CHPRC ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE:	**OWNING ORGANIZATION/FACILITY:**
Annual Status Report(Fiscal Year 2012): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site	CHPRC/Environmental Programs & Strategic Planning

Document Number: DOE/RL-2012-56 **Revision/Change Number:** 0

DOCUMENT TYPE *(Check Applicable)* [ ] Plan [X] Report [ ] Study [ ] Description Document [ ] Other

DOCUMENT ACTION *(Check One)* [X] New [ ] Revision [ ] Cancellation

RESPONSIBLE CONTACTS

Name	Phone Number
Author: WE Nichols	509-376-4553
Manager: AH Aly	509-376-0300

DOCUMENT CONTROL

Is the document intended to be controlled within the Document Management Control System (DMCS)? [X] Yes [ ] No

Does document contain scientific and technical information intended for public use? [X] Yes [ ] No

Does document contain controlled-use information [ ] Yes [X] No

("yes" requires information clearance review in accordance with PRC-PRO-IRM-184)

DOCUMENT REVISION SUMMARY

NOTE: Provide a brief description or summary of the changes for the document listed.

REVIEWERS **Others**

Name *(print)*	Organization
RD Hildebrand	DOE-RL

APPROVAL SIGNATURES

Author:	19 DEC 12	RELEASE / ISSUE
Name: (Print) WE Nichols	Date	
Responsible Manager:	12/19/12	DATE: Dec 27, 2012 HANFORD RELEASE
Name: (print) AH Aly	Date	
Other:		
Name: (print)	Date	

Date Received for Clearance Process (MM/DD/YYYY) JRR
12/12/2012 12/27/2012

INFORMATION CLEARANCE FORM

A. Information Category

- ☐ Abstract
- ☐ Journal Article
- ☐ Summary
- ☐ Internet
- ☐ Visual Aid
- ☐ Software
- ☐ Full Paper
- ☒ Report
- ☐ Other _____

B. Document Number DOE/RL-2012-56 Revision 0

C. Title
Annual Status Report (Fiscal Year 2012): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

D. Proposed Internet Address

E. Required Information (MANDATORY)

1. Is document potentially Classified? ◉ No ○ Yes

Aly, Alaa H Will Nichols for (Approved via IDMS data file)
Manager Required (Print and Sign)

If Yes _____
ADC Required (Print and Sign) ○ No ○ Yes Classified

2. Official Use Only ◉ No ○ Yes Exemption No. ____
3. Export Controlled Information ◉ No ○ Yes OUO Exemption No. 3
4. UCNI ◉ No ○ Yes
5. Applied Technology ◉ No ○ Yes OUO Exemption No. 5
6. Other (Specify) _____

7. Does Information Contain the Following:

a. New or Novel (Patentable) Subject Matter? ◉ No ○ Yes
If "Yes", OUO Exemption No. 3
If "Yes", Disclosure No.: _____

b. Commercial Proprietary Information Received in Confidence, Such as Proprietary and/or Inventions?
◉ No ○ Yes If "Yes", OUO Exemption No. 4

c. Corporate Privileged Information? ◉ No ○ Yes
If "Yes", OUO Exemption No. 4

d. Government Privileged Information? ◉ No ○ Yes
If "Yes", Exemption No. 5

e. Copyrights? ◉ No ○ Yes If "Yes", Attach Permission.

f. Trademarks? ○ No ◉ Yes If "Yes", Identify in Document.

8. Is Information requiring submission to OSTI? ◉ No ○ Yes

9. Release Level? ◉ Public ○ Limited

F. Complete for a Journal Article

1. Title of Journal

G. Complete for a Presentation

1. Title for Conference or Meeting _____
2. Group Sponsoring _____
3. Date of Conference _____ 4. City/State _____
5. Will Information be Published in Proceedings? ◉ No ○ Yes 6. Will Material be Handed Out? ◉ No ○ Yes

H. Information Owner/Author/Requestor

Nichols, Will E Approved via IDMS data file
(Print and Sign)

Responsible Manager

Aly, Alaa H Will Nichols for (Approved via IDMS data file)
(Print and Sign)

Approval by Direct Report to President (Speech/Articles Only) _____
(Print and Sign)

I. Reviewers

	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	☒	Swenson, Raymond T	Approved via IDMS data file	Y / N
Office of External Affairs	☐			Y / N
DOE	☒	Hildebrand, R Doug	Approved via IDMS data file	Y / N
Other	☐			Y / N
Other	☐			Y / N
Other	☐			Y / N

J. Comments

Information Clearance Approval

APPROVED
By Julia Raymer at 1:22 pm, Dec 27, 2012

Approved for Public Release; Further Dissemination Unlimited

If Additional Comments, Please Attach Separate Sheet

A-6001-401 (REV 5)

- <workflow name="DOE/RL-2012-56-00 (JR)" id="174224500">
  - <task name="Clearance Process" id="0" date-initiated="20121220T1442" performer="Julia R Raymer" performer-id="164931488" username="h3310581">
    <comments>Please review DOE/RL-2012-56, Rev. 0 for public release. The due date for this report is 12/27/2012 and the POC is Will E. Nichols. Thank you, Julia Raymer, Information Clearance 509-373--6899</comments>
  </task>
  <task name="Add XML" id="1" date-due="20121220T1442" date-done="20121220T1442" />
  <task name="Expedite - Manager Approval" id="6" date-due="20121224T1442" date-done="20121226T0838" performer="William E Nichols" performer-id="141011074" username="h0063932" disposition="Approve" authentication="true" />
  <task name="Expedite - Document Reviewer1" id="16" date-due="20121228T0838" date-done="20121226T1436" performer="Raymond T Swenson" performer-id="141094653" username="h0059138" disposition="Public Release" authentication="true" />
  <task name="Expedite - Document Reviewer2" id="17" date-due="20121228T0838" date-done="20121226T1629" performer="R (Doug) Hildebrand" performer-id="585415" username="h0073893" disposition="Public Release" authentication="true" />
  <task name="Doc Owner Clearance Review" id="13" date-due="20121227T1629" date-done="20121226T1632" performer="William E Nichols" performer-id="141011074" username="h0063932" disposition="Send On" authentication="true" />
  <task name="Verify Doc Consistency" id="4" date-due="20121227T1632" date-done="20121227T1039" performer="Julia R Raymer" performer-id="164931488" username="h3310581" disposition="Cleared" authentication="true" />
</workflow>

DOE/RL-2012-56
Revision 0

Annual Status Report (Fiscal Year 2012): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

DOE/RL-2012-56
Revision 0

Annual Status Report (Fiscal Year 2012): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

W. E. Nichols
CH2M HILL Plateau Remediation Company

Date Published
December 2012

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Julia Raymer at 1:22 pm, Dec 27, 2012

Release Approval Date

Executive Summary

In accordance with U.S. Department of Energy (DOE) requirements in DOE O 435.1, Chg. 1,[1] and as implemented by DOE/RL-2000-29, Rev. 2,[2] the DOE Richland Operations Office (DOE-RL) has prepared this annual summary of the Hanford Site Composite Analysis for fiscal year (FY) 2012, as originally reported in PNNL-11800[3] and PNNL-11800, Addendum 1[4] (hereafter these reports are referred to collectively as the Composite Analysis), and to address secondary issues identified during the review of the Composite Analysis.

As required by DOE/RL-2000-29, Rev. 2, an annual evaluation of new information and data developed by a number of onsite programs during FY 2012 was completed. The reporting period for this annual evaluation is FY 2012 (October 1, 2011, through September 30, 2012). The information provided in this evaluation includes the following work performed in FY 2012 that is considered pertinent to the Composite Analysis:

Composite Analysis and the Tank Closure & Waste Management Environmental Impact Statement

This document identifies additional data and information to be considered for purposes of an eventual update to the Hanford Site Composite Analysis.

Preliminary statements and conclusions contained herein do not take into consideration the Sitewide cumulative groundwater modeling analyses presented in the Tank Closure and Waste Management Environmental Impact Statement, and are not intended to foreclose reaching different conclusions in future updates of the Composite Analysis.

Preparation of an updated Hanford Site Composite Analysis has been deferred until the Final Tank Closure and Waste Management Environmental Impact Statement is completed and issued (which occurred November 21, 2012, shortly after the reporting period for this document).

[1] DOE O 435.1, Chg. 1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-BOrder-c1/view.

[2] DOE/RL-2000-29, 2003, *Maintenance Plan for the Composite Analysis of the Hanford Site*, *Southeast Washington*, Rev. 2, U.S. Department of Energy Richland Operations Office, Richland, Washington.

[3] PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/594543-mUGcOH/webviewable/594543.pdf.

[4] PNNL-11800, 2001, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Addendum 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-11800-adden-1.pdf.

- Information that could change the source terms considered in the Composite Analysis, including the following:
  - Performance assessment (PA) development and maintenance activities:
  - 200 East Area Low-Level Burial Grounds (LLBG) PA
  - 200 West Area LLBG PA
  - Integrated Disposal Facility PA
  - Waste Management Area C PA
  - Environmental Restoration Disposal Facility (ERDF) PA
  - *Resource Conservation and Recovery Act of 1976*[5] (RCRA) remedial activities
  - *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[6] (CERCLA) remedial activities
- Monitoring, research, and development results, including the following:
  - Groundwater flow and contamination monitoring
  - Remediation science and technology programs

This annual evaluation identified no information in any of the above activities that considered results of data collection and analysis from research, field studies, and monitoring that invalidates the continued adequacy of the current version of the Composite Analysis, as currently approved by the "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1" (Frei, 2002[7]).

---

[5] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/lawsregs/laws/rcra.html.

[6] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq. Available at: http://epw.senate.gov/cercla.pdf.

[7] Frei, 2002, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1" (memorandum to R. Schepens, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from M.W. Frei, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., July 24.

On January 30, 2006, DOE announced its intent to prepare the Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) for the Hanford Site pursuant to the *National Environmental Policy Act of 1969*[8] and implementing regulations (40 CFR 1500-1508,[9] Chapter V and 10 CFR 1021[10]). The Hanford Site has deferred any revision of the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1) until the Final TC&WM EIS[11] was issued, which occurred on November 21, 2012, shortly after the reporting period for this summary ended. Hence, the deferral on revision of the Composite Analysis continued during the reporting period for this summary.

The format for this report follows requirements in DOE G 435.1-1.[12] This report is organized into the following chapters:

- Chapter 1 provides an overview of the purpose and content of this report.
- Chapter 2 provides an assessment of the continued adequacy of the Composite Analysis.
- Chapter 3 includes a review of those Hanford Site activities that have the potential to change the source terms evaluated in the Composite Analysis, including PAs, RCRA remedial activities, and CERCLA remedial activities.
- Chapter 4 provides a review of recent onsite monitoring, research, and development results that are relevant to the current Composite Analysis.
- Chapter 5 reviews key site changes that could affect the Composite Analysis.

[8] *National Environmental Policy Act of 1969*, 42 USC 4321, et seq. Available at: http://ceq.hss.doe.gov/Nepa/regs/nepa/nepaeqia.htm.

[9] 40 CFR 1500-1508, "Purpose, Policy, and Mandate," through "Terminology and Index," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfrv31_08.html.

[10] 10 CFR 1021, "National Environmental Policy Act Implementing Procedures," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/10cfr1021_08.html.

[11] DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Richland, Washington. Available at: http://energy.gov/nepa/downloads/eis-0391-final-environmental-impact-statement.

[12] DOE G 435.1-1, 1999, *Implementation Guide for Use with DOE M 435.1-1*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-EGuide-1ch1/view.

- Chapter 6 contains recommended changes to relevant Hanford Site programs that could affect the Composite Analysis and recommended changes to the Composite Analysis maintenance program.
- Chapter 7 contains the references cited in this report.

Contributors

Contributors (Affiliation)	DOE Authority (Affiliation)	Topic Areas
W.E. Nichols (CHPRC)	R.D. Hildebrand (DOE-RL)	Annual Summary Editors
S. Mehta (CHPRC)	R.D. Hildebrand (DOE-RL)	Low-Level Burial Ground Performance Assessments (Section 3.1.1)
W.E. Nichols (CHPRC) L.E. Thompson (WRPS)	G.L. Pyles (DOE-RL) O.A. Farabee (DOE-RL)	Integrated Disposal Facility Performance Assessment (Section 3.1.2)
S.J. Eberlein (WRPS)	C.J. Kemp (DOE-ORP)	Waste Management Area C Performance Assessment (Section 3.1.3)
S. Mehta (CHPRC) W.J. McMahon (CHPRC)	D.C. Bryson (DOE-RL)	Environmental Restoration Disposal Facility Performance Assessment (Section 3.1.4)
S.J. Eberlein (WRPS)	J.F. Grindstaff (DOE-ORP) B.L. Charboneau (DOE-RL) M.S. Collins (DOE-RL)	Central Plateau RCRA Remedial Activities (Section 3.2)
T.B. Bergman (CHPRC)	B.L. Charboneau (DOE-RL) W.C. Woolery (DOE-RL)	Central Plateau CERCLA Remedial Activities (Section 3.3)
P.A. Burke (CHPRC)	B.L. Charboneau (DOE-RL)	Remediation Activities for Central Plateau Source Operable Units (Section 3.3.1)
W.R. Faught (CHPRC)	B.L. Charboneau (DOE RL)	Remediation Activities for Central Plateau Groundwater Operable Units (Section 3.3.2)
M.A. Casbon (WCH)	O.C. Robertson (DOE-RL)	Environmental Restoration Disposal Facility Operations (Section 3.3.3.2)
W.R. Faught (CHPRC)	N.M. Bland (DOE-RL)	Summary of Groundwater Monitoring (Section 4.1)
M.D. Freshley (PNNL)	K.M. Thompson (DOE-RL)	Remediation Science and Technology (Section 4.2)
T.B. Bergman (CHPRC)	B.L. Charboneau (DOE-RL) M.J. Voogd (DOE-RL)	Changes in Site Land Use and Remediation Plans (Section 5.2)

CHPRC = CH2M HILL Plateau Remediation Company
DOE-ORP = U.S. Department of Energy, Office of River Protection
DOE-RL = U.S. Department of Energy, Richland Operations Office
PNNL = Pacific Northwest National Laboratory
WCH = Washington Closure Hanford
WRPS = Washington River Protection Solutions

This page intentionally left blank.

Contents

Appendix

Figures

Tables

Terms

AEA	*Atomic Energy Act of 1954*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
CLS	Center for Laboratory Sciences
CMS	corrective measures study
CY	calendar year
DAS	disposal authorization statement
DOE	U.S. Department of Energy
DOE-EM	DOE Office of Environmental Management
DOE-ORP	DOE Office of River Protection
DOE-RL	DOE Richland Operations Office
DVZ-AFRI	Deep Vadose Zone Applied Field Research Initiative
DVZTT	deep vadose zone treatability test
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
eSTOMP	parallel version of *Subsurface Transport Over Multiple Phases*
ETF	Effluent Treatment Facility
FBSR	fluidized bed steam reforming
FY	fiscal year
gpm	gallons per minute
HLW	high-level waste
IDF	Integrated Disposal Facility
IFRC	Integrated Field Research Challenge
ILAW	immobilized low-activity waste
LAW	low-activity waste

LLBG	low-level burial ground
LLW	low-level waste
LLWMA	low-level waste management area
N/A	not applicable
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
OU	operable unit
PA	performance assessment
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PUF	pressurized unsaturated flow
PUREX	Plutonium-Uranium Extraction (Plant)
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
REDOX	reduction/oxidation
RI/FS	remedial investigation/feasibility study
RFI	RCRA facility investigation
ROD	Record of Decision
SALDS	State-Approved Liquid Disposal Site
SEM-EDS	scanning electron microscopy with energy-dispersive spectroscopy
SPFT	single-pass flow-through (test)
SRNL	Savannah River National Laboratory
SST	single-shell tank
STOMP	*Subsurface Transport Over Multiple Phases*
SVE	soil vapor extraction
TC&WM EIS	Tank Closure and Waste Management Environmental Impact Statement
TCLP	toxicity characteristic leaching procedure
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TSD	treatment, storage, and disposal

UPR	unplanned release
WCH	Washington Closure Hanford
WIPP	Waste Isolation Pilot Plant
WMA	waste management area
WRPS	Washington River Protection Solutions
WTP	Waste Treatment Plant
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction

This page intentionally left blank.

1 Overview

As required by the U.S. Department of Energy (DOE) in DOE O 435.1 Chg. 1, *Radioactive Waste Management*, and implemented by DOE/RL-2000-29, Rev. 2, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeastern Washington*, the DOE Richland Operations Office (DOE-RL) has prepared this annual status report for fiscal year (FY) 2012 of PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, and the subsequent Addendum 1 (PNNL-11800 Addendum 1, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*). Hereafter, these documents are collectively referred to as the "Composite Analysis." The main emphasis of DOE/RL-2000-29, Rev. 2 is (1) to identify additional data and information that will enhance the Composite Analysis, and (2) to address secondary issues identified during review of the Composite Analysis.

1.1 Composite Analysis Annual Summary Report Requirements

DOE O 435.1 requires that the Hanford Site maintain site performance assessments (PAs) and composite analyses. Requirements for composite analysis maintenance under DOE M 435.1-1 Chg. 1, *Radioactive Waste Management Manual*, are the same as those for PA maintenance and are described in Chapter 3 of *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses* (DOE, 1999). The current plan for maintaining the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1) for the Hanford Site is described in the maintenance plan (DOE/RL-2000-29, Rev. 2) that was approved in 2004 ("Low-Level Disposal Facility Federal Review Group Review of Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington, April 2003" [Talarico, 2004]).

