440-41-7	Beryllium	Metal	µg/L	7.30E+01	4.00E+00	--	--	--	3.20E+01	2.73E+02	4.00E+00	Federal MCL
7440-43-9	Cadmium	Metal	µg/L	1.80E+01	5.00E+00	--	2.50E-01	--	8.00E+00	2.03E+01	2.50E-01	Freshwater CCC
7440-70-2	Calcium	Metal	--	--	--	--	--	--	--	--	--	--
7440-47-3	Chromium	Metal	µg/L	5.50E+04	1.00E+02	--	7.40E+01	--	2.40E+04	2.43E+05	7.40E+01	Freshwater CCC
7440-48-4	Cobalt	Metal	µg/L	1.10E+01	--	--	--	--	4.80E+00	--	4.80E+00	WAC 173-340-720(4)
7440-50-8	Copper	Metal	µg/L	1.50E+03	1.30E+03	--	9.00E+00	1.30E+03	6.40E+02	2.88E+03	9.00E+00	Freshwater CCC
18540-29-9	Hexavalent Chromium	Metal	µg/L	1.10E+02	--	1.00E+01	1.10E+01	--	4.80E+01	4.86E+02	1.00E+01	WAC 173-201A
7439-89-6	Iron	Metal	µg/L	2.60E+04	3.00E+02	--	1.00E+03	3.00E+02	1.12E+04	--	3.00E+02	Federal MCL
7439-92-1	Lead	Metal	µg/L	--	1.50E+01	--	2.50E+00	--	--	--	2.50E+00	Freshwater CCC
7439-95-4	Magnesium	Metal	--	--	--	--	--	--	--	--	--	--
7439-96-5	Manganese	Metal	µg/L	8.80E+02	5.00E+01	--	--	5.00E+01	7.52E+02	--	5.00E+01	Federal MCL
7439-97-6	Mercury	Metal	µg/L	6.30E-01	2.00E+00	1.20E-02	--	--	4.80E+00	--	1.20E-02	WAC 173-201A
7440-02-0	Nickel	Metal	µg/L	7.30E+02	--	--	5.20E+01	6.10E+02	3.20E+02	1.10E+03	5.20E+01	Freshwater CCC
7440-09-7	Potassium	Metal	--	--	--	--	--	--	--	--	--	--
7782-49-2	Selenium	Metal	µg/L	1.80E+02	5.00E+01	5.00E+00	5.00E+00	1.70E+02	8.00E+01	2.70E+03	5.00E+00	Freshwater CCC
7440-22-4	Silver	Metal	µg/L	1.80E+02	1.00E+02	--	--	--	8.00E+01	2.59E+04	8.00E+01	WAC 173-340-720(4)
7440-23-5	Sodium	Metal	--	--	--	--	--	--	--	--	--	--
7440-24-6	Strontium	Metal	µg/L	2.20E+04	--	--	--	--	9.60E+03	--	9.60E+03	WAC 173-340-720(4)
7440-28-0	Thallium	Metal	µg/L	2.40E+00	2.00E+00	--	--	2.40E-01	1.12E+00	1.56E+00	2.40E-01	Human Health Water + Organism
7440-31-5	Tin	Metal	µg/L	2.20E+04	--	--	--	--	9.60E+03	--	9.60E+03	WAC 173-340-720(4)
7440-61-1	Uranium	Metal	µg/L	1.10E+02	3.00E+01	--	--	--	4.80E+01	--	3.00E+01	Federal MCL
7440-62-2	Vanadium	Metal	µg/L	2.60E+02	--	--	--	--	1.12E+02	--	1.12E+02	WAC 173-340-720(4)
7440-66-6	Zinc	Metal	µg/L	1.10E+04	5.00E+03	--	1.20E+02	7.40E+03	4.80E+03	1.65E+04	1.20E+02	Freshwater CCC

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CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
12674-11-2	Aroclor-1016	PCB	µg/L	9.60E-01	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
11104-28-2	Aroclor-1221	PCB	µg/L	6.80E-03	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
11141-16-5	Aroclor-1232	PCB	µg/L	6.80E-03	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
53469-21-9	Aroclor-1242	PCB	µg/L	3.40E-02	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
12672-29-6	Aroclor-1248	PCB	µg/L	3.40E-02	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
11097-69-1	Aroclor-1254	PCB	µg/L	3.40E-02	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
11096-82-5	Aroclor-1260	PCB	µg/L	3.40E-02	--	1.40E-02	1.40E-02	6.40E-05	4.38E-02	1.04E-04	6.40E-05	Human Health Water + Organism
72-54-8	4,4'-Dichlorodiphenyldichloroethane	PEST	µg/L	2.80E-01	--	--	--	3.10E-04	3.65E-01	5.04E-04	3.10E-04	Human Health Water + Organism
72-55-9	4,4-Dichlorodiphenyldichloroethylene	PEST	µg/L	2.00E-01	--	--	--	2.20E-04	2.57E-01	3.56E-04	2.20E-04	Human Health Water + Organism
50-29-3	4,4-Dichlorodiphenyltrichloroethane	PEST	µg/L	2.00E-01	--	1.00E-03	1.00E-03	2.20E-04	2.57E-01	3.56E-04	2.20E-04	Human Health Water + Organism
309-00-2	Aldrin	PEST	µg/L	4.00E-03	--	1.90E-03	--	4.90E-05	2.57E-03	8.16E-05	4.90E-05	Human Health Water + Organism
319-84-6	Alpha-BHC	PEST	µg/L	1.10E-02	--	--	--	2.60E-03	1.39E-02	7.91E-03	2.60E-03	Human Health Water + Organism
5103-71-9	Alpha-Chlordane	PEST	µg/L	--	--	--	4.30E-03	8.00E-04	2.50E-01	1.31E-03	8.00E-04	Human Health Water + Organism
319-85-7	beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	PEST	µg/L	3.70E-02	--	--	--	9.10E-03	4.86E-02	2.77E-02	9.10E-03	Human Health Water + Organism
319-86-8	Delta-BHC	PEST	--	--	--	--	--	--	--	--	--	--
60-57-1	Dieldrin	PEST	µg/L	4.20E-03	--	1.90E-03	5.60E-02	5.20E-05	5.47E-03	8.67E-05	5.20E-05	Human Health Water + Organism
959-98-8	Endosulfan I	PEST	µg/L	--	--	--	5.60E-02	6.20E+01	9.60E+01	5.76E+01	5.60E-02	Freshwater CCC
33213-65-9	Endosulfan II	PEST	µg/L	--	--	--	5.60E-02	6.20E+01	9.60E+01	5.76E+01	5.60E-02	Freshwater CCC
1031-07-8	Endosulfan sulfate	PEST	µg/L	--	--	--	--	6.20E+01	--	--	6.20E+01	Human Health Water + Organism
72-20-8	Endrin	PEST	µg/L	1.10E+01	2.00E+00	2.30E-03	3.60E-02	5.90E-02	4.80E+00	1.96E-01	2.30E-03	WAC 173-201A

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
7421-93-4	Endrin aldehyde	PEST	µg/L	--	--	--	--	2.90E-01	--	--	2.90E-01	Human Health Water + Organism
53494-70-5	Endrin ketone	PEST	--	--	--	--	--	--	--	--	--	--
58-89-9	Gamma-BHC (Lindane)	PEST	µg/L	6.10E-02	2.00E-01	8.00E-02	--	9.80E-01	6.73E-02	3.84E-02	3.84E-02	WAC 173-340-730(3)
76-44-8	Heptachlor	PEST	µg/L	1.50E-02	4.00E-01	3.80E-03	3.80E-03	7.90E-05	1.94E-02	1.29E-04	7.90E-05	Human Health Water + Organism
1024-57-3	Heptachlor epoxide	PEST	µg/L	7.40E-03	2.00E-01	--	3.80E-03	3.90E-05	4.81E-03	6.36E-05	3.90E-05	Human Health Water + Organism
72-43-5	Methoxychlor	PEST	µg/L	1.80E+02	4.00E+01	--	3.00E-02	1.00E+02	8.00E+01	8.36E+00	3.00E-02	Freshwater CCC
8001-35-2	Toxaphene	PEST	µg/L	6.10E-02	3.00E+00	2.00E-04	2.00E-04	2.80E-04	7.95E-02	4.50E-04	2.00E-04	Freshwater CCC
5103-74-2	trans-Chlordane	PEST	µg/L	--	--	--	4.30E-03	8.00E-04	2.50E-01	1.31E-03	8.00E-04	Human Health Water + Organism
14596-10-2	Americium-241	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
14234-35-6	Antimony-125	RAD	pCi/L	--	3.00E+02	--	--	--	--	--	3.00E+02	Federal MCL
14798-08-4	Barium-140	RAD	--	--	--	--	--	--	--	--	--	--
13966-02-4	Beryllium-7	RAD	--	--	--	--	--	--	--	--	--	--
14762-75-5	Carbon-14	RAD	pCi/L	--	2.00E+03	--	--	--	--	--	2.00E+03	Federal MCL
13967-74-3	Cerium-141	RAD	--	--	--	--	--	--	--	--	--	--
14762-78-8	Cerium-144	RAD	pCi/L	--	3.00E+01	--	--	--	--	--	3.00E+01	Federal MCL
13967-70-9	Cesium-134	RAD	pCi/L	--	8.00E+01	--	--	--	--	--	8.00E+01	Federal MCL
10045-97-3	Cesium-137	RAD	pCi/L	--	2.00E+02	--	--	--	--	--	2.00E+02	Federal MCL
14392-02-0	Chromium-51	RAD	--	--	--	--	--	--	--	--	--	--
13981-38-9	Cobalt-58	RAD	--	--	--	--	--	--	--	--	--	--
10198-40-0	Cobalt-60	RAD	pCi/L	--	1.00E+02	--	--	--	--	--	1.00E+02	Federal MCL
14683-23-9	Europium-152	RAD	pCi/L	--	2.00E+02	--	--	--	--	--	2.00E+02	Federal MCL
15585-10-1	Europium-154	RAD	pCi/L	--	6.00E+01	--	--	--	--	--	6.00E+01	Federal MCL
14391-16-3	Europium-155	RAD	pCi/L	--	6.00E+02	--	--	--	--	--	6.00E+02	Federal MCL
12587-46-1	Gross alpha	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
12587-47-2	Gross beta	RAD	--	--	--	--	--	--	--	--	--	--
15046-84-1	Iodine-129	RAD	pCi/L	--	1.00E+00	--	--	--	--	--	1.00E+00	Federal MCL
10043-66-0	Iodine-131	RAD	--	--	--	--	--	--	--	--	--	--

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
14596-12-4	Iron-59	RAD	--	--	--	--	--	--	--	--	--	--
13966-31-9	Manganese-54	RAD	pCi/L	--	3.00E+02	--	--	--	--	--	3.00E+02	Federal MCL
13981-37-8	Nickel-63	RAD	pCi/L	--	5.00E+01	--	--	--	--	--	5.00E+01	Federal MCL
13981-16-3	Plutonium-238	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
15117-48-3	Plutonium-239	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
PU-239/240	Plutonium-239/240	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
13966-00-2	Potassium-40	RAD	--	--	--	--	--	--	--	--	--	--
13982-63-3	Radium-226	RAD	pCi/L	--	5.00E+00	--	--	--	--	--	5.00E+00	Federal MCL
15262-20-1	Radium-228	RAD	pCi/L	--	5.00E+00	--	--	--	--	--	5.00E+00	Federal MCL
13968-53-1	Ruthenium-103	RAD	--	--	--	--	--	--	--	--	--	--
13967-48-1	Ruthenium-106	RAD	pCi/L	--	3.00E+01	--	--	--	--	--	3.00E+01	Federal MCL
10098-97-2	Strontium-90	RAD	pCi/L	--	8.00E+00	--	--	--	--	--	8.00E+00	Federal MCL
14133-76-7	Technetium-99	RAD	pCi/L	--	9.00E+02	--	--	--	--	--	9.00E+02	Federal MCL
14274-82-9	Thorium-228	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
TH-232	Thorium-232	RAD	pCi/L	--	1.50E+01	--	--	--	--	--	1.50E+01	Federal MCL
15065-10-8	Thorium-234	RAD	--	--	--	--	--	--	--	--	--	--
13966-06-8	Tin-113	RAD	--	--	--	--	--	--	--	--	--	--
10028-17-8	Tritium	RAD	pCi/L	--	2.00E+04	--	--	--	--	--	2.00E+04	Federal MCL
U-233/234	Uranium-233/234	RAD	--	--	--	--	--	--	--	--	--	--
15117-96-1	Uranium-235	RAD	--	--	--	--	--	--	--	--	--	--
U-238	Uranium-238	RAD	--	--	--	--	--	--	--	--	--	--
13982-39-3	Zinc-65	RAD	pCi/L	--	3.00E+02	--	--	--	--	--	3.00E+02	Federal MCL
13967-71-0	Zirconium-95	RAD	--	--	--	--	--	--	--	--	--	--
120-82-1	1,2,4-Trichlorobenzene	SVOC	µg/L	8.20E+00	7.00E+01	--	--	3.50E+01	8.00E+01	2.27E+02	3.50E+01	Human Health Water + Organism
106-46-7	1,4-Dichlorobenzene	SVOC	µg/L	4.30E-01	7.50E+01	--	--	6.30E+01	1.82E+00	4.86E+00	1.82E+00	WAC 173-340-720(4)
95-95-4	2,4,5-Trichlorophenol	SVOC	µg/L	3.70E+03	--	--	--	1.80E+03	8.00E+02	--	8.00E+02	WAC 173-340-720(4)
88-06-2	2,4,6-Trichlorophenol	SVOC	µg/L	6.10E+00	--	--	--	1.40E+00	3.98E+00	3.93E+00	1.40E+00	Human Health Water + Organism
120-83-2	2,4-Dichlorophenol	SVOC	µg/L	1.10E+02	--	--	--	7.70E+01	4.80E+01	1.91E+02	4.80E+01	WAC 173-340-720(4)

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
105-67-9	2,4-Dimethylphenol	SVOC	µg/L	7.30E+02	--	--	--	3.80E+02	3.20E+02	5.53E+02	3.20E+02	WAC 173-340-720(4)
51-28-5	2,4-Dinitrophenol	SVOC	µg/L	7.30E+01	--	--	--	6.90E+01	3.20E+01	3.46E+03	3.20E+01	WAC 173-340-720(4)
121-14-2	2,4-Dinitrotoluene	SVOC	µg/L	7.30E+01	--	--	--	1.10E-01	3.20E+01	1.36E+03	1.10E-01	Human Health Water + Organism
606-20-2	2,6-Dinitrotoluene	SVOC	µg/L	3.70E+01	--	--	--	--	1.60E+01	--	1.60E+01	WAC 173-340-720(4)
91-58-7	2-Chloronaphthalene	SVOC	µg/L	2.90E+03	--	--	--	1.00E+03	1.28E+03	1.03E+03	1.00E+03	Human Health Water + Organism
95-57-8	2-Chlorophenol	SVOC	µg/L	1.80E+02	--	--	--	8.10E+01	4.00E+01	9.67E+01	4.00E+01	WAC 173-340-720(4)
91-57-6	2-Methylnaphthalene	SVOC	µg/L	1.50E+02	--	--	--	--	3.20E+01	--	3.20E+01	WAC 173-340-720(4)
95-48-7	2-Methylphenol (cresol, o-)	SVOC	µg/L	1.80E+03	--	--	--	--	4.00E+02	--	4.00E+02	WAC 173-340-720(4)
88-74-4	2-Nitroaniline	SVOC	µg/L	--	--	--	--	--	2.40E+01	--	2.40E+01	WAC 173-340-720(4)
88-75-5	2-Nitrophenol	SVOC	--	--	--	--	--	--	--	--	--	--
91-94-1	3,3'-Dichlorobenzidine	SVOC	µg/L	1.50E-01	--	--	--	2.10E-02	1.94E-01	4.62E-02	2.10E-02	Human Health Water + Organism
99-09-2	3-Nitroaniline	SVOC	µg/L	3.20E+00	--	--	--	--	2.08E+00	--	2.08E+00	WAC 173-340-720(4)
534-52-1	4,6-Dinitro-2-methylphenol	SVOC	µg/L	3.70E+00	--	--	--	1.30E+01	1.60E+00	--	1.60E+00	WAC 173-340-720(4)
101-55-3	4-Bromophenylphenyl ether	SVOC	--	--	--	--	--	--	--	--	--	--
59-50-7	4-Chloro-3-methylphenol	SVOC	µg/L	--	--	--	--	--	8.00E+02	--	8.00E+02	WAC 173-340-720(4)
106-47-8	4-Chloroaniline	SVOC	µg/L	1.20E+00	--	--	--	--	6.40E+01	--	6.40E+01	WAC 173-340-720(4)
7005-72-3	4-Chlorophenylphenyl ether	SVOC	--	--	--	--	--	--	--	--	--	--
106-44-5	4-Methylphenol (cresol, p-)	SVOC	µg/L	1.80E+02	--	--	--	--	4.00E+01	--	4.00E+01	WAC 173-340-720(4)
100-01-6	4-Nitroaniline	SVOC	µg/L	3.20E+00	--	--	--	--	2.08E+00	--	2.08E+00	WAC 173-340-720(4)
100-02-7	4-Nitrophenol	SVOC	µg/L	--	--	--	--	--	1.28E+02	6.27E+03	1.28E+02	WAC 173-340-720(4)
83-32-9	Acenaphthene	SVOC	µg/L	2.20E+03	--	--	--	6.70E+02	9.60E+02	6.43E+02	6.43E+02	WAC 173-340-730(3)
208-96-8	Acenaphthylene	SVOC	µg/L	--	--	--	--	--	9.60E+02	6.43E+02	6.43E+02	WAC 173-340-730(3)
120-12-7	Anthracene	SVOC	µg/L	1.10E+04	--	--	--	8.30E+03	2.40E+03	2.59E+04	2.40E+03	WAC 173-340-720(4)
56-55-3	Benzo(a)anthracene	SVOC	µg/L	2.90E-02	--	--	--	3.80E-03	1.20E-01	2.96E-01	3.80E-03	Human Health Water + Organism
50-32-8	Benzo(a)pyrene	SVOC	µg/L	2.90E-03	2.00E-01	--	--	3.80E-03	1.20E-02	2.96E-02	3.80E-03	Human Health Water + Organism
205-99-2	Benzo(b)fluoranthene	SVOC	µg/L	2.90E-02	--	--	--	3.80E-03	1.20E-01	2.96E-01	3.80E-03	Human Health Water + Organism

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
191-24-2	Benzo(ghi)perylene	SVOC	µg/L	--	--	--	--	--	4.80E+02	--	4.80E+02	WAC 173-340-720(4)
207-08-9	Benzo(k)fluoranthene	SVOC	µg/L	2.90E-01	--	--	--	3.80E-03	8.75E-01	2.16E+00	3.80E-03	Human Health Water + Organism
108-60-1	Bis(2-chloro-1-methylethyl)ether	SVOC	µg/L	3.20E-01	--	--	--	1.40E+03	1.25E+00	3.75E+01	1.25E+00	WAC 173-340-720(4)
111-91-1	Bis(2-Chloroethoxy)methane	SVOC	µg/L	1.10E+02	--	--	--	--	3.98E-02	8.54E-01	3.98E-02	WAC 173-340-720(4)
111-44-4	Bis(2-chloroethyl) ether	SVOC	µg/L	1.20E-02	--	--	--	3.00E-02	3.98E-02	8.54E-01	3.00E-02	Human Health Water + Organism
117-81-7	Bis(2-ethylhexyl) phthalate	SVOC	µg/L	4.80E+00	6.00E+00	--	--	1.20E+00	6.25E+00	3.56E+00	1.20E+00	Human Health Water + Organism
85-68-7	Butylbenzylphthalate	SVOC	µg/L	3.50E+01	--	--	--	1.50E+03	3.20E+03	1.25E+03	1.25E+03	WAC 173-340-730(3)
86-74-8	Carbazole	SVOC	µg/L	--	--	--	--	--	4.38E+00	--	4.38E+00	WAC 173-340-720(4)
218-01-9	Chrysene	SVOC	µg/L	2.90E+00	--	--	--	3.80E-03	8.75E+00	2.16E+01	3.80E-03	Human Health Water + Organism
53-70-3	Dibenz[a,h]anthracene	SVOC	µg/L	2.90E-03	--	--	--	3.80E-03	8.75E-01	2.16E+00	3.80E-03	Human Health Water + Organism
132-64-9	Dibenzofuran	SVOC	µg/L	--	--	--	--	--	3.20E+01	--	3.20E+01	WAC 173-340-720(4)
84-66-2	Diethylphthalate	SVOC	µg/L	2.90E+04	--	--	--	1.70E+04	1.28E+04	2.84E+04	1.28E+04	WAC 173-340-720(4)
131-11-3	Dimethyl phthalate	SVOC	µg/L	--	--	--	--	2.70E+05	1.60E+04	7.20E+04	1.60E+04	WAC 173-340-720(4)
84-74-2	Di-n-butylphthalate	SVOC	µg/L	3.70E+03	--	--	--	2.00E+03	1.60E+03	2.91E+03	1.60E+03	WAC 173-340-720(4)
117-84-0	Di-n-octylphthalate	SVOC	µg/L	--	--	--	--	--	3.20E+02	--	3.20E+02	WAC 173-340-720(4)
206-44-0	Fluoranthene	SVOC	µg/L	1.50E+03	--	--	--	1.30E+02	6.40E+02	9.02E+01	9.02E+01	WAC 173-340-730(3)
86-73-7	Fluorene	SVOC	µg/L	1.50E+03	--	--	--	1.10E+03	6.40E+02	3.46E+03	6.40E+02	WAC 173-340-720(4)
118-74-1	Hexachlorobenzene	SVOC	µg/L	4.20E-02	1.00E+00	--	--	2.80E-04	5.47E-02	4.66E-04	2.80E-04	Human Health Water + Organism
87-68-3	Hexachlorobutadiene	SVOC	µg/L	8.60E-01	--	--	--	4.40E-01	5.61E-01	2.99E+01	4.40E-01	Human Health Water + Organism
77-47-4	Hexachlorocyclopentadiene	SVOC	µg/L	2.20E+02	5.00E+01	--	--	4.00E+01	9.60E+01	3.58E+03	4.00E+01	Human Health Water + Organism
67-72-1	Hexachloroethane	SVOC	µg/L	4.80E+00	--	--	--	1.40E+00	3.13E+00	5.33E+00	1.40E+00	Human Health Water + Organism
193-39-5	Indeno(1,2,3-cd)pyrene	SVOC	µg/L	2.90E-02	--	--	--	3.80E-03	1.20E-01	2.96E-01	3.80E-03	Human Health Water + Organism
91-20-3	Naphthalene	SVOC	µg/L	1.40E-01	--	--	--	--	1.60E+02	4.94E+03	1.60E+02	WAC 173-340-720(4)
98-95-3	Nitrobenzene	SVOC	µg/L	3.40E+00	--	--	--	1.70E+01	1.60E+01	1.79E+03	1.60E+01	WAC 173-340-720(4)

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
621-64-7	n-Nitrosodi-n-dipropylamine	SVOC	µg/L	9.60E-03	--	--	--	5.00E-03	1.25E-02	8.19E-01	5.00E-03	Human Health Water + Organism
86-30-6	n-Nitrosodiphenylamine	SVOC	µg/L	1.40E+01	--	--	--	3.30E+00	1.79E+01	9.73E+00	3.30E+00	Human Health Water + Organism
87-86-5	Pentachlorophenol	SVOC	µg/L	5.60E-01	1.00E+00	--	1.50E+01	2.70E-01	7.29E-01	4.91E+00	2.70E-01	Human Health Water + Organism
85-01-8	Phenanthrene	SVOC	µg/L	--	--	--	--	--	2.40E+03	2.59E+04	2.40E+03	WAC 173-340-720(4)
108-95-2	Phenol	SVOC	µg/L	1.10E+04	--	--	--	2.10E+04	2.40E+03	5.56E+05	2.40E+03	WAC 173-340-720(4)
129-00-0	Pyrene	SVOC	µg/L	1.10E+03	--	--	--	8.30E+02	4.80E+02	2.59E+03	4.80E+02	WAC 173-340-720(4)
TPH-DIESEL	Total petroleum hydrocarbons – diesel range	TPH	µg/L	--	--	--	--	Method A	5.00E+02	--	5.00E+02	WAC 173-340-720(3)
71-55-6	1,1,1-Trichloroethane	VOC	µg/L	9.10E+03	2.00E+02	--	--	--	1.60E+04	9.26E+05	2.00E+02	Federal MCL
79-34-5	1,1,2,2-Tetrachloroethane	VOC	µg/L	6.70E-02	--	--	--	1.70E-01	2.19E-01	6.48E+00	1.70E-01	Human Health Water + Organism
79-00-5	1,1,2-Trichloroethane	VOC	µg/L	2.40E-01	5.00E+00	--	--	5.90E-01	7.68E-01	2.53E+01	5.90E-01	Human Health Water + Organism
75-34-3	1,1-Dichloroethane	VOC	µg/L	2.40E+00	--	--	--	5.50E-01	8.00E+02	--	5.50E-01	Human Health Water + Organism
75-35-4	1,1-Dichloroethene	VOC	µg/L	3.40E+02	7.00E+00	--	--	3.30E+02	7.29E-02	1.93E+00	7.29E-02	WAC 173-340-720(4)
95-50-1	1,2-Dichlorobenzene	VOC	µg/L	3.70E+02	6.00E+02	--	--	4.20E+02	7.20E+02	4.20E+03	4.20E+02	Human Health Water + Organism
107-06-2	1,2-Dichloroethane	VOC	µg/L	1.50E-01	5.00E+00	--	--	3.80E-01	4.81E-01	5.94E+01	3.80E-01	Human Health Water + Organism
540-59-0	1,2-Dichloroethene (Total)	VOC	µg/L	3.30E+02	--	--	--	--	7.20E+01	--	7.20E+01	WAC 173-340-720(4)
78-87-5	1,2-Dichloropropane	VOC	µg/L	3.90E-01	5.00E+00	--	--	5.00E-01	6.43E-01	2.32E+01	5.00E-01	Human Health Water + Organism
541-73-1	1,3-Dichlorobenzene	VOC	µg/L	--	--	--	--	3.20E+02	2.40E+02	1.40E+03	2.40E+02	WAC 173-340-720(4)
71-36-3	1-Butanol	VOC	µg/L	3.70E+03	--	--	--	--	8.00E+02	--	8.00E+02	WAC 173-340-720(4)
78-93-3	2-Butanone	VOC	µg/L	7.10E+03	--	--	--	--	4.80E+03	--	4.80E+03	WAC 173-340-720(4)
591-78-6	2-Hexanone	VOC	µg/L	--	--	--	--	0.00E+00	6.40E+02	--	6.40E+02	WAC 173-340-720(4)
108-10-1	2-Pentanone, 4-Methyl	VOC	µg/L	2.00E+03	--	--	--	--	6.40E+02	--	6.40E+02	WAC 173-340-720(4)
67-63-0	2-Propanol	VOC	--	--	--	--	--	--	--	--	--	--
67-64-1	Acetone	VOC	µg/L	2.20E+04	--	--	--	--	7.20E+03	--	7.20E+03	WAC 173-340-720(4)
71-43-2	Benzene	VOC	µg/L	4.10E-01	5.00E+00	--	--	2.20E+00	7.95E-01	2.27E+01	7.95E-01	WAC 173-340-720(4)

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
75-27-4	Bromodichloromethane	VOC	µg/L	1.10E+00	--	--	--	5.50E-01	7.06E-01	2.79E+01	5.50E-01	Human Health Water + Organism
75-25-2	Bromoform	VOC	µg/L	8.50E+00	--	--	--	4.30E+00	5.54E+00	2.19E+02	4.30E+00	Human Health Water + Organism
74-83-9	Bromomethane	VOC	µg/L	8.70E+00	--	--	--	4.70E+01	1.12E+01	9.68E+02	1.12E+01	WAC 173-340-720(4)
75-15-0	Carbon disulfide	VOC	µg/L	1.00E+03	--	--	--	--	8.00E+02	--	8.00E+02	WAC 173-340-720(4)
56-23-5	Carbon tetrachloride	VOC	µg/L	2.00E-01	5.00E+00	--	--	2.30E-01	3.37E-01	2.66E+00	2.30E-01	Human Health Water + Organism
108-90-7	Chlorobenzene	VOC	µg/L	9.10E+01	1.00E+02	--	--	1.30E+02	1.60E+02	5.03E+03	1.30E+02	Human Health Water + Organism
75-00-3	Chloroethane	VOC	µg/L	2.10E+04	--	--	--	--	--	--	2.10E+04	Regional Screening Values
67-66-3	Chloroform	VOC	µg/L	1.90E-01	7.00E+01	--	--	5.70E+00	7.17E+00	2.83E+02	5.70E+00	Human Health Water + Organism
74-87-3	Chloromethane	VOC	µg/L	1.80E+00	--	--	--	--	3.37E+00	1.33E+02	3.37E+00	WAC 173-340-720(4)
156-59-2	cis-1,2-Dichloroethylene	VOC	µg/L	3.70E+02	7.00E+01	--	--	--	8.00E+01	--	7.00E+01	Federal MCL
10061-01-5	cis-1,3-Dichloropropene	VOC	µg/L	4.30E-01	--	--	--	3.40E-01	2.43E-01	1.89E+01	2.43E-01	WAC 173-340-720(4)
124-48-1	Dibromochloromethane	VOC	µg/L	8.00E-01	--	--	--	4.00E-01	5.21E-01	2.06E+01	4.00E-01	Human Health Water + Organism
107-12-0	Ethyl cyanide	VOC	--	--	--	--	--	--	--	--	--	--
100-41-4	Ethylbenzene	VOC	µg/L	1.50E+00	7.00E+02	--	--	5.30E+02	8.00E+02	6.91E+03	5.30E+02	Human Health Water + Organism
110-54-3	Hexane	VOC	µg/L	8.80E+02	--	--	--	--	4.80E+02	--	4.80E+02	WAC 173-340-720(4)
78-59-1	Isophorone	VOC	µg/L	7.10E+01	--	--	--	3.50E+01	4.61E+01	1.56E+03	3.50E+01	Human Health Water + Organism
75-09-2	Methylene chloride	VOC	µg/L	4.80E+00	5.00E+00	--	--	4.60E+00	5.83E+00	9.60E+02	4.60E+00	Human Health Water + Organism
100-42-5	Styrene	VOC	µg/L	1.60E+03	1.00E+02	--	--	--	1.46E+00	--	1.46E+00	WAC 173-340-720(4)
127-18-4	Tetrachloroethene	VOC	µg/L	1.10E-01	5.00E+00	--	--	6.90E-01	8.10E-02	3.92E-01	8.10E-02	WAC 173-340-720(4)
109-99-9	Tetrahydrofuran	VOC	--	--	--	--	--	--	--	--	--	--
108-88-3	Toluene	VOC	µg/L	2.30E+03	1.00E+03	--	--	1.30E+03	6.40E+02	1.94E+04	6.40E+02	WAC 173-340-720(4)
156-60-5	trans-1,2-Dichloroethylene	VOC	µg/L	1.10E+02	1.00E+02	--	--	1.40E+02	1.60E+02	3.28E+04	1.00E+02	Federal MCL
10061-02-6	trans-1,3-Dichloropropene	VOC	µg/L	4.30E-01	--	--	--	3.40E-01	2.43E-01	1.89E+01	2.43E-01	WAC 173-340-720(4)
79-01-6	Trichloroethene	VOC	µg/L	1.70E+00	5.00E+00	--	--	2.50E+00	4.92E-01	6.87E+00	4.92E-01	WAC 173-340-720(4)