DOE M 435.1-1 requires routine review and revision of PAs and composite analyses. The objective of routine review and revision is to ensure that the PAs and composite analyses are updated appropriately, whenever changes in their bases (assumptions, parameters, etc.) are contemplated or effected, in order to maintain the validity and effectiveness of the controls that are based on the PA and composite analysis. These reviews provide a mechanism for routine assessment of the site plans (e.g., remediation, closure, decommissioning, and land use) developed from the results of a composite analysis. This review process allows potential problems to be identified and managed at an early stage. The revisions ensure cohesive documentation, providing a reasonable basis to conclude that DOE requirements for radiological protection of the public and the environment will be met in the future. The composite analysis is a planning tool that allows evaluation of the cumulative effects of all sources of radioactive materials that may interact with those in the low-level waste (LLW) disposal facility. The impact of future activities on the dose to hypothetical future members of the public can be evaluated using the composite analysis, and the results used to develop land use plans, remediation plans, or long-term stewardship documents. The annual review of the composite analysis is used to determine whether actual and planned conditions are consistent with those contained in the composite analysis. Revisions and special analyses provide a mechanism for evaluating conditions not originally included in the composite analysis to determine if these conditions could be accommodated without violating the conclusions of the composite analysis.

DOE G 435.1-1, Chapter 4, *Implementation Guide for use with DOE M 435.1-1*, states:

> *IV.P (4) Performance Assessment and Composite Analysis Maintenance.*
> *The performance assessment and composite analysis shall be maintained to evaluate changes that could affect the performance, design, and operating bases for the facility. Performance assessment and composite analysis maintenance shall include the conduct of research, field studies, and monitoring needed to address uncertainties or gaps in*

existing data. The performance assessment shall be updated to support the final facility closure. Additional iterations of the performance assessment and composite analysis shall be conducted as necessary during the post-closure period.

Performance assessments and composite analyses shall be reviewed and revised when changes in waste forms or containers, radionuclide inventories, facility design and operations, closure concepts, or the improved understanding of the performance of the waste disposal facility in combination with the features of the site on which it is located alter the conclusions or the conceptual model(s) of the existing performance assessment or composite analysis.

The statements also appear in DOE M 435.1-1 and constitute the requirements for maintaining a PA or a composite analysis. Further guidance is found in the DOE Maintenance Guide (DOE, 1999). Table 1-1 lists the documents prepared to maintain the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1) since maintenance began.

Table 1-1. Maintenance Documents for the Hanford Site Composite Analysis

Reporting Period	Document
FY 2000	DOE/RL-2000-29, Rev. 0, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*
	DOE/RL-2000-29, Rev. 1, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*
FY 2001	Hildebrand and Bergeron, 2002, *Annual Status Report: Composite Analysis for Low-Level Waste Disposal in the 200 Area of the Hanford Site*
FY 2002	DOE/RL-2003-26, Rev. 0, *Annual Status Report: Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2003	DOE/RL-2000-29, Rev. 2, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*
	DOE/RL-2004-12, Rev. 0, *Annual Status Report (FY 2003): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2004	DOE/RL-2005-58, Rev. 0, *2004 Annual Status Report: Composite Analysis of Low-Level Disposal in the Central Plateau at the Hanford Site*
FY 2005	DOE/RL-2006-28, Rev. 0, *Annual Status Report (FY 2005): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2006, 2007	DOE/RL-2008-43, Draft B, *Annual Status Report (FY 2007): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2008	DOE/RL-2009-82, Rev. 1, *Annual Status Report (FY 2008): Composite Analysis of Low-level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2009	DOE/RL-2009-132, Rev. 0, *Annual Status Report (FY 2009): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2010	DOE/RL-2010-105, Rev. 0, *Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2011	DOE/RL-2011-108, Rev. 1, *Annual Status Report (Fiscal Year 2011): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*

Table 1-1. Maintenance Documents for the Hanford Site Composite Analysis

Reporting Period	Document
FY 2012	DOE/RL-2010-56, Rev. 0 (this report), *Annual Status Report (FY 2012): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*

Notes:

"Hanford Site Composite Analysis" refers to *Composite Analysis for Low Level Waste Disposal in the 200 Area Plateau of the Hanford Site* (PNNL-11800) and corresponding Addendum (PNNL-11800 Addendum 1, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*).

Full reference citations for the documents listed in this table are included in Chapter 7 (References).

FY = fiscal year

1.2 Composite Analysis Annual Status Report Content

The format for this report follows requirements established by DOE G 435.1-1. The report structure is defined in DOE/RL-2000-29, Rev. 2. Chapter 2 provides an assessment of the continued adequacy of the Composite Analysis in light of the information presented in this report. Chapter 3 summarizes activities during the reporting period that have a potential to reveal information that could change the source terms considered in the Composite Analysis. Chapter 4 summarizes onsite monitoring, as well as the research and development results for the reporting period that are relevant to the Composite Analysis. Chapter 5 summarizes key site changes during the reporting period that could affect the Composite Analysis. Chapter 6 summarizes recommended changes to the Composite Analysis. Chapter 7 contains a list of references cited in this document.

The reporting period for this annual status report is limited to FY 2012, the period from October 1, 2011, through September 30, 2012. The contaminant inventory considered in this annual status report is limited to radionuclides (the contaminants managed under DOE O 435.1). The scope of this annual status report is limited geographically to the Hanford Site's Central Plateau (the extent of the sources considered in the Composite Analysis). Exceptions to these scope limitations are made where appropriate. For example, pump-and-treat remedial actions in the Hanford Site's River Corridor have the potential to affect the Composite Analysis because these actions occur in the same unconfined aquifer as the Central Plateau and downgradient. Groundwater flow simulated in the Composite Analysis is included for this region. Similarly, if remedial actions for nonradionuclide contaminants provide additional information or insight into the nature and extent of radionuclide contamination, this is also reported. Finally, some information, such as from the Hanford Site groundwater monitoring program, is reported on a calendar year (CY) basis and, although published late in FY 2012, it was reported for CY 2011 and is the most current information available.

This page intentionally left blank.

2 Assessment of Composite Analysis Adequacy

Based on this annual evaluation of new information obtained from a review of PAs, remedial actions, and operations (Chapter 3); from a review of the data collected and analyzed from research, field studies, and monitoring developed by Hanford Site programs (Chapter 4); and from other changes (Chapter 5), no new information was identified that would invalidate the continued adequacy of the Composite Analysis (PNNL-11800; PNNL 11800, Addendum 1), as approved ("Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1" [Frei, 2002]).

The disposal authorization statement (DAS) ("Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2" [Scott, 2001]) conditions on the Hanford Site Composite Analysis have all previously been met through the addendum (PNNL-11800, Addendum 1) and through prior maintenance activities.

On January 30, 2006, DOE announced its intent to prepare a new Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) for the Hanford Site pursuant to the *National Environmental Policy Act of 1969* (NEPA) and its implementing regulations (40 CFR 1500-1508, Chapter V, "Council on Environmental Quality"; and 10 CFR 1021, "National Environmental Policy Act Implementing Procedures"). The TC&WM EIS provides a single, integrated analysis of groundwater at Hanford for waste types previously addressed in the Hanford Solid Waste EIS and the originally planned tank closure EIS. Additionally, the scope of "Notice of Intent to Prepare an Environmental Impact Statement for the Decommissioning of the Fast Flux Test Facility at the Hanford Site, Richland, Washington" (69 FR 50176) was merged into the scope of the TC&WM EIS to integrate foreseeable activities related to waste management and cleanup at the Hanford Site. The draft of the TC&WM EIS (DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*) was published on October 30, 2009, followed by a 140-day public comment period. The final TC&WM EIS (DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*) was issued on November 21, 2012, shortly after the reporting period for this annual summary ended.

This annual summary identifies additional data and information from FY 2012 to be considered for purposes of an eventual update to the Hanford Site Composite Analysis. Revision to the Composite Analysis had been deferred until the final TC&WM EIS was been issued. Since the final TC&WM EIS has now been issued, planning for revision of the EIS is expected to commence in FY 2013. The first activity will be to update the maintenance plan for the Composite Analysis (DOE/RL-2000-29, Rev. 2).

This page intentionally left blank.

3 Source Terms

This chapter identifies changes to the sources of radioactive materials considered in the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1), which could include the following:

- Deletion of sources considered in the Composite Analysis
- Addition of new sources not considered in the Composite Analysis
- Changes to existing sources (e.g., completion of remedial activities at *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [CERCLA] sites)
- Availability of new information that reduces uncertainty in characteristics of existing sources

No major changes occurred to Hanford Site radionuclide inventories in FY 2012 that were evaluated in the Composite Analysis. The inventory of radionuclides disposed and projected for disposal at the Environmental Restoration Disposal Facility (ERDF) was updated in FY 2012 as part of the effort to revise the PA for that facility (Section 3.1.4). Upon completion of the revised ERDF PA, this update will constitute a change to existing sources.

Activities in the following categories are reviewed because they have the potential to reveal new information that could constitute changes to existing radionuclide sources and/or new information that reduces uncertainty in characteristics of existing radionuclide sources:

- DOE O 435.1 PAs (Section 3.1)
- *Resource Conservation and Recovery Act of 1976* (RCRA) remedial activities (Section 3.2)
- CERCLA remedial activities (Section 3.3)

Consideration of the above activities with respect to the Composite Analysis revealed no information that would be expected to, if included in a revised calculation, result in higher dose estimates.

Some activities were qualitatively considered that would be expected to, if included in a revised calculation, result in lower dose estimates. Most notable of these are the CERCLA pump-and-treat systems on the Central Plateau, which are qualitatively evaluated as likely to reduce the projected dose. Such dose reduction would be due to removal of contaminant mass from the groundwater pathway. The Composite Analysis did not account for remedial actions such as pump-and-treat systems. Hydraulic perturbations to the unconfined aquifer at the Central Plateau and contaminant mass reduction in groundwater resulting from pump-and treat systems will be considered in a future revision of the Composite Analysis. The closure of 200-SW-2 Burial Grounds is another change qualitatively evaluated as likely to reduce the projected dose. The dose reduction for this site would be due to the lower realized inventory than was considered in the Composite Analysis resulting from the cessation of the use of the unlined trenches (with the unused portions being withdrawn from the RCRA/Dangerous Waste Permit because they will not be used at this time). The reduction in inventory at this site based on this change will also be considered in a future revision of the Composite Analysis.

3.1 Performance Assessments

Table 3-1 lists the Hanford Site PAs that are currently in planning, scoping, analysis, or maintenance phases, as well as their scope and FY 2012 status. Detailed summaries of activities associated with each of these PAs are provided in Sections 3.1.1 through 3.1.4.

Table 3-1. Hanford Site Performance Assessments in Planning, Scoping, Analysis, and/or Maintenance Phases and FY 2012 Status

Performance Assessment	Scope	FY 2012 Status
Low-Level Burial Grounds	The Low-Level Burial Grounds are located in the 200 East and the 200 West Areas. The burial grounds are operational and contain small, limited quantities of waste.	Maintenance phase
Integrated Disposal Facility	This disposal facility is planned for use in future disposal of tank waste from the Waste Treatment Plant.	Maintenance phase (existing 2001 PA) Ready to commence planning and scoping phases for revised PA upon receipt of DOE release.
Environmental Restoration Disposal Facility	This facility is operational and receives wastes from CERCLA remedial activities.	Maintenance phase (preliminary PA and CERCLA crosswalk) Analysis phase (PA revision completed in FY 2012; currently in review)
Waste Management Area C	This PA is under development to support eventual closure of this single-shell tank facility.	Ready to start analysis phase (scoping phase completed in FY 2011; PA analysis expected to resume in mid-FY 2013)

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE = U.S. Department of Energy
FY = fiscal year
PA = performance assessment

3.1.1 Low-Level Burial Ground Performance Assessments

In the annual review of the Hanford Site Low-Level Burial Ground (LLBG) PAs for FY 2012 (DOE/RL-2012-58, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2012)*), the projected dose estimates from radionuclide inventories disposed in the active LLBGs (at locations shown in Figure 3-1) from September 26, 1988, through September 30, 2012, were calculated using the dose estimate methodology developed in the original PAs (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*; WHC-EP-0645, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*). These estimates were compared with performance objectives defined in DOE O 435.1 and its companion documents (DOE M 435.1-1; DOE G 435.1-1). The performance objectives are currently satisfied. Operational waste acceptance criteria (HNF-EP-0063,

Low-Level Burial Ground Performance Assessments (LLBG PAs) Relevance to the Composite Analysis

Solid waste disposal constitutes one of the sources of radioactive waste inventory. The current estimated inventory disposed and projections of future inventory disposal in the LLBGs are refined regularly as additional data continue to be collected and reported through maintenance of the LLBG PAs. This updated information is pertinent to the Composite Analysis because of its potential to change the LLBG inventory evaluated in the Composite Analysis.

Hanford Site Solid Waste Acceptance Criteria), and waste acceptance practices continue to be sufficient to maintain compliance with performance objectives.

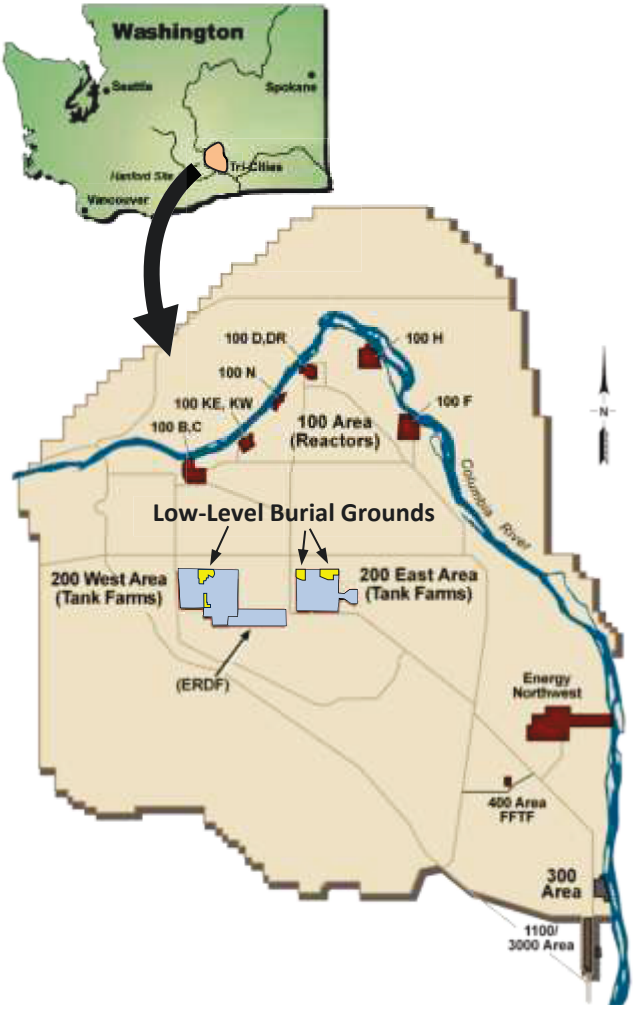


Figure 3-1. Location of the LLBGs

Dose estimate increases from disposed waste for groundwater contamination scenarios occurred only at the 200 West Area LLBGs and were essentially negligible (DOE/RL-2012-58). A minimal dose increment was observed because LLW and mixed LLW disposal are now limited to the double-lined mixed waste trenches (Trenches 31 and 34) in the 200 West Area. Both volumes (less than 1,000 m^3 [35,314.7 ft^3]) and radionuclide inventories (less than 0.2 Ci of long-lived mobile radionuclides) in FY 2012 were small compared to the accumulated waste from previous years. Two naval reactor compartments were disposed in Trench 94 (located in the 200 East Area LLBGs) during FY 2012 with a total volume of 2,070 m^3 (73,101.4 ft^3). Overall, there are no changes to the conclusions of the PA analyses for the LLBGs.

During the reporting period, multi-year experiments were underway to quantify the efficacy of concrete waste forms in retaining key radionuclides such as uranium-238, technetium-99, and iodine-129 while undergoing weathering. The two methods chosen for conducting the experiments were the pressurized

unsaturated flow (PUF) test and the product consistency test. These two test methods focus on different aspects of the concrete waste form weathering process.

3.1.2 Integrated Disposal Facility Performance Assessment

The annual status of the Integrated Disposal Facility (IDF) PA is reported in DOE/RL-2012-57, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2011)*, and is summarized here. Figure 3-2 shows the location of the IDF. In 2001, DOE approved (Scott, 2001) DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*. Continuation of the DAS ("Review of the Annual Summary of the Hanford Immobilized Low-Activity Waste Preformance Assessment for 2003" [Frei, 2003]) was based, in part, on RPP-15834, *Integrated Disposal Facility Risk Assessment*. This PA is maintained in accordance with DOE/ORP-2000-01, *Maintenance Plan for the Hanford Integrated Disposal Facility Performance Assessment*.

Integrated Disposal Facility Performance Assessment (IDF PA) Relevance to the Composite Analysis

Planned waste disposal at the IDF constitutes one of the major sources of radioactive waste inventory at the Hanford Site. Estimates of future inventory disposal of glass and secondary waste forms from the WTP and tank farms that are considered in the IDF PA must be incorporated into the Composite Analysis.

The first construction phase of the IDF was completed on April 28, 2006, which included installation of the cell liners and leachate collection tanks (Figure 3-3). The IDF is now in a pre-active life mode and will not receive treated tank waste for several years. Based on these circumstances, the RCRA Permit for the IDF has been modified to recognize that the facility will not be receiving waste in the near future. A subsequent modification of the RCRA Permit transferred responsibility for the IDF from the DOE Office of River Protection (DOE-ORP) to DOE-RL in FY 2009.

Revision of the IDF PA remained on hold during FY 2012 pending the issue of the final TC&WM EIS and associated Record of Decision (ROD). A schedule for completion of the IDF PA is currently being developed and will be dependent on research and DOE M 435.1-1 activities that are the responsibility of DOE-ORP. Plans for the revised IDF PA envision a scoping process beginning in FY 2013. This scoping process will build on the experience and knowledge gained from a similar scoping process performed for the Hanford single-shell tank (SST) system Waste Management Area (WMA) C PA (Section 3.1.3), which was largely completed in FY 2011 but was not funded in FY 2012; work is currently anticipated to resume on the WMA C PA in mid-FY 2013. The following must be in place before IDF PA calculations will commence:

1. The Planning and Scoping Phases must be completed in accordance with DOE Office of Environmental Management direction to implement a phased approach to Hanford Site PAs using the TC&WM EIS modeling platform as a starting point ("Modeling to Support Regulatory Decisionmaking at Hanford" [Williams, 2012]).
2. The necessary data packages and computer simulation codes to perform qualified reactive transport simulations for glass waste forms must be ready for use in time to support the modeling phase.
3. Authorization to proceed with PA revision must be issued by DOE Office of Environmental Management-EM.

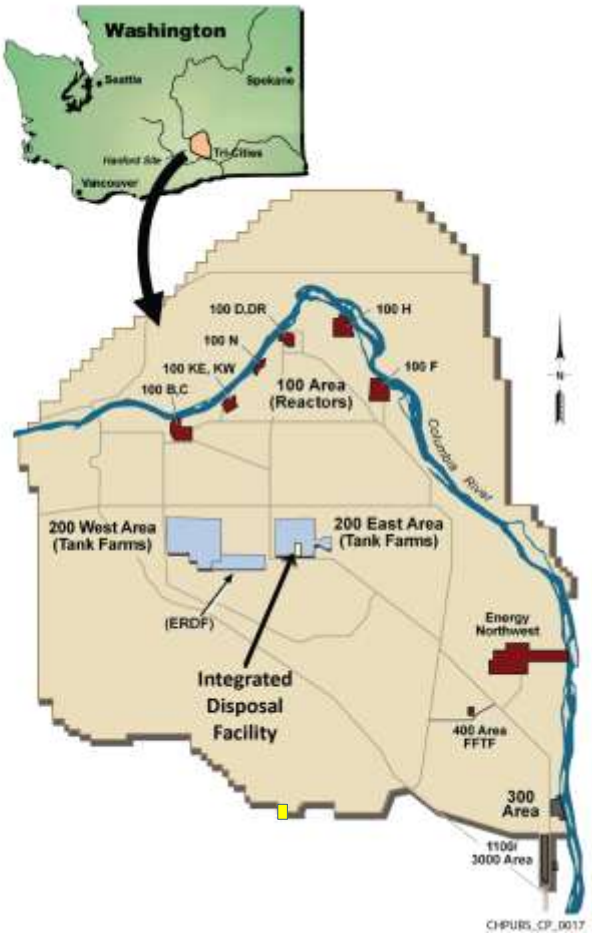


Figure 3-2. Location of the IDF

Figure 3-3. Photograph of the IDF "First Expansion" (Current Configuration)

The current Hanford Site Integrated PA schedule assumes that DOE-RL will authorize work to start in first quarter of FY 2013. From this basis, the schedule projects completion of the revised IDF PA in the second quarter of FY 2016. Review and approval would follow, leading to a DAS in the last quarter of FY 2019. This represents a compressed schedule, subject to further revision. Changes to the Waste Treatment Plant (WTP) construction schedule would directly affect these estimates.

With respect to monitoring, DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*, indicated that the seven wells in the IDF water-level network had been sampled semiannually through CY 2010. In CY 2011, sampling was reduced to an annual frequency for each well in the network to maintain the baseline prior to operational status. The groundwater flow direction has been changing since the network was initially planned, and the current average groundwater flow direction is to the east at 80 degrees (±17 degrees). In contrast, when monitoring began in 2004, the gradient was so flat beneath the IDF that the flow direction was inferred from plume maps (PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*), reflecting past flow conditions more than present. Consequently, the current network is no longer considered adequate. A revised monitoring network plan was provided as part of a RCRA Part B submittal to the Washington State Department of Ecology (Ecology) for review in FY 2011; this plan is still under review.

3.1.2.1 Glass Dissolution Rate Research

Washington River Protection Solutions (WRPS) conducted an immobilized low-activity waste (ILAW) glass testing program that includes experimentation and modeling to provide the technical basis for estimating radionuclide releases from the glass waste form to support future IDF PAs. The program is being conducted as part of the IDF PA maintenance plan (DOE/ORP-2000-01), intended to allow for revisions reflecting new scientific information that reduces the technical uncertainty associated with critical aspects of this assessment.

In FY 2012, WRPS contracted with the Pacific Northwest National Laboratory (PNNL) to continue research from FY 2009 through FY 2011 to develop a better understanding of the long-term dissolution behavior of the ILAW glass waste form, thereby reducing uncertainties associated with future PA analyses. The scope for FY 2012 included the following:

- Enhancements to eSTOMP, the parallel version of the STOMP (Subsurface Transport Over Multiple Phases) computer code (PNNL-11216, *STOMP: Subsurface Transport Over Multiple Phases Application Guide*; PNNL-12030, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: Theory Guide*; PNNL-15782, *STOMP: Subsurface Transport Over Multiple Phases Version 4.0: User's Guide*)
- Characterization of glass alteration phases
- Stochastic modeling (using the Monte Carlo technique) to predict glass dissolution behavior

The code enhancements to eSTOMP are needed because the 2001 ILAW PA (DOE/ORP-2000-24) showed that a key variable was the release rate of the glass waste form, calculated over thousands of years. In that PA, the glass waste form release rate was evaluated by modeling the basic physical and chemical processes known to control the waste form dissolution behavior, instead of using empirical extrapolations from laboratory "leaching" experiments commonly used in other PAs. This methodology was adopted because the radionuclide release rate from dissolving silicate glass or grout cannot be determined independently of other system variables. For example, neglecting the waste form composition, the glass dissolution rate is a function of three variables: temperature, pH, and composition of the fluid contacting the glass (PNNL-13043, *Waste Form Release Data Package for the 2001 Immobilized Low-Activity Waste Performance Assessment*). The temperature of the ILAW disposal system is assumed

known and constant. However, both the pH and the composition of the fluid contacting the glass are variables affected by the following: flow rate, reactions with other engineered materials, gas-water equilibria, secondary phase precipitation, alkali ion exchange, and glass dissolution (a classic feedback mechanism). Consequently, glass dissolution rates vary both in time and as a function of position in the disposal system. A "leach rate" or radionuclide release rate parameter cannot be assigned to a waste form in a dynamic system such as this. One of the principal purposes of the IDF PA is to provide feedback to engineers regarding the effects of design options on disposal system performance. A model based on empirical release rates for different waste forms is inadequate for this task.

During FY 2012, code development for eSTOMP included updating input structure and output capabilities to match those in the serial version STOMP. Key code capabilities that were incorporated included (1) the ability to maintain constant values for species concentrations, (2) the addition of diffusion models for aqueous species transport, (3) the addition of user-defined initial volume fractions for solid phases; and (4) the ability to scale reactive surface area linearly with water saturation. Other updates included the ability to output the kinetic rates and solid-phase surface areas already calculated internally in eSTOMP, and the ability to calculate porosity and permeability changes resulting from precipitation and dissolution reactions. Testing for the reactive geochemical transport updates is also nearly complete. Small-scale differences between STOMP and eSTOMP remain to be resolved when using fixed species concentrations. Preparations were made to perform benchmark simulations with eSTOMP.

The IDF PA modeling work must account for the long-term corrosion rate of the ILAW glasses. In FY 2012, PUF tests on three prototypic ILAW glasses were completed. The reacted glass from each experiment was collected and analyzed using scanning electron microscopy with energy-dispersive spectroscopy (SEM-EDS) and powder X-ray diffraction (XRD). A representative sample developed a 10 μm-thick stratified alteration layer on the surface of the reacted glass. Elemental analyses showed that silicon decreases slightly in the first alteration layer; it then increases in the second alteration layer and further increases in the outer clay-like layer. Aluminum gradually increases from the glass to the outer layer. Calcium remains similar in all of the layers, except the second alteration layer where it is higher. Zirconium concentration increases in each alteration layer, then significantly decreases in the outer clay-like layer. Magnesium and zinc both remain constant, and then increase in the clay-like layer. Alkali elements sodium, potassium, and boron decrease significantly at the glass-to-alteration layer interface and continue to decrease in concentration from the second alteration to the outer layer. The XRD results illustrated that the reacted glass was mainly amorphous and contained only a minor amount of crystalline phases. Both the SEM-EDS and XRD results are consistent with LAW glass samples from previous PUF experiments. Detailed descriptions of modeling results and the supporting theoretical framework are forthcoming in a comprehensive report describing the FY 2012 research. Additional information is provided in PNNL-20781, *Integrated Disposal Facility FY 2011 Glass Testing Summary Report*.

In addition to PUF results, the STOMP and eSTOMP codes also use results from product consistency experiments as input to develop a series of reaction networks, leading to the secondary phases that form during the weathering of the ILAW glasses. Geochemical modeling using Geochemist's Workbench[13] was conducted to determine the reaction network. Product consistency tests data for 128 glasses from FY 2011 and an additional 10 glasses in FY 2012 were used in the geochemical modeling effort. Glass compositions used as input for the modeling are compiled in VSL-11R2270-1, *ILAW Glass Testing for Disposal at IDF: Phase 1 Testing*. The geochemical modeling of the 128 glasses is discussed in the PNNL-20781. Geochemical modeling of the additional 10 glasses is documented in the FY 2012 annual report currently being prepared. For a majority of these glasses, a secondary-phase reaction network

[13] Geochemist's Workbench® is a registered trademark of Aqueous Solutions, LLC, Champaign, Illinois.

previously developed for ILAW glass sample LAWA44 produced good model fits. Notable exceptions were predictions for potassium and lithium solution concentrations in equilibrium with weathered glass. Developing a consistent reaction network of secondary phases for glass samples that had relatively high concentrations of calcium and lithium, and relatively low concentrations of sodium, was not feasible, likely due to the inability to identify and model the phase(s) that control Li concentrations and the lack of actual thermodynamic data for K-chabazite. Additional modeling work was conducted to evaluate whether sepiolite [$Mg_4Si_6O_{15}(OH)_2 \bullet H_2O$] or clinochlore [$Mg_5Al_2Si_3O_{10}(OH)_8$] controlled Mg^{2+} concentrations in solution. The results were inconclusive, suggesting that either phase could potentially control magnesium concentrations. Geochemical modeling of the product consistency test results provides equilibrium information; evaluation of results from kinetic experiments (and perhaps additional experimentation) would be needed to provide rate information.

A stochastic simulation tool using the Monte Carlo method is being developed to predict the composition, extent, and morphology of the weathered glass hydration layer as a function of glass composition. This stochastic simulation tool will be used to provide input data for geochemical modeling of secondary phase formation to be used in PA analyses. The work performed during this reporting period was divided into two activities. The first activity was intended to provide a quantitative comparison between calculated and experimental dissolution properties of borosilicate and aluminoborosilicate glasses using a single set of model parameters. The second activity consisted of extending the stochastic tool to include high field-strength cations, which adopt an octahedral coordination in borosilicate glasses. The results provide key insights into the role of aluminum and high field-strength cations (e.g., zirconium and hafnium) on the hydrolysis and condensation reactions that occur during the dissolution of borosilicate glasses.

Required input for the stochastic simulations includes the glass compositions, the glass structure, and the reactivity of the glass components. During the reporting period, a variety of chemically simple and complex glasses were characterized using aluminum-27, boron-11, and silicon-29 magic-angle spinning nuclear magnetic resonance spectroscopy. In previous FYs, a combination of Raman spectroscopy and X-ray photoelectron spectroscopy (XPS) was also used to characterize unreacted and reacted glasses. A summary of these results will be discussed in the final FY 2013 project report, which will also include the results of eSTOMP code enhancements, glass-alteration phase characterization, and the stochastic Monte Carlo glass weathering simulation tool.

3.1.2.2 Supplemental Immobilization Waste Forms Research

In FY 2012, WRPS performed work to generate data to support selection of a potential alternate waste form for supplemental immobilization of Hanford Site low-activity waste (LAW). This work ultimately supports Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order* [Ecology et al., 1989]) Milestone M-062-40ZZ, which calls for a one-time "Hanford Tank Waste Supplemental Treatment Technologies Report" to include waste form performance data (compared with the performance of borosilicate glass) for the treatment technologies being considered. Technologies being considered in addition to borosilicate glass include bulk vitrification, fluidized bed steam reforming (FBSR), and Cast Stone. In FY 2010, DOE-ORP recognized that the FBSR waste form had a very limited amount of performance data available for the technologies being considered. Therefore, DOE-ORP initiated a program to evaluate these technologies using samples of Hanford Site LAW. Two Hanford Site LAW samples and one Savannah River Site LAW sample, chemically shimmed to match a Hanford 68 tank blend simulant, were tested in a bench-scale reformer at Savannah River National Laboratory (SRNL).

The granular product produced from the SRNL bench-scale tests was shown to have the same mineralogy as material made from simulants at pilot and engineering scales. Granular and monolith versions of the FBSR product were subjected to short-term performance testing via the product consistency test and

toxicity characteristic leaching procedure (TCLP). Longer-term performance tests (i.e., single-pass flow-through [SPFT] and PUF tests) were initiated on products produced from simulants, real waste, and pure-phase minerals. These tests are being conducted to develop kinetic rate law parameters (and confirm results from previous tests) and to determine the types of alteration products that form as the waste form corrodes over time. The data from these tests may be used with the STOMP computer code to predict waste form performance in the IDF. These experiments and data provide the defense-in-depth needed to predict, with a high level of confidence, long-term waste form behavior. Testing of the FBSR product continued in FY 2012 with completion of the long-term (one-year) product consistency tests and PUF tests. The testing generally showed excellent incorporation of contaminants (e.g., technetium and iodine) in the waste form matrix, acceptable performance in the TCLP, and product consistency tests leach resistance comparable to ILAW glass. Results of the SPFT and PUF tests will be compiled, and updated reports on waste form performance will be issued in FY 2013.

In FY 2012, WRPS developed plans for a testing program to expand the body of data on the Cast Stone waste form for immobilizing Hanford Site LAW. The first step was to identify a range of LAW waste feed compositions that would potentially challenge the waste form with respect to processing properties and cured waste form performance. Part of the incentive for this work was the promising results observed in Cast Stone formulation and testing for immobilization of Hanford Site liquid secondary waste and the work performed over the past several years known as the grout variability studies in support of SRNL's Salt Stone Processing Facility. For the Hanford Site LAW application, a Cast Stone LAW technology development plan and a detailed testing plan were prepared. Progress in FY 2012 included developing a statistically designed test matrix and preparing initial waste simulant compositions. Testing activities in FY 2013 and FY 2014 will include formulation development with simulants, followed by bench-scale testing with simulants, and up to four real waste samples. An engineering-scale test with simulants is planned for early FY 2014.

WRPS completed another program (VSL-12R2640-1, *Technetium Retention in WTP LAW Glass with Recycle Flow-Sheet: DM10 Melter Testing*) during this reporting period to obtain data on the effectiveness of the WTP LAW melter off-gas recycle system in incorporating technetium-99 into the glass. In the WTP LAW vitrification facility, the extent to which technetium is incorporated into the LAW glass product and the fraction that is present in secondary waste streams that are disposed as non-glass waste forms are major factors in the IDF PA. The WTP flow sheet incorporates recycle of the liquid effluents from the primary off-gas treatment systems in order to increase the fraction of technetium in the glass and decrease that in the secondary waste streams. Previous expectations have been that partitioning of technetium to the glass versus the secondary waste streams would be very high. However, these estimates were based on limited data on the performance of the various WTP unit operations with respect to technetium retention factors, and much of that information was based on the use of rhenium as a surrogate for technetium. To support these tests, an existing DM10 system (installed at Vitreous State University, Catholic University of America) was modified to add the required recycle loop. Based on the WTP LAW off-gas system design, suitably scaled versions of the submerged bed scrubber, wet electrostatic precipitator, and other key components of the off-gas system were designed, built, and installed into the DM10 system. Seven different simulated LAW waste compositions were processed in nine nominally 72-hour tests. All feeds were spiked with a solution containing technetium-99 in the pertechnetate form; the feeds used in these tests also contained measureable amounts of nonradioactive iodine and rhenium. In each test, a mass balance for technetium and other feed contaminants of concern (COCs) was measured across the glass pool, discharge glasses, throughout the off-gas system, evaporator overheads, and wet electrostatic precipitator exhaust. These tests have produced the first-ever data on the following:

- Technetium retention factors for key WTP unit operations (submerged bed scrubber, wet electrostatic precipitator, and vacuum evaporator)
- The effect of recycle on the incorporation of technetium and other key species in LAW glass
- The distribution and fate of technetium throughout the vitrification system and recycle loop, and the extent of partitioning to secondary waste streams

Key findings from this work are as follows:

- With recycle, retentions of technetium and rhenium in the glass product are increased by factors of at least 2 to 3 over the corresponding single-pass values for nearly all glass compositions.
- The average technetium and rhenium retentions in glass across all compositions tested were 68 percent and 79 percent, respectively.

3.1.2.3 Secondary Liquid Waste Form Testing Research

Hanford Site LAW will be vitrified in a joule-heated ceramic melter to produce a stable product for disposal. Technetium in Hanford tank waste is an important radioactive component due to its high mobility in the subsurface environment and the high dose conversion factors for this radionuclide. A portion of technetium can be volatilized in the melter (and, thus, not be incorporated into the glass waste form) and, following cooling and condensation, end up in the secondary liquid waste. This secondary liquid waste will be solidified at the Effluent Treatment Facility (ETF).

High retention of COCs in the solidified waste is desirable in order to minimize the impact on the IDF PA. Potential areas to explore in improving COC retention in the solidified LAW secondary liquid waste include changes to waste form composition, chemistry, and process conditions. The impact on other COCs also needs to be determined.