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis
108-05-4	Vinyl acetate	VOC	µg/L	4.10E+02	--	--	--	--	8.00E+03	--	8.00E+03	WAC 173-340-720(4)
75-01-4	Vinyl chloride	VOC	µg/L	1.60E-02	2.00E+00	--	--	2.50E-02	2.92E-02	3.69E+00	2.50E-02	Human Health Water + Organism
1330-20-7	Xylenes (total)	VOC	µg/L	2.00E+02	1.00E+04	--	--	--	1.60E+03	--	1.60E+03	WAC 173-340-720(4)
ALKALINITY	Alkalinity	Water quality	--	--	--	--	--	--	--	--	--	--
7664-41-7	Ammonia	Water quality	--	--	--	--	--	--	--	--	--	--
24959-67-9	Bromide	Water quality	--	--	--	--	--	--	--	--	--	--
COD	Chemical Oxygen Demand	Water quality	--	--	--	--	--	--	--	--	--	--
DO	Dissolved oxygen	Water quality	--	--	--	--	--	--	--	--	--	--
EH	Oxidation Reduction Potential	Water quality	--	--	--	--	--	--	--	--	--	--
PH	pH Measurement	Water quality	--	--	--	--	--	--	--	--	--	--
CONDUCT	Specific Conductance	Water quality	--	--	--	--	--	--	--	--	--	--
TEMPERATURE	Temperature	Water quality	--	--	--	--	--	--	--	--	--	--
TDS	Total dissolved solids	Water quality	--	--	--	--	--	--	--	--	--	--
TOC	Total organic carbon	Water quality	--	--	--	--	--	--	--	--	--	--
59473-04-0	Total organic halides	Water quality	--	--	--	--	--	--	--	--	--	--
TURBIDITY	Turbidity	Water quality	--	--	--	--	--	--	--	--	--	--
16887-00-6	Chloride	Wet chemistry	µg/L	--	2.50E+05	--	2.30E+05	--	--	--	2.30E+05	Freshwater CCC
57-12-5	Cyanide	Wet chemistry	µg/L	7.30E+02	2.00E+02	5.20E+00	5.20E+00	1.40E+02	3.20E+02	5.19E+04	5.20E+00	Freshwater CCC
16984-48-8	Fluoride	Wet chemistry	µg/L	2.20E+03	4.00E+03	--	--	--	9.60E+02	--	9.60E+02	WAC 173-340-720(4)
302-01-2	Hydrazine	Wet chemistry	µg/L	2.20E-02	--	--	--	--	1.46E-02	--	1.46E-02	WAC 173-340-720(4)
14797-55-8	Nitrate	Wet chemistry	µg/L	5.80E+04	1.00E+04	--	--	--	2.56E+04	--	1.00E+04	Federal MCL
14797-65-0	Nitrite	Wet chemistry	µg/L	3.70E+03	1.00E+03	--	--	--	1.60E+03	--	1.00E+03	Federal MCL
NO2+NO3-N	Nitrogen in Nitrite and Nitrate	Wet chemistry	--	--	--	--	--	--	--	--	--	--
14265-44-2	Phosphate	Wet chemistry	--	--	--	--	--	--	--	--	--	--
14808-79-8	Sulfate	Wet chemistry	µg/L	--	2.50E+05	--	--	--	--	--	2.50E+05	Federal MCL
18496-25-8	Sulfide	Wet chemistry	µg/L	--	--	--	2.00E+00	0.00E+00	--	--	2.00E+00	Freshwater CCC

Table D1-1. Summary of Federal and State Water Quality Criteria and Action Levels for 100-BC

CAS NO.	Analyte Name	Analyte Class	Units	Regional Screening Values – Residential Tap Water	Federal MCL or MCLG	WAC 173-201A	Freshwater CCC	Human Health Water + Organism	WAC 173-340-720(4)	WAC 173-340-730(3)	Action Level	Action Level Basis

Notes:

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

WAC 173-340-720(3), "Method A Cleanup Levels for Potable Ground Water"

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

WAC 173-340-730(3), "Method B Surface Water Cleanup Levels"

µg/L	=	micrograms per liter	pCi/L	=	picocuries per liter
BHC	=	Benzenehexachloride	PEST	=	pesticides
CAS	=	Chemical Abstracts Service	RAD	=	radiological
CCC	=	criteria continuous concentration	SVOC	=	semi-volatile organic compound
MCL	=	maximum contaminant levels	TPH	=	total petroleum hydrocarbons
MCLG	=	maximum contaminant level goal	VOC	=	volatile organic compound
PCB	=	polychlorinated biphenyl	WAC	=	*Washington Administrative Code*

Table D1-2. Summary of Groundwater Analytes that Meet Exclusion Criteria for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Basis for Exclusion
Calcium	Metal	1/22/1992	7/11/2008	278	278	100.00%	µg/L	--	--	23,500	86,000	Essential Nutrient
Magnesium	Metal	1/22/1992	7/11/2008	278	278	100.00%	µg/L	--	--	6,180	17,800	Essential Nutrient
Potassium	Metal	1/22/1992	7/11/2008	278	268	96.40%	µg/L	1,390	6,020	1,250	7,990	Essential Nutrient
Sodium	Metal	1/22/1992	7/11/2008	278	278	100.00%	µg/L	--	--	7,850	26,400	Essential Nutrient
Delta-BHC	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	--	--	No Toxicity Information
Endrin ketone	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	--	--	No Toxicity Information
Antimony-125	RAD	1/22/1992	6/16/1999	22	11	50.00%	pCi/L	-2.32E+01	1.9	2.7	27	Half-Life less than 3 years
Barium-140	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	-1.00E+01	50	--	--	Half-Life less than 3 years
Beryllium-7	RAD	7/21/1992	6/16/1999	6	0	0.00%	pCi/L	-1.28E+01	70	--	--	Half-Life less than 3 years
Cerium-141	RAD	7/21/1992	4/20/1993	3	0	0.00%	pCi/L	-2.70E+00	50	--	--	Half-Life less than 3 years
Cerium-144	RAD	7/21/1992	4/29/1993	25	0	0.00%	pCi/L	-1.70E+01	70	--	--	Half-Life less than 3 years
Cesium-134	RAD	7/18/1992	6/16/1999	98	0	0.00%	pCi/L	-2.90E+00	20	--	--	Half-Life less than 3 years
Chromium-51	RAD	7/18/1992	4/29/1993	94	0	0.00%	pCi/L	100	800	--	--	Half-Life less than 3 years
Cobalt-58	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	-3.00E+00	7.0	--	--	Half-Life less than 3 years
Gross beta	RAD	7/18/1992	7/11/2008	344	334	97.09%	pCi/L	0.95	51	2.7	345	No Toxicity Information
Iodine-131	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	-1.90E+00	100	--	--	Half-Life less than 3 years
Iron-59	RAD	7/18/1992	4/29/1993	94	0	0.00%	pCi/L	-3.00E+00	100	--	--	Half-Life less than 3 years
Manganese-54	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	0.32	6.0	--	--	Half-Life less than 3 years
Potassium-40	RAD	7/18/1992	6/16/1999	98	3	3.06%	pCi/L	-5.20E+01	300	110	200	Background Radiation
Radium-226	RAD	7/18/1992	4/29/1993	94	3	3.19%	pCi/L	-4.00E+01	100	21	33	Background Radiation
Ruthenium-103	RAD	7/21/1992	4/29/1993	12	0	0.00%	pCi/L	2.6	20	--	--	Half-Life less than 3 years
Ruthenium-106	RAD	1/22/1992	6/16/1999	116	11	9.48%	pCi/L	-5.86E+01	130	0.72	71	Half-Life less than 3 years
Thorium-228	RAD	7/18/1992	4/29/1993	94	3	3.19%	pCi/L	-3.30E-01	22	20	31	Background Radiation
Thorium-232	RAD	7/18/1992	4/29/1993	94	0	0.00%	pCi/L	30	80	--	--	Background Radiation
Thorium-234	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	-9.70E+01	200	--	--	Half-Life less than 3 years
Tin-113	RAD	4/27/1993	4/29/1993	10	0	0.00%	pCi/L	10	20	--	--	Half-Life less than 3 years
Uranium-233/234	RAD	7/18/1992	4/29/1993	88	87	98.86%	pCi/L	0.32	0.32	0.27	1.6	No Toxicity Information
Uranium-235	RAD	7/18/1992	4/29/1993	83	4	4.82%	pCi/L	-1.80E-02	0.13	0.038	0.062	No Toxicity Information
Uranium-238	RAD	7/18/1992	4/29/1993	88	88	100.00%	pCi/L	--	--	0.20	1.1	No Toxicity Information
Zinc-65	RAD	7/18/1992	4/29/1993	94	0	0.00%	pCi/L	-4.40E+00	40	--	--	Half-Life less than 3 years

Table D1-2. Summary of Groundwater Analytes that Meet Exclusion Criteria for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Basis for Exclusion
Zirconium-95	RAD	7/21/1992	4/17/1993	2	0	0.00%	pCi/L	1.7	8.0	--	--	Half-Life less than 3 years
2-Nitrophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	--	--	No Toxicity Information
4-Bromophenylphenyl ether	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	--	--	No Toxicity Information
4-Chlorophenylphenyl ether	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	--	--	No Toxicity Information
Bis(2-ethylhexyl) phthalate	SVOC	7/18/1992	4/29/1993	94	25	26.60%	ug/L	10	35	0.6	69	Common Laboratory Contaminant
Acetone	VOC	7/18/1992	2/1/2001	115	8	6.96%	ug/L	0.21	19	8.0	29	Common Laboratory Contaminant
2-Propanol	VOC	12/19/1994	3/22/1995	8	0	0.00%	µg/L	500	500	--	--	No Toxicity Information
Ethyl cyanide	VOC	9/10/1993	2/1/2001	15	0	0.00%	µg/L	0.96	2.6	--	--	No Toxicity Information
Methylene chloride	VOC	1/22/1992	2/1/2001	156	17	10.90%	ug/L	0.084	14	0.12	4.0	Common Laboratory Contaminant
Tetrahydrofuran	VOC	9/10/1993	2/1/2001	13	0	0.00%	µg/L	1.5	5.0	--	--	No Toxicity Information
Alkalinity	Water quality	3/4/1992	7/11/2008	219	219	100.00%	µg/L	--	--	62,000	140,000	Water Quality
Ammonia	Water quality	7/18/1992	4/29/1993	93	14	15.05%	µg/L	50	100	50	600	No Toxicity Information
Bromide	Water quality	1/22/1992	7/22/1997	35	9	25.71%	µg/L	23	23	50	168	No Toxicity Information
Chemical Oxygen Demand	Water quality	7/18/1992	4/29/1993	93	2	2.15%	µg/L	500	30,000	6,500	34,000	Water Quality
Dissolved oxygen	Water quality	10/6/1993	2/4/2003	83	83	100.00%	µg/L	--	--	1,940	9,610	Water Quality
Oxidation Reduction Potential	Water quality	11/17/2000	2/4/2003	22	22	100.00%	µg/L	--	--	32	227	Water Quality
pH Measurement	Water quality	1/22/1992	11/14/2008	525	525	100.00%	µg/L	--	--	6.3	11	Water Quality
Specific Conductance	Water quality	1/22/1992	11/14/2008	541	541	100.00%	µg/L	--	--	153	623	Water Quality
Temperature	Water quality	1/22/1992	11/14/2008	472	472	100.00%	µg/L	--	--	12	29	Water Quality
Total dissolved solids	Water quality	7/18/1992	4/29/1993	91	91	100.00%	µg/L	--	--	169,000	294,000	Water Quality
Total organic carbon	Water quality	7/18/1992	4/29/1993	71	42	59.15%	µg/L	0.50	500	0.63	10,000	Water Quality
Total organic halides	Water quality	7/18/1992	4/29/1993	68	12	17.65%	µg/L	5.0	20	5.1	421	Water Quality
Turbidity	Water quality	4/16/1993	11/14/2008	364	364	100.00%	µg/L	--	--	0	35	Water Quality
Phosphate	Wet chemistry	1/22/1992	9/29/1997	109	1	0.92%	µg/L	22	400	494	494	No Toxicity Information

Notes:

µg/L = micrograms per liter
BHC = Benzenehexachloride
pCi/L = picocuries per liter
pH = phenyl
PEST = pesticides
RAD = radiological
SVOC = semi-volatile organic compound
VOC = volatile organic compound

Table D1-3. Summary of Groundwater Analytes that were not Detected for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedance
Tin	Metal	1/22/1992	8/11/1994	2	0	0.00%	µg/L	--	--	9,600	WAC 173-340-720(4)	--
Aroclor-1016	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
Aroclor-1221	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	2	2.2	6.40E-05	Human Health Water + Organism	3.13E+04
Aroclor-1232	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1.0	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
Aroclor-1242	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1.0	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
Aroclor-1248	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1.0	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
Aroclor-1254	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1.0	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
Aroclor-1260	PCB	7/18/1992	4/29/1993	94	0	0.00%	µg/L	1.0	1.1	6.40E-05	Human Health Water + Organism	1.56E+04
4,4'-Dichlorodiphenyldichloroethane	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.1	0.11	3.10E-04	Human Health Water + Organism	3.23E+02
4,4-Dichlorodiphenyldichloroethylene	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.1	0.11	2.20E-04	Human Health Water + Organism	4.55E+02
4,4-Dichlorodiphenyltrichloroethane	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.1	0.11	2.20E-04	Human Health Water + Organism	4.55E+02
Aldrin	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.05	0.056	4.90E-05	Human Health Water + Organism	1.02E+03
Alpha-BHC	PEST	7/18/1992	4/29/1993	90	0	0.00%	µg/L	0.05	0.056	2.60E-03	Human Health Water + Organism	1.92E+01
Alpha-Chlordane	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.05	0.056	8.00E-04	Human Health Water + Organism	6.25E+01
beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	0.0091	Human Health Water + Organism	5.49E+00
Dieldrin	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	5.20E-05	Human Health Water + Organism	1.92E+03
Endosulfan I	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	0.056	Freshwater CCC	8.93E-01
Endosulfan II	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	0.056	Freshwater CCC	1.79E+00
Endosulfan sulfate	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	62	Human Health Water + Organism	1.61E-03
Endrin	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	0.002	WAC 173-21A	4.35E+01

Table D1-3. Summary of Groundwater Analytes that were not Detected for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedance
Endrin aldehyde	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.10	0.11	0.29	Human Health Water + Organism	3.45E-01
Gamma-BHC (Lindane)	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	0.038	WAC 173-340-730(3)	1.30E+00
Heptachlor	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	7.90E-05	Human Health Water + Organism	6.33E+02
Heptachlor epoxide	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	3.90E-05	Human Health Water + Organism	1.28E+03
Methoxychlor	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.50	0.56	0.030	Freshwater CCC	1.67E+01
Toxaphene	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	5.0	5.6	2.00E-04	Freshwater CCC	2.50E+04
trans-Chlordane	PEST	7/18/1992	4/29/1993	94	0	0.00%	µg/L	0.050	0.056	8.00E-04	Human Health Water + Organism	6.25E+01
Europium-152	RAD	7/18/1992	6/16/1999	96	0	0.00%	pCi/L	-1.50E+01	30	200	Federal MCL	-7.50E-02
Europium-154	RAD	7/18/1992	6/16/1999	98	0	0.00%	pCi/L	-4.02E-01	20	60	Federal MCL	-6.70E-03
Europium-155	RAD	7/21/1992	6/16/1999	6	0	0.00%	pCi/L	-7.30E+01	20	600	Federal MCL	-1.22E-01
Nickel-63	RAD	12/10/1997	12/10/1997	2	0	0.00%	pCi/L	3.0	3.0	50	Federal MCL	5.94E-02
Plutonium-239	RAD	7/21/1992	4/17/1993	2	0	0.00%	µg/L	0.0080	0.056	15	Federal MCL	5.33E-04
Radium-228	RAD	10/20/1992	10/20/1992	1	0	0.00%	pCi/L	--	--	5.0	Federal MCL	--
2,4-Dinitrophenol	SVOA	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	3.20E+01	WAC 173-340-720(4)	7.81E-01
1,2,4-Trichlorobenzene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	3.50E+01	Human Health Water + Organism	2.86E-01
1,4-Dichlorobenzene	SVOC	5/6/1992	2/1/2001	137	0	0.00%	µg/L	0.056	12	1.82E+00	WAC 173-340-720(4)	3.08E-02
2,4,5-Trichlorophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	8.00E+02	WAC 173-340-720(4)	3.13E-02
2,4,6-Trichlorophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.40E+00	Human Health Water + Organism	7.14E+00
2,4-Dichlorophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.80E+01	WAC 173-340-720(4)	2.08E-01
2,4-Dimethylphenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	3.20E+02	WAC 173-340-720(4)	3.13E-02
2,4-Dinitrotoluene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.10E-01	Human Health Water + Organism	9.09E+01
2,6-Dinitrotoluene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.60E+01	WAC 173-340-720(4)	6.25E-01
2-Chloronaphthalene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.00E+03	Human Health Water + Organism	1.00E-02
2-Chlorophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.00E+01	WAC 173-340-720(4)	2.50E-01
2-Methylnaphthalene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	3.20E+01	WAC 173-340-720(4)	3.13E-01
2-Methylphenol (cresol, o-)	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.00E+02	WAC 173-340-720(4)	2.50E-02

Table D1-3. Summary of Groundwater Analytes that were not Detected for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedance
2-Nitroaniline	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	2.40E+01	WAC 173-340-720(4)	1.04E+00
3,3'-Dichlorobenzidine	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	2.10E-02	Human Health Water + Organism	4.76E+02
3-Nitroaniline	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	2.08E+00	WAC 173-340-720(4)	1.20E+01
4,6-Dinitro-2-methylphenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	1.60E+00	WAC 173-340-720(4)	1.56E+01
4-Chloro-3-methylphenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	8.00E+02	WAC 173-340-720(4)	1.25E-02
4-Chloroaniline	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	6.40E+01	WAC 173-340-720(4)	1.56E-01
4-Methylphenol (cresol, p-)	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.00E+01	WAC 173-340-720(4)	2.50E-01
4-Nitroaniline	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	2.08E+00	WAC 173-340-720(4)	1.20E+01
4-Nitrophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	1.28E+02	WAC 173-340-720(4)	1.95E-01
Acenaphthene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	6.43E+02	WAC 173-340-730(3)	1.56E-02
Acenaphthylene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	6.43E+02	WAC 173-340-730(3)	1.56E-02
Anthracene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	2.40E+03	WAC 173-340-720(4)	4.17E-03
Benzo(a)anthracene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Benzo(a)pyrene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Benzo(b)fluoranthene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Benzo(ghi)perylene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	480	WAC 173-340-720(4)	2.08E-02
Benzo(k)fluoranthene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Bis(2-chloro-1-methylethyl)ether	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.3	WAC 173-340-720(4)	8.00E+00
Bis(2-Chloroethoxy)methane	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.040	WAC 173-340-720(4)	2.51E+02
Bis(2-chloroethyl) ether	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.030	Human Health Water + Organism	3.33E+02
Butylbenzylphthalate	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1,250	WAC 173-340-730(3)	8.00E-03
Carbazole	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.4	WAC 173-340-720(4)	2.28E+00
Chrysene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Dibenz[a,h]anthracene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Dibenzofuran	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	32	WAC 173-340-720(4)	3.13E-01
Dimethyl phthalate	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	16,000	WAC 173-340-720(4)	6.25E-04

Table D1-3. Summary of Groundwater Analytes that were not Detected for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedance
Fluoranthene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	90	WAC 173-340-730(3)	1.11E-01
Fluorene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	640	WAC 173-340-720(4)	1.56E-02
Hexachlorobenzene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	2.80E-04	Human Health Water + Organism	3.57E+04
Hexachlorobutadiene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.44	Human Health Water + Organism	2.27E+01
Hexachlorocyclopentadiene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	40	Human Health Water + Organism	2.50E-01
Hexachloroethane	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	1.4	Human Health Water + Organism	7.14E+00
Indeno(1,2,3-cd)pyrene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0038	Human Health Water + Organism	2.63E+03
Naphthalene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	160	WAC 173-340-720(4)	6.25E-02
Nitrobenzene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	16	WAC 173-340-720(4)	6.25E-01
n-Nitrosodi-n-dipropylamine	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	0.0050	Human Health Water + Organism	2.00E+03
n-Nitrosodiphenylamine	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	3.3	Human Health Water + Organism	3.03E+00
Pentachlorophenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	25	30	0.27	Human Health Water + Organism	9.26E+01
Phenanthrene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	2,400	WAC 173-340-720(4)	4.17E-03
Phenol	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4,800	WAC 173-340-720(4)	2.08E-03
Pyrene	SVOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	480	WAC 173-340-720(4)	2.08E-02
Total petroleum hydrocarbons – diesel range	TPH	12/18/1993	12/20/1993	3	0	0.00%	µg/L	2,000	2,000	500	WAC 173-340-720(3)	4.00E+00
1,1,2-Trichloroethane	VOC	5/6/1992	2/1/2001	136	0	0.00%	µg/L	0.047	10	5.90E-01	Human Health Water + Organism	7.97E-02
1,1-Dichloroethane	VOC	1/22/1992	2/1/2001	157	0	0.00%	µg/L	--	10	5.50E-01	Human Health Water + Organism	--
1,1-Dichloroethene	VOC	7/18/1992	6/16/1999	94	0	0.00%	µg/L	0.15	10	7.29E-02	WAC 173-340-720(4)	2.06E+00
1,2-Dichlorobenzene	VOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	4.20E+02	Human Health Water + Organism	2.38E-02
1,2-Dichloroethane	VOC	1/22/1992	2/1/2001	157	0	0.00%	µg/L	0.049	10	3.80E-01	Human Health Water + Organism	1.29E-01
1,2-Dichloroethene (Total)	VOC	7/18/1992	9/10/1993	94	0	0.00%	µg/L	10	10	7.20E+01	WAC 173-340-720(4)	1.39E-01
1,2-Dichloropropane	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	5.00E-01	Human Health Water + Organism	2.00E+01

Table D1-3. Summary of Groundwater Analytes that were not Detected for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedance
1,3-Dichlorobenzene	VOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	2.40E+02	WAC 173-340-720(4)	4.17E-02
1-Butanol	VOC	9/10/1993	2/1/2001	15	0	0.00%	µg/L	2.5	7	8.00E+02	WAC 173-340-720(4)	3.13E-03
Bromodichloromethane	VOC	7/18/1992	3/22/1995	101	0	0.00%	µg/L	0.50	10	0.55	Human Health Water + Organism	9.09E-01
Bromoform	VOC	7/18/1992	3/22/1995	101	0	0.00%	µg/L	0.50	10	4.3	Human Health Water + Organism	1.16E-01
Bromomethane	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	11	WAC 173-340-720(4)	8.93E-01
Chloroethane	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	21,000	Regional Screening Values	4.76E-04
Chloromethane	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	3.4	WAC 173-340-720(4)	2.97E+00
cis-1,2-Dichloroethylene	VOC	1/22/1992	2/1/2001	62	0	0.00%	µg/L	0.049	0.50	70	Federal MCL	7.00E-04
cis-1,3-Dichloropropene	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	0.24	WAC 173-340-720(4)	4.12E+01
Dibromochloromethane	VOC	7/18/1992	3/22/1995	101	0	0.00%	µg/L	0.50	10	0.40	Human Health Water + Organism	1.25E+00
Isophorone	VOC	7/18/1992	4/29/1993	94	0	0.00%	µg/L	10	12	35	Human Health Water + Organism	2.86E-01
Styrene	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	1.5	WAC 173-340-720(4)	6.85E+00
trans-1,2-Dichloroethylene	VOC	1/22/1992	2/1/2001	63	0	0.00%	µg/L	0.045	0.50	100	Federal MCL	4.50E-04
trans-1,3-Dichloropropene	VOC	7/18/1992	4/29/1993	93	0	0.00%	µg/L	10	10	0.24	WAC 173-340-720(4)	4.12E+01
Vinyl acetate	VOC	1/24/1993	1/24/1993	1	0	0.00%	µg/L	10	10	8,000	WAC 173-340-720(4)	1.25E-03
Vinyl chloride	VOC	5/6/1992	2/1/2001	136	0	0.00%	µg/L	0.10	10	0.025	Human Health Water + Organism	4.00E+00
Sulfide	Wet chemistry	7/18/1992	4/29/1993	84	0	0.00%	µg/L	100	1,000	2.0	Freshwater CCC	5.00E+01

Notes:

µg/L = micrograms per liter
BHC = Benzenehexachloride
CCC = criteria continuous concentration
MCL = maximum contaminant levels
PCB = polychlorinated biphenyl
pCi/L = picocuries per liter
PEST = pesticides
RAD = radiological
SVOA = semi-volatile organics analysis
SVOC = semi-volatile organic compound
TPH = total petroleum hydrocarbon
VOC = volatile organic compound
WAC = *Washington Administrative Code*

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Table D1-4. Summary of Groundwater Analytes that do not Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Exclusion
Barium	Metal	1/22/1992	7/11/2008	278	272	97.84%	µg/L	7.2	20	4.4	111	1.00E+03	Human Health Water + Organism	1.11E-01	No	Max concentration and MDLs < action level
Silver	Metal	1/22/1992	7/11/2008	278	14	5.04%	µg/L	1.1	10	2.8	27	8.00E+01	WAC 173-340-720(4)	3.35E-01	No	Max concentration and MDLs < action level
Strontium	Metal	9/29/1997	7/11/2008	53	53	100.00%	µg/L	--	--	130	353	9.60E+03	WAC 173-340-720(4)	3.68E-02	No	All concentrations < action level
Uranium	Metal	5/3/1993	8/11/1994	11	11	100.00%	µg/L	--	--	1.1	2.2	3.00E+01	Federal MCL	7.20E-02	No	All concentrations < action level
Vanadium	Metal	1/22/1992	7/11/2008	278	210	75.54%	µg/L	2.5	61	3.4	85	1.12E+02	WAC 173-340-720(4)	7.56E-01	No	Max concentration and MDLs < action level
Americium-241	RAD	7/18/1992	4/29/1993	88	3	3.41%	pCi/L	-3.30E-02	0.049	0.021	0.89	1.50E+01	Federal MCL	5.93E-02	No	Max concentration and MDLs < action level
Carbon-14	RAD	7/18/1992	10/20/1995	204	20	9.80%	pCi/L	-1.10E+02	120	3.9	410	2.00E+03	Federal MCL	2.05E-01	Yes	Current data needed to determine contribution to 4 mrem/yr standard
Cesium-137	RAD	1/22/1992	6/16/1999	117	11	9.40%	pCi/L	-1.14E+01	20	0	9.2	2.00E+02	Federal MCL	4.60E-02	Yes	Current data needed to determine contribution to 4 mrem/yr standard
Cobalt-60	RAD	1/22/1992	6/16/1999	117	12	10.26%	pCi/L	-8.33E+00	30	0.44	5.6	1.00E+02	Federal MCL	5.56E-02	Yes	Current data needed to determine contribution to 4 mrem/yr standard
Gross alpha	RAD	12/8/1992	7/11/2008	288	96	33.33%	pCi/L	-3.60E+00	2.2	0.88	10	1.50E+01	Federal MCL	6.67E-01	Yes	Use as an indicator parameter to confirm current concentrations do not exceed MCL
Iodine-129	RAD	8/3/1994	6/16/1999	7	1	14.29%	pCi/L	-5.78E-01	0.61	0.020	0.020	1.00E+00	Federal MCL	2.02E-02	Yes	Current data needed to determine contribution to 4 mrem/yr standard
Plutonium-238	RAD	7/18/1992	4/29/1993	92	1	1.09%	pCi/L	-2.00E-02	0.033	0.017	0.017	1.50E+01	Federal MCL	1.13E-03	No	Max concentration and MDLs < action level
Plutonium-239/240	RAD	7/18/1992	4/29/1993	87	1	1.15%	pCi/L	-9.00E-03	0.020	0.015	0.015	1.50E+01	Federal MCL	1.00E-03	No	Max concentration and MDLs < action level
Technetium-99	RAD	1/22/1992	7/11/2008	244	212	86.89%	pCi/L	-3.85E+00	6.4	0.61	150	9.00E+02	Federal MCL	1.67E-01	Yes	Current data needed to determine contribution to 4 mrem/yr standard
Diethylphthalate	SVOC	7/18/1992	4/29/1993	94	1	1.06%	µg/L	10	10	0.70	0.70	1.28E+04	WAC 173-340-720(4)	5.47E-05	No	Max concentration and MDLs < action level
Di-n-butylphthalate	SVOC	7/18/1992	4/29/1993	94	4	4.26%	µg/L	10	10	1.0	10	1.60E+03	WAC 173-340-720(4)	6.25E-03	No	Max concentration and MDLs < action level
Di-n-octylphthalate	SVOC	7/18/1992	4/29/1993	94	1	1.06%	µg/L	10	12	2.0	2.0	3.20E+02	WAC 173-340-720(4)	6.25E-03	No	Max concentration and MDLs < action level