The scope of this testing task is divided into three phases. In the first phase, the contractor performed a literature search of previous work pertaining to WTP secondary liquid waste and on secondary solid wastes. This literature survey highlighted three viable, low-temperature solidification processes (Cast Stone, Ceramicrete, and DuraLith) and the FBSR process as potential waste forms for solidifying the WTP secondary liquid waste. In the second part of Phase 1, preliminary screening tests were performed on the low-temperature waste forms. These screening tests were used as a measure to see if the waste forms were viable for retaining the COCs. The screening test results and literature survey were presented at a workshop to a panel of experts. These experts reviewed the data and literature information available to justify carrying the waste forms forward into Phase 2 testing.

Phase 2 used a multi-faceted approach to waste form testing, which included performing screening tests on the monolithed FBSR product and optimization tests on three low-temperature immobilization waste forms. Optimized waste form formulations were used for performing waste acceptance testing on samples of Ceramicrete,[14] DuraLith, and Cast Stone to determine the TCLP, compressive strength, and presence of free liquids, as well as iodine-129 and technetium-99 leach indices. These tests are all part of the acceptance criteria for disposal at the IDF, and the tests provide short-term leach data that can be used to understand long-term waste performance. In addition, engineering-scale demonstration tests were performed on Ceramicrete and DuraLith to assess challenges associated with larger scale production, as these waste forms had previously been limited to laboratory-scale test samples.

[14] Ceramicrete® is a registered trademark of The University of Chicago, Chicago, Illinois.

The other part of Phase 2 testing focused on radionuclide retention studies and data package preparation. The purposes of the radionuclide tests were to determine how each waste form holds onto or encapsulates the waste, and to determine how and at what rate the degradation process of the waste form released the COCs. The radionuclide retention tests were at a very preliminary level and will need to be evaluated further as long-term testing progresses. The contractor also put together data packages on the four waste forms studied throughout Phases 1 and 2. These data packages consolidated a large amount of data, optimized formulations, radionuclide test results, leachability data, high-level process descriptions, scale tests, and waste form attributes into one report for each waste form. The data packages will be used to support a waste form selection.

Early in FY 2012, the Secondary Liquid Waste Treatment Project selected Cast Stone as the immobilization matrix to be used for secondary liquid waste based on its superior performance characteristics, similarity to other waste forms produced worldwide for comparable applications (e.g., Salt Stone at the DOE's Savannah River Site), maturity, and relative simplicity of the process. Based on this decision, the Secondary Liquid Waste Treatment Project proceeded with the CD2 design based on a Cast Stone-type process.

In FY 2012, WRPS prepared RPP-51790, *Secondary Liquid Waste Treatment Cast Stone Technology Development Plan*; PNNL-21656, *Secondary Liquid Waste Cast Stone Waste Form Qualification Testing Plan*; and RPP-RPT-51770, *Cast Stone Engineering Test Plan for Secondary Liquid Waste Treatment Project (T3W08)*. These reports define all of the testing required to mature the Cast Stone waste form and immobilization process for Hanford Site aqueous secondary wastes treated at the ETF, and to qualify the waste form for disposal onsite at the IDF. This maturation program includes the following: refinement and optimization of the Cast Stone formulation, demonstration of the robustness of the Cast Stone process to handle the expected range of secondary waste feeds, engineering- and pilot-scale tests to demonstrate the integration of the elements of the Cast Stone immobilization process, resolution of design issues, measurement of contaminant release rates, and evaluation of the long-term weathering of the Cast Stone product in the IDF environment.

WRPS also contracted with the Center for Laboratory Sciences (CLS) in Pasco, Washington, in FY 2012 to conduct bench-scale studies to investigate variations in the Cast Stone formulation and waste loading. The bench-scale testing included waste-loading optimization to attempt to increase the Cast Stone waste loading over that previously demonstrated. CLS was prepared acceptable Cast Stone samples with dry waste loadings up to 16.5 weight percent. The basic Cast Stone dry-blend formulation consists of 8 weight percent Portland cement (Type I/II), 45 weight percent Class F fly ash, and 47 weight percent blast furnace slag. One of the key objectives in developing an alternative Cast Stone formulation is to minimize the porosity of the waste form, thereby decreasing the diffusivity of COCs out of the waste form. Cast Stone formulation enhancements attempted at CLS included variations in the proportions of blast furnace slag and fly ash, and the addition of silica fume.

CLS also performed a mixing demonstration designed to evaluate the efficacy of a small-scale (0.0283 m3 [1 ft^3]) ribbon blender in providing adequate mixing of the secondary liquid waste Cast Stone formulation and the associated flowability of the material. The intention of the optional larger scale flow study was to demonstrate the flow of the material under conditions approximating flow into the proposed Cast Stone disposal container. The results of this small-scale mixing demonstration will provide valuable input to the secondary liquid waste Cast Stone design.

3.1.3 Waste Management Area C Performance Assessment

WMA C includes the C Tank Farm and ancillary equipment, and it is located in the eastern portion of the 200 East Area. In FY 2009, a scoping process was initiated to develop the risk assessments and PAs

required for closure of WMA C. A series of working sessions are being held with the regulatory agencies and stakeholders to solicit input and obtain a common understanding regarding the scope, methods, and data to be used in the planned risk assessments and PAs. In addition to DOE-ORP, Ecology, and Site contractors, working session members also include representatives from the U.S. Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Commission (NRC), interested Tribal Nations, other stakeholders groups, DOE-RL personnel and their contractors involved with groundwater/vadose zone or composite analyses efforts, and members of the interested public. NRC staff involvement in the working sessions is a technical resource to assess whether required waste determinations by DOE-RL for waste incidental to reprocessing are based on sound technical assumptions, analyses, and conclusions relative to applicable incidental waste criteria. The scoping phase was completed in FY 2011.

Planned modeling activities resulting from the WMA C PA scoping process were not started in FY 2011 or FY 2012 because the analysis phase for the WMA C PA was deferred until issuance of the Final TC&WM EIS.

In the second half of FY 2012, an evaluation was initiated to support WMA C PA planning that identified differences between the post-closure analysis performed as a part of the Draft TC&WM EIS, as documented in DOE/EIS-0391 in October 2009, and the planned post-closure analysis of the WMA C PA developed from the scoping process. Details of the TC&WM EIS modeling analysis were derived from data and information reported in the Draft TC&WM EIS and other technical references that were cited as key documents in the that EIS. Details evaluated for the planned WMA C PA modeling effort were derived from data and information provided in data packages and presentations developed by WRPS and its subcontractors for use in the WMA C PA scoping process and working sessions conducted between January 2009 and May 2011. Results of the initial comparisons indicate that the local-scale vadose zone model and information on the underlying groundwater system at the WMA C used in the TC&WM EIS analysis can provide an initial basis for a local-scale model that will be developed to support the WMA C PA effort. The planned modeling effort for the WMA C PA will likely make use of a combined vadose zone and groundwater model specifically designed for assessing near-field impacts at the WMA C fence line.

3.1.4 Environmental Restoration Disposal Facility Performance Assessment

The ERDF was constructed in 1996 to receive waste generated by remediation of CERCLA sites at Hanford, and the facility began operations in July 1996. Figure 3-4 shows the location of the ERDF. The ERDF is an active operating disposal facility managed by Washington Closure Hanford (WCH) for DOE-RL. This section reviews PA activities in FY 2012, and Section 3.3.3.2 provides information about FY 2012 disposal operations for ERDF.

Authorization to operate the ERDF was granted by EPA in 1995 with EPA/ROD/R10-95/100, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*, and by DOE-RL with a DAS (Scott, 2001) per DOE Order 5820.2A, *Radioactive Waste Management*. The primary technical analyses supporting approval to operate include the remedial investigation/feasibility study (RI/FS) completed in 1994 (DOE/RL-93-99, *Remedial Investigation and Feasibility Study Report for the Environmental Restoration*

ERDF Relevance to the Composite Analysis

Similar to the LLBGs, disposal of solid waste at ERDF constitutes one of the sources of radioactive waste inventory. Because this facility is in active use, the current estimated inventory disposed is adjusted annually to reflect waste received. This updated information is pertinent to the Composite Analysis because of its potential to change the ERDF inventory evaluated in the Composite Analysis.

Information on the current inventory and operations for ERDF is reported in Section 3.3.3.2.

Disposal Facility) for the ROD, and a preliminary PA analysis (BHI-00169, *Environmental Restoration Disposal Facility Performance Assessment*) to address DOE Order 5820.2A requirements. A crosswalk analysis was completed to show that DOE O 5820.2A facility performance requirements would be satisfied ("Environmental Restoration Disposal Facility CERCLA/DOE Order 5820.2a Roadmap" [Dronen, 1996]). DOE-RL determined that the RI/FS and the preliminary PA analysis adequately evaluated the ability of the ERDF to satisfy specific performance objectives in DOE Order 5820.2A and showed a reasonable expectation that these objectives would be met. A second crosswalk was completed to demonstrate compliance with DOE O 435.1 ("Environmental Restoration Disposal Facility (ERDF) Crosswalk to DOE Order 435.1 Requirements" [Klein, 2000]), which resulted in issuance of a DAS on June 18, 2001 (Scott, 2001).

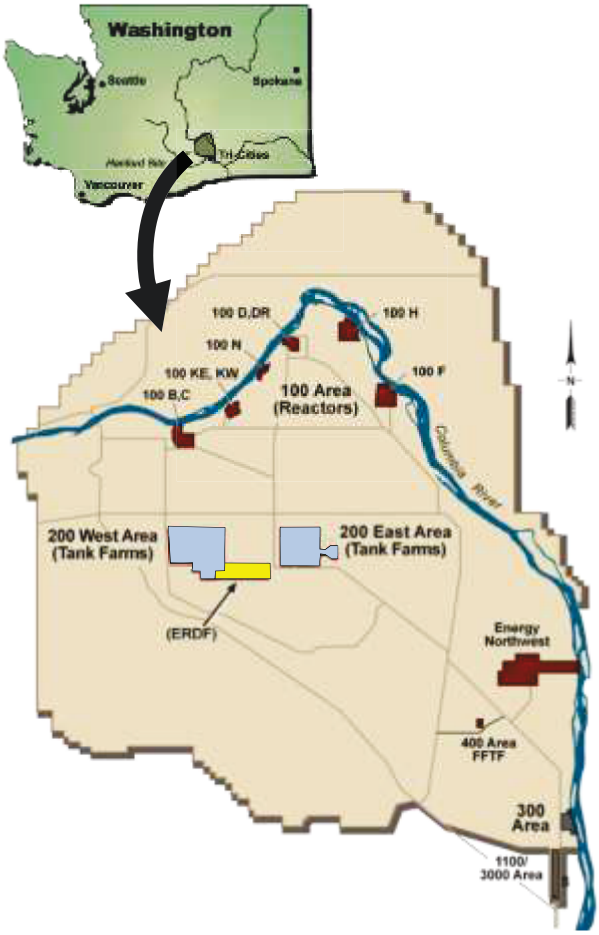


Figure 3-4. Location of the ERDF

Since the completion of the preliminary PA analysis, two factors led to DOE-RL's decision to update the PA analysis and complete the formal review process per DOE O 435.1, which is the successor to DOE Order 5820.2A. First, the ERDF has accepted additional radioactive waste at higher inventory levels than originally foreseen (although still within the limits provided in the preliminary PA analysis); secondly, new information has been developed at the Hanford Site that identifies large conservatisms in the initial analysis. The updated PA analysis is intended to provide a more realistic evaluation of ERDF performance and to optimize the capability of the ERDF to complete its mission for disposal of CERCLA remediation waste for the remainder of Hanford Site cleanup activities.

In FY 2011, WCH-426, Rev. 0, *Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility*, was prepared and approved ("Approval of the Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility, WCH-426, Revision 0, October 2010" [Einan, 2011]), and a modeling approach (WCH-462, *ERDF Performance Assessment Modeling Approach*) was developed for the ERDF PA. Subsequent to issuance of the work plan, efforts were undertaken in FY 2011 to align the modeling approach with that of the TC&WM EIS to maintain an integrated modeling methodology.

The work plan to prepare the new ERDF PA was revised early in FY 2012 (WCH-426, Rev. 1, *Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility*) to incorporate applicable TC&WM EIS methodology and tools into the modeling approach. The PA calculations were completed in FY 2012 in accordance with the revised work plan (WCH-426, Rev. 1), and the draft PA was prepared. Additionally, the following draft data packages supporting the ERDF PA were also prepared:

- WCH-463, *Hydrogeologic Model for the Environmental Restoration Disposal Facility, Hanford Site*
- WCH-464, *Hydrologic Data Package in Support of Environmental Restoration Disposal Facility Performance Assessment Modeling*
- WCH-475, *Biota Description Data Package for the Post Closure Environmental Restoration Disposal Facility Location*
- WCH-476, *Chemical Reactivity of Radionuclides with Waste Material and Subsurface Soils During Release and Migration from the Environmental Restoration Disposal Facility*
- WCH-477, *Conceptual Models for Release and Transport of Environmental Restoration Disposal Facility Waste Contaminants through the Near Field Environment*
- WCH-478, *Exposure and Inadvertent Scenarios for the Environmental Restoration Disposal Facility*
- WCH-479, *Inventory Data Package for ERDF Waste Disposal*
- WCH-515, *Parameter Uncertainty for the ERDF Performance Assessment Uncertainty and Sensitivity Analysis*

The revised ERDF PA was undergoing review by EPA in early FY 2013 and is planned for submission to DOE's Low-Level Federal Review Group in the second quarter of FY 2013.

Relevance of RCRA and CERCLA Remedial Activities to the Composite Analysis

Remediation actions are pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory in time, location, and waste form. Updated knowledge and information acquired in the conduct of remedial actions have the potential to change the analysis evaluated in the Composite Analysis and are reviewed here to assess any such impact.

3.2 Central Plateau RCRA Remedial Activities

The RCRA corrective action program directed by DOE-ORP is pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory considered in the Composite Analysis in time, location, and waste form.

The Tank Farm Vadose Zone Project, a component of DOE's overall RCRA corrective action program, conducted field efforts in WMA C during FY 2012. The direct-push technique using a hydraulic hammer was used to obtain eight samples at one

location in WMA C. Laboratory analyses on those samples, and other samples collected during FY 2011, were completed and reports were issued. During decommissioning of the direct-push probe holes, deeply buried electrodes were installed to measure soil resistivity, which is useful in defining soil contamination extent. The direct push in WMA C was located at a site defined in the WMA C work plan (RPP-PLAN-39114, *RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*) in support of a corrective measures study.

Application of geophysical exploration techniques was completed in WMA B-BX-BY in FY 2012. No discernible subsurface resistivity targets were identified as part of the three-dimensional resistivity characterization of an unplanned release (UPR) site, UPR-200-E-82, located in WMA C (RPP-RPT-50052, *Surface Geophysical Exploration of UPR-200-E-82 Near the C Tank Farm*). Results from the BY East surface geophysical exploration characterization activities (RPP-RPT-50758, *Three-Dimensional Surface Geophysical Exploration of the Eastern Portion of the BY Tank Farm*), in conjunction with previous studies performed in BY West, did not indicate resistivity targets below the excavation depth of the tanks and some small targets in the spaces in between the tanks in the very near surface area.

Monitoring continued for the demonstration interim surface barrier in WMA T, which was completed in FY 2008 to reduce infiltration of precipitation through the surface overlying the vadose zone plume resulting from the tank 241-T-106 release that occurred in 1973. Monitoring was performed for the interim surface barrier in the TY Tank Farm that was constructed in FY 2010. Monitoring results to date were evaluated in FY 2012, and it was concluded that the frequency of recording monitoring data could be reduced to once per day (rather than hourly) without loss of data quality (RPP-RPT-53570, *Technical Basis for Soil Moisture and Soil Pore Pressure Head Measurement Frequency Reduction at T and TY Farm Interim Surface Barriers*).

3.3 Central Plateau CERCLA Remedial Activities

CERCLA remedial activities directed by DOE-RL are pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory considered in the Composite Analysis in time, location, and waste form. Updated knowledge and information acquired in the conduct of remedial actions have the potential to change the analysis evaluated in the Composite Analysis and are reviewed here to assess any such impact.

The Central Plateau consists of approximatley195 km^2 (75 mi^2) near the middle of the Hanford Site. Most activities are concentrated in two main processing areas: 20- East Area and 200 West Area. The Central Plateau contains excess facilities formerly used in the plutonium production process, including five large chemical processing facilities (commonly known as canyons) and the Plutonium Finishing Plant (PFP), as well as individual waste sites including both buried solid waste and contaminated soil.

The approach for cleanup of the Central Plateau focuses on these three major components:

- The Inner Area, where the final footprint area of the Hanford Site will be dedicated to waste management and containment of residual contamination
- The Outer Area, which contains the balance of the Central Plateau
- Groundwater, which is comprised of contaminant plumes underlying the Central Plateau and originating from waste sites on the Central Plateau

Several operating waste disposal facilities in the Inner Area will continue to receive waste from Hanford Site cleanup activities and from limited offsite sources. The ERDF was constructed for the disposal of waste generated during cleanup of the Hanford Site. Additional cells will be constructed in the ERDF, as needed, to implement cleanup decisions. The LLW or radioactive mixed waste generated from Hanford Site activities may also be disposed in the LLBGs or mixed waste trenches, as appropriate. A future IDF is in the RCRA permitting process for disposal of some waste generated from radioactive liquid waste tank cleanup and, potentially, from other Hanford Site activities.

Cleanup actions have already been initiated for some areas of the Central Plateau. The U Plant facility (221-U) is one of five massive processing facilities at the Hanford Site. The building, commonly called a "canyon," was built during World War II to extract plutonium from fuel rods irradiated in the Hanford Site's production reactors. It was used for training and equipment work, and was later converted to recover uranium from waste generated at the other canyon facilities. *Record of Decision 221-U Facility (Canyon Disposition Initiative) Hanford Site, Washington* (EPA et al., 2005), issued in October 2005, determined that the U Plant Canyon would be disposed in place with a suitable surface barrier to prevent infiltration of water and/or intrusion by human or ecological receptors. Existing contaminated equipment from the canyon deck (a near ground-level portion of this facility) was size-reduced as necessary and placed in the canyon process cells (a belowground level portion of this facility) and grouted in place during FY 2011. The upper portion of the canyon building will be demolished to approximately the level of the canyon deck or slightly higher. Debris from this partial demolition will be placed on or adjacent to the canyon deck. Appropriate action, such as grouting, will be taken where necessary to minimize voids. The partially demolished building and debris will be covered with a surface barrier. Final decisions for the remaining canyons and the storage tunnels located at the Plutonium-Uranium Extraction (PUREX) Plant will be made as part of the upcoming CERCLA and RCRA cleanup decisions.

The disposition of remaining facilities, including PFP facilities, is being addressed with a combination of NEPA, CERCLA, and RCRA processes. Radioactive or other hazardous substances are removed and treated, if necessary, and packaged for disposal in approved disposal facilities. Debris and rubble from the demolition process are disposed onsite at the ERDF or offsite in solid waste landfills, as appropriate. Limited volumes of transuranic (TRU) wastes generated during the demolition process are packaged for disposal at the Waste Isolation Pilot Plant (WIPP). The RCRA closure requirements are integrated into the process where necessary. Potential subsurface contaminants will be addressed in a manner consistent with the waste site remedial alternatives discussed in the following paragraphs.

Approximately 15,000 m^3 (approximately 20,000 yd^3) of suspect TRU waste were placed in retrievable storage trenches in four LLBGs starting in 1970. The waste is being retrieved from the trenches and characterized to determine whether it is TRU or LLW. Approximately 12,500 m^3 (16,000 yd^3) have been retrieved to date. Two additional waste sites located outside the 200 Areas (618-10 and 618-11 Burial Grounds) contain approximately 10,000 m^3 (13,000 yd^3) of suspect TRU waste. The low-level fraction will be treated and disposed onsite, and the TRU fraction will be shipped to WIPP.

The following extensive and significant inventory of radionuclides exists in other forms that require disposition:

- Approximately 2,000 cesium and strontium capsules are stored underwater at the Waste Encapsulation Storage Facility. These are classified as high-level waste (HLW) and are to be disposed at a HLW geologic repository.

- PNNL produced 34 borosilicate, glass-filled canisters for the Federal Republic of Germany. These "German logs" were isotopic heat sources for a repository testing program in Germany and are designated as nonhazardous, remote-handled TRU waste. The canisters are stored at the Central Waste Complex in the 200 West Area, pending decisions on final disposition.

- Spent nuclear fuel is stored in multi-canister overpacks at the Canister Storage Building in the 200 East Area. Examples include material from the K Basins, N Reactor, and Shippingport Pressurized Water Reactor Core 2 blanket fuel assemblies. The 200 Area Interim Storage Area, located adjacent to the Canister Storage Building, is used to store other nondefense spent nuclear fuel in aboveground dry cask storage containers, including material from the Fast Flux Test Facility, Neutron Radiography Facility, and TRIGA (a class of small nuclear reactor) light water reactor spent nuclear fuel. The Canister Storage Building/Interim Storage Area is designed for interim storage until a suitable long-term repository is established.

The Central Plateau includes more than 800 soil waste sites, consisting of cribs, ponds, ditches, trenches, landfills, pipelines, diversions boxes, UPRs, and other types of sites used for liquid or solid waste disposal. Remedial actions or interim removal actions have been conducted for some of the soil waste sites located in the Outer Area. Sites in the 200 North Area have been remediated in accordance with 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 (100 Area Remaining Sites)*, issued in 1999. Interim action has been conducted in the southern part of the Outer Area to remove surface contamination and reduce the footprint of areas requiring radiological control.

Remediation of the remaining Central Plateau soil waste sites will be completed in accordance with CERCLA and RCRA corrective action requirements. CERCLA guidance requires that a range of alternatives be evaluated, including the following:

1. No action
2. Removal of contaminants as the primary remedy
3. Containment as the predominant remedy
4. Treatment of the contaminants to reduce their toxicity, mobility, or volume as the primary remedy

The evaluation of remedial alternatives conducted for the Central Plateau operable units (OUs) will consider these alternatives, as well as an alternative that employs a combination of those key features.

Alternatives that involve removal will include treatment, where appropriate, and disposal in an approved disposal facility such as ERDF. Containment remedies may involve maintaining or enhancing existing soil covers, capping with suitable engineered surface barrier, or other containment remedies. Treatment-based remedies may involve monitored natural attenuation (to allow radioactive materials to decay), immobilization, or other forms of treatment. Surface barriers will be designed to limit the infiltration of water and, thereby, slow the movement of contaminants currently in the vadose zone into the underlying groundwater. Barriers will also be designed to prevent intrusion by plants and animals so underlying contamination is not dispersed.

All alternatives are expected to result in the need for institutional controls as long as the hazards are present in order to maintain environmental monitoring and surface barriers, to limit access to authorized users, and to prevent unapproved excavation and inadvertent intrusion. DOE-RL has committed to retain the Central Plateau, as well as other areas of the Hanford Site, under federal control for the foreseeable future.

3.3.1 Central Plateau Source Operable Units

The CH2M HILL Plateau Remediation Company (CHPRC) Soil and Groundwater Remediation Project implements the RI/FS process for several source operable units (OUs) in the Central Plateau. Since the inception of CERCLA programs on the Central Plateau, the configuration of the waste site OUs has been modified as needed to support the RI/FS process. In 2010, DOE, EPA, and Ecology agreed to restructure the OUs to promote consistency in decision making and to facilitate a geographic approach to cleanup implementation. Some existing OUs were retained, while others were absorbed into new geographic-based OUs. Table 3-2 lists the restructured Central Plateau source OUs and FY 2012 activity by OU.

The decision-making process for these OUs will incorporate data and analyses previously conducted for the predecessor OUs, as appropriate. New or revised Tri-Party Agreement (Ecology et al., 1989) milestones were negotiated for the RI/FS process in FY 2012. The OUs listed in Table 3-2 are subject to completion of the RI/FS process and remediation in accordance with the negotiated major and interim Tri-Party Agreement milestones to track the progress listed in Table 3-3.

Table 3-2. Central Plateau Source OUs

OU Group	Description	FY 2012 Activity
Inner Area		
200-PW-1/3/6 and 200-CW-5	Plutonium-contaminated soil sites located near the Plutonium Finishing Plant and cesium-contaminated sites near PUREX	• ROD issued September 30, 2011 (EPA et al., 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*). • No activity in FY 2012 (work unfunded). • RDR/RAWP is currently planned for September 30, 2015.
200-WA-1 and 200-BC-1	Soil waste sites located in the 200 West Inner Area that are not included in the 200-SW-2, 200-CR-1, 200-PW-1/6, 200-CW-5, and 200-IS-1 OUs Soil waste sites in the BC Cribs and Trenches	• DOE/RL-2010-49, Draft A, *Remedial Investigation/Feasibility Study Work Plan 200-WA-1 and 200-BC Operable Units*, was delivered to the regulatory agencies on December 28, 2011. Comments were received from EPA; DOE-RL and EPA personnel are addressing these comments. • No additional activity in FY 2012 (work not funded).
200-EA-1	200 East Inner Area sites not included in the 200-SW-2, 200-CB-1, 200-CP-1, and 200-PW-3 OUs	• No activity in FY 2012 (work not funded).
200 IS-1	Pipelines and diversion boxes in the 200-IS-1 OU	• DOE/RL-2010-114, Draft A, *200-IS-1 Operable Unit Pipeline Waste Sites RFI/CMS/RI/FS Work Plan*, was delivered to the regulatory agencies on November 10, 2011. Comments were received from Ecology on this draft. • No additional activity in FY 2012 (work not funded).

Table 3-2. Central Plateau Source OUs

OU Group	Description	FY 2012 Activity
200-SW-2	Solid Waste Burial Grounds and waste sites in the footprint of the burial grounds	• DOE/RL-2004-60, Rev. 1 Draft A, *200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility Investigation/Corrective Measures Study/Remedial Investigation/Feasibility Study Work Plan*, was delivered to the regulatory agencies on November 7, 2011. Comments were received from Ecology on this draft. • No additional activity in FY 2012 (work not funded).
200-DV-1	Selected soil waste sites in the Inner Area with deep vadose zone contamination	• DOE/RL-2011-104, *Characterization Sampling and Analysis Plan for the 200-DV-1 Operable Unit*, was finalized.
200-CB-1	B Plant Canyon Associated waste sites	• No activity in FY 2012 (work not funded).
200-CP-1	PUREX Canyon Associated waste sites	• No activity in FY 2012 (work not funded).
200-CR-1	REDOX Canyon Associated waste sites	• No activity in FY 2012 (work not funded).
Outer Area		
200-OA-1, 200-CW-1, and 200-CW-3	Sites located in the Outer Area	• No activity in FY 2012 (work not funded).

DOE-RL = U.S. Department of Energy, Richland Operations Office
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
FY = fiscal year
OU = operable unit
PUREX = Plutonium-Uranium Extraction (Plant)
RDR/RAWP = remedial design report/remedial action work plan
REDOX = Reduction-Oxidation (Facility)
ROD = Record of Decision

Table 3-3. Central Plateau CERCLA/RCRA Deliverables, FY 2012 through FY 2018

TPA Milestone Number	Title	Due Date
M-091-40L-032 to -059	Submit Quarterly Burial Ground Sample Results from 4th Quarter FY 2011 to 3rd Quarter FY 2018.	3.5 months from previous quarter
M-015-90	Submit RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS work plan for 200-IS-1 OU to Ecology.	12/31/2011 (completed)
M-015-91A	Submit RI/FS Work Plan for the 200-WA-1 OU (200 West Inner Area) to EPA.	12/28/2011 (completed)
M-015-93A	Submit revised RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS Work Plan for the 200-SW-2 OU to Ecology.	12/31/2011 (Draft A completed)
M-085-10A	Submit RI/FS Work Plan for the 200-CB-1 OU (B Plant Canyon/ associated past practice waste sites) to Ecology.	6/30/2014
M-037-03	Submit revised closure plans to support TSD closure of two (2) TSD Units: 216-B-3 Main Pond system and 216-S-10 Pond and Ditch.	4/30/2013
M-015-38B	Submit a revised Feasibility Study Report and revised Proposed Plan(s) for the 200-CW-1, 200-CW-3, and 200-OA-1 OU for Waste Sites in the Outer Area of the Central Plateau to EPA.	10/30/2014
M-015-92A	Submit a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS Work Plan for the 200-EA-1 OU (200 East Inner Area) to Ecology.	6/30/2015
M-015-91B	Submit Feasibility Study Report and Proposed Plan for the 200-WA-1 OU (200-West Inner Area) to EPA.	12/31/2015
M-037-02	Submit revised closures plans to support TSD closure of five (5) TSD Units: 207-A South Retention Basin; 216-A-20 Ditch; 216-A-36B Crib; 216-A-37-1 Crib and 216-B-63 Trench.	6/30/2014
M-015-92B	Submit Corrective Measures Study and Feasibility Study Report(s) and Proposed Plan(s)/Proposed Corrective Action Decision(s) for the 200-EA-1 and 200-IS-1 OUs (Central Plateau 200 East Inner Area) to Ecology.	12/31/2016
M-085-20A	Submit RI/FS Work Plan for the 200-CP-1 OU (PUREX Canyon/ associated past practice waste sites) to Ecology.	9/30/2015
M-037-11	Complete unit-specific closure requirements for two (2) TSD Units: 216-B-3 Main Pond System and 216-S-10 Pond and Ditch.	9/30/2016
M-015-93B	Submit RCRA Facility Investigation/Corrective Measures Study and RI/FS Report and Proposed Corrective Action Decision/Proposed Plan for the 200-SW-2 OU to Ecology.	12/31/2016
M-015-00	Complete the RI/FS (or RI/CMS) process for all non-tank farm OUs except for canyon/associated past-practice waste site OUs covered in M-85-00. A day-for-day slip in submitting the feasibility study report and proposed plan milestone will be given for each day the RI/FS work plan is not approved following six months after submittal.	12/31/2016

Table 3-3. Central Plateau CERCLA/RCRA Deliverables, FY 2012 through FY 2018

TPA Milestone Number	Title	Due Date
M-085-30A	Submit RI/FS Work Plan for the 200-CR-1 OU (REDOX Canyon/ associated past-practice waste sites) to EPA.	12/31/2017
M-037-10	Complete unit-specific closure requirements according to the Closure plans for seven TSD Units: 207-A South Retention Basin; 216-A-29 Ditch; 216-A-36B Crib; 216-A-37-1 Crib; 216-B-63 Trench; Hexone Storage and Treatment Facility (276-S-141/142), and 241-CX Tank System (241-CX-70/71/72).	9/30/2020
M-085-01	Submit a change package to formally establish a date for Tri-Party Agreement major Milestone M-085-00.	9/30/2012
M-085-50	Submit revised removal action work plan for the 224B Concentration Facility in accordance with DOE/RL-2004-36, *Action Memorandum for the Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility*. A change package with a completion milestone will accompany the submittal of the work plan.	3/31/2013
M-085-60	Complete Engineering Evaluation/Cost Analysis report(s) for all Tier 2 facilities listed in Appendix J.	3/31/2018
M-085-51	Submit removal action work plan for the 224T Transuranic Storage and Assay Facility in accordance with DOE/RL-2004-68, *Action Memorandum for the Non-Time-Critical Removal Action for the 224-T Plutonium Concentration Facility*. A change package with a completion milestone will accompany the submittal of the work plan.	12/31/2025
M-085-00	Complete response actions for the specified canyon facilities and waste sites.	To be decided
M-016-00	Complete remedial actions for all non-tank farm and non-canyon OUs.	9/30/2024

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMS = corrective measures study
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
FY = fiscal year
OU = operable unit
PUREX = Plutonium-Uranium Extraction (Plant)
RCRA = *Resource Conservation and Recovery Act of 1976*
RI/FS = remedial investigation/feasibility study
RFI = RCRA facility investigation
TSD = treatment, storage, and disposal (unit)

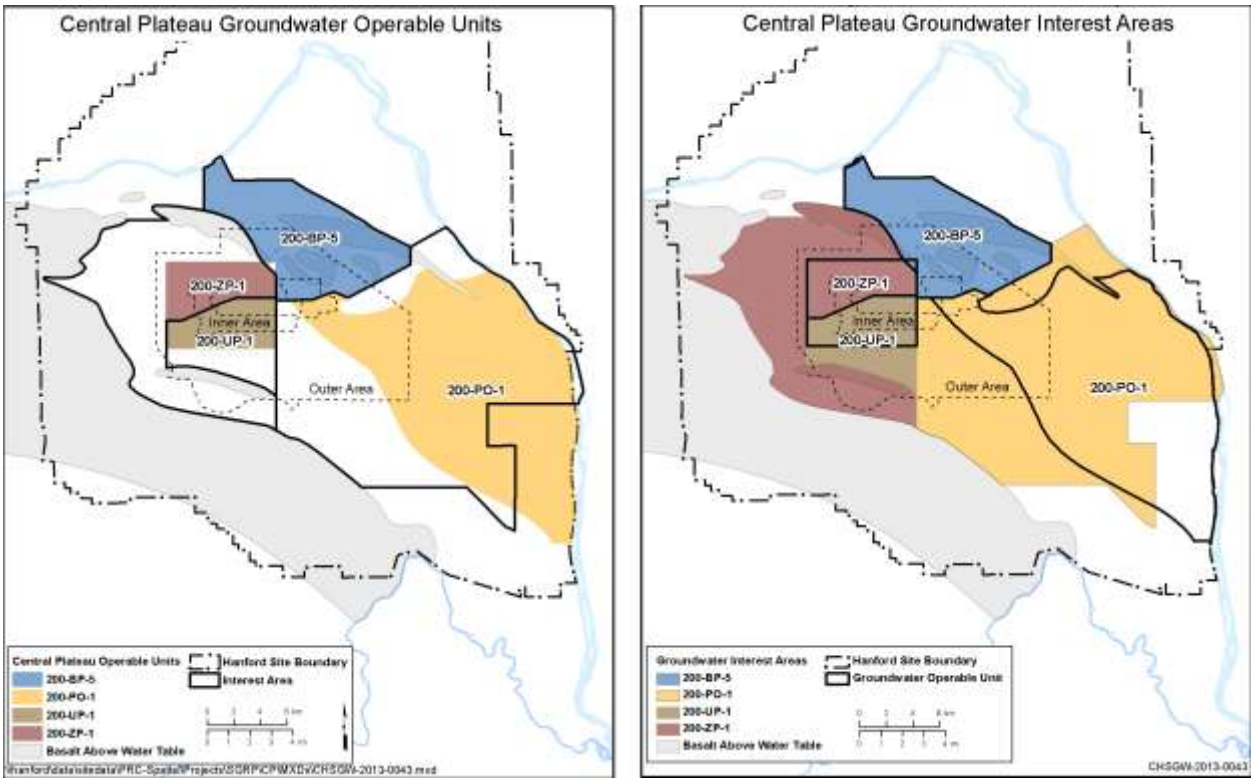
3.3.2 Central Plateau Groundwater Operable Units

This section presents the results of DOE-RL's groundwater monitoring program for the Central Plateau groundwater OUs for the period from January 1, 2011, through December 31, 2011 (CY 2011). The groundwater monitoring data and the interpreted results for CY 2011 are drawn from information presented in DOE/RL-2011-118 (published in August 2012). That report describes monitoring results for RCRA treatment, storage, and disposal units; (TSD) CERCLA groundwater OUs; and for the *Atomic Energy Act of 1954* (AEA), as required by DOE orders. Extracted information reported here focuses on activities that pertain to the Composite Analysis.