Table D1-4. Summary of Groundwater Analytes that do not Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Exclusion
1,1,1-Trichloroethane	VOC	1/22/1992	2/1/2001	157	2	1.27%	µg/L	0.061	10	0.30	2.0	2.00E+02	Federal MCL	1.00E-02	No	Max concentration and MDLs < action level
2-Butanone	VOC	7/18/1992	2/1/2001	116	1	0.86%	µg/L	0.42	12	5.0	5.0	4.80E+03	WAC 173-340-720(4)	1.04E-03	No	Max concentration and MDLs < action level
2-Hexanone	VOC	7/18/1992	4/29/1993	93	2	2.15%	µg/L	10	10	3.0	4.0	6.40E+02	WAC 173-340-720(4)	6.25E-03	No	Max concentration and MDLs < action level
2-Pentanone, 4-Methyl	VOC	7/18/1992	2/1/2001	116	4	3.45%	µg/L	0.15	10	1.0	3.0	6.40E+02	WAC 173-340-720(4)	4.69E-03	No	Max concentration and MDLs < action level
Carbon disulfide	VOC	7/18/1992	2/1/2001	108	2	1.85%	µg/L	0.13	10	1.0	2.0	8.00E+02	WAC 173-340-720(4)	2.50E-03	No	Max concentration and MDLs < action level
Chlorobenzene	VOC	7/18/1992	4/29/1993	93	1	1.08%	µg/L	10	10	2.0	2.0	1.30E+02	Human Health Water + Organism	1.54E-02	No	Max concentration and MDLs < action level
Chloroform	VOC	1/22/1992	2/1/2001	157	23	14.65%	µg/L	0.029	10	0.050	2.0	5.70E+00	Human Health Water + Organism	3.51E-01	No	MDLs > action level;
Ethylbenzene	VOC	1/22/1992	8/29/1996	140	2	1.43%	µg/L	0.034	10	0.091	0.12	5.30E+02	Human Health Water + Organism	2.26E-04	No	Max concentration and MDLs < action level
Hexane	VOC	7/23/1992	7/23/1992	1	1	100.00%	µg/L	--	--	5.0	5.0	4.80E+02	WAC 173-340-720(4)	1.04E-02	No	Max concentration and MDLs < action level
Methylene chloride	VOC	1/22/1992	2/1/2001	156	17	10.90%	µg/L	0.084	14	0.12	4.0	4.60E+00	Human Health Water + Organism	8.70E-01	No	MDLS > action level; not identified as vadose zone target analyte
Toluene	VOC	1/22/1992	2/1/2001	157	15	9.55%	µg/L	0.048	10	0.070	9.0	6.40E+02	WAC 173-340-720(4)	1.41E-02	No	Max concentration and MDLs < action level
Xylenes (total)	VOC	1/22/1992	2/1/2001	160	5	3.13%	µg/L	0.085	10	0.18	10	1.60E+03	WAC 173-340-720(4)	6.25E-03	No	Max concentration and MDLs < action level
Chloride	Wet chemistry	1/22/1992	7/11/2008	311	311	100.00%	µg/L	--	--	1,140	43,300	2.30E+05	Freshwater CCC	1.88E-01	No	All concentrations < action level
Fluoride	Wet chemistry	1/22/1992	7/11/2008	427	402	94.15%	µg/L	100	500	36	900	9.60E+02	WAC 173-340-720(4)	9.38E-01	No	Max concentration and MDLs < action level
Nitrogen in Nitrite and Nitrate	Wet chemistry	7/18/1992	4/29/1993	91	86	94.51%	ug/L	250	250	450	6,900	1.00E+04	Federal MCL	6.90E-01	No	Max concentration and MDLs < action level
Nitrite	Wet chemistry	1/22/1992	7/11/2008	215	4	1.86%	µg/L	3.3	250	279	920	1.00E+03	Federal MCL	9.20E-01	No	Max concentration and MDLs < action level
Sulfate	Wet chemistry	1/22/1992	7/11/2008	428	428	100.00%	µg/L	--	--	9,800	94,200	2.50E+05	Federal MCL	3.77E-01	No	All concentrations < action level

Notes:

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

Table D1-4. Summary of Groundwater Analytes that do not Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Exclusion

µg/L = micrograms per liter
CCC = criteria continuous concentration
COPC = contaminant of potential concern
MCL = maximum contaminant levels
MDLs = method detection limits
pCi/L = picocuries per liter
RAD = radiological
SVOC = semi-volatile organic compound
VOC = volatile organic compound
WAC = *Washington Administrative Code*

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Table D1-5. Summary of Groundwater Analytes that Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Inclusion
Aluminum	Metal	7/18/1992	2/19/2002	254	85	33.46%	µg/L	10.6	125	15.5	4,590	5.00E+01	Federal MCL	9.18E+01	No	Naturally occurring; not identified as a vadose zone target analyte
Iron	Metal	1/22/1992	7/11/2008	278	217	78.06%	µg/L	4.8	130	9.2	9,800	3.00E+02	Federal MCL	3.27E+01	No	Naturally occurring; not identified as a vadose zone target analyte
1,1,2,2-Tetrachloroethane	VOC	7/18/1992	4/29/1993	93	2	2.15%	µg/L	10	10	1	2	1.70E-01	Human Health Water + Organism	1.18E+01	Yes	All MCLs > action level
Tetrachloroethene	VOC	1/22/1992	2/1/2001	159	1	0.63%	µg/L	0.035	10	0.11	0.11	8.10E-02	WAC 173-340-720(4)	1.36E+00	No	Anomalous results; not a vadose zone target analyte
Cyanide	Wet chemistry	2/20/1992	4/18/1995	101	4	3.96%	µg/L	10	20	23.8	23.8	5.20E+00	Freshwater CCC	4.58E+00	No	Anomalous results; not identified as a vadose zone target analyte
Hydrazine	Wet chemistry	4/23/1992	4/29/1993	34	1	2.94%	µg/L	3	3	5	5	1.46E-02	WAC 173-340-720(4)	3.42E+02	No	Anomalous results; not a vadose zone target analyte
Antimony	Metal	1/22/1992	7/11/2008	278	7	2.52%	µg/L	2	60	49.1	74.2	5.60E+00	Human Health Water + Organism	1.33E+01	Yes	Max concentration and MDLs > action level
Arsenic	Metal	7/18/1992	3/31/1997	212	116	54.72%	µg/L	0.8	28.9	1.1	829	1.80E-02	Human Health Water + Organism	4.61E+04	Yes	Max concentration and MDLs > action level
Beryllium	Metal	1/22/1992	7/11/2008	278	34	12.23%	µg/L	0.1	4	0.28	73.9	4.00E+00	Federal MCL	1.85E+01	Yes	Max concentration > action level
Cadmium	Metal	1/22/1992	7/11/2008	278	13	4.68%	µg/L	0.24	7	1.3	77.8	2.50E-01	Federal MCL	3.11E+02	Yes	Max concentration and MDLs > action level
Chromium	Metal	1/22/1992	7/11/2008	278	236	84.89%	µg/L	2.1	30	2.4	358	7.40E+01	Freshwater CCC	4.84E+00	Yes	Max concentration and MDLs > action level
Cobalt	Metal	1/22/1992	7/11/2008	278	15	5.40%	µg/L	1.3	11	1.6	72	4.80E+00	WAC 173-340-720(4)	1.50E+01	Yes	Max concentration and MDLs > action level
Copper	Metal	1/22/1992	7/11/2008	278	70	25.18%	µg/L	1.4	43.5	2.7	423	9.00E+00	Freshwater CCC	4.70E+01	Yes	Max concentration and MDLs > action level

Table D1-5. Summary of Groundwater Analytes that Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Inclusion
Hexavalent Chromium	Metal	12/14/2005	12/8/2008	28	28	100.00%	µg/L	--	--	8	64	1.10E+01	Freshwater CCC	5.82E+00	Yes	Max concentration and MDLs > action level
Lead	Metal	7/18/1992	3/31/1997	213	70	32.86%	µg/L	0.6	36.2	1.2	529	2.50E+00	Freshwater CCC	2.12E+02	Yes	Max concentration and MDLs > action level
Manganese	Metal	1/22/1992	7/11/2008	278	157	56.47%	µg/L	0.8	26.5	0.84	321	5.00E+01	Federal MCL	6.42E+00	Yes	Max concentration and MDLs > action level
Mercury	Metal	7/18/1992	3/31/1997	213	13	6.10%	µg/L	0.10	0.20	0.11	0.25	1.20E-02	WAC 173-21A	2.08E+01	Yes	Max concentration and MDLs > action level
Nickel	Metal	1/22/1992	7/11/2008	278	54	19.42%	µg/L	1.3	37.5	1.7	122	5.20E+01	Freshwater CCC	2.35E+00	Yes	Max concentration and MDLs > action level
Selenium	Metal	7/21/1992	3/31/1997	176	60	34.09%	µg/L	0.7	3300	0.93	31.9	5.00E+00	Freshwater CCC	6.38E+00	Yes	Max concentration and MDLs > action level
Thallium	Metal	7/18/1992	3/31/1997	213	14	6.57%	µg/L	0.5	239	0.53	5.9	2.40E-01	Human Health Water + Organism	2.46E+01	Yes	Max concentration and MDLs > action level
Zinc	Metal	1/22/1992	7/11/2008	278	160	57.55%	µg/L	2.9	47.1	2.6	335	1.20E+02	Freshwater CCC	2.79E+00	Yes	Max concentration and MDLs > action level
Strontium-90	RAD	2/11/1992	2/15/2008	404	239	59.16%	pCi/L	-0.51	1.4	0.015	170	8.00E+00	Federal MCL	2.13E+01	Yes	Max concentration and MDLs > action level
Tritium	RAD	1/22/1992	7/11/2008	451	390	86.47%	pCi/L	-202.63	254	240	420,000	2.00E+04	Federal MCL	2.10E+01	Yes	Max concentration and MDLs > action level
Benzene	VOC	1/22/1992	2/1/2001	160	8	5.00%	µg/L	0.059	10	0.12	5	7.95E-01	WAC 173-340-720(4)	6.29E+00	Yes	Max concentration and MDLs > action level
Carbon tetrachloride	VOC	1/22/1992	2/1/2001	157	3	1.91%	µg/L	0.047	10	0.13	0.48	2.30E-01	Human Health Water + Organism	2.09E+00	Yes	Max concentration and MDLs > action level
Trichloroethene	VOC	1/22/1992	2/1/2001	159	97	61.01%	µg/L	0.099	10	0.1	3	4.92E-01	WAC 173-340-720(4)	6.10E+00	Yes	Max concentration and MDLs > action level
Nitrate	Wet chemistry	1/22/1992	7/11/2008	243	243	100.00%	µg/L	--	--	708	92,500	1.00E+04	Federal MCL	9.25E+00	Yes	Max concentration and MDLs > action level

Table D1-5. Summary of Groundwater Analytes that Exceed an Action Level for 100-BC

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis	Level of Exceedance	COPC?	Basis for Inclusion

Notes:

WAC 173-21A, "Water Quality Standards for Surface Waters of the State of Washington"

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

µg/L	=	micrograms per liter	pCi/L	=	picocuries per liter
CCC	=	criteria continuous concentration	RAD	=	radiological
COPC	=	contaminant of potential concern	SVOC	=	semi-volatile organic compound
MCL	=	maximum contaminant levels	VOC	=	volatile organic compound
MDLs	=	method detection limits	WAC	=	*Washington Administrative Code*

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Table D1-6. Groundwater COPCs and Recommended Analytical Methods for 100-BC Area

Analyte Name	Analyte Class	Analytical Method	Units	EQL	Action Level	Action Level Basis
Antimony	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	6	5.60	Human Health for the Consumption of Water + Organism[1]
Arsenic	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	10	0.018	Human Health for the Consumption of Water + Organism[1]
Beryllium	Metal	ICP/MS (6020 or 200.8)	µg/L	2	4.0	40 CFR 141.62
Cadmium	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	2	0.25	Freshwater CCC[1]
Chromium	Metal	ICP Metals – 6010	µg/L	10	74	Freshwater CCC[1]
Cobalt	Metal	ICP Metals – 6010	µg/L	20	4.8	WAC 173-340-720(4)(b)(iii)(A) and (B)
Copper	Metal	ICP Metals – 6010	µg/L	10	9	Freshwater CCC[1]
Hexavalent Chromium	Metal	Cr(VI) – 7196	µg/L	10	10	WAC 173-201A
Lead	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	5	2.5	Freshwater CCC[1]
Manganese	Metal	ICP Metals – 6010	µg/L	5	50	40 CFR 143.3
Mercury	Metal	Mercury – 7470	µg/L	0.5	0.0120	WAC 173-201A
Nickel	Metal	ICP Metals – 6010	µg/L	40	52	Freshwater CCC[1]
Selenium	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	10	5	Freshwater CCC[1]
Thallium	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	µg/L	5	0.24	Human Health for the Consumption of Water + Organism[1]
Uranium	Metal	Trace – ICP (6010) or ICP/MS (6020 or 200.8) or Total Uranium (chemical)	µg/L	15	30	40 CFR 141.62
Zinc	Metal	ICP Metals – 6010	µg/L	10	120	Freshwater CCC[1]
Carbon-14	RAD	Carbon-14	pCi/L	200	2,000	40 CFR 141.66
Cesium-137	RAD	Gamma Energy Analysis	pCi/L	15	200	40 CFR 141.66
Cobalt-60	RAD	Gamma Energy Analysis	pCi/L	25	100	40 CFR 141.66
Europium-155	RAD	Gamma Energy Analysis	pCi/L	50	600	40 CFR 141.66
Iodine-129	RAD	Iodine-129 (low-level)	pCi/L	1	1	40 CFR 141.66
Nickel-63	RAD	Nickel-63	pCi/L	15	50	40 CFR 141.66
Radium-228	RAD	Gamma Energy Analysis	pCi/L	3	5	40 CFR 141.66
Strontium-90	RAD	Sr-90	pCi/L	2	8	40 CFR 141.66
Technetium-99	RAD	Technetium-99	pCi/L	15	900	40 CFR 141.66
Tritium	RAD	Tritium (H-3)	pCi/L	400	20,000	40 CFR 141.66
Total petroleum hydrocarbons – diesel range	TPH	Northwest Total Petroleum Hydrocarbons – Diesel (NWTPH-Dx)	µg/L	500	2,000	WAC 173-340-900, Table 720-1
1,1-Dichloroethene	VOC	Volatile organics – 8260	µg/L	2	0.0729	WAC 173-340-720(4)(b)(iii)(A) and (B)
1,1,2,2-Tetrachloroethane	VOC	Volatile organics – 8260	µg/L	5	0.17	Human Health for the Consumption of Water + Organism[1]

Table D1-6. Groundwater COPCs and Recommended Analytical Methods for 100-BC Area

Analyte Name	Analyte Class	Analytical Method	Units	EQL	Action Level	Action Level Basis
Benzene	VOC	Volatile organics – 8260	µg/L	5 (1.5)	0.795	Groundwater Method B
Carbon Tetrachloride	VOC	Volatile organics – 8260	µg/L	1.0	0.23	Human Health Water + Organism
Chloroform	VOC	Volatile organics – 8260	µg/L	5	5.7	Human Health for the Consumption of Water + Organism[1]
Tetrachloroethene	VOC	Volatile organics – 8260	µg/L	5	0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)
Trichloroethene	VOC	Volatile organics – 8260	µg/L	1.0	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)
Vinyl Chloride	VOC	Volatile organics – 8260	µg/L	10	0.029	Human Health for the Consumption of Water + Organism[1]
Nitrate	Wet chemistry	Anions by IC – 300.0	µg/L	250	45,000	40 CFR 141.62

Notes:

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

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

1. National recommended Water Quality Criteria Table (ambient water quality criteria for aquatic life and human health) at www.epa.gov/waterscience/criteria/wqctable/index.html

µg/L = micrograms per liter
CCC = criteria continuous concentration
CFR = Code of Federal Regulations
COPCs = contaminants of potential concern
Cr(VI) = hexavalent chromium
EQL = Estimated Quantitation Limit
IC = Ion Chromatography
ICP = inductively coupled plasma
MS = mass spectrometry
pCi/L = picocuries per liter
RAD = radiological
Sr-90 = Strontium-89/90
VOC = volatile organic compound
WAC = *Washington Administrative Code*

D2 100-BC Target Analyte List Development for Soil

WCH-329
Rev. 0

STANDARD APPROVAL PAGE

Title: 100-B/C Target Analyte List Development for Soil

Author Name: R. W. Ovink, Integration Project Task Lead

Approval: J. A. Lerch, Mission Completion

Signature _____ Date 3/15/2010

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D2.1 Purpose

This report documents the process used to identify source area target analytes in support of the 100-BC remedial investigation/feasibility study (RI/FS) addendum to DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study (RI/FS) Work Plan*. A "target analyte" is defined as a constituent suspected of being site-related that is carried into an investigation plan for characterization through sampling and analysis by approved laboratory methods. Target analytes identified for 100 Area operable units must support RI/FS nature and extent characterization plus final remedial action decisions for source areas. This report also establishes the analyte exclusion criteria applicable for 100-BC use and the analytical methods needed to analyze the target analytes.

D2.2 Approach

The approach for development of vadose zone soil target analytes was a multi-step process. In Steps 1 and 2, initial target and master analyte lists were developed. The third step developed location-specific target analyte lists for waste sites where additional characterization is planned. Finally, the analyte list received regulatory review and input. This resulted in final location-specific target analytes.

Step 1 – Prepare Initial Target Analyte List

Remediation and characterization information (historic and current) were identified and reviewed to develop an initial list of target analytes. The list of initial target analytes represents potential contaminants in the vadose zone. The following types of reference documents and information sources were evaluated:

- Focused feasibility studies (FFSs), limited field investigation (LFI) reports
- Interim action records of decision (IARODs)
- Cleanup verification documents (cleanup verification packages [CVPs], remaining sites verification packages [RSVPs])
- Technical baseline reports
- Databases containing analytical data resulting from these activities (i.e., characterization, remediation, waste management information)
- Other pertinent documents.

Step 2 – Prepare Master Target Analyte List

After the initial target analyte list is compiled, the information underwent additional evaluation to refine the list to a master target analyte list. The master target analyte list is comprehensive and includes all analytes with credible potential to be present in the vadose zone above action thresholds. The following steps were taken to prepare the master decision unit target analyte list:

- Apply the following exclusion criteria to the initial set of target analytes.
  - Radionuclides with a half-life of 3 years or less (and no significant daughters).
  - Naturally occurring radionuclides that are not associated with past Hanford processes in the 100 Area (e.g., potassium-40).
  - Radionuclides potentially present only as trace impurities in solid irradiated materials.

  - Essential nutrients for human nutrition. Recommended daily allowances are developed for essential nutrients to estimate safe and adequate daily dietary intakes (NRC 1989, *Recommended Daily Allowances*).
  - Analytes that have no toxicity values (based on the hierarchy of toxicity values recommended by the U. S. Environmental Protection Agency (EPA) in Human Health Toxicity Values for Superfund Risk Assessments [OSWER Directive 9285.7-53]).
  - Common laboratory contaminants.
- Compare the resulting list for vadose zone soil with the contaminant of potential concern (COPC) list developed for the groundwater operable unit. Groundwater COPCs not found on the soil target analyte list were further evaluated to determine if there is a valid basis for their inclusion.

Appropriate analytical methods and estimated quantitation limits were then identified for the resulting master target analyte list.

Step 3 – Develop Location-Specific Target Analyte List

Location-specific target analytes were identified for each waste site from the master list using the following approach.

- Identify contaminants of concern (COCs) and COPCs for each specific waste site where characterization is proposed from the applicable IAROD (which reflects information from LFI and technical baseline reports). The default decision was to carry these analytes forward as target analytes for characterization unless a specific basis was available to eliminate them.
- Identify COCs and COPCs for each specific waste site where characterization is proposed from the site-specific interim cleanup verification documentation (typically developed based on the applicable IAROD). The default decision was to carry these analytes forward as target analytes for characterization unless a specific basis was available to eliminate them.
- Retain any analyte identified globally as a 100-BC groundwater COPC as a soil target analyte.
- Remaining analytes on the master list were then considered individually on a site-specific basis. The default decision was to carry these analytes forward as target analytes for characterization unless a specific basis was available to eliminate them.

Step 4 – Agency Review of Locations and Location-Specific Target Analyte Lists

The lead regulatory agency for the 100-BC Area (EPA) was consulted during the process to determine if adjustments were required to address additional information needs for each site. General process and site-specific input from EPA has been included in the final lists developed for each waste site.

D2.3 Assumptions

- Older analytical data (e.g., pre-*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [CERCLA]) reflect laboratory state-of-the-art procedures. Analytical methods have improved, resulting in lower detection limits for many analytes and better data quality assurance/ quality control.

- Characterization activities implemented since initiating remediation under the IARODs may provide additional contaminant information that should be considered during pending RI/FS field investigations.
- Post-remediation characterization and cleanup verification data reflect focused lists of analytes that are unique to each waste site and have been evaluated against IAROD cleanup requirements.
- Examining existing data and waste site process information will be useful in developing laboratory analytical needs for RI/FS characterization tasks.
- Universally-accepted exclusion criteria may be applied to the initial target analyte list to develop a "master" target analyte list.
- Additional exclusion criteria (e.g., statistical Hanford Site background comparisons, infrequently detected analytes, and analytes not detected at concentrations/activities exceeding required cleanup levels) may be applied during the RI/FS process as more data become available.

D2.4 Software Considerations

No statistical or algebraic calculations were performed for this activity. The evaluations conducted included analyte comparisons/sorting using Microsoft® Excel®.

D2.5 Soil Target Analyte List Development

Step 1 – 100-BC Initial Target Analyte List

1. The documents listed in Table D2-1 were used to develop the 100-BC target analyte list.

Table D2-1. Documents Used to Develop the 100-BC Target Analyte List

Reference	Document Number	Document Type
1. Cleanup Verification Package for the 116-B-5 Crib	100 NPL Agreement/ Change Form: Control Number 111	CVP
2. Cleanup Verification Package for the 116-C-1 Process Effluent Trench	CVP-98-00006	CVP
3. Cleanup Verification Package for the 116-B-14 North Sludge Trench	CVP-99-00003	CVP
4. Cleanup Verification Package for the 116-B-10 Dry Well/Quench Tank	CVP-99-00010	CVP
5. Cleanup Verification Package for the 116-B-4 Dry French Drain	CVP-99-00014	CVP
6. Cleanup Verification Package for the 116-B-7, 132-B-6 and 132-C-2 B/C Area Outfalls	CVP-2002-00003	CVP
7. Cleanup Verification Package for the 1607-B-10 Septic Tank System	CVP-2003-00007	CVP

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Table D2-1. Documents Used to Develop the 100-BC Target Analyte List

Reference	Document Number	Document Type
8. Cleanup Verification Package for the 118-C-4, 105-C Horizontal Control Rod Cave	CVP-2003-00015	CVP
9. Cleanup Verification Package for the 118-B-5 Burial Ground	CVP-2004-00003	CVP
10. Cleanup Verification Package for the 118-B-6, 108-B Solid Waste Burial Ground	CVP-2006-00002	CVP
11. Cleanup Verification Package for the 105-C Reactor Building Below-Grade Structures and Underlying Soils	CVP-98-00009	CVP
12. Cleanup Verification Package for the 116-C-5 Retention Basin	CVP-99-00004	CVP
13. Cleanup Verification Package for the 118-B-3 and 118-B-2 Burial Ground	CVP-2005-00001	CVP
14. Cleanup Verification Package for the 118-B-4 Spacer Burial Ground	CVP-2004-00002	CVP
15. Cleanup Verification Package for the 100-B-5 Effluent Vent Disposal Trench	CVP-2003-00014	CVP
16. Cleanup Verification Package for the 1607-B-9 Septic Tank System	CVP-2003-00006	CVP
17. Cleanup Verification Package for the 116-C-2A Pluto Crib, 116-C-2B Pump Station, 116-C-2C Sand Filter, and Overburden Soils from Group 3 Sites at the 100-BC Area Pluto Crib	CVP-99-00019	CVP
18. Cleanup Verification Package for the 116-B-3 Pluto Crib	CVP-99-00013	CVP
19. Cleanup Verification Package for the 116-B-6A Crib and 116-B-16 Fuel Examination Tank	CVP-99-00011	CVP
20. Cleanup Verification Package for the 118-C-1, 105-C Solid Waste Burial Ground	CVP-2006-00011	CVP
21. Cleanup Verification Package for the 118-B-10 Burial Ground	CVP-2004-00004	CVP
22. Cleanup Verification Package for the 100-B-8:2, 100-C-6:2, 100-C-6:3, and 100-C-6:4 100-BC North Effluent Pipelines	CVP-2003-00019	CVP
23. Cleanup Verification Package for the 116-B-2 Fuel Storage Basin Trench	CVP-99-00015	CVP
24. Cleanup Verification Package for the 1607-B-7 Septic Tank System	CVP-2003-00004	CVP
25. Cleanup Verification Package for the 1607-B-11 Septic Tank System	CVP-2003-00008	CVP
26. Cleanup Verification Package for the 116-B-11 Retention Basin	CVP-99-00001	CVP
27. Cleanup Verification Package for the 116-B-12 Seal Pit Crib	CVP-99-00008	CVP

Table D2-1. Documents Used to Develop the 100-BC Target Analyte List

Reference	Document Number	Document Type
28. Cleanup Verification Package for the 116-B-1 Process Effluent Trench	CVP-99-00012	CVP
29. Cleanup Verification Package for the 116-B-6B Crib	CVP-99-00017	CVP
30. Cleanup Verification Package for the 1607-B-8 Septic Tank System	CVP-2003-00005	CVP
31. Cleanup Verification Package for the 100-C-3 French Drain	CVP-2003-00009	CVP
32. Cleanup Verification Package for the 100-B-8:1 and 100-C-6:1, 100-BC South Effluent Pipelines	CVP-2003-00022	CVP
33. Cleanup Verification Package for the 118-C-2 Burial Ground	CVP-2004-00005	CVP
34. Cleanup Verification Package for the 116-B-13 South Sludge Trench	CVP-99-00002	CVP
35. Cleanup Verification Package for the 116-B-9 French Drain	CVP-99-00009	CVP
36. Cleanup Verification Package for the 118-B-1, 105-B Solid Waste Burial Ground	CVP-2007-00006	CVP
37. Remaining Sites Verification Package for the 100-B-1 Surface Chemical And Solid Waste Dumping Area	RSVP-2006-003	RSVP
38. Remaining Sites Verification Package for the 100-B-14:1 Process Sewer	RSVP-2004-005	RSVP
39. Remaining Sites Verification Package for the 1607-B2 Septic System And 100-B-14:2 Sanitary Sewer System	RSVP-2006-055	RSVP
40. Remaining Sites Verification Package for the 100-B-16 Utility Poles And Fixtures Debris Pile	RSVP-2005-009	RSVP
41. Remaining Sites Verification Package for the 100-B-18, 184-B Power House Debris Pile	RSVP-2007-020	RSVP
42. Remaining Sites Verification Package for the 100-B-20, 1716-B Maintenance Garage Underground Tank	RSVP-2006-019	RSVP
43. Remaining Sites Verification Package for the 100-B-21:2 Subsite (100-BC Discovery Pipeline DS-100B/C-002	RSVP-2008-003	RSVP
44. Remaining Sites Verification Package for the 100-B-22:1 Pipelines and Associated Soils	RSVP-2005-042	RSVP
45. Remaining Sites Verification Package for the 100-B-23, 100-BC Area Surface Debris Waste Site	RSVP-2008-027	RSVP
46. Remaining Sites Verification Package for the 100-B-24 Spillway	RSVP-2006-051	RSVP
47. Remaining Sites Verification Package for the 100-B-26 Spillway	RSVP-2006-052	RSVP
48. Remaining Sites Verification Package for the 116-C-3, 105-C Chemical Waste Tanks	RSVP-2008-002	RSVP

Table D2-1. Documents Used to Develop the 100-BC Target Analyte List

Reference	Document Number	Document Type
49. Remaining Sites Verification Package for 118-B-9 104-B-1 Tritium Vault and 104-B-2 Tritium Laboratory (104-B2 Storage Building) Site	RSVP-2004-004	RSVP
50. Remaining Sites Verification Package for 100-B-11 115-B/C Caisson, Sump, Drywell, Tank, and Caisson Valve Pit Site	RSVP-2004-003	RSVP
51. Remaining Sites Verification Package for 100-B-14:3 West Process Sewer Pipelines Site	RSVP-2004-007	RSVP
52. Remaining Sites Verification Package for 100-B-14:6 184-B Powerhouse Pipelines Site	RSVP-2004-010	RSVP
53. Remaining Sites Verification Package for 100-B-14:7 185-B/190-B Sump and Pipelines Site	RSVP-2004-011	RSVP
54. Remaining Sites Verification Package for the 100-C-9:1 Main Process Sewer Collection Line	RSVP-2004-012	RSVP
55. Remaining Sites Verification Package for the 100-C-9:2 Sanitary Sewer Pipelines	RSVP-2004-013	RSVP
56. Remaining Sites Verification Package for the 100-C-9:3 183-C Clearwells Site	RSVP-2004-014	RSVP
57. Remaining Sites Verification Package for the 118-C-3:3, 105-C French Drains	RSVP-2006-016	RSVP
58. Remaining Sites Verification Package for the 120-B-1, 105-B Battery Acid Sump	RSVP-2006-057	RSVP
59. Remaining Sites Verification Package for the 126-B-2, 183-B Clearwells	RSVP-2007-004	RSVP
60. Remaining Sites Verification Package for the 126-B-3, 184-B Coal Pit Dumping Area	RSVP-2005-028	RSVP
61. Remaining Sites Verification Package for the 128-B-2, 100-B Burn Pit #2 Waste Site	RSVP-2005-038	RSVP
62. Remaining Sites Verification Package for the 128-B-3 Burn Pit Site	RSVP-2006-058	RSVP
63. Remaining Sites Verification Package for the 128C-1 Burn Pit Waste Site	RSVP-2005-019	RSVP
64. Remaining Sites Verification Package for the 1607-B1 Septic System	RSVP-2007-015	RSVP
65. Remaining Sites Verification Package for the 1607-B2 Septic System and 100-B-14:2 Sanitary Sewer System	RSVP-2006-055	RSVP
66. Remaining Sites Verification Package for the 600-233 Waste Site, Vertical Pipe Near 100-B Electrical Laydown Area	RSVP-2005-041	RSVP
67. Limited Field Investigation Report for the 100-BC-2 Operable Unit	DOE/RL-94-42	LFI

Table D2-1. Documents Used to Develop the 100-BC Target Analyte List

Reference	Document Number	Document Type
68. Limited Field Investigation Report for the 100-BC-1 Operable Unit	DOE/RL-93-06	LFI
69. Hazards Summary Report, Volume 3- Description of the 100-B, 100-C, 100-D, 100-DR, 100-F and 100-H Production Reactor Plants	HW-74094	HSR
70. Remedial Investigation Feasibility Study Work Plan for the 100-BC-2 Operable Unit, Hanford Site, Richland, Washington	DOE/RL-91-07	RI/FS
71. Remedial Investigation Feasibility Study Work Plan for the 100-BC-1 Operable Unit, Hanford Site, Richland, Washington	DOE/RL-90-07	RI/FS
72. Remedial Investigation Feasibility Study Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland, Washington	DOE/RL-90-08	RI/FS
73. Qualitative Risk Assessment for the 100-BC-1 Source Operable Unit	WHC-SD-EN-RA-003	RA
74. 100 Area Source Operable Unit Focused Feasibility Study	DOE/RL-94-61	FFS
75. Radiological Characterization of the Retired 100 Areas/Dorian and Richards	UNI-946	Dorian/Richards
76. 100-B Area Technical Baseline Report	WHC-SD-EN-TI-220	Technical baseline
77. Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site	EPA/ROD/R10-99/039	IAROD
78. Declaration of the Record Of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site	EPA/ROD/R10-95/126	IAROD
79. Amended Record of Decision for the 100 Area	DOE-RL 1997	IAROD
80. Declaration of the Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, and 100-DR-2, 100-HR-2, 100-KR-2 (100 Area Burial Grounds) Operable Units, Hanford Site	EPA et. al 2000	IAROD
81. 100-BC Area Ecological Risk Assessment Sampling and Analysis Plan	DOE/RL-2003-08	SAP

Notes:

CVP = cleanup verification package
FFS = focused feasibility study
HSR = hazards summary report
IAROD = interim action record of decision
LFI = limited field investigation
RA = risk assessment
RI/FS = remedial investigation/feasibility study
ROD = record of decision
RSVP = remaining sites verification package
SAP = sampling and analysis plan

2. The initial list of target analytes presented in Table D2-2 was created from the review and evaluation of the Table 1 documents. Note that, where an analyte was identified in multiple documents, only one reference is provided for simplicity.

Table D2-2. Summary of 100-BC Initial Target Analytes and References

Analyte	Example Reference	Analyte	Example Reference
Radionuclides			
Americium-241	CVP-98-00006	Potassium-40	DOE/RL-94-42
Carbon-14	CVP-2004-00003	Radium-226	DOE/RL-94-42
Cobalt-58	DOE/RL-94-42	Radium-228	DOE/RL-94-42
Cobalt-60	CVP-98-00006	Ruthenium-106	DOE/RL-91-07
Cesium-134	DOE/RL-94-42	Silver-108m	CVP-2006-00011
Cesium-137	CVP-98-00006	Sodium-22	DOE/RL-94-61
Europium-152	CVP-98-00006	Strontium-90	CVP-98-00006
Europium-154	CVP-98-00006	Technetium-99	CVP-98-00009
Europium-155	CVP-98-00006	Thorium-228	DOE/RL-94-42
Iodine-129	DOE/RL-91-07	Thorium-232	DOE/RL-94-42
Nickel-63	CVP-98-00006	Tritium	CVP-2002-00003
Plutonium-238	CVP-98-00006	Uranium-233/234	CVP-99-00010
Plutonium-239/240	CVP-98-00006	Uranium-235	CVP-2002-00003
Plutonium-241	CVP-2006-00011	Uranium-238	CVP-98-00006
Nonradionuclides			
4-Methyl-2-pentanone	CVP-2007-00006	Gamma-BHC (lindane)	RSVP-2006-055
4-Methylphenol (p-cresol)	RSVP-2004-014	Di-n-octylphthalate	RSVP-2006-055
Acetone	RSVP-2007-020	Dinoseb	RSVP-2006-055
Acenapthene	RSVP-2007-020	Endosulfan I	RSVP-2006-055
Aldrin	CVP-2007-00006	Endosulfan II	RSVP-2006-055
Alpha-BHC	RSVP-2006-055	Endosulfan sulfate	RSVP-2006-055
Alpha-chlordane	RSVP-2006-055	Endrin	RSVP-2006-055
Aluminum	DOE/RL-94-42	Endrin aldehyde	RSVP-2006-055
Anthracene	RSVP-2006-055	Endrin ketone	RSVP-2006-055
Antimony	CVP-2006-00011	Fluoranthene	RSVP-2006-055
Arsenic	CVP-2003-00015	Fluorene	RSVP-2006-055
Asbestos	RSVP-2005-038	Gamma-chlordane	RSVP-2006-055

Table D2-2. Summary of 100-BC Initial Target Analytes and References

Analyte	Example Reference	Analyte	Example Reference
Barium	CVP-2003-00015	Heptachlor	CVP-2007-00006
Benzene	CVP-2006-00011	Heptachlor epoxide	RSVP-2006-003
Benzo(a)anthracene	RSVP-2006-055	Indeno(1,2,3-cd)-pyrene	RSVP-2006-055
Benzo(a)pyrene	RSVP-2006-055	Iron	DOE/RL-94-42
Benzo(b)fluoranthene	RSVP-2006-055	Isophorone	RSVP-2004-014
Benzo(k)fluoranthene	RSVP-2006-055	Lead	CVP-98-00006
Benzo(g,h,i)perylene	RSVP-2006-055	Lithium	RSVP-2006-055
Beryllium	CVP-2006-00011	Magnesium	DOE/RL-94-42
Beta-BHC	RSVP-2006-055	Manganese	CVP-2006-00011
Bis[2-ethylhexyl]phthalate	CVP-2003-00008	Mercury	CVP-98-00006
Boron	CVP-2006-00011	Molybdenum	CVP-2006-00011
Butylbenzylphthalate	RSVP-2006-055	Naphthalene	RSVP-2007-020
Cadmium	CVP-2003-00015	Nickel	CVP-2006-00011
Calcium	DOE/RL-94-42	Nitrate (as nitrogen)	RSVP-2008-002
Carbazole	RSVP-2006-003	Nitrite	DOE/RL-91-07
Carbon tetrachloride	CVP-2007-00006	N-nitrosodiphenyl-amine	RSVP-2005-028
Chromium (total)	CVP-98-00006	Polychlorinated biphenyls	CVP-2003-00008
Chromium (hexavalent)	CVP-98-00006	Pentachlorophenol	RSVP-2006-055
Chrysene	RSVP-2006-055	Phenol	RSVP-2005-038
Cobalt	CVP-2006-00011	Phenanthrene	RSVP-2006-055
Copper	CVP-2006-00011	Picloram	CVP-2007-00006
Dalapon	CVP-2007-00006	Potassium	DOE/RL-94-42
DB;2,4- [4-(2,4-dichlorophenoxy)butanoic acid] (Butoxone)	RSVP-2006-055	Pyrene	RSVP-2006-055
Delta-BHC	RSVP-2006-003	Selenium	CVP-2003-00015
Dibenzo(a,h)anthracene	RSVP-2007-020	Silver	CVP-2003-00015
Dibenzofuran	RSVP-2006-055	Strontium	RSVP-2006-055
Dicamba	CVP-2007-00006	Sulfate	DOE/RL-94-42
Dichlorodiphenlydichlorethane (4,4'-DDD)	RSVP-2006-055	Tin	RSVP-2006-055
Dichlorodiphenyldichloroethylene (4,4'-DDE)	RSVP-2006-055	Titanium	RSVP-2006-055

Table D2-2. Summary of 100-BC Initial Target Analytes and References

Analyte	Example Reference	Analyte	Example Reference
Dichlorodiphenyltrichloroethane (4,4'-DDT)	RSVP-2006-055	Toluene	RSVP-2005-038
Dichlorophenoxyacetic acid; 2,4-	RSVP-2006-055	Total petroleum hydrocarbons	CVP-2006-00011
Dichloroprop	CVP-2007-00006	1,2,4-Trichlorobenzene	RSVP-2005-028
Dieldrin	CVP-2003-00006	2,4,5-Trichloropheno-xyacetic acid (2,4,5-T)	RSVP-2006-055
Diethylphthalate	RSVP-2006-003	2,4,5-Tp- [silvex; (2,4,5-Trichloro-phenoxy) Propionic Acid, 2]	RSVP-2006-055
Di-n-butylphthalate	RSVP-2006-003	Uranium	DOE/RL-2003-08
Methylene chloride	RSVP-2006-058	Vanadium	CVP-2006-00011
Methoxychlor	RSVP-2006-055	Xylenes (total)	RSVP-2006-058
Methylnaphthalene; 2-	RSVP-2005-028	100.Zinc	CVP-2006-00011

Notes:

CVP = cleanup verification package

RSVP = remaining sites verification package

Step 2 – 100-BC Master Target Analyte List

The exclusion criteria identified in Section D2.2 were applied to the initial soil target analyte list to identify the excluded analytes listed in Table D2-3. The list of groundwater COPCs was then reviewed to reconcile potential gaps. This resulted in the addition of thallium, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, chloroform, tetrachloroethene, trichloroethene, and vinyl chloride for soil. Radium-228 was identified as a groundwater COPC but was not added for soil based on soil exclusion criteria.

Exclusion of the analytes listed in Table D2-3 and inclusion of additional groundwater COPCs resulted in the master target analyte list presented in Table D2-4.

Table D2-3. 100-BC Soil Analytes Broadly Excluded from Further Consideration

Analyte	Exclusion Rationale
Radionuclides	
Cobalt-58	Half-life less than 3 years (70.856 d), stable daughter product
Cesium-134	Half-life less than 3 years (2.0662 y), stable daughter product
Ruthenium-106	Half-life less than 3 years (1.0235 y), stable daughter product
Sodium-22	Half-life less than 3 years (2.6036 y), stable daughter product
Potassium-40	Naturally-occurring background radiation not associated with 100 Area processes

Table D2-3. 100-BC Soil Analytes Broadly Excluded from Further Consideration

Analyte	Exclusion Rationale
Radium-226	Naturally-occurring background radiation not associated with 100 Area processes (insufficient in-growth time for potential introduction as decay daughter of Hanford U-234/Th-230)
Radium-228	Naturally-occurring background radiation not associated with 100 Area processes (present in secular equilibrium with parent Th-232 isotope)
Silver 108m	Present only as a potential trace impurity in certain irradiated materials; no confirmed detections in 100 Area samples to-date
Thorium-228	Naturally-occurring background radiation not associated with 100 Area processes (present in secular equilibrium with parent Ra-228 isotope)
Thorium-232	Naturally-occurring background radiation not associated with 100 Area processes
Nonradionuclides	
Acetone	Laboratory contaminant
bis[2-Ethylhexyl]phthalate	Laboratory contaminant
Di-n-butylphthalate	Laboratory contaminant
Methylene chloride	Laboratory contaminant
Calcium	Essential nutrient
Iron	Essential nutrient
Magnesium	Essential nutrient
Potassium	Essential nutrient
Sulfate	No toxicity information available
delta-BHC	No toxicity information available

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (pCi/g)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (pCi/g)	Groundwater Protection (pCi/g)	River Protection (pCi/g)	
Radionuclides					
Americium-241[b]	1	32.1	--[c]	--[c]	Gamma energy analysis
Cobalt-60[d]	0.05	1.4	13,900	27,800	
Cesium-137[d]	0.1	6.2	1,465	2,930	
Europium-152	0.1	3.3	--[c]	--[c]	
Europium-154	0.1	3.0	--[c]	--[c]	
Europium-155[d]	0.1	125	--[c]	--[c]	
Carbon-14[d]	2	8.69	--[c]	--[c]	LSC (C-14)
Nickel-63[d]	30	4,013	--[c]	--[c]	LSC (Ni-63)
Technetium-99[d]	0.25	5.8	0.46	0.92	LSC (Tc-99)
Tritium[d]	10	459	12.6	25.2	LSC (H-3)
Plutonium-238	1	38.8	--[c]	--[c]	Alpha energy analysis
Plutonium-239/240	1	35.1	--[c]	--[c]	
Plutonium-241	15	854	--[c]	--[c]	LSC (Pu-241)
Uranium-233/234	1	1.1	1.1	1.1	Alpha energy analysis
Uranium-235	0.5	0.61	0.5	0.5	
Uranium-238	1	1.1	1.1	1.1	
Iodine-129[d]	2	2	2	2	Low energy-gamma energy analysis
Strontium-90[d]	1	4.5	27.6	55.2	Gas flow proportional counting

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (mg/kg)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (mg/kg)	Groundwater Protection (mg/kg)	River Protection (mg/kg)	
Nonradionuclides					
Butylbenzylphthalate	0.33	16,000	893	698	EPA 8270 (SVOA)
Carbazole	0.33	50	0.33	--	
Dibenzofuran	0.33	160	7.36	--	
Diethylphthalate	0.33	64,000	72.2	259	
Di-n-octylphthalate	0.33	1,600	532,000	--	
Isophorone	0.33	1,050	0.33	15.4	
Methylnaphthalene; 2-	0.33	320	2.03	4.07	
Methylphenol; 4- (p-cresol)	0.33	400	0.507	1.01	
N-nitrosodiphenyl-amine	0.33	204	--	--	
Pentachlorophenol	0.33	8.33	0.33	0.33	
Phenol	0.33	24,000	11.0	192	
Trichlorobenzene; 1,2,4-	0.33	800	2.98	5.22	
Dalapon	0.1	2,400	0.811	1.62	EPA 8151 (herbicides)
DB;2,4- [4-(2,4-dichlorophenoxy)butanoic acid] (Butoxone)	0.1	640	0.768	--	
Dicamba	0.1	2,400	2.20	4.39	
Dichlorophenoxy-acetic acid; 2,4-	0.4	800	0.4	0.642	
Dichloroprop	0.1	640	0.321	0.642	
Dinoseb	0.33	80.0	0.524	1.05	
Picloram	0.1	5,600	2.18	4.36	
TP-; 2,4,5-(2,4,5-Trichlorophenoxy) Propionic acid, 2]	0.02	640	0.280	0.561	
Trichlorophenoxy-acetic acid; 2,4,5- (2,4,5-T)	0.02	800	0.761	1.59	

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (mg/kg)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (mg/kg)	Groundwater Protection (mg/kg)	River Protection (mg/kg)	
Dichlorodiphenlydi-chlorethane (4,4'-DDD)	0.0033	4.17	0.335	0.0033	EPA 8081 (pesticides)
Dichlorodiphenyldi-chloro-ethylene (4,4'-DDE)	0.0033	2.94	0.446	0.0033	
Dichlorodiphenyltri-chloro-ethane (4,4'-DDT)	0.0033	2.94	3.49	0.00965	
Aldrin	0.00165	0.0588	0.00504	0.00165	
Hexachlorocyclo-hexane; alpha (alpha-BHC, HCH)	0.00165	0.159	0.00165	0.00165	
Hexachlorocyclohexane; beta (beta-BHC, HCH)	0.00165	0.556	0.00227	0.00259	
Dieldrin	0.0033	0.0625	0.0033	0.0033	
Endosulfan I	0.00165	480	4.3	0.0833	
Endosulfan II	0.0033	480	4.3	0.0833	
Endosulfan sulfate	0.0033	480	4.3	0.0833	
Endrin	0.0033	24.0	0.440	0.335	
Endrin aldehyde	0.0033	24	0.2	0.039	
Endrin ketone	0.0033	24	0.2	0.039	
Lindane (Gamma-BHC) (1,2,3,4,5,6-hexachlorocyclo-hexane)	0.00165	0.769	0.00209	0.00238	
Heptachlor	0.00165	0.222	0.0370	0.00165	
Heptachlor epoxide	0.00165	0.110	0.008	0.00165	
Methoxychlor	0.0165	400	64.2	26.8	
Technical chlordane (alpha and gamma)	0.0165	2.86	2.06	0.0165	

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (mg/kg)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (mg/kg)	Groundwater Protection (mg/kg)	River Protection (mg/kg)	
Acenapthene	0.1	4,800	97.9	131	EPA-8310 (PAH)
Anthracene	0.05	2,270	1,140	9,100	
Benzo(a)anthracene	0.015	1.37	0.856	0.040	
Benzo(a)pyrene	0.015	0.137	2.33	0.109	
Benzo(b)fluoranthene	0.015	1.37	2.95	0.138	
Benzo(k)fluoranthene	0.015	1.37	21.5	0.138	
Benzo(g,h,i)perylene	0.03	2,400	25,700	7,070	
Chrysene	0.1	13.7	9.56	0.1	
Dibenzo(a,h) anthracene	0.03	1.37	4.29	0.200	
Fluoranthene	0.05	3,200	631	178	
Fluorene	0.03	3,200	101	411	
Indeno(1,2,3-cd)pyrene	0.03	1.37	8.33	0.389	
Naphthalene	0.1	1,600	4.46	275	
Phenanthrene	0.05	24,000	1,140	9,100	
Pyrene	0.05	2,400	655	2,620	

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (mg/kg)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (mg/kg)	Groundwater Protection (mg/kg)	River Protection (mg/kg)	
Aluminum	5	80,000	480,000	960,000	EPA 6010 (ICP metals)
Antimony[d]	6	32	5.4	25.3	
Arsenic[d]	10	20[e]	20[e]	20[e]	
Barium	2	16,000	1,650	3,300	
Beryllium[d]	0.5	160	63.2	126	
Boron	2	16,000	210	--	
Cadmium[d]	0.5	80	0.69	0.5	
Chromium (total)[d]	1	120,000	2,000	2,600	
Cobalt[d]	2	24	15.7	--	
Copper[d]	1	3,200	284	1,150	
Lead[d]	5	250	3,000	840	
Lithium	2.5	160	192	--	
Manganese[d]	5	3,760	512	512	
Molybdenum	2	400	32.3	--	
Nickel[d]	4	1,600	130	357	
Selenium[d]	1	400	5.2	1.04	
Silver	1	400	13.6	1	
Strontium	1	48,000	2,920	--	
Thallium[d]	5	5.6	1.59	4.45	
Tin	10	48,000	48,000	--	
Titanium	0.5	320,000	1,280,000	--	
Vanadium	2.5	560	2,240	--	
Zinc[d]	1	24,000	5,970	226	

Table D2-4. Master 100-BC Target Analyte List

Target Analyte	Estimated Quantitation Limit (mg/kg)	Preliminary Remediation Goals[a]			Analytical Methods
		Direct Exposure (mg/kg)	Groundwater Protection (mg/kg)	River Protection (mg/kg)	
Benzene[d]	0.005	18.2	0.005	0.014	EPA 8260 (volatile organics)
1,1-Dichloroethene[d]	0.01	1.67	0.01	0.028	
1,1,2,2-Tetrachloroethane[d]	0.005	5	0.005	0.005	
Carbon tetrachloride[d]	0.005	7.69	0.031	0.005	
Chloroform[d]	0.005	164	0.0381	0.0607	
Methyl isobutyl ketone (4-Methyl-2-pentanone)	0.01	6,400	2.71	--	
Tetrachloroethene[d]	0.005	800	0.0086	0.0083	
Trichloroethene[d]	0.005	11.2	0.0032	0.035	
Toluene	0.005	--	4.65	99	
Vinyl chloride[d]	0.01	240	0.01	0.025	
Xylenes (total)	0.01	16,000	14.6	183	
Nitrate[d]	2.5	128,000	40	80	EPA 300.0 (IC Anions) or EPA 353.2 (N in Nitrate and Nitrite)
Nitrite	2.5	8,000	4.0	8	
Asbestos	1%	--	--	--	Microscopy
Chromium (hexavalent)[d]	0.5	2.1[f]	18.4[e]	7.70[e]	EPA 7196 (Cr-VI)
Mercury[d]	0.2	24	2.09	0.33	EPA 7471 (Hg cold vapor)
Aroclor-1016 (PCB)	0.017	0.5	0.094	0.017	EPA 8082 (PCB by GC)
Aroclor-1221 (PCB)	0.017	0.5	0.017	0.017	
Aroclor-1232 (PCB)	0.017	0.5	0.017	0.017	
Aroclor-1242 (PCB)	0.017	0.5	0.0394	0.017	
Aroclor-1248 (PCB)	0.017	0.5	0.0386	0.017	
Aroclor-1254 (PCB)	0.017	0.5	0.0664	0.017	
Aroclor-1260 (PCB)	0.017	0.5	0.721	0.017	
Total petroleum hydrocarbons[d]	5	2,000	2,000	--	NWTPH-D+
Uranium (total)[d]	1	240	3.21	3.21	U-KPA or via isotopic analysis

Table D2-4. Master 100-BC Target Analyte List

Notes:

a. Preliminary remediation goals for individual radionuclides are based on attainment of total radionuclide excess dose rates as well as radionuclide-specific requirements. Additional details for the determination of these values are provided in DOE/RL-96-17. Preliminary remediation goals for human health for chemicals are calculated per WAC 173-340, Method B for (Ecology 2007) using input parameters from the most current values from Ecology's Cleanup Levels and Risk Calculations database (updated February 12, 2009) and including appropriate consideration of background and achievable quantitation limits per WAC 173-340 (Ecology 2007). Calculated soil values for protection of the Columbia River assume a groundwater-to-river dilution attenuation factor of 2 based on practice for interim remedial actions.

b. If strong gamma emissions interfere with analysis of Am-241, Am-241 can be analyzed using a Cm/Am Alpha Emission Analysis method.

c. Radionuclide is not predicted to impact groundwater (and, thus, the Columbia River) in 1,000 years based on modeling assuming no uncontaminated vadose zone.

d. Analyte identified as a groundwater contaminant of potential concern.

e. Tasks are included in DOE/RL-2008-46, Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan to reevaluate arsenic and hexavalent chromium cleanup levels. Values listed for arsenic are based on the use of WAC 173-340, Method A for approved interim remedial action goals, further described in DOE/RL-96-17.

f. Carcinogenic cleanup level calculated based on the inhalation exposure pathway per WAC 173-340-750 (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m^3.

--	=	not applicable	KPA	=	kinetic phosphorescence analysis
EPA	=	U.S. Environmental Protection Agency	PAH	=	polycyclic aromatic hydrocarbon
GC	=	gas chromatograph	PCB	=	polychlorinated biphenyl
IC	=	ion chromatography	SVOA	=	semi-volatile organic analysis
ICP	=	inductively coupled plasma	VOA	=	volatile organic analysis
LSC	=	liquid scintillation counting	WAC	=	Washington Administrative Code

Steps 3 and 4 – Location Specific Target Analyte Identification and Agency Input

1. The IAROD COCs and COPCs for each specific waste site where characterization is proposed were identified (which reflects information from LFI and technical baseline reports). The default decision was to carry these analytes forward as target analytes for site-specific characterization unless a specific basis was available to eliminate them.

2. The interim cleanup verification COCs and COPCs for each specific waste site where characterization is proposed were identified. The default decision was to carry these analytes forward as target analytes for site-specific characterization unless a specific basis was available to eliminate them.

3. Global 100-BC groundwater COPCs were identified. These analytes were retained for site-specific characterization without further consideration, with the exception of total uranium, total petroleum hydrocarbons, and radionuclides for the 118-B-6 Burial Ground. Radioactive risk is a greater driver for uranium in soil than chemical risk; uranium isotopes were evaluated on a site-by-site basis, and total uranium was excluded for all sites. Total petroleum hydrocarbons were identified as a groundwater COPC based on inclusion in the soil master target analyte list and limited available groundwater data. Total petroleum hydrocarbons were evaluated for inclusion for soils on a

site-specific basis. Sufficient basis is available from remediation of the 118-B-6 Burial Ground to preclude the need for additional analysis for all radionuclides.

4. The remaining analytes from the 100-BC master list were considered individually on a site-specific basis. The default decision was to carry these analytes forward as target analytes for characterization unless a specific basis was available to eliminate them. Specific lead agency input was incorporated in these considerations.

Analytes that were not retained for site-specific characterization at any of the proposed waste sites at the conclusion of this process are listed in Table D2-5 for convenience.

Table D2-5. Analytes Excluded for All Proposed Characterization Locations

Analyte	Exclusion Basis
Plutonium-241	Component of spent nuclear fuel that does not measurably contribute to potential risk relative to its ratio to other constituents of spent nuclear fuel
Phenol	No environmental persistence – readily biodegradable organic compound
Dalapon	No known discharges of herbicides to waste sites proposed for characterization. No significant detections of herbicides (relative to action thresholds) in 100 Area soil samples collected to-date.
DB;2,4- [4-(2,4-dichlorophenoxy)butanoic acid] (Butoxone)	
Dicamba	
Dichlorophenoxy-acetic acid; 2,4-	
Dichloroprop	
Dinoseb	
Picloram	
TP-; 2,4,5-(2,4,5-Trichlorophenoxy) Propionic acid, 2]	
Trichlorophenoxy-acetic acid; 2,4,5-(2,4,5-T)	
Aldrin	No known discharges of pesticides to waste sites proposed for characterization. Potential incidental discharges would not be significant relative to other waste streams.
Dichlorodiphenlydi-chlorethane (4,4'-DDD)	
Dichlorodiphenyldi-chloro-ethylene (4,4'-DDE)	
Dichlorodiphenyltri-chloro-ethane (4,4'-DDT)	
Dieldrin	
Endosulfan I	
Endosulfan II	

Table D2-5. Analytes Excluded for All Proposed Characterization Locations

Analyte	Exclusion Basis
Endosulfan sulfate	No known discharges of pesticides to waste sites proposed for characterization. Potential incidental discharges would not be significant relative to other waste streams.
Endrin	
Endrin aldehyde	
Endrin ketone	
Hexachlorocyclo-hexane; alpha (alpha-BHC, HCH)	
Hexachlorocyclohexane; beta (beta-BHC, HCH)	
Hexachlorocyclo-hexane; delta (delta-BHC, HCH)	
Lindane (Gamma-BHC) (1,2,3,4,5,6-hexachlorocyclo-hexane)	
Heptachlor	
Heptachlor epoxide	
Methoxychlor	
Technical chlordane (alpha and gamma)	
Butylbenzylphthalate	No known discharges of these organics to waste sites proposed for characterization. No significant detections of herbicides (relative to action thresholds) in 100 Area soil samples collected to-date.
Dibenzofuran	
Diethyphthalate	
Di-n-octylphthalate	
Isophorone	
Methylnaphthalene; 2-	
Methyl isobutyl ketone (4-Methyl-2-pentanone)	
Methyl phenol; 4-	
N-nitrosodiphenyl-amine	
Pentachlorophenol	
Toluene	
Trichlorbenzene; 1,2,4-	
Xylenes (total)	
Carbazole	These organics are potentially present only in association with oils and solid bituminous materials used in construction. These compounds do not represent a significant potential contributor to cumulative risk in the quantities they would be present in relative to other polycyclic aromatic hydrocarbons.
Acenaphthene	
Anthracene	
Fluorene	

Table D2-5. Analytes Excluded for All Proposed Characterization Locations

Analyte	Exclusion Basis
Molybdenum	Not associated with Hanford processes except as solid metals in equipment and in trace impurities.
Tin	
Titanium	
Vanadium	
Strontium	Not significant as a non-radionuclide. Radioactive risk is a greater driver for strontium-90 than chemical risk.
Asbestos	Potentially present in mastic coatings and facilities, but would not have an impact to remaining soils.
Uranium (total)	Radioactive risk is a greater driver for uranium than chemical risk. Uranium isotopes are addressed on a site-by-site basis.
Nitrite	Limited environmental persistence; not associated with waste sites proposed for characterization.

The product of steps three and four is the identification of location-specific target analyte lists for the remedial investigation. Tables D2-6 through D2-14 present the target analytes that were retained and analytes that were excluded on a site-specific basis.

Table D2-6. 100-B-5 Trench Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	IAROD/CVP
Cesium-137	IAROD/CVP; groundwater COPC
Cobalt-60	IAROD/CVP; groundwater COPC
Europium-152	IAROD/CVP
Europium-154	IAROD/CVP
Europium-155	IAROD/CVP; groundwater COPC
Nickel-63	Potentially present with other fission products as a contributor to cumulative risk; groundwater COPC
Plutonium-238	IAROD/CVP
Plutonium-239/240	IAROD/CVP
Strontium-90	IAROD/CVP; groundwater COPC
Iodine-129	Groundwater COPC
Tritium	Groundwater COPC
Carbon-14	Groundwater COPC
Technetium-99	Groundwater COPC

Table D2-6. 100-B-5 Trench Target Analytes

Target Analyte	Inclusion Rationale
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion – potentially present due to use in reactor and potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	IAROD/CVP; groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	Groundwater COPC
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	IAROD/CVP; groundwater COPC
Chromium (hexavalent)	IAROD/CVP; groundwater COPC
1,1-Dichloroethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Nitrate	Groundwater COPC

Table D2-6. 100-B-5 Trench Target Analytes

Target Analyte	Inclusion Rationale
Excluded Analytes	
Uranium-233/234	Not present at activities significant for potential cumulative dose risk near the preliminary remediation goal relative to other isotopes in general radioactive liquid effluent waste. Uranium-238 was not detected was not detected above background levels in previous cleanup verification sampling.
Uranium-235	
Uranium-238	
Aluminum	**Not associated with reactor cooling systems except as solid metals and in trace impurities.**
Barium	
Lithium	
Benzo(a)anthracene	May have been present in former pipe mastic coatings and sealants. No significant discharge of organic chemicals to radioactive liquid effluent process sewers.
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total petroleum hydrocarbons	
Aroclor-1016	Potentially present in radioactive liquid waste only as a trace impurity from sealing compounds. Past water leakage from pipelines would not contain an environmentally significant total inventory.
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-7. 116-B-5 Crib Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Cesium-137	IAROD/closure documentation; groundwater COPC
Cobalt-60	IAROD/closure documentation; groundwater COPC
Europium-152	IAROD/closure documentation
Europium-154	IAROD/closure documentation
Europium-155	IAROD/closure documentation; groundwater COPC
Nickel-63	Potentially present with other fission products as a contributor to cumulative risk; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Associated with site process history; groundwater COPC
Iodine-129	Groundwater COPC
Strontium-90	Groundwater COPC
Carbon-14	Groundwater COPC
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Barium	IAROD/closure documentation
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion –potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	Groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	Groundwater COPC
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	IAROD/closure documentation; groundwater COPC
Chromium (hexavalent)	Groundwater COPC
1,1-Dichloroethene	Groundwater COPC

Table D2-7. 116-B-5 Crib Target Analytes

Target Analyte	Inclusion Rationale
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl Chloride	Groundwater COPC
Nitrate	Groundwater COPC
Excluded Analytes	
Americium-241	Not associated with tritium separation/production process.
Plutonium-238	
Plutonium-239/240	
Uranium-233/234	
Uranium-235	
Uranium-238	
Aluminum	Associated with tritium production process only as solid metals; no credible potential for discharge to crib.
Lithium	
Benzo(a)anthracene	May have been present in former pipe mastic coatings and sealants. No known or expected discharges of oils to crib.
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total Petroleum Hydrocarbons	No known or expected discharges of oils to crib.