3.3.2.1 Central Plateau Groundwater Background

When the Hanford Site was in operation, irradiated fuel reprocessing, isotope recovery, and associated waste management activities occurred on the Central Plateau. Since the 1990s, DOE-RL has worked to characterize, contain, and treat groundwater, and to remove and dispose of soil contamination from past operations from all locations onsite. Principally, the contaminant sources included unlined cribs, trenches, ponds, ditches, and leakage from underground storage tanks (WMAs).

Four groundwater interest areas are located within the Central Plateau, and four groundwater OUs are located within those groundwater interest areas. The OUs are the 200-ZP-1 and 200-UP-1 Groundwater OUs in the 200 West Area, and the 200-BP-5 and 200-PO-1 Groundwater OUs in the 200 East Area. Figure 3-5 presents the locations and boundaries of these four groundwater areas/OUs. Any activity in these four groundwater OUs that provides new information on radionuclide constituents relevant to the Composite Analysis is discussed below. Remedial actions directed at nonradioactive contaminants are also discussed wherever it was found that these actions could potentially influence the characterization, extent, or remediation of radioactive constituents and, thereby, become relevant to the Composite Analysis.



Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

Figure 3-5. Central Plateau Groundwater OUs and Groundwater Interest Areas

Cleanup activities on the Central Plateau are being performed to protect human health, the environment, and the Columbia River. Waste sites within the Central Plateau are a lower priority for cleanup than waste sites within the River Corridor due to the proximity of the latter to the Columbia River (see DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*). Remediation of the Central Plateau waste sites is expected to accelerate once many of the River Corridor sites transition into long-term stewardship. Until that time, cleanup activities on the Central Plateau will continue to focus on

groundwater restoration through completing CERCLA decision documents and deactivating, decontaminating, decommissioning, and demolishing structures and facilities.

3.3.2.2 Central Plateau Groundwater Decisions

The following groundwater interim and final remedial actions were operated during the reporting period. Some of these actions will continue into the next reporting period, while some actions will stop or have stopped as they were superseded by other interim or final action RODs. These include actions in the 200-ZP-1 OU (soil vapor and groundwater pump-and-treat), the 200-UP-1 OU (groundwater pump-and-treat), and the 200-BP-5 OU (groundwater pump-and-treat in the perched water zone). The remedial actions and supporting key documentation are as follows:

- **200-UP-1 Groundwater OU interim remedial action (1997 and amended in 2009):** A pilot-scale treatability test (DOE/RL-95-02, *Treatability Test Report for the 200-UP-1 Operable Unit – Hanford Site*) consisting of an onsite pump-and-treat system, plus single extraction and injection wells, was constructed adjacent to the 216-U-17 Crib. Phase I pump-and-treat operations commenced September 25, 1995, and continued until February 7, 1997. The treatability test demonstrated that the ion exchange resin and granular activated carbon were effective at removing technetium-99, uranium and carbon tetrachloride from groundwater. On February 25, 1997, an interim ROD was issued (EPA/ROD/R10-97/048, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*).

  This cleanup action started in 1997. The remedial action objectives were met, and the system was shut down in 2012. This ROD was amended through an explanation of significant differences in 2009 (*Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit Hanford Site Benton County, Washington* [Ecology et al., 2009a]), which updated the uranium cleanup level from 48 μg/L to 30 μg/L. This system removed nearly 886×10^6 L (234×10^6 gal) of contaminated groundwater with 220 kg of uranium, 127 g (2 Ci) of technetium-99, 41 kg of carbon tetrachloride, and 49,000 kg of nitrate.

  The implementation of a groundwater pump-and-treat system for technetium-99 at the S-SX Tank Farms is now underway, as required by the revised DOE/RL-97-36, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*. The design consists of a three-well extraction system, aboveground pipelines, and a transfer building to pump extracted groundwater to the 200 West Area treatment facility. An average pumping rate is designed at 300 L/min (80 gallons per minute [gpm]). The system became operational in 2012. The following titles are provided for the ROD, the associated explanation of significant differences, and the work plan:

  – EPA et al., 1997, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit Hanford Site, Benton County, Washington* (February 25, 1997)

  – EPA et al., 2009a, *Explanation of Significant Differences for The Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit Hanford Site Benton County, Washington* (March 11, 2009)

  – DOE/RL-97-36 (June 23, 2010)

- **200-ZP-1 OU interim remedial action (1995):** In 1996, a groundwater pump-and-treat system was implemented to reduce the mass of carbon tetrachloride and to contain the plume where concentrations exceeded 2 mg/L. This action was completed, and the interim pump-and-treat system was deactivated in 2012. The ROD title is as follows:

– EPA/ROD/R10-95/114, *Record of Decision for the USDOE Hanford 200-ZP-1 Operable Unit, 200 Area NPL Site Interim Remedial Measure* (June 5, 1995)

A soil vapor extraction (SVE) system was implemented as an expedited response action to remove and treat carbon tetrachloride contamination in the vadose zone at 200-PW-1 OU waste sites. The system has been operating since 1992 and has been effective in removing and treating carbon tetrachloride. SVE was incorporated into the 2011 ROD for the vadose waste sites. The ROD title is as follows:

– EPA et al., 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units* (September 2011)

- **200-ZP-1 ROD (2008)**: *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008) identifies the use of pump-and-treat technology, monitored natural attenuation, and institutional controls to remediate contaminated groundwater. Groundwater pumping from this activity impacts the direction of groundwater flow and the levels of carbon tetrachloride present in the 200 West Area (including the 200-UP-1 OU). The pump-and-treat facility (known as 200 West Pump and Treat) began operation in 2012. The ROD title is as follows:

  – EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington* (September 29, 2008)

- **200-PO-1 remedial investigation (2012)**: The final remedial investigation for the 20-PO-1 OU was completed and released in 2012 (DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*). No remedial decisions have been made at this time. DOE-RL prepared a deep vadose zone treatability test plan in 2007 to study the effects of desiccation on soil-bound contaminants. The work began in the field in November 2010 with nitrogen injection and enhanced vacuum extraction, concluding in June 2011. The final report was issued in May 2012.

  – DOE/RL-2009-85 (October 2012)

  – DOE/RL-2007-56, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau*

  – PNNL-21369, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau Final Report*

- **200-BP-5 remedial investigation (2012)**: The process to prepare the remedial investigation report began in 2009, but no work was completed on the report in 2011. There are no active remediation systems within this OU, but a treatability test to remediate the uranium-contaminated groundwater beneath the B Complex began in 2011 as part of the 200-DV-1 deep vadose zone OU. In addition, a perched water removal/extraction project was started in 2011. The document titles are as follows:

  – DOE/RL-2011-40, *Field Test Plan for the Perched Water Pumping/Pore Water Extraction Treatability Test*

  – DOE/RL-2010-74, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit*

3.3.2.3 Central Plateau Groundwater Remedial Activities

Central Plateau groundwater and vadose zone remediation systems have removed more than 93,000 kg of carbon tetrachloride from groundwater since 1992. During 2011, DOE-RL completed 89 new wells for monitoring, remediation, and/or characterization, and 180 wells were decommissioned that were no longer needed. DOE-RL also collected and analyzed samples from 931 monitoring wells and

285 shoreline aquifer tubes across the Hanford Site to determine the distribution and movement of contaminants. Many of the wells and aquifer tubes were sampled multiple times during the reporting period, resulting in 4,147 well sampling events. A total of 15,798 analyses were performed for the groundwater program for the most common contaminants found onsite, including 1,688 analyses for tritium; 1,212 analyses for technetium-99; 1,336 analyses for uranium; 601 analyses for iodine-129; 2,422 analyses for nitrate; and 3,827 analyses for chromium.

Pump-and-treat systems located in the Central Plateau may target radionuclides and, therefore, are of direct interest with respect to the Composite Analysis. However, all pump-and-treat systems are of indirect interest because pertubations to the hydraulic flow system induced by pump-and-treat systems was not included in the features, events, and processes modeled for the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1). The groundwater model for the Composite Analysis was developed in the 1990s, before remedial decisions for groundwater had been made; at that time, it was not possible to reasonably anticipate the locations, rates, and durations of extraction and injection wells that since have been used to accomplish groundwater remedial actions. Table 3-4 summarizes the status of Central Plateau pump-and-treat systems for the reporting period. The radionuclide activity removed to date and the hydraulic pertubations induced by pump-and-treat systems reviewed here are not yet considered to have a significant impact if these to be included in the Composite Analysis model. It is reasonable to infer that the impact of inclusion of this feature in the model would result in a reduction the projected radiological dose estimate from the groundwater pathway. However, newer large-scale pump-and-treat systems, particularly in the 200-ZP-1 and 200-UP-1 OUs, are planned to operate for an extended period of time, and consideration of the full impact of these systems will need to be addressed in a future revision of the Composite Analysis.

Four groundwater OUs are located in the Central Plateau: 200-UP-1, 200-ZP-1, 200-BP-5, and 200-PO-1 (as shown in Figure 3-5, along with other groundwater OUs in the River Corridor that are not pertinent to the Composite Analysis). Activities in these four groundwater OUs that provide new information on radionuclide constituents relevant to the Composite Analysis are discussed in the following subsections for each groundwater OU. Remedial actions directed at nonradioactive contaminants are also discussed wherever it was determined that these actions could potentially influence the characterization, extent, or remediation of radioactive constituents and, thereby, have relevance to the Composite Analysis.
The remediation status for each of the applicable Central Plateau groundwater OUs is presented if remediation information exists for the OU for the reporting period. If remedial action was not in progress during the reporting period, the groundwater concentration status is summarized, as well as any other relevant work that occurred in the reporting period.

3.3.2.4 200-BP-5 Groundwater Operable Unit

The 200-BP-5 Groundwater OU includes groundwater beneath the northern portion of 200 East Area and the region to the northwest, where mobile contaminants have migrated between Gable Mountain and Gable Butte and where the highest uranium concentrations on the Hanford Site have been measured in monitoring wells. Figure 3-6 shows the location of the 200-BP-5 OU, surface and subsurface features in this OU, and the locations of monitoring wells used for groundwater data collection. Nitrate, iodine-129, technetium-99, and tritium form the largest contaminant plumes in the OU. These mobile contaminants have migrated to the northwest due to past groundwater flow. The tritium plume has declined significantly, but the other large plumes have either grown or remained stable over the past decade. Cyanide and uranium are present in smaller plumes that have increased in size over the past 10 years. A strontium-90 plume has decreased in size, and low-mobility contaminants cobalt-60, cesium-137, and plutonium-239/240 are present only near their former source areas.

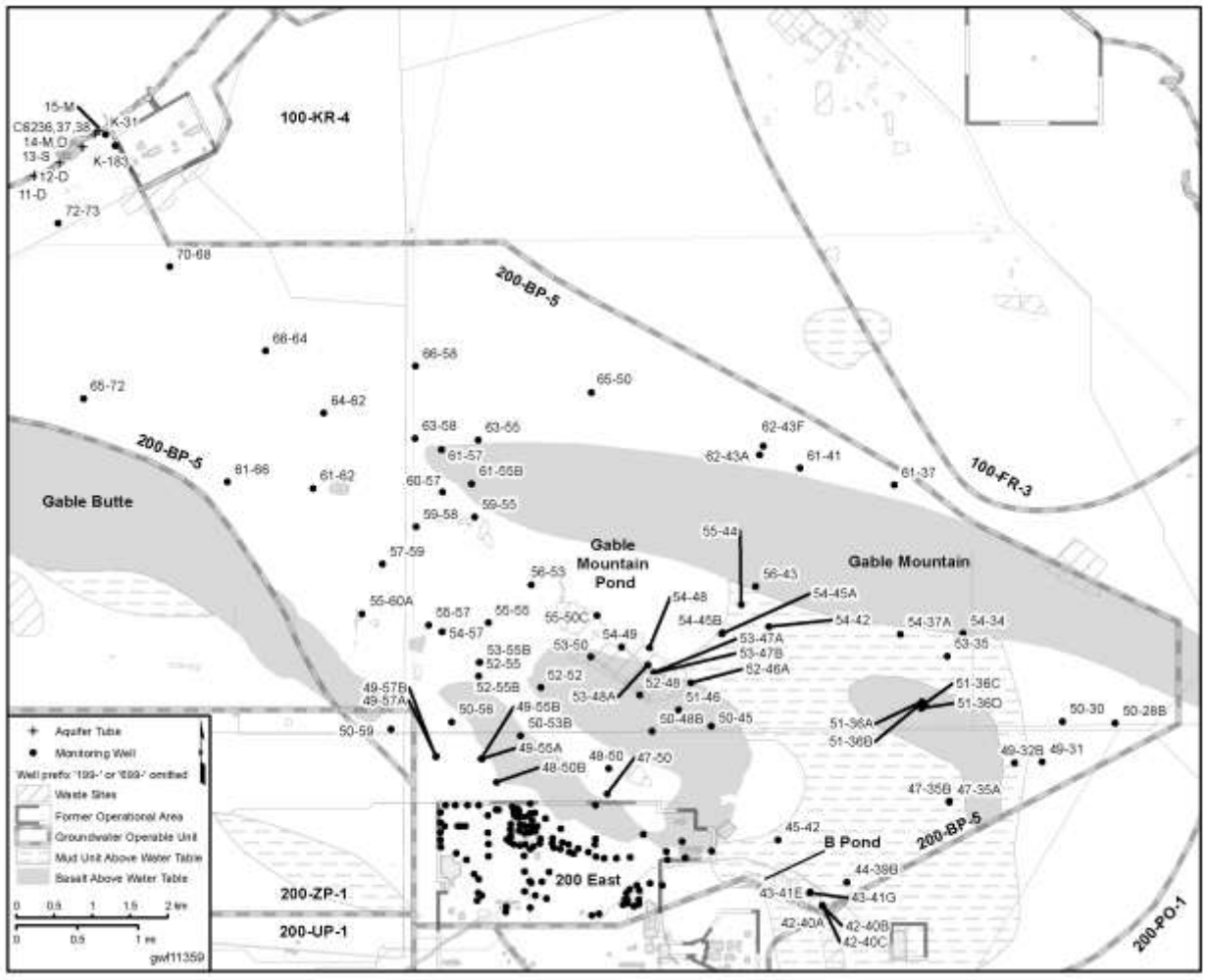
Table 3-4. Status of Central Plateau Groundwater Remediation in CY 2011

Area	Remedial Action Site	Active Dates	Purpose and Progress on Major Contaminant During Reporting Period
200 West	200-ZP-1 pump-and-treat	1994 to present	In 2011, system sustained an average flow rate of 1,442 L/min (381 gpm). The extraction wells produced 758 million L (200.2 million gal) in 2011(33 percent increase over 2010). Since 1996, the total volume of groundwater extracted is 5.8 billion L (1.5 billion gal). A total of 791.8 kg of carbon tetrachloride was removed in 2011, which is a 13 percent increase compared to 2010.
	200-PW-1 SVE	1992 to present	Two SVE systems, with a total design capacity of 28.4 m^3/min, were used from March through October. The systems were maintained in standby mode during the winter to allow time for carbon tetrachloride vapor concentrations to rebound. During 2011, the two systems removed 195 kg of carbon tetrachloride and treated 3.7 million m^3 of vapor. Since startup in 1992, 79,945 kg of carbon tetrachloride have been removed in 115 million m^3 of soil vapor. Passive SVE systems operated during 2011 at eight wells near the 216-Z-1A Tile Field and the 216-Z-18 Crib near the PFP. During 2011, this system removed approximately 4 kg of carbon tetrachloride from the vadose zone. Since operations began in 2001, the passive systems have removed approximately 104 kg of carbon tetrachloride.
	WMA T technetium-99 test system	2007 to present	During 2011, this system pumped 58.2 million liters of groundwater. The system removed 13.3 grams (0.23 Ci) of technetium-99; 57.9 kilograms of carbon tetrachloride; 23,024 kilograms of nitrate; and 6.9 kilograms of chromium during the period.
	200-UP-1 (U Plant) pump-and-treat	1994 to 2005; 2007 to present	From January to March 2011, a total of 1.1 million L (0.3 million gal) of groundwater was extracted and treated, removing 0.24 kg of uranium, 0.24 g (0.0041 Ci) of technetium-99, 0.2 kg of carbon tetrachloride, and 734 kg of nitrate. The volume of water removed from the aquifer since operations began in 1994 is 887 million L (234 million gal) and the mass removed is 221 kg of uranium, 127 g (2.17 Ci) of technetium-99, 41.4 kg of carbon tetrachloride, and 49,200 kg of nitrate.
	WMA S-SX (well 299-W23-19) extended purging	2003 to present	Quarterly sampling began in March 2000 with purging and disposal of at least 3,785 L (1,000 gal) of technetium-99-contaminatedgroundwater. About 0.011 Ci (or 0.62 g) of technetium-99 was removed since startup in 2003. This remedy has been discontinued due to startup of the S-SX pump-and-treat system.

Table 3-4. Status of Central Plateau Groundwater Remediation in CY 2011

Area	Remedial Action Site	Active Dates	Purpose and Progress on Major Contaminant During Reporting Period
200 East	200-BP-5, B Complex (see SGW-53604)	2011 to present	Initiated and operated a perched water removal program that extracted 246,000 L (65,000 gal) of contaminated water, and removed 13 kg of uranium and 0.12 g of technetium-99.
	200-PO-1 (BC-1 OU)	2011 to present	Negligible contaminant removal; removed 18,000 kg of soil water.

gpm = gallons per minute
OU = operable unit
PFP = Plutonium Finishing Plant
SVE = soil vapor extraction



Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

Figure 3-6. 200-BP-5 Groundwater OU Surface and Subsurface Features and Monitoring Well Locations

Most of the groundwater contamination in this OU is concentrated beneath WMA B-BX-BY and adjacent waste sites in the northwestern portion of this OU. Preparation of a draft remedial investigation report began in 2011; therefore, cleanup decisions have not yet been made for this groundwater OU.