Table D2-7. 116-B-5 Crib Target Analytes

Target Analyte	Inclusion Rationale
Aroclor-1016	No known or expected usage of polychlorinated biphenyls associated with crib. Not detected at waste site during the limited field investigation.
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Notes:

COPC = contaminant of potential concern

IAROD = interim action Record of Decision

Table D2-8. 116-B-6B Crib Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	Potentially present – limited available characterization data
Cesium-137	Potentially present – limited available characterization data; groundwater COPC
Cobalt-60	Potentially present – limited available characterization data; groundwater COPC
Europium-152	Potentially present – limited available characterization data
Europium-154	Potentially present – limited available characterization data
Europium-155	Potentially present – limited available characterization data; groundwater COPC
Carbon-14	Potentially present – limited available characterization data; groundwater COPC
Nickel-63	Potentially present with other fission products as a contributor to cumulative risk; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Groundwater COPC
Plutonium-238	Potentially present – limited available characterization data
Plutonium-239/240	Potentially present – limited available characterization data
Iodine-129	Groundwater COPC
Strontium-90	Potentially present – limited available characterization data; groundwater COPC

Table D2-8. 116-B-6B Crib Target Analytes

Target Analyte	Inclusion Rationale
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion – potentially present due to use in reactor and potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	Groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	IAROD/CVP; groundwater COPC
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	Groundwater COPC
Chromium (hexavalent)	Groundwater COPC
1,1-Dichloroethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl Chloride	Groundwater COPC
Nitrate	Groundwater COPC
Excluded Analytes	
Uranium-233/234	Not present at activities significant for potential cumulative dose risk near the preliminary remediation goal relative to other isotopes in general radioactive liquid effluent waste. Uranium-238 was not detected was not detected above background levels in previous cleanup verification sampling.
Uranium-235	
Uranium-238	

Table D2-8. 116-B-6B Crib Target Analytes

Target Analyte	Inclusion Rationale
Aluminum	Not associated with irradiated spacers or general contaminated equipment except as solid materials.
Barium	
Lithium	
Benzo(a)anthracene	May have been present in former pipe mastic coatings and sealants. No known or expected discharges of oils to crib.
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total petroleum hydrocarbons	
Aroclor-1016	No known usage of polychlorinated biphenyls at the 111-B facility or other basis for potential discharge to the crib.
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-9. 116-B-9 French Drain Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	Incomplete basis for exclusion
Cesium-137	IAROD/CVP; groundwater COPC
Cobalt-60	IAROD/CVP; groundwater COPC
Europium-152	IAROD/CVP
Europium-154	IAROD/CVP
Europium-155	IAROD/CVP; groundwater COPC
Carbon-14	Groundwater COPC
Nickel-63	Potentially present with other fission products as a contributor to cumulative risk; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	IAROD/CVP; groundwater COPC
Plutonium-238	Incomplete basis for exclusion
Plutonium-239/240	Incomplete basis for exclusion
Iodine-129	Groundwater COPC
Strontium-90	Incomplete basis for exclusion; groundwater COPC
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion – potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	Groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	Groundwater COPC
Lithium	Associated with site process history (solid irradiated lithium targets)
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC

Table D2-9. 116-B-9 French Drain Target Analytes

Target Analyte	Inclusion Rationale
Zinc	Groundwater COPC
Mercury	Groundwater COPC
Chromium (hexavalent)	Groundwater COPC
1,1-Dichloroethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Nitrate	Groundwater COPC
Excluded Analytes	
Uranium-233/234	Not associated with tritium separation/production process.
Uranium-235	
Uranium-238	
Aluminum	Associated with tritium production process only as solid metals; no credible potential for discharge to crib.
Barium	
Benzo(a)anthracene	May have been present in former pipe mastic coatings and sealants. No known or expected discharges of oils to crib.
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total petroleum hydrocarbons	

Table D2-9. 116-B-9 French Drain Target Analytes

Target Analyte	Inclusion Rationale
Aroclor-1016	No known or expected usage of polychlorinated biphenyls associated with crib.
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-10. 116-B-14 Trench Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	IAROD/CVP
Cesium-137	IAROD/CVP; groundwater COPC
Cobalt-60	IAROD/CVP; groundwater COPC
Europium-152	IAROD/CVP
Europium-154	IAROD/CVP
Europium-155	IAROD/CVP; groundwater COPC
Carbon-14	Incomplete basis for exclusion; groundwater COPC
Nickel-63	Potentially present with other fission products as a contributor to cumulative risk; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Groundwater COPC
Plutonium-238	IAROD/CVP
Plutonium-239/240	IAROD/CVP
Iodine-129	Groundwater COPC
Strontium-90	IAROD/CVP; groundwater COPC
Uranium-238	Vadose Zone COC
Chromium (hexavalent)	IAROD/CVP; groundwater COPC
Aluminum	Incomplete basis for exclusion
Antimony	Groundwater COPC

Table D2-10. 116-B-14 Trench Target Analytes

Target Analyte	Inclusion Rationale
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion – potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	IAROD/CVP; groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	IAROD/CVP; groundwater COPC
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	IAROD/CVP; groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
1,1-Dichlorethene	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Vinyl Chloride	Groundwater COPC
Nitrate	Groundwater COPC
Aroclor-1221	Potentially present in disposed sludge, incomplete basis for exclusion
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	
Aroclor-1221	
Excluded Analytes	
Uranium-233/234	Not present at activities significant for potential cumulative dose risk near the preliminary remediation goal relative to other isotopes in general radioactive liquid effluent waste. Uranium-238 was not detected was not detected above background levels in previous cleanup verification sampling.
Uranium-235	

Table D2-10. 116-B-14 Trench Target Analytes

Target Analyte	Inclusion Rationale
Barium	Not associated with reactor cooling systems except as solid metals and in trace impurities.
Lithium	
Benzo(a)anthracene	May have been present in former pipe and facility mastic coatings and sealants. No significant discharge of organic chemicals to radioactive liquid effluent process sewers.
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd) pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total petroleum hydrocarbons	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-11. 118-B-6 Burial Ground Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Tritium	IAROD/CVP; groundwater COPC
Iodine-129	Groundwater COPC; limited available characterization data for beta-emitters
Strontium-90	Groundwater COPC; limited available characterization data for beta-emitters
Aluminum	Associated with site process history (solid aluminum wastes)
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Cadmium	Groundwater COPC
Chromium (total)	Groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC

Table D2-11. 118-B-6 Burial Ground Target Analytes

Target Analyte	Inclusion Rationale
Lead	IAROD/CVP; groundwater COPC
Lithium	Associated with site process history (solid lithium wastes)
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	IAROD/CVP; groundwater COPC
Chromium (hexavalent)	Groundwater COPC
1,1-Dichlorethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Nitrate	Groundwater COPC
Excluded Analytes	
Target Analyte	Exclusion Rationale
Americium-241	The 118-B-6 Burial Ground received a unique radionuclide waste stream by design, limited to specific tritium separation project wastes. Field-screening during remediation confirmed the absence of other potential radionuclides.
Cobalt-60	
Cesium-137	
Europium-152	
Europium-154	
Europium-155	
Carbon-14	
Nickel-63	
Technetium-99	
Plutonium-238	
Plutonium-239/240	The 118-B-6 Burial Ground received a unique radionuclide waste stream by design, limited to specific tritium separation project wastes. Field-screening during remediation confirmed the absence of other potential radionuclides.
Uranium-233/234	
Uranium-235	
Uranium-238	

Table D2-11. 118-B-6 Burial Ground Target Analytes

Target Analyte	Inclusion Rationale
Silver	Not associated with solid wastes formerly disposed at site.
Boron	
Barium	
Benzo(a)anthracene	
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h) anthracene	
Fluoranthene	
Indeno(1,2,3-cd) pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total petroleum hydrocarbons	
Aroclor-1016	
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-12. 118-B-8:1 Reactor Fuel Storage Basin and 118-B-8:3 Process Sewer Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	IAROD/RSVP
Cobalt-60	IAROD/RSVP; groundwater COPC
Cesium-137	IAROD/RSVP; groundwater COPC

Table D2-12. 118-B-8:1 Reactor Fuel Storage Basin and 118-B-8:3 Process Sewer Target Analytes

Target Analyte	Inclusion Rationale
Europium-152	IAROD/RSVP
Europium-154	IAROD/RSVP
Europium-155	IAROD/RSVP; groundwater COPC
Carbon-14	IAROD/RSVP; groundwater COPC
Nickel-63	IAROD/RSVP; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Groundwater COPC
Plutonium-238	IAROD/RSVP
Plutonium-239/240	IAROD/RSVP
Uranium -234	IAROD/RSVP
Uranium-235	IAROD/RSVP
Uranium-238	IAROD/RSVP
Iodine-129	Groundwater COPC
Strontium-90	IAROD/RSVP; groundwater COPC
Chromium (hexavalent)	IAROD/RSVP; groundwater COPC
Antimony	Groundwater COPC
Arsenic	IAROD/RSVP; groundwater COPC
Barium	IAROD/RSVP
Beryllium	IAROD/RSVP; groundwater COPC
Boron	IAROD/RSVP
Cadmium	IAROD/RSVP; groundwater COPC
Chromium (total)	IAROD/RSVP; groundwater COPC
Cobalt	IAROD/RSVP; groundwater COPC
Copper	IAROD/RSVP; groundwater COPC
Lead	IAROD/RSVP; groundwater COPC
Manganese	IAROD/RSVP; groundwater COPC
Nickel	IAROD/RSVP; groundwater COPC
Selenium	IAROD/RSVP; groundwater COPC
Silver	IAROD/RSVP; groundwater COPC
Thallium	Groundwater COPC
Zinc	IAROD/RSVP; groundwater COPC

Table D2-12. 118-B-8:1 Reactor Fuel Storage Basin and 118-B-8:3 Process Sewer Target Analytes

Target Analyte	Inclusion Rationale
Mercury	IAROD/RSVP; groundwater COPC
Nitrate	Groundwater COPC
1,1-Dichlorethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Aroclor-1016	IAROD/RSVP
Aroclor-1221	IAROD/RSVP
Aroclor-1232	IAROD/RSVP
Aroclor-1242	IAROD/RSVP
Aroclor-1248	IAROD/RSVP
Aroclor-1254	IAROD/RSVP
Aroclor-1260	IAROD/RSVP
Benzo(a)anthracene	IAROD/RSVP
Benzo(a)pyrene	IAROD/RSVP
Benzo(b)fluoranthene	IAROD/RSVP
Benzo(ghi)perylene	IAROD/RSVP
Benzo(k)fluoranthene	IAROD/RSVP
Chrysene	IAROD/RSVP
Dibenzo(a,h)anthracene	IAROD/RSVP
Fluoranthene	IAROD/RSVP
Indeno(1,2,3-cd)-pyrene	IAROD/RSVP
Naphthalene	IAROD/RSVP
Phenanthrene	IAROD/RSVP
Pyrene	IAROD/RSVP
Total petroleum hydrocarbons	Incomplete basis for exclusion – potentially present based on polycyclic aromatic hydrocarbon detections
Nitrate	Groundwater COPC

Table D2-12. 118-B-8:1 Reactor Fuel Storage Basin and 118-B-8:3 Process Sewer Target Analytes

Target Analyte	Inclusion Rationale
Excluded Analytes	
Aluminum	Not associated with fuel storage basin or process sewers except as solid materials and in trace impurities.
Lithium	

Notes:

COPC = contaminant of potential concern

IAROD = interim action Record of Decision

RSVP = remaining sites verification package

Table D2-13. 118-C-3:2 Reactor Fuel Storage Basin Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	IAROD/CVP
Cesium-137	IAROD/CVP; groundwater COPC
Cobalt-60	IAROD/CVP; groundwater COPC
Europium-152	IAROD/CVP
Europium-154	IAROD/CVP
Europium-155	IAROD/CVP; groundwater COPC
Carbon-14	IAROD/CVP; groundwater COPC
Nickel-63	IAROD/CVP; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Groundwater COPC
Plutonium-238	IAROD/CVP
Plutonium-239/240	IAROD/CVP
Uranium-233/234	IAROD/CVP
Uranium-235	IAROD/CVP
Uranium-238	IAROD/CVP
Iodine-129	Groundwater COPC
Strontium-90	IAROD/CVP; groundwater COPC
Antimony	Groundwater COPC
Arsenic	IAROD/CVP; groundwater COPC
Barium	IAROD/CVP

Table D2-13. 118-C-3:2 Reactor Fuel Storage Basin Target Analytes

Target Analyte	Inclusion Rationale
Beryllium	IAROD/CVP; groundwater COPC
Boron	IAROD/CVP
Cadmium	Groundwater COPC
Chromium (total)	IAROD/CVP; groundwater COPC
Cobalt	IAROD/CVP; groundwater COPC
Copper	IAROD/CVP; groundwater COPC
Lead	IAROD/CVP; groundwater COPC
Manganese	IAROD/CVP; groundwater COPC
Nickel	IAROD/CVP; groundwater COPC
Selenium	IAROD/CVP; groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	IAROD/CVP; groundwater COPC
Chromium (hexavalent)	IAROD/CVP; groundwater COPC
Mercury	IAROD/CVP; groundwater COPC
Benzene	Groundwater COPC
1,1-Dichlorethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Carbon tetrachloride	Groundwater COPC
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Aroclor-1016	IAROD/CVP
Aroclor-1221	IAROD/CVP
Aroclor-1232	IAROD/CVP
Aroclor-1242	IAROD/CVP
Aroclor-1248	IAROD/CVP
Aroclor-1254	IAROD/CVP
Aroclor-1260	IAROD/CVP

Table D2-13. 118-C-3:2 Reactor Fuel Storage Basin Target Analytes

Target Analyte	Inclusion Rationale
Benzo(a)anthracene	Incomplete basis for exclusion – potentially present due to use of mastics and oils
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(g,h,i)perylene	
Benzo)k)fluoranthene	
Chrysene	
Dibenzo(a,h)anthracene	
Fluoranthene	
Indeno(1,2,3-cd)-pyrene	
Pyrene	
Total petroleum hydrocarbons	Incomplete basis for exclusion – potentially present due to use of mastics and oils
Nitrate	Groundwater COPC
Excluded Analytes	
Aluminum	Not associated with fuel storage basin or process sewers except as solid materials and in trace impurities.
Lithium	
Naphthalene	These compounds do not represent a significant potential contributor to cumulative risk in the quantities they would be present in relative to other polycyclic aromatic hydrocarbons.
Phenanthrene	

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

Table D2-14. 116-C-5 Retention Basin Target Analytes

Target Analyte	Inclusion Rationale
Retained Analytes	
Americium-241	IAROD/CVP
Cobalt-60	IAROD/CVP; groundwater COPC
Cesium-137	IAROD/CVP; groundwater COPC
Europium-152	IAROD/CVP
Europium-154	IAROD/CVP
Europium-155	IAROD/CVP; groundwater COPC

Table D2-14. 116-C-5 Retention Basin Target Analytes

Target Analyte	Inclusion Rationale
Carbon-14	Groundwater COPC
Nickel-63	IAROD/CVP; groundwater COPC
Technetium-99	Groundwater COPC
Tritium	Groundwater COPC
Plutonium-238	IAROD/CVP
Plutonium-239/240	IAROD/CVP
Uranium-238	IAROD/CVP
Iodine-129	Groundwater COPC
Strontium-90	IAROD/CVP; groundwater COPC
Chromium (hexavalent)	IAROD/CVP; groundwater COPC
Antimony	Groundwater COPC
Arsenic	Groundwater COPC
Beryllium	Groundwater COPC
Boron	Incomplete basis for exclusion – potential ecological risk driver
Cadmium	Groundwater COPC
Chromium (total)	IAROD/CVP; groundwater COPC
Cobalt	Groundwater COPC
Copper	Groundwater COPC
Lead	IAROD/CVP; groundwater COPC
Manganese	Groundwater COPC
Nickel	Groundwater COPC
Selenium	Groundwater COPC
Silver	Incomplete basis for exclusion
Thallium	Groundwater COPC
Zinc	Groundwater COPC
Mercury	IAROD/CVP; groundwater COPC
Nitrate	Groundwater COPC
1,1-Dichlorethene	Groundwater COPC
1,1,2,2-Tetrachloroethane	Groundwater COPC
Benzene	Groundwater COPC
Carbon tetrachloride	Groundwater COPC

Table D2-14. 116-C-5 Retention Basin Target Analytes

Target Analyte	Inclusion Rationale
Chloroform	Groundwater COPC
Tetrachloroethene	Groundwater COPC
Trichloroethene	Groundwater COPC
Vinyl chloride	Groundwater COPC
Benzo(a)anthracene	Incomplete basis for exclusion – may be present due to use of bituminous mastics and sealants; previously detected at trace concentrations
Benzo(a)pyrene	
Benzo(k)fluoranthene	
Chrysene	
Fluoranthene	
Total petroleum hydrocarbons	Incomplete basis for exclusion - potentially present based on polycyclic aromatic hydrocarbon detections
Excluded Analytes	
Uranium-233/234	Not present at activities significant for potential cumulative dose risk near the preliminary remediation goal relative to other isotopes in general radioactive liquid effluent waste. Uranium-238 was not detected was not detected above background levels in previous cleanup verification sampling.
Uranium-235	
Aluminum	Not associated with reactor cooling systems except as solid metals and in trace impurities.
Barium	
Lithium	
Benzo(b)fluoranthene	Potentially formerly present in mastics and bituminous sealants, but not detected in previous characterization sampling.
Benzo(g,h,i)perylene	
Dibenzo(a,h)anthracene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Pyrene	
Phenanthrene	
Aroclor-1016	Not detected during previous limited field investigation characterization.
Aroclor-1221	
Aroclor-1232	
Aroclor-1242	
Aroclor-1248	
Aroclor-1254	
Aroclor-1260	

Table D2-14. 116-C-5 Retention Basin Target Analytes

Target Analyte	Inclusion Rationale

Notes:

COPC = contaminant of potential concern

CVP = cleanup verification package

IAROD = interim action Record of Decision

D2.6 Conclusions

This approach provides for a systematic identification of analytes of potential interest, considering available data and recognized potential deficiencies. The analytical methods identified in Table 4 should be verified and documented in the quality assurance project plan section of the sampling and analysis plan for the 100-BC remedial investigation. As additional soil and groundwater data become available, other suitable exclusion criteria should be considered and evaluated for use in the target analyte list development process.

D2.7 References

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DOH	Washington State Department of Health
DQA	data quality assessment
Ecology	Washington State Department of Ecology
EQL	estimated quantitation limit
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
OU	operable unit
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOA	volatile organics analysis
VOC	volatile organic compound
WAC	*Washington Administrative Code*

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1 Introduction

This sampling and analysis plan (SAP) supports the remedial investigation (RI)/feasibility study (FS) process for 100-BC. The 100-BC Area is located on the Hanford Site in southeastern Washington and is associated with two source operable units (OUs), 100-BC-1 OU and 100-BC-2 OU. The 100-BC-5 Groundwater OU underlies the two-source operable units. This SAP describes the sampling and analysis to be performed associated with environmental investigation borings (boreholes), test pits, and groundwater monitoring wells. Figure 1-1 shows the location of the planned and existing boreholes, test pits, and groundwater monitoring wells within the scope of this SAP. Table 1-1 presents the intersection of data gaps discussed in the addendum and sampling and analysis activities. The 100-BC RI/FS Work Plan, Chapter 2, describes the site background and, environmental setting of 100-BC (DOE/RL-2008-46-ADD3, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan Addendum 3: 100 BC-1, 100-BC-2, and 100-BC-5 Operable Units).*

Table 1-1. Plan Activities and Data Gaps

Planned Activity	100-BC Quantity	100-BC Location	Data Needs No.
Soil sample collection – Leach test	1*	100-C-7	1, 7
New boreholes (vadose zone)**	7	100-B-5 Trench 116-B-5 Crib 116-B-14 Trench 116-C-5 Retention Basin 118-B-6 Burial Ground 118-B-8:1 Reactor Fuel Storage Basin 118-C-3 Reactor Fuel Storage Basin	2, 3
New test pits (vadose zone)	3	116-B-6B Crib 116-B-9 French Drain 118-B-8:3 Process Sewer	2
New wells (unconfined aquifer)**	5	Well No. 1 Well No. 2 Well No. 3 Well No. 4 Well No. 5	4, 7
New well (Water-bearing Ringold Upper Mud Unit)**	1	Well No. 6	4, 6
Groundwater upwelling (pore water) samples	10	10 existing locations, with additional locations possible based on results	5
Sample spatial/temporal uncertainty groundwater monitoring wells	18	18 existing locations (includes 4 monitoring wells installed under DOE/RL-2009-61)	8

Notes:

* Samples will be collected during the remediation of 100-C-7. More than one sample may be collected for leach testing as necessary.

** Boreholes and groundwater monitoring wells will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples also will be logged.

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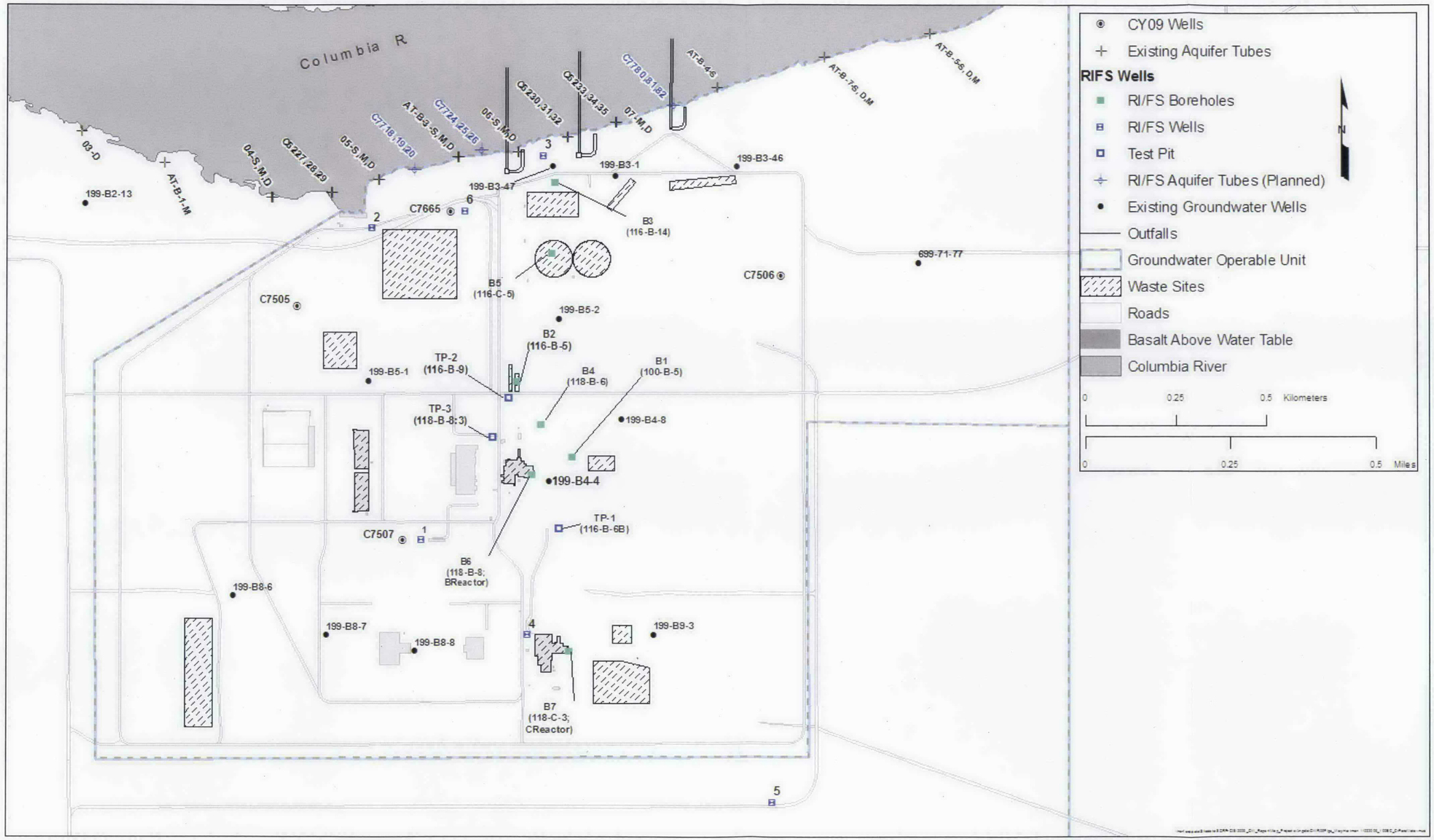

Figure 1-1. 100-BC Planned New Sampling Locations

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1.1 Vadose Zone Characterization

This SAP describes activities planned to characterize the vadose zone at 10 waste sites within 100-BC, and at six groundwater monitoring well locations. In addition, soil will be collected from the 100-C-7 waste site for leach testing, in support of Data Gap Nos. 1 and 7, as described in Table 3-1. The following waste sites will be characterized by drilling a borehole to groundwater within the waste site boundary.

- 100-B-5 Trench
- 116-B-5 Crib
- 116-B-14 Trench
- 116-C-5 Retention Basin
- 118-B-6 Burial Ground
- 118-B-8 Reactor Fuel Storage Basin
- 118-C-3 Reactor Fuel Storage Basin

Additionally, the following waste sites will be characterized by test pit excavations.

- 116-B-6B Crib
- 116-B-9 French Drain
- 118-B-8:3 Process Sewer

Groundwater wells drilled as part of the 100-BC RI also will have vadose zone soil samples collected during drilling. Samples will be collected and analyzed to evaluate the nature and extent of contamination at the subject waste sites.

1.2 Groundwater Characterization

Groundwater samples will be collected and analyzed from new and existing groundwater monitoring wells. The groundwater monitoring wells will be sampled and analyzed to define the extent of contamination and to support evaluation of contaminant transport. Where possible, new well locations and construction have been selected to satisfy multiple project data needs, such as delineating vadose zone and groundwater contamination. In addition, pore water will be sampled as presented in Section 3.5.2.

1.3 Target Analytes and Contaminants of Potential Concern

This section presents the master soil and groundwater contaminant lists.

1.3.1 Soil Target Analytes

Table 1-2 presents the soil target analytes. The detailed bases of target analyte selection is provided in Appendix D. Waste site-specific constituents for analysis are based on the master list.

Table 1-2. Master Soil Target Analyte List for the 100-BC OUs

Radionuclides	Non-radionuclides		
Americium-241	Butylbenzylphthalate	Lindane (Gamma-BHC) (1,2,3,4,5,6-hexachlorocyclo-hexane)	Nickel
Cobalt-60	Carbazole	Heptachlor	Selenium

Table 1-2. Master Soil Target Analyte List for the 100-BC OUs

Radionuclides	Non-radionuclides		
Cesium-137	Dibenzofuran	Heptachlor epoxide	Silver
Europium-152	Diethylphthalate	Methoxychlor	Strontium
Europium-154	Di-n-octylphthalate	Technical chlordane (alpha and gamma)	Thallium
Europium-155	Isophorone	Acenaphthene	Tin
Carbon-14	Methylnaphthalene; 2-	Anthracene	Titanium
Nickel-63	Methylphenol; 4- (p-cresol)	Benzo(a)anthracene	Vanadium
Technetium-99	N-nitrosodiphenyl-amine	Benzo(a)pyrene	Zinc
Tritium	Pentachlorophenol	Benzo(b)fluoranthene	Benzene
Plutonium-238	Phenol	Benzo(k)fluoranthene	1,1-Dichloroethene
Plutonium-239/240	Trichlorobenzene; 1,2,4-	Benzo(g,h,i)perylene	1,1,2,2-Tetrachloroethane
Plutonium-241	Dalapon	Chrysene	Carbon tetrachloride
Uranium-233/234	DB;2,4- [4-(2,4-dichlorophenoxy)butanoic acid] (Butoxone)	Dibenzo(a,h) anthracene	Chloroform
Uranium-235	Dicamba	Fluoranthene	Methyl isobutyl ketone (4-Methyl-2-pentanone)
Uranium-238	Dichlorophenoxy-acetic acid; 2,4-	Fluorene	Tetrachloroethene
Iodine-129	Dichloroprop	Indeno(1,2,3-cd)pyrene	Trichloroethene
Strontium-90	Dinoseb	Naphthalene	Toluene
	Picloram	Phenanthrene	Vinyl chloride
	TP-; 2,4,5-(2,4,5-Trichlorophenoxy) Propionic acid, 2]	Pyrene	Xylenes (total)
	Trichlorophenoxy-acetic acid; 2,4,5- (2,4,5-T)	Aluminum	Nitrate
	4,4'-Dichlorodiphenyldi-chlorethane	Antimony	Nitrite
	4,4-Dichlorodiphenyldi-chloro-ethylene	Arsenic	Asbestos
	4,4-Dichlorodiphenyltri-chloro-ethane	Barium	Chromium (hexavalent)
	Aldrin	Beryllium	Mercury
	Hexachlorocyclo-hexane; alpha (alpha-BHC, HCH)	Boron	Aroclor-1016 (PCB)
	Hexachlorocyclohexane; beta (beta-BHC, HCH)	Cadmium	Aroclor-1221 (PCB)

Table 1-2. Master Soil Target Analyte List for the 100-BC OUs

Radionuclides	Non-radionuclides		
	Dieldrin	Chromium (total)	Aroclor-1232 (PCB)
	Endosulfan I	Cobalt	Aroclor-1242 (PCB)
	Endosulfan II	Copper	Aroclor-1248 (PCB)
	Endosulfan sulfate	Lead	Aroclor-1254 (PCB)
	Endrin	Lithium	Aroclor-1260 (PCB)
	Endrin aldehyde	Manganese	Total petroleum hydrocarbons
	Endrin ketone	Molybdenum	Uranium (total)

Notes:

BHC = Benzenehexachloride
HCH = Hexachlorocyclohexane
OUs = operable units
PCB = polychlorinated biphenyl

1.3.2 Groundwater COPCs

Table 1-3 presents the groundwater contaminants of potential concern (COPCs). Chapter 4 of the 100-BC RI/FS Work Plan (DOE/RL-2008-46-ADD3) presents the approach used for development of the COPCs. The detailed bases of COPC selection is provided in Appendix D of the 100-BC work plan (DOE/RL-2008-46-ADD3).

Table 1-3. Groundwater COPCs for the 100-BC OUs

Radionuclides	Non-radionuclides	
Carbon-14	Antimony	Selenium
Cesium-137	Arsenic	Thallium
Cobalt-60	Beryllium	Zinc
Europium-155	Cadmium	1,1-Dichloroethene
Iodine-129	Chromium	1,1,2,2-Tetrachloroethane
Nickel-63	Cobalt	Benzene
Radium-228	Copper	Carbon Tetrachloride
Strontium-90	Hexavalent Chromium	Chloroform
Technetium-99	Lead	Tetrachloroethene
Tritium	Manganese	Trichloroethene
Uranium (total)	Mercury	Vinyl Chloride
	Nickel	Nitrate
		TPH – Diesel range

Table 1-3. Groundwater COPCs for the 100-BC OUs

Radionuclides	Non-radionuclides

Notes:

OUs = operable units

TPH = Total Petroleum Hydrocarbons

1.4 Data Gaps

A systematic planning process was used to identify 100-BC problem statements and data gaps. The identified data needs resulting from the planning process are discussed in Chapter 4 of 100-BC RI/FS Work Plan (DOE/RL-2008-46-ADD3).

1.5 Sampling Design

The type of sampling design is judgmental (e.g., based on prior knowledge and professional judgment/expertise). The locations of waste sites and groundwater monitoring were defined to address the uncertainties and data gaps identified during planning. Figure 1-1 shows the locations of boreholes and groundwater monitoring wells described in this SAP. Tables 2-2 through 2-15 present the analytical methods selected to meet the estimated quantitation limits (EQLs) and the analytical performance requirements.