Six TSD units are monitored under RCRA in coordination with CERCLA and AEA requirements. These TSD units include the Low-Level Waste Management Area 1 (LLWMA-1), Low-Level Waste Management Area 2 (LLWMA-2), WMA B-BX-BY, WMA C, Liquid Effluent Retention Facility, and 216-B-63 Trench. Interim status indicator evaluation monitoring continued at LLWMA-1, LLWMA-2, and the 216-B-63 Trench, with no significant changes in 2011. Assessment monitoring continued at WMA B-BX-BY and WMA C, and the results were consistent with previous years.

The WMA B-BX-BY assessment plan is being revised to incorporate the results of the recent CERCLA remedial investigation and the addition of new monitoring wells.

Treatability Testing. DOE designed and published a treatability test (DOE/RL-2010-74) to evaluate pump-and-treat of groundwater to remediate uranium and technetium-99 contamination near WMA B (B-BX-BY Tank Farms). In 2011, DOE began installation of an extraction well to support the test, and it was completed in 2012.

Perched Water. A fine-grained geologic unit beneath the B Plant region has created an area of saturated sediments (a "perched" aquifer) in the deep vadose zone above the regional water table. This perched water is contaminated with uranium and other contaminants at concentrations higher than in the underlying aquifer. To address the groundwater impact associated with infiltration from the perching horizon, DOE-RL initiated a perched water pumping test in 2011 (DOE/RL-2011-40). Well 299-E33-344 was used for extraction during the test. Pumping began in August and continued until early December, when extracted perched water results received from the laboratory increased significantly and required a different waste disposal path. Pumping resumed in April 2012. The uranium results showed an increase from 4,500 µg/L in September to 63,600 µg/L in October. The increase in concentration was confirmed in December with a result of 71,500 µg/L. These were the highest uranium concentrations detected at the Hanford Site during 2011. Approximately 90,000 L (23,775.5 gal) of contaminated water were removed during the 4-month test period.

Review of FY 2012 CERCLA investigations and CERCLA monitoring activities for CY 2011 reported in DOE/RL-2011-118 and evaluated in FY 2012 did not reveal any new information associated with the 200-BP-5 Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1).

3.3.2.5 200-PO-1 Groundwater Operable Unit

The 200-PO-1 Groundwater OU is located in the southern portion of the 200 East Area. Disposal of large volumes of liquid waste from PUREX and its related facilities created regional groundwater plumes of tritium, iodine-129, and nitrate. Concentrations of tritium are declining as the plume attenuates naturally from radioactive decay and dispersion. The size of the tritium plume has decreased by one-third since 1980. The area of the iodine-129 plume above the 1.0 pCi/L drinking water standard (DWS) has decreased slightly over the past decade, and maximum concentrations have declined significantly because of dispersion. Radioactive decay has not decreased the level of iodine-129 noticeably because of low decay rate (15.7 million years half-life) of this isotope. The nitrate plume covers a large area, with concentrations above background, but mostly below the DWS for nitrate. Other contaminants include strontium-90, technetium-99, and uranium in smaller areas near their sources. In 2012, DOE-RL published the final CERCLA RI report (DOE/RL-2009-85).

Soil Desiccation Test. A soil desiccation treatability test was performed from 2010 to 2011 in an interval containing high moisture and associated technetium-99 contamination near the BC Cribs and Trenches. This technology is being considered as a potential remedy in the deep vadose zone. For a period of 6 months, nitrogen was injected into a well and soil gas was extracted from another well. A combination of in situ sensors and geophysical measurements provided data to monitor performance. As anticipated, desiccation occurred more rapidly from higher permeability sediment. The active portion of the test was completed, and DOE-RL continues to monitor rewetting of the desiccated region.

RCRA Assessment Monitoring. During 2011, monitoring continued at these six RCRA units: the PUREX Cribs (also called the RCRA PUREX Cribs), WMA A-AX (SSTs), 216-A-29 Ditch, IDF, 216-B-3 Pond, and Nonradioactive Dangerous Waste Landfill. Two other facilities are monitored that are not regulated under RCR but are subject to *Washington Administrative Code* requirements: the 200 Area Treated Effluent Disposal Facility, and the Solid Waste Landfill. The IDF is an expandable, double-lined landfill that is regulated under RCRA and the AEA. (Note: The PA for IDF is discussed in Section 3.1.2 of this report.) The IDF is not yet in use, and current groundwater monitoring is directed at obtaining baseline data. The Solid Waste Landfill is regulated under Washington State's solid waste handling regulations. As in previous years, some of the downgradient wells showed higher concentrations of regulated constituents than the statistically calculated background values. Background threshold values exceeded during 2011 included coliform bacteria, pH, specific conductance, nitrite, sulfate, and total organic carbon.

Review of FY 2011 CERCLA investigations and CERCLA monitoring activities reported in DOE/RL-2011-118 and evaluated in FY 2012 did not reveal any new information associated with the 200-PO-1 Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1).

3.3.2.6 200-UP-1 Groundwater Operable Unit

The 200-UP-1 Groundwater OU includes the southern portion of the 200 West Area and adjacent areas to the east and south. Primary contaminant sources in this OU are cribs, ditches, ponds, and SSTs. Carbon tetrachloride, technetium-99, uranium, tritium, iodine-129, nitrate, and chromium plumes are present in groundwater. Strontium-90 and trichloroethene also exceed their respective DWSs in isolated areas, but monitoring data are limited due to well location and depths. The carbon tetrachloride plume originated from the 200-ZP-1 OU. The technetium-99 plume area, located near WMA S-SX and U Plant, has decreased substantially (near the U Plant pump-and-treat system), but the plume near WMA S-SX has increased in area. The technetium-99 concentrations in the 200-UP-1 are the highest measured in groundwater on the Hanford Site. A new pump-and-treat system began operation in 2012 that is addressing the plumes downgradient of WMA S-SX. The tritium plume is attenuating due to dispersion and radioactive decay but has not migrated substantially, and the areal extents of other plumes in the OU have remained largely unchanged or have decreased slightly in the past decade.

Decision Documents. In 2012, DOE-RL released the final RI/FS report (DOE/RL-2009-122, *Remedial Investigation/Feasibility Study for the 200-UP-1 Groundwater Operable Unit*) and a proposed plan (DOE/RL-2010-05, *Proposed Plan for Remediation of the 200-UP-1 Groundwater Operable Unit*). *Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit* (EPA et al., 2012) was signed in September 2012 and was issued as interim for all 200-UP-1 COCs. The selected remedies use a combination of groundwater pump-and-treat, monitored natural attenuation, and institutional controls. Work on the remedial design/remedial action work plan began immediately in October 2012, after the ROD was signed. Figure 3-7 shows the location of the 200 West Area, as well as associated production facilities and the remedial action locations.

Remedial Actions. The U Plant interim pump-and-treat system operated from March 1994 through March 2011. The system remediated uranium and technetium-99 originating from the 216-U-1 and 216-U-2 Cribs. In March 2011, EPA and DOE-RL agreed to discontinue operation of this system (including manual purging of monitoring well 299-W23-19) due to low flow rates from the extraction wells and because the remedial action objectives had been achieved.

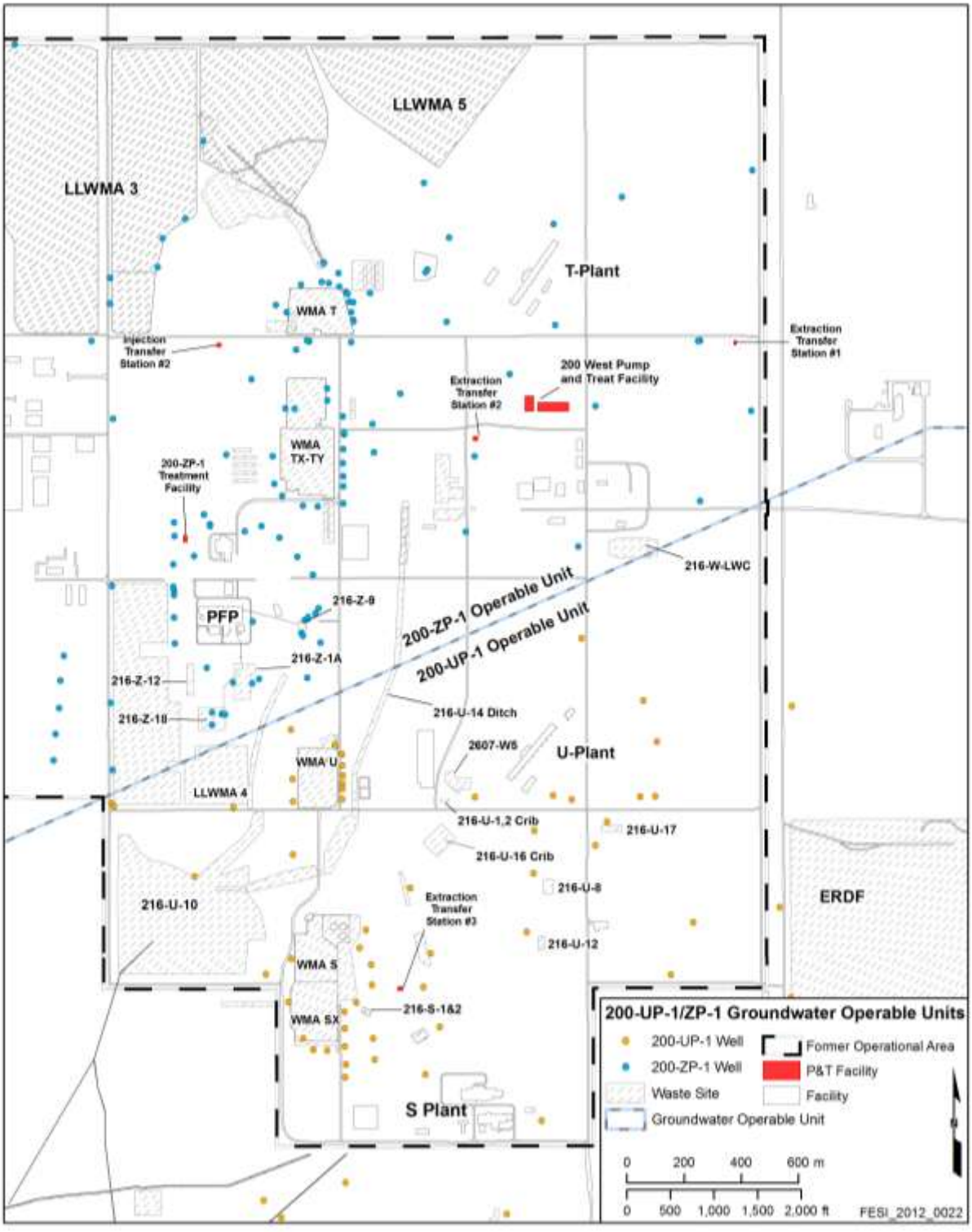
From January through March 2011, a total of 1.1 million L (0.3 million gal) of groundwater was extracted and treated for removal of 0.24 kg of uranium, 0.24 g (0.0041 Ci) of technetium-99, 0.2 kg of carbon tetrachloride, and 734 kg of nitrate. Because system operations were terminated in March, the volume of water treated during the reporting period was less than the 4.6 million L (1.2 million gal) treated in the prior reporting period. The volume of water removed from the aquifer since operations began in March 1994 is 887 million L (234 million gal), and the mass removed is 221 kg of uranium, 127 g (2.17 Ci) of technetium-99, 41.4 kg of carbon tetrachloride, and 49,200 kg of nitrate. Overall, the interim system achieved the objectives of 9,000 pCi/L for technetium-99 (achieved in 2005) and 300 μg/L for uranium (achieved in 2009). The ROD, signed in 2012 for 200-UP-1, addresses remediation for all groundwater COCs in the OU and supersedes the prior interim action requirements.

RCRA Monitoring. In 200-UP-1, RCRA monitoring included interim status groundwater quality assessment monitoring at WMA S-SX and WMA U, and interim status indicator parameter evaluation monitoring at the 216-S-10 Pond and Ditch. Revised monitoring plans were implemented at WMA S-SX and WMA U in 2011. Monitoring results did not show major changes in the extent of contamination. Indicator parameters did not exceed statistical comparison values at the 216-S-10 Pond and Ditch during 2011. RCRA monitoring in 200-UP-1 also included the ERDF monitoring program; ERDF is a low-level radioactive mixed waste landfill used for disposal of waste from surface remedial actions on the Hanford Site. (Note: The ERDF PA is discussed in Section 3.1.4 and ERDF operations are discussed in Section 3.3.3.2 of this report.) The results of groundwater monitoring in 2011 continued to indicate that the facility has not adversely affected groundwater quality.

Review of FY 2012 CERCLA investigations and CERCLA monitoring activities for CY 2011 reported in DOE/RL-2011-118 and evaluated in FY 2012 did not reveal any new information associated with the 200-UP-1 Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1).

3.3.2.7 200-ZP-1 Groundwater Operable Unit

The 200-ZP-1 OU groundwater interest area contains two CERCLA interim action pump-and-treat systems for groundwater, two soil vapor remediation system for the vadose zone, four TSD units (LLWMA-3, LLWMA-4, WMA T, and WMA TX-TY) monitored under RCRA (in coordination with CERCLA and AEA), and one state-permitted unit (the State-Approved Liquid Disposal Site [SALDS]). Figure 3-1 provides a general perspective of facilities, waste sites, and groundwater wells for the 200 West Area.



Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

Figure 3-7. 200 West Area Production Facilities, Remediation Treatment Facilities, Waste Sites, and Groundwater Wells

The COCs for this OU are carbon tetrachloride, trichloroethene, iodine-129, technetium-99, nitrate, hexavalent chromium, total chromium, and tritium. DOE-RL installed six injection wells in 2011. When completed, the network will include 36 injection and extraction wells. These wells will support the new pump-and-treat system, which will remediate groundwater from the entire aquifer thickness. Major portions of construction of the new treatment facility were completed in 2011, and the system became operational in 2012. Since 1994, DOE-RL has operated an interim action groundwater pump-and-treat system to prevent carbon tetrachloride in the upper portion of the aquifer from spreading. The interim system has limited the movement of shallow, high-concentration portions of the plume but does not address contamination deeper in the aquifer and at the periphery of the plume. In 2011, 792 kg of carbon tetrachloride were removed from 758 million L (over 200 million gal) of groundwater. Since startup of pump-and-treat operations, 13,503 kg of carbon tetrachloride have been removed from 5.8 billion L (1.5 billion gal) of groundwater. The volume of water treated in 2011 was 33 percent more than in 2010.

Two additional interim action pump-and-treat system extraction wells are located at the northeastern corner of the T Tank Farm. During 2011, this system pumped 58.2 million L (15.4 million gal) of groundwater. The average pumping rate for the two extraction wells was 111 L/min (29.3 gpm). This system removed 13.3 g (0.23 Ci) of technetium-99, 57.9 kg of carbon tetrachloride, 23,024 kg of nitrate, and 6.9 kg of chromium during 2011.

Operation of the SVE systems to remove carbon tetrachloride from the vadose zone near the PFP continued during 2011. Two SVE systems, with a total design capacity of 28.4 m^3/min (1,002.9 ft^3/min), were used from March through October. During 2011, the two systems removed 195 kg of carbon tetrachloride from the vadose zone and treated 3.7 million m^3 (1.3 million ft^3) of vapor. Since startup of operations in 1992, 79,945 kg of carbon tetrachloride have been removed from the vadose zone in 115 million m^3 (4.1 million ft^3) of soil vapor. The passive SVE systems operated at eight wells near the 216-Z-1A Tile Field and 216-Z-18 Crib near the PFP in 2011. Passive SVE is a naturally occurring process driven by barometric pressure fluctuations. During 2011, this system removed approximately 4 kg of carbon tetrachloride from the vadose zone. Since operations began in 2001, the systems have removed 104 kg of carbon tetrachloride.

The broader 200-ZP-1 groundwater pump-and-treat system selected in the ROD became operational in 2012, and the interim groundwater systems were shut down. This system can extract carbon tetrachloride, chromium, iodine-129, nitrate, technetium-99, and trichloroethene over a large part of the northern 200 West Area and will capture contamination throughout much of the aquifer thickness. During 2011, 6 new injection wells were installed, bringing the total number of wells supporting the system to 26. The current pumping rate for the entire system is 1,400 L/min (369.8 gpm). The 200-PW-1 SVE system will continue to operate in the future.

Two LLWMAs in the 200-ZP-1 OU are monitored under RCRA interim status contaminant indicator parameter programs. At LLWMA-3, upgradient/downgradient comparisons have not been conducted in recent years because the upgradient wells were dry. A new upgradient well was installed in 2011, which will allow statistical evaluations to resume. No significant changes occurred at LLWMA-4 in 2011.

RCRA assessment monitoring continued at WMA T and WMA TX-TY. The concentrations and extent of dangerous waste constituents from these facilities are declining. The SALDS receives treated water from the ETF and is regulated under a state waste discharge permit. The declining water table in the 200 West Area has caused several of the SALDS monitoring wells to go dry over the years, including two additional wells during 2011. This issue is being addressed during the permit renewal process.

Review of FY 2012 CERCLA investigations and CERCLA monitoring activities for CY 2011 reported in DOE/RL-2011-118 and evaluated in FY 2012 did not reveal any new information associated with the

200-ZP-1 Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis (PNNL-11800; PNNL-11800, Addendum 1).

3.3.3 Other Central Plateau Remediation Activities

Other remediation activities on the Central Plateau, aside from source and groundwater OU activities, are presented in this section. For FY 2012, confined aquifer monitoring and ERDF operations are activities reported in this category.