1.6 Project Schedule

The 100-BC RI field efforts are planned to occur between approximately March 2010 and December 2010, depending on the date of work plan approval. The drilling lead will prepare the relative borehole and groundwater well schedule for new installations. A spatial and temporal uncertainty sample round, or event, will be collected from each of the following: a seasonal high water level, a seasonal low water level, and a mid-point water level, for a total of three samples per well. Each round of monitoring in the network of wells for this area will be completed within 30 consecutive calendar days to minimize statistical variability in water levels. The RI report will document the results provided by sampling and analysis in this plan.

2 Quality Assurance Project Plan

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

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

Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b) (Tri-Party Agreement Action Plan), require that quality assurance (QA)/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as past practice processes. Therefore, this QAPjP follows the QA elements of QA/R-5 (EPA/240/B-01/003). The QAPjP demonstrates conformance to Part B requirements of ANSI/ASQ E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use.*

In addition to the requirements cited above, the following reference also was used as a resource for identifying QAPjP elements:

- EPA-505-B-04-900A, *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual* (UFP-QAPP Manual).

The UFP-QAPP Manual (EPA-505-B-04-900A) is not imposed through the Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*). However, the UFP-QAPP Manual is a valuable resource and provides a comprehensive treatment of quality elements that should be addressed in any SAP. The UFP-QAPP Manual also was designed to be compatible with QA/R-5 (EPA/240/B-01/003), which forms the basis for this QAPjP.

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

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

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

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

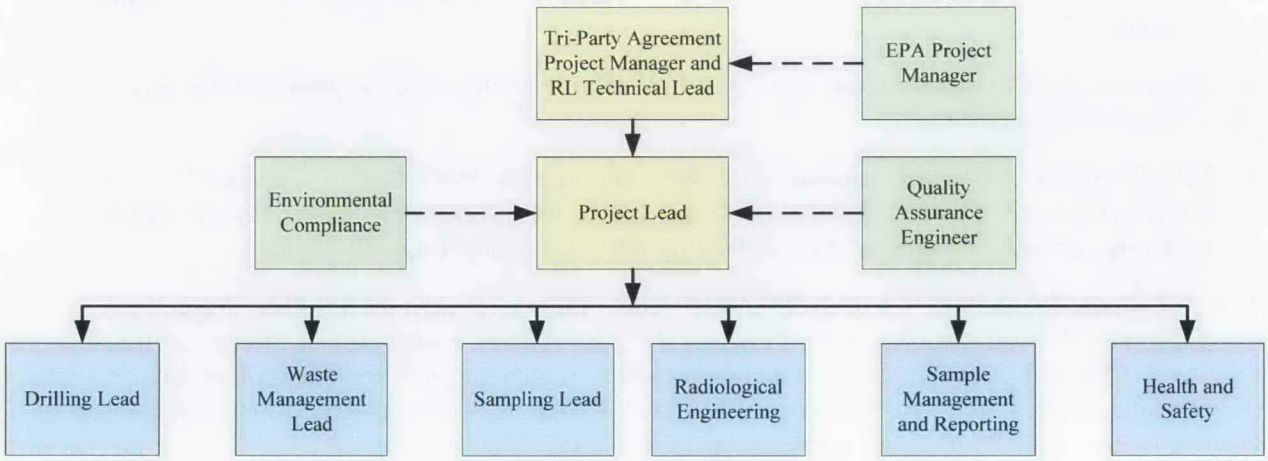
Section 2.4 Data Validation and Usability – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementing these elements ensures data conform to the specified criteria, thus achieving the project objectives.

2.1 Project Management

The following sections address the basic aspects of project management, ensuring that the project has defined goals, the project team understands the goals and the approaches used, and the planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under the SAP.

2.1.1 Project and Task Organization

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



EPA = United States Environmental Protection Agency
RL = U.S. Department of Energy, Richland Operations Office
Tri-Party Agreement = Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*

Figure 2-1. Project Organization

EPA Project Manager. The U.S. Environmental Protection Agency (EPA) has assigned project managers responsible for overseeing cleanup projects and activities. The EPA has approval authority as the lead regulatory agency for the work being performed under this SAP. The EPA will work with the U.S. Department of Energy, Richland Operations Office (RL) to resolve concerns over the work as described in this SAP in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

Tri-Party Agreement Project Manager and RL Technical Lead. The Tri-Party Agreement Project Manager is responsible for authorizing RI/FS activities for the 100 Area. The Tri-Party Agreement Project Manager also is responsible for obtaining lead regulatory approval of the work plan and SAP that authorize the RI/FS activities under the Tri-Party Agreement (Ecology et at., 1989a). The RL technical lead is responsible for overseeing the contractor in performing the work scope, working with the

contractor and the regulatory agencies to identify and work through issues, and providing technical input to the Tri-Party Agreement Project Manager.

Environmental Compliance. The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The environmental compliance officer also reviews plans, procedures, and technical documents to ensure environmental requirements have been addressed; identifies environmental issues affecting operations and develops cost-effective solutions; and responds to environmental and regulatory issues or concerns raised by RL and/or the regulatory agencies. The environmental compliance officer also may oversee project implementation for compliance with applicable internal and external environmental requirements.

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

Quality Assurance Engineer. The QA engineer is matrixed to the project lead and is responsible for QA issues on the project including overseeing implementation of the project QA requirements; reviewing project documents, including data needs summary reports, field sampling plan, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA engineer must be independent of the unit generating the data.

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

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

Sampling Lead. The sampling lead has overall responsibility for planning, coordinating, and executing sampling activities. Specific responsibilities include converting the sampling design requirements into field task instructions providing specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure the sampling design is understood and can be performed as specified. The sampling lead also communicates with the project lead designee to identify field constraints or emergent conditions affecting sampling design and execution, directs the procurement and installation of materials and equipment needed to support fieldwork, and prepares data packages based on instructions from the project lead designee and information contained in this SAP. The

shipping lead reports to the sampling lead for shipment authorization. No sample material will be transported on or off the Hanford Site without permission from an authorized shipper or designee.

Radiological Engineering. The Radiological Engineering lead is responsible for the radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for work planning. In addition, the Radiological Engineering lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The radiological engineering lead also interfaces with the project Health and Safety contact, and plans and directs radiological control technician support for activities.

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

The Sample Management and Reporting organization is also responsible for the performance of the data needs process, or equivalent. Additional related responsibilities include development of the SAP, including documentation of the data needs and the sampling design, preparation of associated presentations, resolution of technical issues, and any revisions to the SAP. Samples collected in the field and released to River Corridor Closure Contractor for shipping and analysis, as well as the resulting data, will be managed in accordance with applicable procedures, and work plans.

Laboratories. The laboratories analyze samples in accordance with established procedures, provide necessary sample reports, and explain results in support of data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

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

2.1.2 Problem Definition and Background

This SAP describes the sampling and analysis to be performed associated with boreholes and groundwater monitoring wells. The specific problems to be solved, background information, and general information are provided in the work plan. Media to be sampled include water, aquifer sediment, and soil. Figure 1-1 shows the locations of the planned and existing boreholes and groundwater monitoring wells within the scope of this SAP. Regulatory drivers and reference to agreement documents for the activity are provided in the work plan.

2.1.3 Project and Task Description

Chapter 3 presents the field sampling plan. Tables 1-2 and 1-3 present the target analytes and COPCs. Section 1.6 provides guidance on the implementation schedule.

2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance for providing data of known and appropriate quality. Data quality indicators describe data quality, by evaluation against identified data needs, and by evaluation against the work activities identified in this SAP. The applicable QC guidelines, EQLs, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal data quality indicators are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These data quality indicators are defined for the purposes of this document in Table 2-1. The data quality indicators will be evaluated during the data quality assessment (DQA) process (Section 2.4).

Analytical performance requirements for samples collected are presented in Tables 2-2 through 2-15. Laboratory operations and analytical services shall comply with Volume 4 of HASQARD (DOE/RL-96-68, *Laboratory Technical Requirements*) and any specific criteria identified in Tables 2-2 through 2-15 below. Criteria in Tables 2-2 through 2-15 take precedence over similar criteria in HASQARD. In consultation with the laboratory, the project lead, and/or others as appropriate, Sample Management and Reporting can approve changes to analytical methods as long as the method is based upon a nationally recognized standard (e.g., EPA, American Society for Testing and Materials [ASTM]) method, the new method achieves project data quality objectives (DQOs) as well or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Action Examples
Precision	The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated either as the range or as the standard deviation. May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze co-located samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	Field precision: At randomly selected locations, duplicate samples will be taken 1 per 20 samples per media. Laboratory precision: analysis of laboratory duplicate or matrix spike duplicate samples.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of sampling and analytical operations.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicate results.	If recovery does not meet objective: • Qualify the data before use • Request reanalysis or re-measurement

Table 2-1. Data Quality Indicators

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

Table 2-1. Data Quality Indicators

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

Notes:

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

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

QA = quality assurance

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-B-5 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic – Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-B-5 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent Chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-B-5 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]
75-35-4	1,1-Dichloroethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[l]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[l]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-B-5 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. Precision criteria shown are for batch laboratory replicate sample relative percent differences.

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-B-5 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*								
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*								

CAS	=	Chemical Abstracts Service	GEA	=	gamma energy analysis	N/A	=	not applicable
cm^2	=	square centimeters	IC	=	ion chromatography	NV	=	no value
Cr(VI)	=	hexavalent chromium	ICP	=	inductively coupled plasma	pCi/g	=	average picores per gram
dpm	=	disintegrations per minute	LSC	=	liquid scintillation counter	PRG	=	preliminary remediation goals
EQL	=	estimated quantitation limit	mg/kg	=	milligrams per kilogram	RESRAD	=	RESidual RADioactivity (dose model)
EPA	=	Environmental Protection Agency	MS	=	mass spectroscopy	TBD	=	to be determined

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-5 Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
10045-97-3	Cesium-137[e]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[e]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[g]	NV[g]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[g]	NV[g]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[g]	NV[g]			
10098-97-2	Strontium-90[e,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[g]	NV[g]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[e]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium[e]	10 pCi/g	510 pCi/g	12.6 pCi/g	125.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-5 Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-5 Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
75-35-4	1,1-Dichloroethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kl[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[l]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[l]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-5 Crib

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

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. Precision criteria shown are for batch laboratory replicate sample relative percent differences.

g. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

l. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

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

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

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

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-5 Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*								

CAS	=	Chemical Abstracts Service	GEA	=	gamma energy analysis	N/A	=	not applicable
cm^2	=	square centimeters	IC	=	ion chromatography	NV	=	no value
Cr(VI)	=	hexavalent chromium	ICP	=	inductively coupled plasma	pCi/g	=	average picores per gram
dpm	=	disintegrations per minute	LSC	=	liquid scintillation counter	RESRAD	=	RESidual RADioactivity (dose model)
EPA	=	Environmental Protection Agency	mg/kg	=	milligrams per kilogram	TBD	=	to be determined
EQL	=	estimated quantitation limit	MS	=	mass spectroscopy			

Table 2-4. Analytical Performance Requirements for Soil Samples from 116-B-6B Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic - Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]

Table 2-4. Analytical Performance Requirements for Soil Samples from 116-B-6B Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-38-2	Arsenic[k]	10 mg/kg[j]	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]

Table 2-4. Analytical Performance Requirements for Soil Samples from 116-B-6B Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]
75-35-4	1,1-Dicholoroethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetracholoroethane	0.005 mg/kg[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[l]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl Chloride	0.005 mg/kg[il]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A

Table 2-4. Analytical Performance Requirements for Soil Samples from 116-B-6B Crib

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area,* predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

Table 2-4. Analytical Performance Requirements for Soil Samples from 116-B-6B Crib

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

l. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

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

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

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

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*

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

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*

CAS	=	Chemical Abstracts Service	GEA	=	gamma energy analysis	N/A	=	not applicable
cm^2	=	square centimeters	IC	=	ion chromatography	NV	=	no value
Cr(VI)	=	hexavalent chromium	ICP	=	inductively coupled plasma	pCi/g	=	average picores per gram
dpm	=	disintegrations per minute	LSC	=	liquid scintillation counter	RESRAD	=	RESidual RADioactivity (dose model)
EQL	=	estimated quantitation limit	mg/kg	=	milligrams per kilogram	TBD	=	to be determined
EPA	=	Environmental Protection Agency	MS	=	mass spectroscopy			

Table 2-5. Analytical Performance Requirements for Soil Samples from 116-B-9 French Drain

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic – Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]

Table 2-5. Analytical Performance Requirements for Soil Samples from 116-B-9 French Drain

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-93-2	Lithium	2.5 mg/kg	160 mg/kg	192 mg/kg	NV			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-5. Analytical Performance Requirements for Soil Samples from 116-B-9 French Drain

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
18540-29-9	Hexavalent chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]
75-35-4	1,1-Dichloroethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[li]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[l]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A

Table 2-5. Analytical Performance Requirements for Soil Samples from 116-B-9 French Drain

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area,* predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values for were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

Table 2-5. Analytical Performance Requirements for Soil Samples from 116-B-9 French Drain

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

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

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

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*

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

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*

CAS	=	Chemical Abstracts Service	GEA	=	gamma energy analysis	MS	=	mass spectroscopy
Cr(VI)	=	hexavalent chromium	IC	=	ion chromatography	N/A	=	not applicable
dpm	=	disintegrations per minute	ICP	=	inductively coupled plasma	NV	=	no value
EQL	=	estimated quantitation limit	LSC	=	liquid scintillation counter	RESRAD	=	RESidual RADioactivity (dose model)

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30[f]	70-130[f]
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30	70-130[f]
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic-Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]≤	70-130[f]
7440-61-1	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic-Uranium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as Nitrogen)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]
7439-14-2	Aluminum	5 mg/kg	80,000 mg/kg	480,000 mg/kg	960,000 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
18540-29-9	Hexavalent chromium [k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]
75-35-4	1,1-Dichloroethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[l]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl Chloride	0.005 mg/kg[l]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.094 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30[m]	70-130[m]
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg[l]	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-B-14 Trench

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*								
ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*								
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.*								

CAS = Chemical Abstracts Service
Cr(VI) = hexavalent chromium
dpm = disintegrations per minute
EQL = estimated quantitation limit
GC = gas chromatography
GEA = gamma energy analysis
IC = ion chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MS = mass spectroscopy
N/A = not applicable
NV = no value
NWTPH-D = Northwest total petroleum hydrocarbon – diesel
PCB = polychlorinated biphenyl
RESRAD = RESidual RADioactivity (dose model)
TPH = total petroleum hydrocarbon

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-C-5 Retention Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic-Plutonium	≤30[f]	70-130[f]
	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	NV[e]	NV[e]	LSC-Nickel	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-C-5 Retention Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
7440-61-1	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic-Uranium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[i]	70-130[i]
7440-36-0	Antimony	6 mg/kg[j]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[i]	70-130[i]
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[j]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[j]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[j]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[j]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-C-5 Retention Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[i]	70-130[i]
75-35-4	1,1-Dichlorethene	0.01 mg/kg[l]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[l]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[l]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[l]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[l]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[l]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
56-55-3	Benzo(a)anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30[m]	70-130[m]
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg[l]	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
68334-30-5	TPH/diesel oil and motor oil	5 mg/kg	2,000 mg/kg	2,000 mg/kg	NV	NWTPH-D	≤20[m]	80-120[m]
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-C-5 Retention Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-C-5 Retention Basin

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

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

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*

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

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*

CAS	=	Chemical Abstracts Service	IC	=	ion chromatography	NV	=	no value
Cr(VI)	=	hexavalent chromium	ICP	=	inductively coupled plasma	NWTPH-D	=	Northwest total petroleum hydrocarbon – diesel
dpm	=	disintegrations per minute	LSC	=	liquid scintillation counter	RESRAD	=	RESidual RADioactivity (dose model)
EQL	=	estimated quantitation limit	MS	=	mass spectroscopy	TPH	=	total petroleum hydrocarbon
GEA	=	gamma energy analysis	N/A	=	not applicable			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-6 Burial Ground

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
10028-17-8	Tritium[e]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
10098-97-2	Strontium-90[e,g]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[h]	70-130[h]
7439-14-2	Aluminum	5 mg/kg	80,000 mg/kg	480,000 mg/kg	960,000 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[h]	70-130[h]
7440-36-0	Antimony	6 mg/kg[i]	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic[j]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg[i]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-6 Burial Ground

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-93-2	Lithium	2.5 mg/kg	160 mg/kg	192 mg/kg	NV			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[i]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-28-0	Thallium	5 mg/kg[i]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium[j]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[h]	70-130[h]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[h]	70-130[h]
75-35-4	1,1-Dichlorethene	0.01 mg/kg[k]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[l]	70-130[l]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[k]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[k]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[k]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[k]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[k]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-6 Burial Ground

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Performance Requirements for Physical Properties					
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

g. Strontium-90 will be assessed as total radioactive strontium.

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-6 Burial Ground

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

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

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

j. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

l. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

ASTM D422-63, *Standard Test Method For Particle-Size Analysis of Soils*

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

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*

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

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*

CAS = Chemical Abstracts Service
Cr(VI) = hexavalent chromium
dpm = disintegrations per minute
EQL = estimated quantitation limit
IC = ion chromatography
ICP = inductively coupled plasma
MS = mass spectroscopy
N/A = not applicable

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic-Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC-Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
13966-29-5	Uranium-234	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic-Uranium	≤30[f]	70-130[f]
15117-96-1	Uranium-235	0.5 pCi/g[i]	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
7440-61-1	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Laboratory Measurements (Nonradiological)								
18540-29-9	Hexavalent chromium[j]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[k]	70-130[k]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[k]	70-130[k]
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[k]	70-130[k]
7440-36-0	Antimony	6 mg/kg[l]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[k]	70-130[k]
7440-38-2	Arsenic[j]	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[l]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[l]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[l]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[l]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
75-35-4	1,1-Dichlorethene	0.01 mg/kg[i]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[i]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[i]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[i]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[i]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[i]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.094 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30[m]	70-130[m]
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
56-55-3	Benzo(a)-anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30[m]	70-130[m]
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)-fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi)perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k)-fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg[i]	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd)-pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
91-20-3	Naphthalene	0.1 mg/kg	1,600 mg/kg	4.46 mg/kg	275 mg/kg			
85-01-8	Phenanthrene	0.05 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
68334-30-5	TPH/diesel oil and motor oil	5 mg/kg	2,000 mg/kg	2,000 mg/kg	NV	NWTPH-D	≤20[m]	80-120[m]
			Performance Requirements for Physical Properties					
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area,* predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

j. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*								
ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*								
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*								

CAS	=	Chemical Abstracts Service	ICP	=	inductively coupled plasma	NV	=	no value
Cr(VI)	=	hexavalent chromium	LSC	=	liquid scintillation counter	NWTPH-D	=	Northwest total petroleum hydrocarbon – diesel
dpm	=	disintegrations per minute	IC	=	ion chromatography	PCB	=	polychlorinated biphenyl
EQL	=	estimated quantitation limit	N/A	=	not applicable	RESRAD	=	RESidual RADioactivity (dose model)
GEA	=	gamma energy analysis	MS	=	mass spectroscopy	TPH	=	total petroleum hydrocarbon
GC	=	gas chromatography						

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic-Plutonium	≤30[f]	70-130[f]
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC-Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
13966-29-5	Uranium-234	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic-Uranium	≤30[f]	70-130[f]
15117-96-1	Uranium-235	0.5 pCi/g[i]	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
7440-61-1	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Laboratory Measurements (Nonradiological)								
18540-29-9	Hexavalent chromium[j]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[k]	70-130[k]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[k]	70-130[k]
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[k]	70-130[k]
7440-36-0	Antimony	6 mg/kg[l]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[k]	70-130[k]
7440-38-2	Arsenic[j]	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[l]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[l]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[l]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[l]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
75-35-4	1,1-Dichlorethene	0.01 mg/kg[i]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[i]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[i]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[i]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[i]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[i]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.094 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30[m]	70-130[m]
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
56-55-3	Benzo(a)-anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30[m]	70-130[m]
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)-fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi)perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k)-fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg[i]	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd)-pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
91-20-3	Naphthalene	0.1 mg/kg	1,600 mg/kg	4.46 mg/kg	275 mg/kg			
85-01-8	Phenanthrene	0.05 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
68334-30-5	TPH/diesel oil and motor oil	5 mg/kg	2,000 mg/kg	2,000 mg/kg	NV	NWTPH-D	≤20[m]	80-120[m]
			Performance Requirements for Physical Properties					
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

j. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-B-8:3 Process Sewer

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*								
ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*								
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*								

CAS	=	Chemical Abstracts Service	ICP	=	inductively coupled plasma	NV	=	no value
Cr(VI)	=	hexavalent chromium	LSC	=	liquid scintillation counter	NWTPH-D	=	Northwest total petroleum hydrocarbon – diesel
dpm	=	disintegrations per minute	IC	=	ion chromatography	PCB	=	polychlorinated biphenyl
EQL	=	estimated quantitation limit	N/A	=	not applicable	RESRAD	=	RESidual RADioactivity (dose model)
GEA	=	gamma energy analysis	MS	=	mass spectroscopy	TPH	=	total petroleum hydrocarbon
GC	=	gas chromatography						

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV[e]	NV[e]	Americium-241/ Curium-244	≤30[f]	70-130[f]
10045-97-3	Cesium-137[g]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[g]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[e]	NV[e]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[e]	NV[e]			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Iodine-129, Low Energy	≤30[f]	70-130[f]
10098-97-2	Strontium-90[g,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV[e]	NV[e]	Isotopic-Plutonium	≤30[f]	70-130[f]
	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV[e]	NV[e]			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV[e]	NV[e]	LSC-Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63[g]	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC-Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99[g]	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC-Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium[g]	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC-Tritium	≤30[f]	70-130[f]
13966-29-5	Uranium-234	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic-Uranium	≤30[f]	70-130[f]
15117-96-1	Uranium-235	0.5 pCi/g[i]	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
7440-61-1	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Laboratory Measurements (Nonradiological)								
18540-29-9	Hexavalent chromium[i]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[k]	70-130[k]
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 or 200.8 (Mercury cold vapor)	≤30[k]	70-130[k]
7440-36-0	Antimony	6 mg/kg[l]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[k]	70-130[k]
7440-38-2	Arsenic[j]	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg[l]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[l]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kgl	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[l]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg	EPA 300.0 (Anions by IC)	≤30[k]	70-130[k]

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
75-35-4	1,1-Dichlorethene	0.01 mg/kg[i]	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organics)	≤30[m]	70-130[m]
79-34-5	1,1,2,2-Tetrachloroethane	0.005 mg/kg[i]	5 mg/kg	0.0012 mg/kg	0.0019 mg/kg			
71-43-2	Benzene	0.005 mg/kg[i]	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg[i]	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg[i]	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.005 mg/kg[i]	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.094 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30[m]	70-130[m]
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg[i]	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
56-55-3	Benzo(a)-anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30[m]	70-130[m]
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)-fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi)perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k)-fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg[i]	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
53-70-3	Dibenz[a,h]anthracene	0.03 mg/kg	1.37 mg/kg	4.29 mg/kg	0.2 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd)-pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
68334-30-5	TPH/diesel oil and motor oil	5 mg/kg	2,000 mg/kg	2,000 mg/kg	NV	NWTPH-D	≤20[m]	80-120[m]
	Performance Requirements for Physical Properties							
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

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

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

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

g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

h. Strontium-90 will be assessed as total radioactive strontium.

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

j. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

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

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

m. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-C-3 Reactor Fuel Storage Basin

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*								
ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*								
ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*								
ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*								

CAS = Chemical Abstracts Service
Cr(VI) = hexavalent chromium
dpm = disintegrations per minute
EQL = estimated quantitation limit
GEA = gamma energy analysis
GC = gas chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
IC = ion chromatography
MS = mass spectroscopy
N/A = not applicable
NV = no value
NWTPH-D = Northwest total petroleum hydrocarbon – diesel
PCB = polychlorinated biphenyl
RESRAD = RESidual RADioactivity (dose model)
TPH = total petroleum hydrocarbon

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	—[c]
—	Gross alpha	100 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
—	Gross beta	5,000 dpm/ 100 cm^2	N/A	N/A	N/A	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)[d]								
10045-97-3	Cesium-137[e]	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	GEA	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[e]	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV[g]	NV[g]			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV[g]	NV[g]			
10098-97-2	Strontium-90[e,h]	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (Nonradiological)								
7440-36-0	Antimony	6.0 mg/kg[i]	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[j]	70-130[j]
7440-38-2	Arsenic[k]	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg[i]	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-96-5	Manganese	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg[i]	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg[i]	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg[i]	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium[k]	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30[i]	70-130[i]
—	Distribution coefficient for EPA 6010/6020/7196/ 7470 or 200.8 metals	N/A	N/A	N/A	N/A	Desorption distribution coefficient using 1:1 water extract and acid leach	N/A	N/A
	Performance Requirements for Physical Properties							
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

b. Equivalent methods may be substituted. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

c. Field measurements have no specific QC requirements for accuracy except to perform checks to verify manufacturer's expected performance.

d. The PRG for the total of all radiological analytes is <15 mRem per year.

e. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. Precision criteria shown are for batch laboratory replicate sample relative percent differences.

g. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years. However, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

h. Strontium-90 will be assessed as total radioactive strontium.

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

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

k. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan* to re-evaluate arsenic and hexavalent chromium cleanup levels.

ASTM D422-63, Standard Test Method for Particle-Size Analysis of Soils

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

ASTM D2434-68, Standard Test Method for Permeability of Granular Soils (Constant Head)

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

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals: Direct Exposure	Preliminary Cleanup Goals: Groundwater Protection	Preliminary Cleanup Goals: River Protection	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
ASTM D5084-03, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter								

CAS = Chemical Abstracts Service
Cr(VI) = hexavalent chromium
dpm = disintegrations per minute
EQL = estimated quantitation limit
GEA = gamma energy analysis
ICP = inductively coupled plasma
MS = mass spectroscopy
N/A = not applicable
NV = no value
RESRAD = RESidual RADioactivity (dose model)

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Leach Tests

CAS Number	Analyte	EQL[a]	Preliminary Cleanup Goals			Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
7440-47-3	Chromium	10 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30[c]	70-130[c]
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30[c]	70-130[c]

Notes:

a. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

b. Equivalent methods may be substituted. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

CAS # = Chemical Abstracts Service Number
EQL = estimated quantitation limit
ICP = inductively coupled plasma
N/A = not applicable

Table 2-14. Analytical Performance Requirements for Groundwater Samples

CAS Number	Analyte	Analytical Method[a]	EQL[b]	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	—[c]	—[c]	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	—[c]	—[c]	N/A	N/A
—	Specific conductance	PROBE	1 µS/cm	—[c]	—[c]	N/A	N/A
—	Temperature	PROBE	--	—[c]	—[c]	N/A	N/A
—	Dissolved oxygen	PROBE	--	—[c]	—[c]	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	—[c]	—[c]	N/A	N/A
Performance Requirements for Laboratory Measurements (Radiological)							
15046-84-1	Iodine-129	Iodine-129 – Low Level	1 pCi/L	≤30[d]	70-130[d]	1 pCi/L	40 CFR 141.66
10098-97-2	Strontium-90[e]	Strontium-90	2 pCi/L	≤30[d]	70-130[d]	8 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC-Tritium	400 pCi/L	≤30[d]	70-130[d]	20,000 pCi/L	40 CFR 141.66
12587-46-1	Gross alpha	GPC	3 pCi/L	≤30[d]	70-130[d]	15 pCi/L	Federal MCL
12587-47-2	Gross beta	GPC	4 pCi/L	≤30[d]	70-130[d]	N/A	4 mrem/year Federal MCL
Performance Requirements for Laboratory Measurements (Nonradiological)							
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	≤20[f]	80-120[f]	5.6 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L[g,h]	≤20[f]	80-120[f]	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-41-7	Beryllium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20[f]	80-120[f]	4.0 µg/L	40 CFR 141.62

Table 2-14. Analytical Performance Requirements for Groundwater Samples

CAS Number	Analyte	Analytical Method[a]	EQL[b]	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
7440-43-9	Cadmium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[g,h]	≤20[f]	80-120[f]	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20[f]	80-120[f]	74 µg/L	Freshwater CCC
7440-48-4	Cobalt	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20[f]	80-120[f]	4.8 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)
7440-50-8	Copper	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	8 µg/L	≤20[f]	80-120[f]	9 µg/L	Freshwater CCC
18540-29-9	Hexavalent chromium	EPA 7196 (Cr(VI))	3.7 µg/L	≤20[f]	80-120[f]	10 µg/L	Freshwater CCC
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20[f]	80-120[f]	2.1 µg/L	WAC 173-201A
7439-97-6	Mercury	EPA 7470 or 200.8 (mercury)	0.5 µg/L[g]	≤20[f]	80-120[f]	0.05 µg/L	WAC 173-21A Freshwater CCC
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20[f]	80-120[f]	50 µg/L	Secondary MCL
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20[f]	80-120[f]	52 µg/L	Freshwater CCC
7782-49-2	Selenium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20[f]	80-120[f]	5 µg/L	Freshwater CCC
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[g,h]	≤20[f]	80-120[f]	0.24 µg/L	Human Health for the Consumption of Water + Organism
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20[f]	80-120[f]	91 µg/L	WAC 173-201A
7440-61-1	Uranium	Total Uranium (chemical)	1 µg/L	≤20[f]	80-120[f]	30 µg/L	40 CFR 141.62
75-35-4	1,1-Dichloroethene	EPA 8260 (VOCs)	2 µg/L[h]	≤20[i]	80-120[i]	0.073 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)
79-34-5	1,1,2,2-Tetrachloroethane	EPA 8260 (VOCs)	1.5 µg/L[h]	≤20[i]	80-120[i]	0.17 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)

Table 2-14. Analytical Performance Requirements for Groundwater Samples

CAS Number	Analyte	Analytical Method[a]	EQL[b]	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
71-43-2	Benzene	EPA 8260 (VOCs)	1.5 µg/L[h]	≤20[i]	80-120[i]	0.795 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)
56-23-5	Carbon tetrachloride	EPA 8260 (VOCs)	1 µg/L[h]	≤20[i]	80-120[i]	0.23 µg/L	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (VOCs)	5 µg/L	≤20[i]	80-120[i]	5.7 µg/L	Human Health for the Consumption of Water + Organism
127-18-4	Tetrachloroethene	EPA 8260 (VOCs)	5 µg/L[h]	≤20[i]	80-120[i]	0.081 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)
79-01-6	Trichloroethene	EPA 8260 (VOCs)	1 µg/L[h]	≤20[i]	80-120[i]	0.49 µg/L	WAC 173-340-720 (4)(b)(iii)(A) and (B)
75-01-4	Vinyl chloride	EPA 8260 (VOCs)	5 µg/L[h]	≤20[i]	80-120[i]	0.029 µg/L	Human Health for the Consumption of Water + Organism
14797-55-8	Nitrate (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[f]	80-120[f]	10,000 µg/L	40 CFR 141.62

Notes:

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

b. The EQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

c. Field measurements have no specific QC requirements except to perform checks to verify manufacturer's expected performance.

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

e. Strontium-90 will be assessed as total radioactive strontium.

f. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on

Table 2-14. Analytical Performance Requirements for Groundwater Samples

CAS Number	Analyte	Analytical Method[a]	EQL[b]	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis

statistical control limits for analytical batch laboratory control samples is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample relative percent differences.

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

h. Action levels are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

i. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

40 CFR 141.62, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Inorganic Contaminants."

40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides."

WAC 173-340-720(4), "Model Toxics Control Act-Cleanup," "Ground Water Cleanup Standards."

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

CAS #	=	Chemical Abstracts Service	ICP	=	inductively coupled plasma	MS	=	mass spectrometry
CCC	=	criterion continuous concentration	LSC	=	liquid scintillation counter	N/A	=	not applicable
Cr(VI)	=	hexavalent chromium	MCL	=	maximum contaminant level	NTU	=	nephelometric turbidity unit
EQL	=	estimated quantitation limit	MDL	=	method detection limit	VOC	=	volatile organic compound
IC	=	ion chromatography						

Table 2-15. Analytical Performance Requirements for Pore Water Samples

CAS Number	Analyte	Analytical Method[a]	EQL[b]	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	—[c]	—[c]	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	—[c]	—[c]	N/A	N/A
—	Specific conductance	PROBE	1 µS/cm	—[c]	—[c]	N/A	N/A
—	Temperature	PROBE	--	—[c]	—[c]	N/A	N/A
—	Dissolved oxygen	PROBE	--	—[c]	—[c]	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	—[c]	—[c]	N/A	N/A
Performance Requirements for Laboratory Measurements (Nonradiological)							
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20[d]	80-120[d]	74 µg/L	Freshwater CCC
18540-29-9	Hexavalent chromium	EPA 7196 (Cr(VI))	10 µg/L	≤20[d]	80-120[d]	10 µg/L	Freshwater CCC

Notes:

a. Equivalent methods may be substituted. See SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

b. The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

c. Field measurements have no specific QC requirements except to perform checks to verify manufacturer's expected performance.

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

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
Cr(VI) = hexavalent chromium
ICP = inductively coupled plasma
N/A = not applicable
NTU = nephelometric turbidity unit

2.1.5 Special Training and Certification

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

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

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

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

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling being performed in the field, soil/aquifer sediment sampling and water sampling.
- The Radiation Protection Program establishes qualification requirements for radiological control technicians. Radiological control technicians assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

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

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

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

2.1.6 Documents and Records

The project lead is responsible for ensuring the current version of the SAP is being used and for providing any updates to field personnel. Version control is maintained through the administrative document control process. Before implementation, DOE and the regulatory agency will review and approve changes to the sampling plan that affect the data needs. Information pertinent to sampling and analysis will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols in accordance with HASQARD (DOE/RL-96-68).

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

The project lead, drilling lead, sampling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities. Table 2-16 presents the change control for this project.

Table 2-16. Change Control for the 100-BC Project

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

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

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

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

- Field logbooks or operational records
- Data forms

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

The laboratory is responsible for maintaining, and having available upon request, the following:

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

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Agreement.

2.2 Data Generation and Acquisition

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

2.2.1 Sampling Process Design (Experimental Design)

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

2.2.2 Sampling Methods

Section 3.6 describes the sampling methods. The specific information includes the following:

- Field sampling methods
- Corrective actions for sampling activities (the task lead will be responsible for corrective action)

- Decontamination of sampling equipment
- Radiological field data

2.2.3 Sample Handling and Custody

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

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

Section 3.7 provides the following specific sample handling information:

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

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by Sample Management and Reporting.

2.2.4 Analytical Methods

Tables 2-2 through 2-15 provide information on analytical methods. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor, or vadose zone contractor as applicable, participates in oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, the laboratory must provide method validation data to confirm the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Tables 2-2 through 2-15 must be approved by Sample Management and Reporting in consultation with the project lead.

Laboratories providing analytical services in support of this SAP will have in place a corrective action program addressing analytical system failures and documenting the effectiveness of corrective actions. Issues affecting analytical results are to be resolved by Sample Management and Reporting in coordination with the project lead.

Batch leaching tests will be performed on soil and aquifer sediment samples. Standardized batch leach tests are done using a leach procedure based on ASTM D3987-06, *Standard Test Method for Shake Extraction of Solid Waste with Water*. The procedure recommends using soil screened through 9.5 mm (3/8-inch) mesh. Demineralized water will be used as the leaching liquid. Selected soil samples will be leached at soil to water weight ratios of 1 to 1, 1 to 2.5, and 1 to 5 with one test in each series duplicated. Soil/water mixtures are placed in clean, watertight sample containers (extraction vessels) and rotated end-over-end through the vessel centerline at a rate of about 30 rotations per minute for 18 hours. Following

18 hours of mixing, the soil/water slurry is pressure-filtered using a 0.45-μm filter. The leachate will be analyzed for pH, conductivity, and metals or other contaminants of interest. Details of the test will be discussed with the laboratory personnel before analysis.

Desorption distribution coefficient determinations using reagent water extract aliquots and results of soil analysis from EPA SW-846 Methods 6010, 6020, 7196, 7470, or 200.8 metals as applicable will support modeling needs. Details of the test will be discussed with the laboratory personnel before analysis.

2.2.5 Quality Control

QC procedures must be followed in the field and laboratory to ensure reliable data are obtained. Field personnel will collect QC samples to evaluate the potential for cross contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field duplicate, trip or field transfer blank, equipment rinsate blank, and field split samples. Laboratory QC samples estimate the precision and bias of the analytical data. Table 2-17 summarizes field and laboratory QC samples.

Table 2-17. Project Quality Control Checks

QC Sample Type	Purpose	Frequency
	Field Quality Control	
Full trip blank	Assess contamination from containers or transportation.	One per 20 samples *per media sampled.*
Field transfer blank	Assess contamination from sampling site.	One per day when volatile organic components are sampled *per media sampled.*
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination.	As needed.[a] If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, 1 per 20 samples *per media sampled.*
Field duplicates	Estimate precision, including sampling and analytical variability.	One per batch,[b] 20 samples maximum, *per media sampled.*
Field split	Estimate precision, including sampling, analytical, and inter-laboratory variability.	One for every analytical method, except for Pacific Northwest National Laboratory specific tests, *per media sampled.*
	Laboratory Quality Control[b]	
Method blank	Assess response of an entire laboratory analytical system.	One per batch,[b] 20 samples maximum, or as identified by method guidance *per media sampled.*
Matrix spike	Identify analytical (preparation and analysis) bias; possible matrix affect on the analytical method used.	One per batch,[b] 20 samples maximum, or as identified by the method guidance *per media sampled.*
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision.	One per batch,[b] 20 samples maximum, or as identified by the method guidance *per media sampled.*
Laboratory control samples	Assess method accuracy.	One per batch,[b] 20 samples maximum, or as identified by the method guidance *per media sampled.*
Surrogates	Estimate recovery/yield.	As identified by the method guidance *per media sampled.*

Table 2-17. Project Quality Control Checks

QC Sample Type	Purpose	Frequency

Notes:

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

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

2.2.5.1 Field QC Samples

The Field QC sample types are discussed within this section.

Full trip blanks are samples prepared by the sampling team before traveling to the sampling site. The preserved bottle set is identical to the set collected in the field, but it is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Full trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. However, the analytical list for full trip blanks on soil may be limited to volatile organic analysis (VOA), semi-volatile organic analysis, and total petroleum hydrocarbons, depending on resolution/determination of the target analyte list. Full trip blanks are not required on aquifer sediments being analyzed for metals, mercury, and hexavalent chromium.

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

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

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

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

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

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

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

A **field split** is a representative sample from a sampling event sent to a third party laboratory (i.e., reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability. Large relative percent differences can be an indication of laboratory performance problems and should be investigated. Only those results greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated.

2.2.5.2 Laboratory QC Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined for three digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*, and EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) and four digit EPA methods (SW-846), and will be run at the frequency specified in the respective reference. QC checks outside of control limits will be reflected in the data validation process and during the DQA described in Section 2.4.

2.2.5.3 QC Requirements

If only disposable equipment is used or equipment is dedicated to a particular well, an equipment rinsate blank is not required. If no VOC samples are collected, a field transfer blank is not required.

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

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are stated in Tables 2-2 through 2-15.

Holding time is the elapsed time period between sample collection and analysis, or sample collection to extraction and sample extraction to analysis, as applicable to the method. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the analytical method, as specified for three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846). Data associated with exceeded holding times are flagged.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The laboratories participate in national studies such as the EPA sanctioned water pollution and water supply performance evaluation studies. The Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and

performance evaluation studies are presented in the annual groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). Failure of QC will be determined and evaluated during data validation and the DQA process. Data will be qualified as appropriate.

2.2.6 Instrument and Equipment Testing, Inspection, and Maintenance

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

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846), or with auditable Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

2.2.7 Instrument and Equipment Calibration and Frequency

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

2.2.8 Inspection and Acceptance of Supplies and Consumables

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

2.2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Non-direct measurements will not be evaluated as part of the activities within the scope of this SAP.

2.2.10 Data Management

Sample Management and Reporting, in coordination with the project lead, is responsible for ensuring analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be through a database (e.g., HEIS or a project specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

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

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

- Chain-of-custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

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

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

2.3 Assessment and Oversight

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

2.3.1 Assessments and Response Actions

Contractor management, regulatory compliance, quality, and/or Health and Safety organizations may conduct random surveillance and assessments to verify compliance with the requirements outlined in this

SAP, project work packages, the QAPjP, procedures, and regulatory requirements. Section 2.4 discusses the only planned assessment, a DQA, for the activities identified in this SAP. The results of the DQA will be provided to the project lead.

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

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

2.3.2 Reports to Management

Reports to management on data quality issues will be made if these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting, which initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the project lead. At the end of the project, a DQA report will be prepared to determine whether the type, quality, and quantity of collected data met the quality objectives described in this SAP.

2.4 Data Validation and Usability

The elements under data validation and usability address the QA activities occurring after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review, Verification, and Validation

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

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

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

2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Validation will be performed on target and non-target analytes from each method as part of the methods-based analysis. Data validation may be performed by the analytical laboratory, Sample Management and Reporting, and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure data are usable. Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the dataset. Data validation will be documented in data validation reports. An example of questionable data is if the positive detections are greater than the practical quantitation limit or reporting limit in soil/aquifer sediment from a site that should not have exhibited contamination. Similarly, results below background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in a DQA report. Data validation will be documented in data validation reports, which will be included in the project file.

2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The results of the DQA will be used in interpreting the data and determining whether the objectives of this activity have been met. The DQA will be in accordance with EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide,* and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners.*

2.4.4 Corrective Actions

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

3 Field Sampling Plan

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

3.1 Site Background and Objectives

Site background information is contained in DOE/RL-2008-46-ADD3. The target analytes and COPCs are presented in Tables 1-2 and 1-3. Section 1.6 of this SAP provides a schedule for implementation. The objective of the field sampling plan is to identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the systematic planning process and presents the design to identify sampling locations, the total number of samples to be collected, and analyses to be performed.

3.2 Documentation of Field Activities

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

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

3.3 Sampling Design

As Section 2.2.1 presents, the sampling design is judgmental sampling.

3.4 Calibration of Field Equipment

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

Calibrations must be performed as follows:

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

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

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

3.5 Sample Location and Frequency

The purpose of this section is to identify the sampling locations and frequencies and define the sampling and analysis requirements for samples and measurements to be collected. Figure 1-1 shows the approximate locations of boreholes and groundwater monitoring wells described in this SAP. The actual locations will be determined based on a field walk down of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

3.5.1 Vadose Zone Characterization

Samples will be collected from boreholes, test pits, and groundwater monitoring wells to support characterization of the vadose zone and groundwater as outlined in Table 1-1. The vadose zone will be characterized by performing intrusive investigations at ten waste sites: 100-B-5 Trench, 116-B-5 Crib, 116-B-14 Trench, 116-C-5 Retention Basin, 118-B-6 Burial Ground, 118-B-8 Reactor Fuel Storage Basin, 118-C-3 Reactor Fuel Storage Basin, 116-B-6B Crib, 116-B-9 French Drain, and 118-B-8:3 Process Sewer. Intrusive investigations consist mainly of collecting and analyzing samples from planned boreholes, from groundwater monitoring wells during drilling, and from test pits in areas of known or suspected contamination. Each groundwater well will also have deep vadose zone samples collected for vadose zone characterization. These activities are planned to characterize the nature and vertical extent of contamination in the vadose zone beneath waste sites, characterize the physical properties of soil/aquifer sediments, locate potential sources, and verify contaminant distribution coefficients to support modeling and an assessment of risk. The data from these activities will be used to verify the adequacy of interim remedial actions and refine the preliminary conceptual site model of 100-BC.

The scope of vadose zone characterization efforts includes field screening, collecting and analyzing soil samples from the vadose zone, collecting and analyzing aquifer sediment, performing groundwater sampling and analysis, and performing geophysical logging. The general intent of the borehole sampling design is to begin sample collection at the maximum depth of remedial action or bottom of the engineered

structure and sample at 1.5 m (5 ft) intervals. The soil sampling frequency will be continuous within 3.1 m (10 ft) of the expected water table. Vadose zone samples will be collected according to the sampling scheme shown in Table 3-1. The sampling scheme for each borehole and groundwater monitoring wells includes collecting soil samples periodically throughout the vadose zone, and collecting one sample of aquifer sediments 1.5 m (5 ft) into the water table. Groundwater samples will be collected from boreholes and wells as described in Section 3.5.2. Additional samples may be collected and drilling depth may be extended based on observations made in the field.

Physical property samples will be collected to provide site-specific values to support modeling efforts. The physical property samples will be collected from lithologies representing major facies in the vadose zone. The physical property samples will be collected in conjunction with split-spoon sample intervals, where possible.

3.5.1.1 Field Screening

Radiological field screening data, visual observation of lithologies, visual observation of contamination, or site geologist professional judgment may be used to adjust sampling points presented in Table 3-1, assist in determining sample shipping requirements, and support worker health and safety monitoring. Section 3.6.3 describes radiological field screening methods.

3.5.1.2 Geophysical Logging

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

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
100-C-7	Depths to be determined. Sample(s) to be collected from areas where Cr(VI) is visually apparent, and where high concentrations are suspected.	Batch leach test in accordance with Table 2-13.	None	None
100-B-5 Trench One borehole to 5 ft below groundwater (approximately 73 ft bgs) Justification: The 100-B-5 Trench was selected for characterization because mercury and chromium are above screening levels for groundwater protection at a depth of 28 ft below surface. No other contaminants were above screening levels for protection of groundwater. Although, strontium and hexavalent chromium were detected below screening for groundwater protection, this site is also selected because it is located correlative to the two respective groundwater plumes. A portion of the 100-B-8 and 100-C-6 effluent pipelines are located adjacent to this site, therefore data will also be provided to characterize process pipelines.	28-30.5, 33-35.5, 38-40.5, 43-45.5, 48-50.5, 53-55.5, 58-60.5, 63-65.5, 65.5-68, 68-70.5, 70.5-73 (75.5-78 aquifer sediment sample[b]) by split spoon (12 samples [estimated])	Target analytes and field screening parameters batch leach in accordance with Table 2-2. Batch leach test in accordance with Table 2-13. Aquifer sediment sample will only be analyzed for strontium-90, metals, hexavalent chromium, and mercury.	During drilling 75.5 ft to 78 ft bgs, collect one filtered groundwater sample from unconfined aquifer[b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-2.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
116-B-5 Crib One borehole to 5 ft below groundwater (approximately 65 ft bgs) Justification: The 116-B-5 Trench was selected for characterization because tritium, mercury, and barium are above screening levels for groundwater protection at a depth of approximately 16 ft bgs. No other contaminants were above screening levels for protection of groundwater. This site is also located correlative to the tritium, hexavalent chromium, and Sr-90 groundwater plumes and the site is a likely source of the tritium groundwater contamination. Process information indicates that 2.6 million gallons of tritiated effluent containing hundreds of gallons of mercury along with solvents and degreasers such as carbon tetrachloride, methyl alcohol, and trichloroethylene were released to the soil column. The volume of effluent release was sufficient to affect the entire vadose zone beneath the waste site.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 57.5-60, 60-62.5, 62.5-65 (67.5-70 aquifer sediment sample[b]) by split spoon (13 samples [estimated])	Target analytes and field screening parameters, batch leach in accordance with Table 2-3. Batch leach test in accordance with Table 2-13. Aquifer sediment sample will only be analyzed for strontium-90, tritium, metals, hexavalent chromium, and mercury.	During drilling 67.5 ft to 70 ft bgs[b], collect one filtered groundwater sample from unconfined aquifer (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-4.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
116-B-6B Crib One test pit. Justification: The 116-B-6B Crib was selected for characterization because it received 100 kg of sodium dichromate in 4,000 L of effluent. Based on the soil column pore volume of 198 m^3, the volume discharged was not sufficient to affect groundwater. Thus, the volume of effluent discharged to the soil column remains in the vadose zone and may be a future source of groundwater contamination. Because the engineered structure is approximately 5 ft below the depth of remedial action, contamination above screening levels for protection of groundwater may be present near the bottom of the waste site at 15 ft. Verification data indicate contaminants did not exceed screening criteria for groundwater protection. This site is also located correlative to the Sr-90 and hexavalent chromium groundwater plumes.	16.4-18.4 (1 sample [estimated]) 19.4-21.4 (1 sample [estimated])	Target analytes and field screening parameters batch leach in accordance with Table 2-4. Batch leach test in accordance with Table 2-13. Physical properties in accordance with Table 2-4.	N/A	N/A
116-B-9 French Drain One test pit. Justification: This site was selected for characterization because data is not available to evaluate the concentration and distribution of tritium at this site. The site was part of the P-10 project and tritium was not included in the analysis list for the close out data.	8-10 (1 sample [estimated]) 11-13 (1 sample [estimated])	Target analytes and field screening parameters in accordance with Table 2-5. Batch leach test in accordance with Table 2-13. Physical properties in accordance with Table 2-5.	N/A	N/A

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
116-B-14 Trench One borehole to 5 ft below groundwater (approximately 45 ft bgs). Justification: This site received sludge from the 116-B-11 Retention Basin. There is no history of this site receiving a high volume liquid waste stream. This site is being characterized to support conceptual site model development of a low-volume liquid site; there is also a lack of polychlorinated biphenyl data at this site. Site is also located relative to the hexavalent chromium, tritium, and strontium groundwater plumes adjacent to the Columbia River.	20-22.5, 25-27.5, 30-32.5, 32.5-35, 35-37.5, 37.5-40 (45-47.5 aquifer sediment sample[b]) by split spoon (7 samples [estimated])	Target analytes and field screening parameters batch leach in accordance with Table 2-6. Batch leach test in accordance with Table 2-13. Aquifer sediment sample only will be analyzed for strontium-90, metals, hexavalent chromium, and mercury.	During drilling 45 ft to 47.5 ft bgs, collect one filtered groundwater sample from unconfined aquifer [b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-6.		
116-C-5 Retention Basin One borehole to 5 ft below groundwater (approximately 45 ft bgs). Justification: This site was selected for characterization because hexavalent chromium, total chromium, lead, mercury, nickel-63 exceed remedial action goals in the deep zone. The site is also located relative to the hexavalent chromium, tritium, and strontium groundwater plumes adjacent to the Columbia River.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 37.7-40, 40-42.5, 42-5-45 (50-52.5 aquifer sediment sample[b]) by split spoon (9 samples [estimated])	Target analytes and field screening parameters batch leach in accordance with Table 2-7. Batch leach test in accordance with Table 2-13. Aquifer sediment sample only will be analyzed for strontium-90, metals, hexavalent chromium, and mercury.	During drilling 50-52.5 ft bgs, collect one filtered groundwater sample from unconfined aquifer[b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-7.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
118-B-6 Burial Ground One borehole to 5 ft below groundwater (approximately 71 ft bgs). Justification: The 118-B-6 Burial Ground was selected for characterization because tritium in the soil column at a depth of 23 ft is approximately 200 times the soil concentration that is protective of groundwater. This site is also located relative to the strontium-90 and hexavalent chromium groundwater plumes.	21-23.5, 26-28.5, 31-33.5, 36-38.5, 41-43.5, 46-48.5, 51-53.5 , 56-58.5 , 61-63.5, 63.5-66, 66-68.5, 68.5-71 (73.5-76 aquifer sediment sample[b]) by split spoon (13 samples [estimated])	Target analytes and field screening parameters batch leach in accordance with Table 2-8. Batch leach test in accordance with Table 2-13. Aquifer sediment sample only will be analyzed for strontium-90, tritium, metals, hexavalent chromium, and mercury.	During drilling 73.5 ft to 76 ft bgs, collect one filtered groundwater sample from unconfined aquifer[b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14)
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-8.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
Sampling Location	**Sample Interval Depth (ft bgs)**	**Analyte Property List**	**Sample Interval Depth (ft bgs)**	**Analyte List**
118-B-8 Reactor Fuel Storage Basin One borehole to 5 ft below groundwater (approximately 74 ft bgs) Justification: This site is selected because little or no data has been collected in the immediate vicinity of the reactor. The reactor fuel storage basin is known to have leak and contained fuel pool water, spent fuel and sludge. The site is also located relative to the hexavalent chromium, and strontium groundwater plumes adjacent to the Columbia River. Data are needed to evaluate the vertical extent of contamination at the 105-B reactor museum.	0-2.5, 5-7.5, 10-12.5, 12.5-15, 17.5-20, 22.5-25, 27.5-30, 32.5-35, 37.5-40, 42.5-45, 47.5-50, 52.5-55, 55-57.5, 57.5-60, 62.5-65, 65-67.5, 67.5-70, 70-72.5, 72.5-75 (80-82.5 aquifer sediment sample[b]) by split spoon (20 samples [estimated])	Target analytes and field screening parameters in accordance with Table 2-9. Batch leach test in accordance with Table 2-13. Aquifer sediment sample only will be analyzed for strontium-90, tritium, metals, hexavalent chromium, and mercury.	During drilling 80 ft to 82.5 ft bgs, collect one filtered groundwater sample from unconfined aquifer[b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-9.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
118-B-8:3 Process Sewer One test pit. Justification: This site was selected for characterization because the pipeline is located near the 118-B-8 Reactor. Samples will be collected from inside the pipe and below the pipe to evaluate risk and contaminant level below the 105-B reactor museum.	Inside pipe, at approximately 22 ft bgs, and at approximately 23 ft bgs. (3 samples [estimated])	Target analytes and field screening parameters in accordance with Table 2-10. Batch leach test in accordance with Table 2-13. Physical properties in accordance with Table 2-10.	N/A	N/A
118-C-3 Reactor Fuel Storage Basin One borehole to 5 ft below groundwater (approximately 99 ft bgs) Justification: This site is selected because the reactor fuel storage basin is known to have leak and contained fuel pool water, spent fuel and sludge. Data are needed to evaluate the vertical extent of contamination at the reactor.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 75-77.5, 80-82.5, 85-87.5, 87.5-90, 90-92.5, 92.5-95, 95-97.5, 97.5-100, (103-105.5 sediment sample) by split spoon (21 samples [estimated])	Target analytes and field screening parameters in accordance with Table 2-11. Batch leach test in accordance with Table 2-13. Aquifer sediment sample only will be analyzed for strontium-90, tritium, metals, hexavalent chromium, and mercury.	During drilling 103-105.5 ft bgs, collect one filtered groundwater sample from unconfined aquifer[b] (1 sample). Expedited turnaround time for Cr(VI) analysis will be requested.	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	Major formation and lithology changes samples by split spoon (2 samples [estimated])	Physical properties in accordance with Table 2-11.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 1 Install borehole reaching a total depth approximately 5 ft within the RUM and screened in the unconfined aquifer in 100-BC.	During drilling, archive samples of drill cuttings will be grab collected every 5 ft, or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c]	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (estimated 22 samples).	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the RUM within a non-water-bearing unit by split spoon (8 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods • Physical properties • EPA Methods 7196 and 6010	During drilling, 5 ft below water table[b] (1 filtered groundwater sample).	Metals, hexavalent chromium, strontium-90, and mercury in accordance with Table 2-14.
	Major formation and lithology changes and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-12.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 2 Install borehole reaching a total depth approximately 5 ft within the RUM and screened in the unconfined aquifer in 100-BC	During drilling, archive samples of drill cuttings will be grab collected every 5 ft or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c].	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (estimated 22 samples).	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, at the bottom of the unconfined aquifer, and 5 ft into the RUM within a non-water-bearing unit by split spoon (8 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods • Physical properties • EPA Methods 7196 and 6010	During drilling, 5 ft below water table[b] (1 filtered groundwater sample).	Metals, hexavalent chromium, strontium-90, and mercury in accordance with Table 2-14.
	Major formation and lithology changes and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-13.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 3 Install borehole reaching a total depth approximately 5 ft within the RUM and screened in the unconfined aquifer in 100-BC	During drilling, archive samples of drill cuttings will be grab collected every 5 ft or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c]	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (estimated 22 samples). During drilling, 5 ft below water table[b] (1 filtered groundwater sample).	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14). Metals, hexavalent chromium, strontium-90, and mercury in accordance with Table 2-14.
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the RUM within a non-water-bearing unit by split spoon (8 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods • Physical properties • EPA Methods 7196 and 6010		
	Major formation and lithology changes, and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-12.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 4 Install borehole reaching a total depth approximately 5 ft within the RUM and screened in the unconfined aquifer in 100-BC	During drilling, archive samples of drill cuttings will be grab collected every 5 ft or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c].	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (estimated 22 samples).	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the RUM within a non water-bearing unit by split spoon (8 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods • Physical properties • EPA Methods 7196 and 6010	During drilling, 5 ft below water table[b] (1 filtered groundwater sample).	Metals, hexavalent chromium, strontium-90, and mercury in accordance with Table 2-14.
	Major formation and lithology changes and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-12.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 5 Install borehole reaching a total depth approximately 5 ft within the RUM and screened in the unconfined aquifer in 100-BC	During drilling, archive samples of drill cuttings will be grab collected every 5 ft or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c].	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (estimated 22 samples).	Table 1-3 constituents in accordance with Table 2-14. Field screening parameters in accordance with Table 2-14.
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the RUM within a non-water-bearing unit by split spoon (8 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods • Physical properties • EPA Methods 7196 and 6010	During drilling, 5 ft below water table[b] (1 filtered groundwater sample).	Metals, hexavalent chromium, Sr-90, and mercury in accordance with Table 2-14.
	Major formation and lithology changes and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-12.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Well No. 6 Install borehole reaching a total depth approximately 50 ft within the RUM and screened in the first water bearing unit of the RUM in 100-BC	During drilling, archive samples of drill cuttings will be grab collected every 5 ft or where lithology changes occur in a pint jar and a chip tray.	Geologic archive samples[c].	During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer and from water-bearing intervals of the RUM unit if sufficient water is available (24 samples).	Table 1-3 constituents (in accordance with Table 2-14). Field screening parameters (in accordance with Table 2-14).
	During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, at the bottom of the unconfined aquifer and from the top, middle, and bottom of the non-water-bearing units of the RUM unit by split spoon (10 samples [estimated])	In accordance with Tables 2-12 and 2-13: • Batch leach test • Distribution coefficient • Radiological methods. • Physical properties • EPA Methods 7196 and 6010	During drilling, from water-bearing unit in RUM[b] (1 filtered groundwater sample).	Metals, hexavalent chromium, strontium-90, and mercury in accordance with Table 2-14.
	Major formation and lithology changes and 10 ft and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (6 samples [estimated])	Physical properties in accordance with Table 2-13.		

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Sample 18 spatial/temporal uncertainty monitoring wells (Table 3-2); multiple rounds (This includes existing wells and 4 groundwater monitoring wells installed under Sampling and Analysis Plan DOE/RL-2009-61).	None	None	Multiple sampling rounds to support remedial investigation (18 wells × 3 rounds = 54 samples).	Table 1-3 constituents at standard turnaround time in accordance with Table 2-14. Field screening parameters in accordance with Table 2-14.
Sample pore water at 10 (minimum) locations selected for Phase III sampling under *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* (DOE/RL-2008-11)	None	None	A minimum of one round of sampling will occur. Exact locations to be identified in the field based on favorable flow, temperature, and conductivity measurements. (10 locations x 1 round = 10 samples).	Total chromium and hexavalent chromium in accordance with Table 1-15. Additional analytes as agreed upon by DOE and EPA.
Estimated number of samples	Soil/aquifer sediment chemical: 152 Physical property: 57 Geologic archive samples: variable		Water samples collected during drilling: 147 Spatial/temporal uncertainty samples: 54 Pore water samples: 10	
Estimated minimum number of field QC samples	Soil/aquifer sediment chemical: 25 (8 equipment rinsate blank, 8 field blank, 8 duplicate, 1 split) Physical property: 0 Geologic archive samples: 0		Water samples collected during drilling: 25 (8 equipment rinsate blank, 8 field blank, 8 duplicate, 1 split) Spatial/temporal uncertainty samples: 10 (3 equipment rinsate blank, 3 field blank, 3 duplicate, 1 split) Pore water samples: 4 (1 equipment rinsate blank, 1 field blank, 1 duplicate, 1 split)	

Table 3-1. Borehole and Groundwater Well Sample/Measurement Locations and Depths

Sampling Location	Soil/Aquifer Sediment Sample/Measurement[a]		Water Sample/Measurement	
	Sample Interval Depth (ft bgs)	Analyte Property List	Sample Interval Depth (ft bgs)	Analyte List
Total number of samples	Soil/aquifer sediment chemical: 177 Physical property: 57 Geologic archive samples: variable		Water samples collected during drilling: 172 Spatial/temporal uncertainty samples: 64 Pore water samples: 14	

Notes:

a. Upon visual observation of contamination, a depth discrete sample will be collected for applicable analysis. For example, if hexavalent chromium contamination is observed at any interval other than those stated for sampling, a depth discrete sample would be collected for hexavalent chromium analysis.

b. This aquifer sediment sample will be collected from the unconfined aquifer, 5 ft below the water table.

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

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

bgs = below ground surface

GEA = gamma energy analysis

RUM = Ringold Fm Upper Mud

3.5.2 Groundwater Characterization

Groundwater characterization, including well activities, identification of wells to be sampled, well depth and screen placement, and well drilling and completion procedures, is discussed in this section.

3.5.2.1 New Groundwater Wells

Table 3-1 summarizes groundwater monitoring well activities. From the new well screened in the Ringold Fm Upper Mud Unit, slug testing and pump testing will be performed to characterize hydraulic conductivity.

Well Depth and Screen Placement

For the five new groundwater wells in the unconfined aquifer in 100-BC, the screen length and placement will be determined after initial aquifer samples are reviewed.

For the one new groundwater well in 100-BC to be drilled into the uppermost water-bearing unit within the Ringold Fm Upper Mud Unit, the screen length and placement will be determined based on the thickness and ability to produce water in the water-bearing Ringold Fm Upper Mud Unit.

Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160. The wells will be drilled using 25-cm (10 in.) diameter (or larger) casing to total depth. The drilling method will be determined based on discussions between the drilling lead and drilling contractor. The wells will be constructed as 15.24 cm (6-in.) wells with Schedule 10, Type 304 or 316 stainless steel, V-slot continuous wire wrap screen, atop a 0.6 m (2 ft) long stainless steel sump with end cap. A Schedule 10 stainless steel riser will be used to extend the permanent well into the vadose zone, with Schedule 10 stainless steel casing through the vadose zone to ground surface. Colorado silica sand will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; and Type I/II Portland cement will be used for cement grout.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place before job completion. The protective casing will be a minimum of 5 cm (2 in.) larger in diameter than the permanent casing. Protective casing will rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing will rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing will have a lockable well cap extending approximately 38.1 cm (15 in.) above the top of the protective casing.

Final well design, including screen placement and length, will be determined by concurrence of the field geologist, drilling lead, and operable unit lead based on field conditions.

Well Sampling During Drilling

Soil samples will be collected during well drilling for vadose zone characterization, as described in Section 3.5.1. Groundwater samples will be collected during drilling of borings and groundwater monitoring wells as described in Table 3-1. Generally, samples will be collected at 5 ft intervals throughout the unconfined aquifer and below the water table.

After completion, samples will be collected from the groundwater wells installed under the scope of this SAP quarterly for the first year, with a reduction in frequency for subsequent years, if warranted. These sampling and analysis activities will be conducted as part of DOE/RL-2003-38, *100-BC-5 Operable Unit Sampling and Analysis Plan*, Rev 1.

Columbia River Pore Water Sampling

Additional groundwater upwelling (pore water) samples will be collected in the Columbia River. Samples will be collected from established upwelling locations, and the focus will be on sites where contamination was detected in previous pore water sampling conducted under the *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* (DOE/RL-2008-11). At a minimum, attempts will be made to collect samples at ten of the 100-BC locations that were selected for Phase III sampling under the RI Work Plan for the Hanford Site Releases to the Columbia River (DOE/RL-2008-11). Exact sample locations will be identified in the field using the procedures for identification of favorable flow conditions relating to temperature and conductivity, as outlined in the RI Work Plan for the Hanford Site Releases to the Columbia River (DOE/RL-2008-11). Additional sampling location requirements will be determined through a collaborative process with DOE and EPA.

Laboratory analysis from pore water will include, at a minimum, hexavalent chromium (Cr(VI)) and total chromium. Additionally, those contaminants detected above either aquatic protection levels or drinking water standards (whichever is most restrictive) during the Phase III sampling described above will be sampled for from selected locations as indicated by the Phase III results. This need for additional analytes will be determined through a collaborative process with DOE and EPA.

3.5.2.2 Groundwater Network to Evaluate Spatial and Temporal Uncertainty

Table 3-1 summarizes groundwater monitoring activities to address spatial and temporal uncertainties. Table 3-2 presents the wells to be sampled. Multiple rounds of groundwater samples will be collected for analysis to support the remedial investigation in the existing groundwater wells for each contaminant identified in Table 1-3.

Table 3-2. Spatial and Temporal Uncertainty Groundwater Monitoring Well Network

C7505 (new)	199-B3-46	199-B4-4	199-B5-1	C7665 (new)	199-B9-3	699-67-86
199-B2-13	199-B3-47	C7507 (new)	199-B5-2	699-65-83	699-65-72	699-71-77
199-B3-1	C7506 (new)	199-B4-8	199-B8-6			

To determine the spatial and temporal risk uncertainty for potential human and ecological receptors, the RI process requires that the groundwater be sampled, providing representative data of aquifer conditions, both spatially and temporally. It is required that the groundwater be sampled throughout an area without regard to the location of surface facilities or known groundwater plumes. If there are temporal changes in groundwater conditions, samples must be collected to capture these varying stages to properly delineate temporal risk uncertainties to potential receptors. The resulting well network data will be used to evaluate the groundwater risk information presented in DOE/RL-2007-21, *Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment.* Observations and conclusions regarding the data collected and the DOE/RL-2007-21 evaluation will be documented in the RI report (e.g., risk uncertainties associated with temporal and spatial representativeness, verifying groundwater risk conclusions, ensuring no contaminants were inadvertently overlooked, and establishing a "present condition" dataset that can be used to measure the progress of future cleanup actions).

Sampling Frequency

To capture baseline aquifer conditions fully, it is required that samples represent not only spatial variations but also changes that occur over time. Near the river, these varying conditions are observed as changes in groundwater flow, both direction and rate, causing temporary movement of contaminants through different portions of the unconfined aquifer. For areas bordering on the Columbia River, the

changing aquifer conditions are caused by fluctuating river elevations associated with flood control and hydroelectric production. For representing baseline groundwater conditions, samples are required to represent these varying aquifer conditions associated with high, low and mid-point or transitional river elevations. The date and frequency of sample collection is based on measurements of the river elevation to optimize collection of samples representing these temporal changes in groundwater conditions.

Effect of River Elevation on Groundwater Conditions

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

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

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

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

Groundwater Sampling Dates

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

Based on the previous discussion, three sampling events are recommended to represent the temporal fluctuations in groundwater conditions. One sampling event captures the effect on the aquifer when the

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

3.6 Sampling Methods

Soil/aquifer sediment sampling will be performed in accordance with approved procedures for soil and aquifer sediment sampling using a 10.2 cm (4-in.) split-spoon sampler. The split-spoon samplers will be equipped with separate stainless steel or polycarbonate liners. Site personnel will not overdrive the sampling device. Samples for VOCs will be packaged first. Next, the remaining soil/aquifer sediment will be transferred to a pre-cleaned, stainless steel mixing bowl or other suitable pre-cleaned container, homogenized, then containerized in accordance with the sampling procedure. If sample volume requirements cannot be met, samples will be collected according to the following priority: hexavalent chromium, metals (including mercury and uranium), batch leach test, tritium, nitrate, strontium-90, technetium-99, other radionuclides, polychlorinated biphenyls, semi-volatile organic compounds, hydraulic properties, and other anions. Sufficient volume should be available to perform these analyses. It is desirable to have a consistent priority for all samples.

Groundwater samples collected during drilling, before development, will be pumped from selected intervals. The pump will be operated long enough to provide stabilized field readings, but not necessarily three casing volumes.

For the groundwater monitoring well network, prior to sample capture, the pump will be operated for a period sufficient to provide stabilized field readings, and at least three casing volumes.

3.6.1 Corrective Actions and Deviations for Sampling Activities

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

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

Sample location changes that are more significant but not affecting the data needs will require notification and approval of the project lead. Changes to sample locations resulting in impacts to meeting the data needs will require concurrence with DOE and regulatory project leads. Changes to the SAP will be documented as noted in Section 2.1.6.

3.6.2 Decontamination of Sampling and Drilling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination procedure. To prevent contamination of the samples, care should be taken to use clean equipment for each

sampling activity. Special care should be taken to avoid the following common ways in which cross contamination or background contamination may compromise the samples:

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

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

3.6.3 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. Generally, cuttings from boreholes (excluding slough) will be field screened for evidence of radiological contamination. Screening will be conducted visually and with field instruments. Radiological screening will be performed by the radiological control technician or other qualified personnel. The radiological control technician will record field measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the field geologist for inclusion into the field logbook or operational records daily, as applicable.

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

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

3.7 Sample Handling

Sample handling, including container packaging, container labeling, sample custody, and sample transportation, is discussed in this section.

3.7.1 Container Packaging

Level I EPA pre-cleaned sample containers will be used for soil/aquifer sediment and water samples collected for chemical analysis. Container sizes may vary depending on laboratory specific volumes and requirements for meeting analytical detection limits. Radiological Engineering will measure the

contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead, in consultation with Sample Management and Reporting, can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Tables 3-3 and 3-4.

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

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
Alpha energy analysis	None	6 months	G/P	10 g
Americium-241/Curium-244	None	6 months	G/P	5 g
Gamma energy analysis	None	6 months	G/P	750 g
Liquid scintillation counter	None	6 months	G	33 g
Isotopic – plutonium	None	6 month	G/P	5 g
Isotopic – uranium	None	6 months	G/P	5 g
Strontium-90	None	6 months	G/P	5 g
Iodine-129 – Low Level	None	6 months	G/P	150 g
EPA 200.8	None	6 months	G/P	15 g
EPA 6010	Cool ~4° C	6 months	G/P	15 g
EPA 7196	Cool ~4° C	30 days	G/P	50 g
EPA 7471	None	28 days	G/P	15 g
UKPA	None	6 months	G/P	10 g
EPA 8260[b]	Cool ~4° C	14 days	G	50 g
EPA 8270	Cool ~4° C	14/40 days	aG	250 g
EPA 8082	Cool ~4° C	14/40 days	aG	50 g
EPA 8310	Cool ~4° C	14/40 days	aG	250 g
EPA 300.0	Cool ~4° C	48 hours/28 days	G/P	50 g
ASTM D2216-05	None	None	Moisture-proof container	200 g
ASTM D2937-04	None	None	G/P	1,000 g
ASTM D2434-68	None	None	P	1,000 g
ASTM D5084-03	None	None	P	1,000 g
Batch leaching test	Cool ~4° C	28 days from field to extraction	G	100 g/120 mL
Distribution coefficient	Cool ~4 °C		Moisture-proof container	250 g

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

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]

Notes:

a. Based on minimum QC requirements.

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

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

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

ASTM D2434-68(2006), *Standard Test Method for Permeability of Granular Soils (Constant Head)*

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

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*

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

14/40 days = 14 days to extraction, then 40 days for analysis

aG = amber glass

G = glass

P = plastic

UKPA = total uranium by kinetic phosphorescence analysis

Table 3-4. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*
Iodine-129 – Low Level	None	6 months	G/P	2000 mL
Strontium-90	HNO_3 to pH <2	6 months	G/P	2,000 mL
EPA 6020 or 200.8	HNO_3 to pH <2	6 months	G/P	300 mL
LSC – Tritium	None	6 months	G	60 mL
EPA 900.0	HNO_3 to pH <2	6 months	G/P	2,000 mL
EPA 6010	HNO_3 to pH <2	6 months	G/P	300 mL
EPA 7196	Cool ~4° C	24 hours	aG	500 mL
EPA 7470	HNO_3 to pH <2	28 days	G	500 mL
EPA 6020 or 200.8	HNO_3 to pH <2	28 days	G	300 mL
EPA 8260	Cool ~4° C, HCl or H_2SO_4 to pH <2	14 days	aGs	40 mL
EPA 300.0	Cool ~4° C	48 hours/28 days	P	125 mL

Table 3-4. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*

Notes:

* Based on minimum QC requirements.

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

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

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

aG = amber glass

aGs = amber glass septum; no headspace

G = glass

P = plastic

3.7.2 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. Each sample container will be labeled with the following information on firmly affixed, water resistant labels:

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

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

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

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

3.7.3 Sample Custody Requirements

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be

indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample Management and Reporting within 48 hours of shipping.

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

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

3.7.4 Sample Transportation

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

3.8 Management of Waste

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with DOE/RL-2004-30, *Waste Control Plan for the 100-BC-5 Operable Unit*. Pursuant to 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," approval from the lead regulatory agency Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

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4 Health and Safety

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

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5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

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Appendix A

Laboratory Standard Compound List

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A1 Laboratory Standards Compound List

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

A2 References

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

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
24959-67-9	Bromide	250	2,500	≤20%/≤30%	80-120%/70-130%
16887-00-6	Chloride	200	2,000	≤20%/≤30%	80-120%/70-130%
16984-48-8	Fluoride	500	5,000	≤20%/≤30%	80-120%/70-130%
14797-55-8	Nitrate*	250	2,500	≤20%/≤30%	80-120%/70-130%
14797-65-0	Nitrite*	250	2,500	≤20%/≤30%	80-120%/70-130%
NO3-N	Nitrogen in nitrate*	75	750	≤20%/≤30%	80-120%/70-130%
NO2-N	Nitrogen in nitrite*	75	750	≤20%/≤30%	80-120%/70-130%
14265-44-2	Phosphate*	500	5,000	≤20%/≤30%	80-120%/70-130%
14808-79-8	Sulfate	500	5,000	≤20%/≤30%	80-120%/70-130%

Notes:

* Nitrate, nitrite, and phosphate suite or nitrogen in nitrate, nitrogen in nitrite, and phosphorus in phosphate suite may either be reported.

EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*

CAS = Chemical Abstract Services

EQL = estimated quantitation limit

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

CAS Number	Constituent	Water RDL (pCi/L)	Soil RDL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7429-90-5	Aluminum	50	5,000	≤20%/≤30%	80-120%/70-130%
7440-36-0	Antimony	60	6,000	≤20%/≤30%	80-120%/70-130%
7440-38-2	Arsenic	100	10,000	≤20%/≤30%	80-120%/70-130%
7440-39-3	Barium	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-41-7	Beryllium	2	500	≤20%/≤30%	80-120%/70-130%
7440-69-9	Bismuth	100	10,000	≤20%/≤30%	80-120%/70-130%
7440-42-8	Boron	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-43-9	Cadmium	2	500	≤20%/≤30%	80-120%/70-130%
7440-70-2	Calcium	1,000	100,000	≤20%/≤30%	80-120%/70-130%
7440-47-3	Chromium	10	1,000	≤20%/≤30%	80-120%/70-130%
7440-48-4	Cobalt	4	2,000	≤20%/≤30%	80-120%/70-130%
7440-50-8	Copper	8	1,000	≤20%/≤30%	80-120%/70-130%
7439-89-6	Iron	50	5,000	≤20%/≤30%	80-120%/70-130%
7439-92-1	Lead	50	5,000	≤20%/≤30%	80-120%/70-130%
7439-93-2	Lithium	25	2,500	≤20%/≤30%	80-120%/70-130%
7439-95-4	Magnesium	750	75,000	≤20%/≤30%	80-120%/70-130%
7439-96-5	Manganese	5	5,000	≤20%/≤30%	80-120%/70-130%
7439-98-7	Molybdenum	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-02-0	Nickel	40	4,000	≤20%/≤30%	80-120%/70-130%
7723-14-0	Phosphorus	100	50,000	≤20%/≤30%	80-120%/70-130%
7440-09-7	Potassium	4,000	400,000	≤20%/≤30%	80-120%/70-130%
7782-49-2	Selenium	100	10,000	≤20%/≤30%	80-120%/70-130%
7440-21-3	Silicon	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-22-4	Silver	10	1,000	≤20%/≤30%	80-120%/70-130%
7440-23-5	Sodium	500	50,000	≤20%/≤30%	80-120%/70-130%
7440-24-6	Strontium (elemental)	10	1,000	≤20%/≤30%	80-120%/70-130%
7440-28-0	Thallium	50	5,000	≤20%/≤30%	80-120%/70-130%
7440-31-5	Tin	100	10,000	≤20%/≤30%	80-120%/70-130%
7440-62-2	Vanadium	25	2,500	≤20%/≤30%	80-120%/70-130%
7440-66-6	Zinc	10	10,000	≤20%/≤30%	80-120%/70-130%

Notes:

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

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

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

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7440-36-0	Antimony	5	600	≤20%/≤30%	80-120%/70-130%
7440-38-2	Arsenic	4	1,000	≤20%/≤30%	80-120%/70-130%
7440-39-3	Barium	5	500	≤20%/≤30%	80-120%/70-130%
7440-41-7	Beryllium	2	200	≤20%/≤30%	80-120%/70-130%
7440-43-9	Cadmium	2	200	≤20%/≤30%	80-120%/70-130%
7440-47-3	Chromium	2	200	≤20%/≤30%	80-120%/70-130%
7439-92-1	Lead	2	500	≤20%/≤30%	80-120%/70-130%
7782-49-2	Selenium	4	1,000	≤20%/≤30%	80-120%/70-130%
7440-22-4	Silver	2	200	≤20%/≤30%	80-120%/70-130%
7440-28-0	Thallium	2	500	≤20%/≤30%	80-120%/70-130%

Notes:

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

For Method 6020, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8260

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
71-55-6	1,1,1-trichloroethane	5	5	≤20%/≤30%	80-120%/70-130%
79-34-5	1,1,2,2-tetrachloroethane	5	5	≤20%/≤30%	80-120%/70-130%
79-00-5	1,1,2-trichloroethane	2	5	≤20%/≤30%	80-120%/70-130%
75-34-3	1,1-dichloroethane	2	10	≤20%/≤30%	80-120%/70-130%
75-35-4	1,1-dichloroethene	10	10	≤20%/≤30%	80-120%/70-130%
107-06-2	1,2-dichloroethane	5	5	≤20%/≤30%	80-120%/70-130%
540-59-0	1,2-dichloroethene(total)	10	5	≤20%/≤30%	80-120%/70-130%
78-87-5	1,2-dichloropropane	5	5	≤20%/≤30%	80-120%/70-130%
78-93-3	2-butanone	10	10	≤20%/≤30%	80-120%/70-130%
591-78-6	2-hexanone	20	20	≤20%/≤30%	80-120%/70-130%

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8260

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
108-10-1	4-methyl-2-pentanone	10	10	≤20%/≤30%	80-120%/70-130%
67-64-1	Acetone	20	20	≤20%/≤30%	80-120%/70-130%
71-43-2	Benzene	1.5	5	≤20%/≤30%	80-120%/70-130%
75-27-4	Bromodichloromethane	5	5	≤20%/≤30%	80-120%/70-130%
75-25-2	Bromoform	5	5	≤20%/≤30%	80-120%/70-130%
74-83-9	Bromomethane	10	10	≤20%/≤30%	80-120%/70-130%
75-15-0	Carbon disulfide	5	5	≤20%/≤30%	80-120%/70-130%
56-23-5	Carbon tetrachloride	2	5	≤20%/≤30%	80-120%/70-130%
108-90-7	Chlorobenzene	5	5	≤20%/≤30%	80-120%/70-130%
75-00-3	Chloroethane	10	10	≤20%/≤30%	80-120%/70-130%
67-66-3	Chloroform	5	5	≤20%/≤30%	80-120%/70-130%
74-87-3	Chloromethane	10	10	≤20%/≤30%	80-120%/70-130%
156-59-2	cis-1,2-Dichloroethylene	5	5	≤20%/≤30%	80-120%/70-130%
10061-01-5	cis-1,3-dichloropropene	5	5	≤20%/≤30%	80-120%/70-130%
124-48-1	Dibromochloromethane	5	5	≤20%/≤30%	80-120%/70-130%
100-41-4	Ethylbenzene	5	5	≤20%/≤30%	80-120%/70-130%
75-09-2	Methylene chloride	5	5	≤20%/≤30%	80-120%/70-130%
100-42-5	Styrene	5	5	≤20%/≤30%	80-120%/70-130%
127-18-4	Tetrachloroethene	5	5	≤20%/≤30%	80-120%/70-130%
108-88-3	Toluene	5	5	≤20%/≤30%	80-120%/70-130%
10061-02-6	trans-1,3-dichloropropene	5	5	≤20%/≤30%	80-120%/70-130%
79-01-6	Trichloroethene	1	5	≤20%/≤30%	80-120%/70-130%
75-01-4	Vinyl chloride	5	5	≤20%/≤30%	80-120%/70-130%
1330-20-7	Xylenes (total)	10	10	≤20%/≤30%	80-120%/70-130%

Notes:

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

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8270

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
120-82-1	1,2,4-Trichlorobenzene	10	330	≤20%/≤30%	80-120%/70-130%
95-50-1	1,2-Dichlorobenzene	10	330	≤20%/≤30%	80-120%/70-130%
541-73-1	1,3-Dichlorobenzene	10	330	≤20%/≤30%	80-120%/70-130%
106-46-7	1,4-Dichlorobenzene	5	330	≤20%/≤30%	80-120%/70-130%
95-95-4	2,4,5-Trichlorophenol	10	330	≤20%/≤30%	80-120%/70-130%
88-06-2	2,4,6-Trichlorophenol	10	330	≤20%/≤30%	80-120%/70-130%
120-83-2	2,4-Dichlorophenol	10	330	≤20%/≤30%	80-120%/70-130%
105-67-9	2,4-Dimethylphenol	10	330	≤20%/≤30%	80-120%/70-130%
51-28-5	2,4-Dinitrophenol	25	825	≤20%/≤30%	80-120%/70-130%
121-14-2	2,4-Dinitrotoluene	10	330	≤20%/≤30%	80-120%/70-130%
606-20-2	2,6-Dinitrotoluene	10	330	≤20%/≤30%	80-120%/70-130%
91-58-7	2-Chloronaphthalene	10	330	≤20%/≤30%	80-120%/70-130%
95-57-8	2-Chlorophenol	10	330	≤20%/≤30%	80-120%/70-130%
91-57-6	2-Methylnaphthalene	10	330	≤20%/≤30%	80-120%/70-130%
95-48-7	2-Methylphenol (cresol, o-)	10	330	≤20%/≤30%	80-120%/70-130%
88-74-4	2-Nitroaniline	10	330	≤20%/≤30%	80-120%/70-130%
88-75-5	2-Nitrophenol	20	660	≤20%/≤30%	80-120%/70-130%
91-94-1	3,3'-Dichlorobenzidine	10	330	≤20%/≤30%	80-120%/70-130%
65794-96-9	3+4 Methylphenol (cresol, m+p)*	10	330	≤20%/≤30%	80-120%/70-130%
99-09-2	3-Nitroaniline	10	330	≤20%/≤30%	80-120%/70-130%
534-52-1	4,6-Dinitro-2-methylphenol	10	330	≤20%/≤30%	80-120%/70-130%
101-55-3	4-Bromophenylphenyl ether	10	330	≤20%/≤30%	80-120%/70-130%
59-50-7	4-Chloro-3-methylphenol	10	330	≤20%/≤30%	80-120%/70-130%
106-47-8	4-Chloroaniline	10	330	≤20%/≤30%	80-120%/70-130%
7005-72-3	4-Chlorophenylphenyl ether	10	330	≤20%/≤30%	80-120%/70-130%
100-01-6	4-Nitroaniline	10	330	≤20%/≤30%	80-120%/70-130%
100-02-7	4-Nitrophenol	20	660	≤20%/≤30%	80-120%/70-130%
83-32-9	Acenaphthene	10	330	≤20%/≤30%	80-120%/70-130%
208-96-8	Acenaphthylene	10	330	≤20%/≤30%	80-120%/70-130%
120-12-7	Anthracene	10	330	≤20%/≤30%	80-120%/70-130%

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8270

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
56-55-3	Benzo(a)anthracene	10	330	≤20%/≤30%	80-120%/70-130%
50-32-8	Benzo(a)pyrene	10	330	≤20%/≤30%	80-120%/70-130%
205-99-2	Benzo(b)fluoranthene	10	330	≤20%/≤30%	80-120%/70-130%
191-24-2	Benzo(ghi)perylene	10	330	≤20%/≤30%	80-120%/70-130%
207-08-9	Benzo(k)fluoranthene	10	330	≤20%/≤30%	80-120%/70-130%
108-60-1	Bis(2-chloro-1-methylethyl)ether	10	330	≤20%/≤30%	80-120%/70-130%
111-91-1	Bis(2-Chloroethoxy)methane	10	330	≤20%/≤30%	80-120%/70-130%
111-44-4	Bis(2-chloroethyl) ether	10	330	≤20%/≤30%	80-120%/70-130%
117-81-7	Bis(2-ethylhexyl) phthalate	10	330	≤20%/≤30%	80-120%/70-130%
85-68-7	Butylbenzylphthalate	10	330	≤20%/≤30%	80-120%/70-130%
86-74-8	Carbazole	10	330	≤20%/≤30%	80-120%/70-130%
218-01-9	Chrysene	10	330	≤20%/≤30%	80-120%/70-130%
53-70-3	Dibenz[a,h]anthracene	10	330	≤20%/≤30%	80-120%/70-130%
132-64-9	Dibenzofuran	10	330	≤20%/≤30%	80-120%/70-130%
84-66-2	Diethylphthalate	10	330	≤20%/≤30%	80-120%/70-130%
131-11-3	Dimethyl phthalate	10	330	≤20%/≤30%	80-120%/70-130%
84-74-2	Di-n-butylphthalate	10	330	≤20%/≤30%	80-120%/70-130%
117-84-0	Di-n-octylphthalate	10	330	≤20%/≤30%	80-120%/70-130%
206-44-0	Fluoranthene	10	330	≤20%/≤30%	80-120%/70-130%
86-73-7	Fluorene	10	330	≤20%/≤30%	80-120%/70-130%
118-74-1	Hexachlorobenzene	10	330	≤20%/≤30%	80-120%/70-130%
87-68-3	Hexachlorobutadiene	10	330	≤20%/≤30%	80-120%/70-130%
77-47-4	Hexachlorocyclopentadiene	10	330	≤20%/≤30%	80-120%/70-130%
67-72-1	Hexachloroethane	10	330	≤20%/≤30%	80-120%/70-130%
193-39-5	Indeno(1,2,3-cd)pyrene	10	330	≤20%/≤30%	80-120%/70-130%
78-59-1	Isophorone	10	330	≤20%/≤30%	80-120%/70-130%
91-20-3	Naphthalene	10	330	≤20%/≤30%	80-120%/70-130%
98-95-3	Nitrobenzene	10	330	≤20%/≤30%	80-120%/70-130%
621-64-7	n-Nitrosodi-n-dipropylamine	10	330	≤20%/≤30%	80-120%/70-130%
86-30-6	n-Nitrosodiphenylamine	10	330	≤20%/≤30%	80-120%/70-130%

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8270

CAS Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
87-86-5	Pentachlorophenol	10	330	≤20%/≤30%	80-120%/70-130%
85-01-8	Phenanthrene	10	330	≤20%/≤30%	80-120%/70-130%
108-95-2	Phenol	10	330	≤20%/≤30%	80-120%/70-130%
129-00-0	Pyrene	10	330	≤20%/≤30%	80-120%/70-130%

Notes:

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

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

CAS = Chemical Abstracts Service EQL = estimated quantitation limit

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8310

Chemical Abstracts Service Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
83-32-9	Acenaphthene	20	100	≤20 / ≤30	80-120 / 70-130
208-96-8	Acenaphthylene	25	100	≤20 / ≤30	80-120 / 70-130
120-12-7	Anthracene	10	50	≤20 / ≤30	80-120 / 70-130
56-55-3	Benzo(a)anthracene	0.3	15	≤20 / ≤30	80-120 / 70-130
50-32-8	Benzo(a)pyrene	0.5	15	≤20 / ≤30	80-120 / 70-130
205-99-2	Benzo(b)fluoranthene	0.5	15	≤20 / ≤30	80-120 / 70-130
191-24-2	Benzo(ghi)perylene	1	30	≤20 / ≤30	80-120 / 70-130
207-08-9	Benzo(k)fluoranthene	0.5	15	≤20 / ≤30	80-120 / 70-130
218-01-9	Chrysene	5	100	≤20 / ≤30	80-120 / 70-130
53-70-3	Dibenz[a,h]anthracene	1	30	≤20 / ≤30	80-120 / 70-130
206-44-0	Fluoranthene	5	50	≤20 / ≤30	80-120 / 70-130
86-73-7	Fluorene	3	30	≤20 / ≤30	80-120 / 70-130
193-39-5	Indeno(1,2,3-cd)pyrene	1	30	≤20 / ≤30	80-120 / 70-130
91-20-3	Naphthalene	20	100	≤20 / ≤30	80-120 / 70-130
85-01-8	Phenanthrene	10	50	≤20 / ≤30	80-120 / 70-130
129-00-0	Pyrene	5	50	≤20 / ≤30	80-120 / 70-130

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8310

Chemical Abstracts Service Number	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)

Notes:

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

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-7. U.S. Environmental Protection Agency SW-846 Method 8082

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

Notes:

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

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-8. Gamma Spectroscopy, Germanium High Energy Detectors (Gamma Energy Analysis)

CAS Number	Constituent	Water EQL (µg/L)	Soil EQLt (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
14234-35-6	Antimony-125	50	0.3	≤30	70-130
13966-02-4	Beryllium-7	50	0.3	≤30	70-130
13967-70-9	Cesium-134	15	0.1	≤30	70-130
10045-97-3	Cesium-137	15	0.1	≤30	70-130
10198-40-0	Cobalt-60	25	0.05	≤30	70-130
14683-23-9	Europium-152	50	0.1	≤30	70-130
15585-10-1	Europium-154	50	0.1	≤30	70-130
14391-16-3	Europium-155	50	0.1	≤30	70-130
13966-00-2	Potassium-40			≤30	70-130
13967-48-1	Ruthenium-106			≤30	70-130

Notes:

a. Where EQL is not specified, the EQLs attainable by the laboratories for the methods-based constituents using the same analytical conditions as for the contaminants of concern are applicable.

pCi/L = picocuries per liter
pCi/g = picocuries per gram
CAS = Chemical Abstracts Service
EQL = estimated quantitation limit

Table A-9. Isotopic Uranium

CAS Number	Constituent	Water EQL (µg/L)	Soil EQLt (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13966-29-5	Uranium-234	1	1	≤30	70-130
15117-96-1	Uranium-235	1	0.5	≤30	70-130
U-238	Uranium-238	1	1	≤30	70-130

Notes:

pCi/L = picocuries per liter
pCi/g = picocuries per gram
CAS = Chemical Abstracts Service
EQL = estimated quantitation limit

Table A-10. Plutonium

CAS Number	Constituent	Water EQL (µg/L)	Soil EQLt (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13981-16-3	Plutonium-238	1	1	≤30	70-130
PU-239/240	Plutonium-239/240	1	1	≤30	70-130

Notes:

pCi/L = picocuries per liter
pCi/g = picocuries per gram
CAS = Chemical Abstracts Service
EQL = estimated quantitation limit

Table A-11. Gross Alpha/Beta by Gas Proportional Flow Counting Method 900.0

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (pCi/L)	Soil Estimated Quantitation Limit (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
12587-46-1	Gross Alpha Activity	3	NA	≤30	70-130
12587-47-2	Gross Beta Activity	4	NA	≤30	70-130

NA = not applicable
pCi/L = picocuries per liter
pCi/g = picocuries per gram

Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
G. L. Sinton	A6-38	60
DOE Public Reading Room	H2-53	1
CH2M HILL Plateau Remediation Company		
J. V. Borghese	H3-21	15
Publications Technical Library	H3-21	1
Washington Closure Hanford, LLC		
R. O. Ovink	H4-21	6
Pacific Northwest National Laboratory		
J. S. Fruchter	K6-96	2
Administrative Record	H6-08	1
Document Clearance	H6-08	1

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