3.3.3.1 Confined Aquifer Monitoring

Although most Hanford Site groundwater contamination is found in the unconfined aquifer, DOE-RL monitors the deep aquifers because of potential downward movement of contamination and potential migration of contamination off site. There is no evidence of offsite migration via the confined aquifers. One confined aquifer occurs within sand and gravel at the base of the Ringold Formation. Carbon tetrachloride, nitrate, and technetium-99 have contaminated this unit in a portion of the 200 West Area where the upper confining unit is absent. New wells have been installed in recent years to monitor this contamination.

A new RCRA groundwater monitoring plan was implemented in 2011 for the 216-A-36B Crib and the PUREX Cribs above the 200-PO-1 Groundwater OU (DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*). The uppermost aquifer beneath these cribs is confined beneath the Ringold Formation lower mud unit. Groundwater monitoring is performed to demonstrate that the mud unit continues to protect the confined aquifer. Iodine-129 and tritium are detected in wells at this location, but the contamination has not migrated downgradient. Groundwater within basalt fractures and joints, interflow contacts, and sedimentary interbeds make up the upper basalt-confined aquifer system. No significant contamination is detected in the confined basalt aquifer, except in northwestern portion on the 200 East Area, where poor monitoring well construction and temporary drilling effects have allowed migration of groundwater from the overlying unconfined aquifer.

3.3.3.2 Environmental Restoration Disposal Facility Operations

WCH operates the ERDF for disposal of Hanford Site low-level radioactive, hazardous, dangerous, and low-level mixed waste generated during waste site closures and remediation activities from other Hanford contractors, as authorized by CERCLA. Details on the preparation of a revised PA for ERDF are reported in Section 3.1.4, and the following provides a review of ERDF operations during FY 2012.

The ERDF began operating in July 1996. Located between the 200 East and 200 West Areas, the facility currently operates 10 cells, covering approximately 42.5 ha (105 ac). Construction of super cells 9 and 10 (super cells are twice the size of regular cells) was completed in the second and third quarters of FY 2011, respectively. The configuration of the ERDF cells is shown in Figure 3-8 and Figure 3-9.

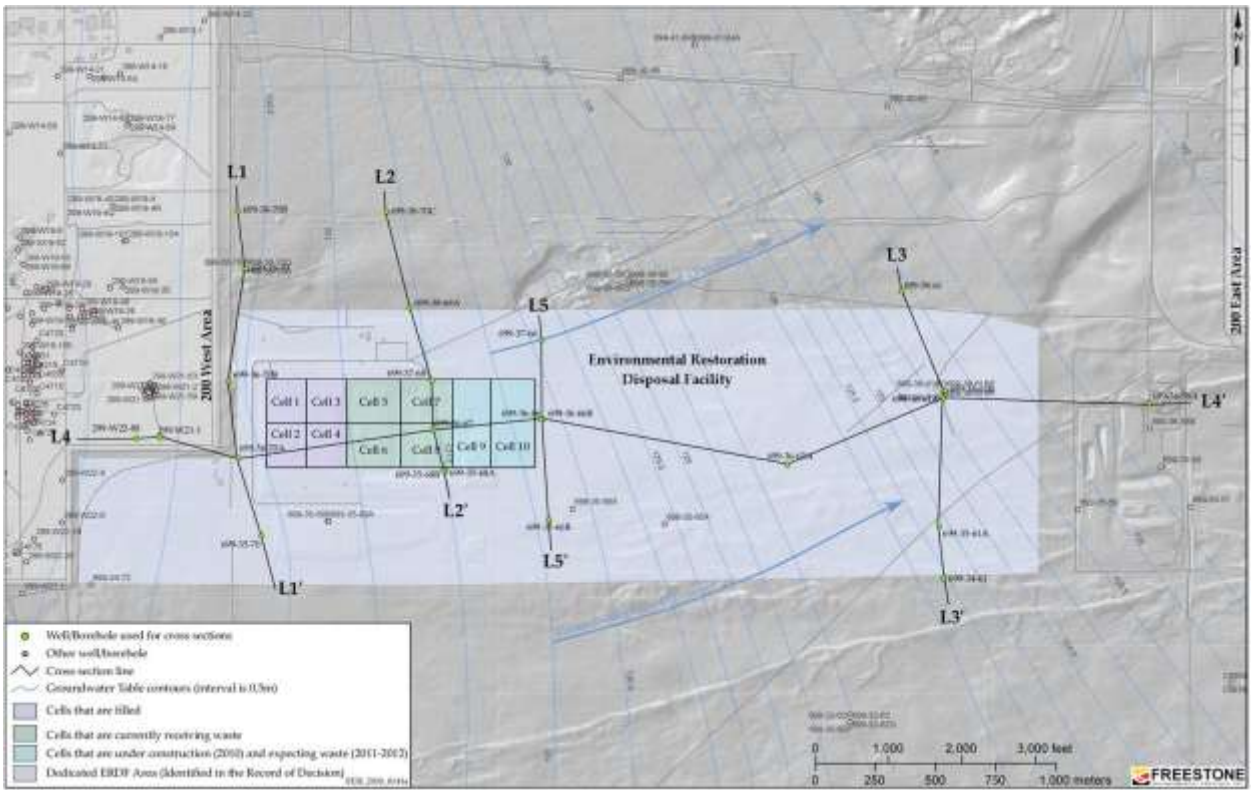


Figure 3-8. Configuration of Disposal Cells in the ERDF

Figure 3-9. Photograph of the ERDF with Indication of Disposal Cells

The requirements associated with the facility are identified in the following ROD and amendments:

- EPA/ROD/R10-95/100, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*
- EPA/AMD/R10-97/101, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*
- EPA/AMD/R10-99/038, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*
- EPA/AMD/R10-02/030, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*
- EPA et al., 2007, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington Amended Record of Decision, Decision Summary and Responsiveness Summary*
- EPA et al., 2009b, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site 200 Area Benton County, Washington, Amended Record of Decision and Explanation of Significant Differences*

Leachate Monitoring. Each cell is double lined to collect leachate resulting from water added as a dust suppressant and from precipitation. The liner is sloped to a sump in each cell, and the leachate is pumped from the sump to holding tanks. The leachate is then pumped to the ETF for treatment.

Additionally, ERDF leachate is sampled for constituents identified in the 1999 ERDF ROD amendment (EPA/AMD/R10-99/038) and WCH-173, *Environmental Restoration Disposal Facility Leachate Sampling and Analysis Plan*. The 2002 ERDF ROD amendment (EPA/AMD/R10-02/030) delisted leachate and identified the necessary sampling frequency. Leachate samples are obtained directly from the holding tanks. The constituents detected in ERDF leachate samples are then compared with the groundwater monitoring analyte list to determine whether additional analytes should be added to the Groundwater Performance Assessment Project. The leachate data are also evaluated for trends. The target analytes for groundwater monitoring are consistent with the leachate monitoring program. Based on the groundwater sampling and leachate data, no impact to groundwater has occurred from ERDF operations from the double-lined leachate collection system and other design features. Although technetium-99 and uranium have slightly increased in the leachate over time, the increase presents no impact to groundwater. The groundwater sampling data indicate that no uranium or technetium-99 values in the groundwater samples are out of historical trends. WCH produces an annual report summarizing the leachate and groundwater monitoring data, providing conclusions and recommendations as appropriate. The most recent report is WCH-536, *Groundwater and Leachate Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year (CY) 2011*.

Current Inventory Estimates. The quantity of waste received and disposed at ERDF during FY 2012 was slightly less than that disposed during FY 2011. Appendix A, Table A-1 provides the annual activity inventory of key radionuclides placed in ERDF for CY 2008 through CY 2012. Appendix A, Table A-2 provides details for FY 2012 and the waste totals from inception of ERDF operations (July 1, 1996) through September 30, 2012. In 1996, Bechtel Hanford, Inc. estimated that fewer than 500 Ci were disposed to the ERDF. In more than 16 years of operation since inception of operations, more than 135,625 Ci have been disposed at ERDF (Table A-1 in Appendix A). The data source for this summary is the monthly inventory disposal report from the WCH Waste Management Information System. The annual activity count increased every year between CY 2006 and CY 2009. The rate of

inventory accumulation varies from year to year between FY 2009 and FY 2012. Accumulation of inventory in FY 2012 was roughly half of that accumulated in FY 2011 in spite of the increased tonnage received in FY 2012. This is due to the disposal of a larger amount of nonradiological waste in FY 2012.

A DOE O 435.1 PA is being developed for the ERDF (see Section 3.1.4), with completion projected in 2013. The draft inventory data package developed for that PA (WCH-179, *Environmental Restoration Disposal Facility Operations Plan*) indicates that the ERDF inventory estimate is very conservative. The ERDF inventories are derived from the ERDF waste acceptance system, which is operated to ensure that no waste above the established limits (WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*) enters the ERDF. The waste acceptance criteria include biasing of every element of the process (e.g., profiles and onsite waste tracking forms [the ERDF manifest]) to the highest possible levels before comparison with the established limits. The net effect of this bias is that the ERDF inventory is artificially inflated. While this bias does not allow for precise knowledge of the actual inventory, it does provide excellent assurance that inventory limits are not being exceeded. Because of this deliberate bias, however, it is inappropriate to expect that the listed ERDF inventories (Appendix A) will match best-estimate inventories prepared for other purposes, such as the Composite Analysis.

4 Monitoring and Research and Development Results

This chapter describes the status of Hanford Site monitoring and the research and development activities in FY 2011 relevant to the Composite Analysis. Included is a summary of the groundwater flow conditions and extent of groundwater radionuclide contamination determined from monitoring, as well as results of the Remediation Science and Technology Program.

Consideration of monitoring and the research and development activities with respect to the Composite Analysis revealed no information that would be expected to, if included in a revised calculation, result in higher dose estimates.

4.1 Summary of Groundwater Flow Conditions and Extent of Contamination

DOE-RL has developed a plan to address groundwater and vadose zone contamination in consultation with the EPA and Ecology. Key elements associated with managing the Hanford Site groundwater and vadose zone contamination are to (1) protect the Columbia River and groundwater, (2) develop a cleanup decision process, and (3) achieve final cleanup.

DOE is committed to protecting the Columbia River, human health, and the environment from the Hanford Site's contaminated groundwater. As part of this commitment, DOE-RL developed four corner stone documents for the monitoring and remediation of Hanford Site contaminated soils and groundwater:

- DOE/RL-2002-59, *Hanford Site Groundwater Strategy – Protection, Monitoring, and Remediation*
- DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*
- DOE/RL-2002-68, *Hanford's Groundwater Management Plan: Accelerated Cleanup and Protection*
- DOE/RL-2007-20, *Hanford Integrated Groundwater and Vadose Zone Management Plan*

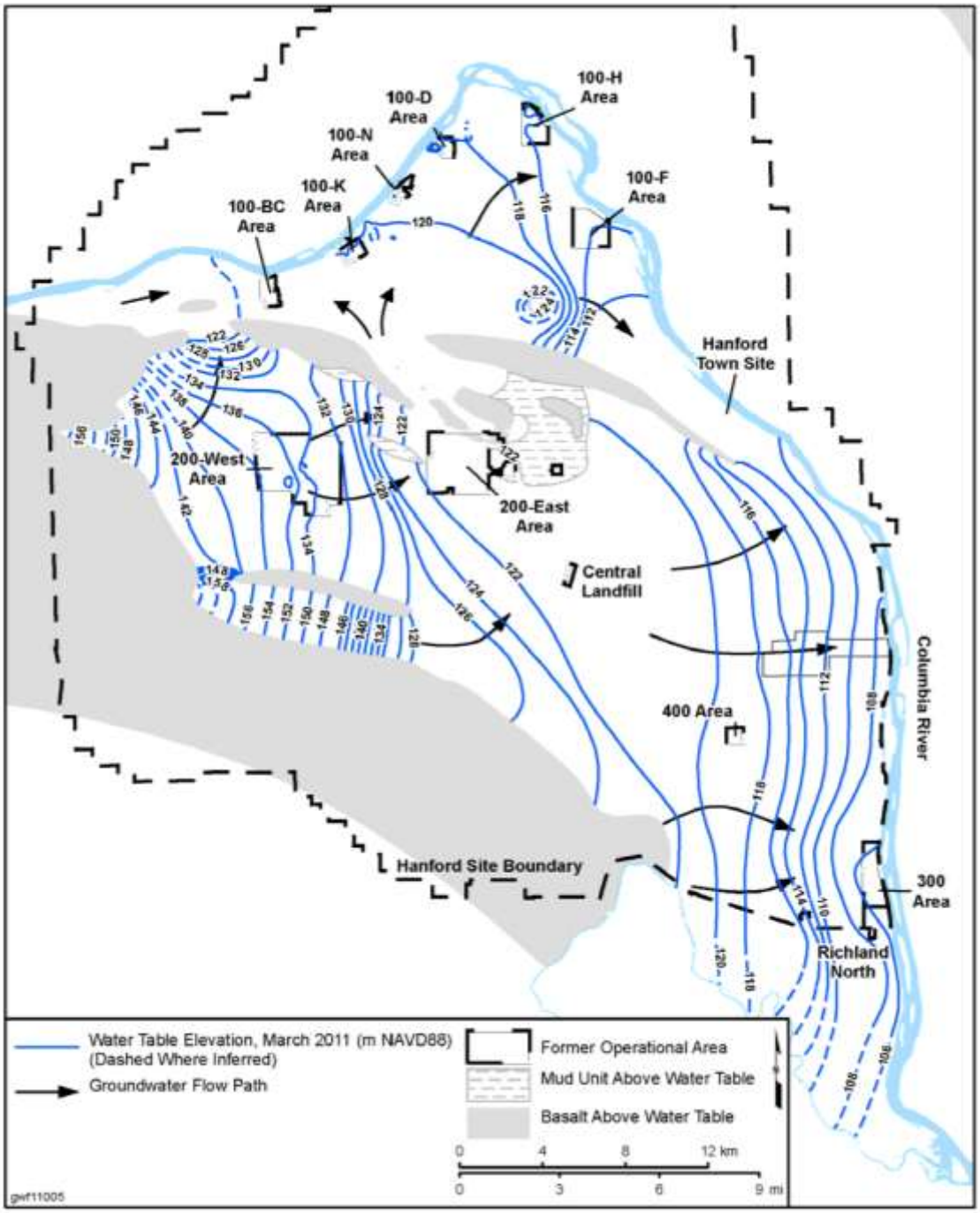
Relevance of Groundwater Monitoring to the Composite Analysis

The groundwater monitoring program provides additional data that serve to validate or revise the modeling basis used in the Composite Analysis. The unconfined aquifer at the Hanford Site was subject to immense liquid discharges during the Site's operational phase (1944 to 1989) and is now experiencing a slow decline to pre-Hanford flow conditions. It is also subject to pumping stresses associated with pump-and-treat actions. Historical groundwater data predominately reflect the operational phase. Consequently, later data continue to support improvement in the predictive capability of groundwater flow models as the system approaches long-term flow conditions.

Similarly, monitoring of groundwater contamination provides important data to validate or revise the modeling basis used in the Composite Analysis.

Due to the reporting cycle for the groundwater monitoring program, the results discussed below reflect the sampling and analyses completed in CY 2011 that were reported in FY 2012 in DOE/RL-2011-118. DOE-RL approval of this report constitutes approval of the appropriateness of this monitoring program.

The natural pattern of groundwater flow was altered during the Hanford Site's operating years by water table mounds created by the discharge of large volumes of wastewater to the ground. These mounds were present in each reactor area and beneath the 200 Areas. Since effluent disposal decreased significantly in the 1990s, these mounds have dissipated in the reactor areas and have declined considerably in the 200 Areas. Declining water levels from the mounding continue to affect groundwater flow and depth to water. Figure 4-1 shows the water table and inferred groundwater flow directions in March 2011.



Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

Figure 4-1. Water Table and Inferred Groundwater Flow Directions for the Hanford Site, March 2011

Groundwater radioactive contaminant plumes of tritium, iodine-129, technetium-99, and uranium formed when the waste discharged to ponds and cribs reached the aquifer. The status of these plumes is summarized as follows:

- Tritium occurs above DWS within all four Central Plateau groundwater interest areas. The highest tritium result was 580,000 pCi/L at the PUREX Cribs in the 200 East Area. The tritium plume from the PUREX Cribs extends east through the 200-PO-1 interest area to the Columbia River. Concentrations of tritium are declining in many of the wells as the contaminant naturally attenuates through radioactive decay and dispersion.

- The largest iodine-129 plume occurs within the 200-PO-1 Groundwater OU, extending from the 200 East Area, but the highest concentrations occur in the 200 West Area. At the 1 pCi/L contour, the 200-PO-1 OU plume extends 12 km (7.5 mi) east of the 200 East Area, and its extent has changed very little over the past 17 years. While the contaminant continues to migrate downgradient, concentrations at the leading edge of the plume are being reduced by dispersion, and the contour position at 1 pCi/L is stable. Iodine-129 was detected in wells near the Columbia River shoreline below the DWS. There is no significant reduction in concentrations due to radioactive decay because iodine-129 has a long half-life (15.7 million years). The maximum concentration within the 200-PO-1 OU during 2011 was 9.98 pCi/L near B Pond, and the maximum sample result measured in wells on the Central Plateau was 22.5 pCi/L in a 200-ZP-1 OU well near WMA TX-TY.

- The most substantial uranium plumes occur within the 200-BP-5 and 200-UP-1 groundwater interest areas. The 200-BP-5 plume originates from the B Complex, where the maximum concentration in the unconfined aquifer in 2011 was 2,420 µg/L. Uranium is entering the aquifer from a perched zone beneath the B Complex, where the maximum measured concentration in the perched zone was 71,500 µg/L in 2011. The uranium plume in the 200-UP-1 groundwater interest area occurs near U Plant and originates from the 216-U-1 and 216-U-2 Cribs.

- Five separate technetium-99 plumes are present in the 200-UP-1 Groundwater OU, but the largest plume occurs within the 200-BP-5 Groundwater OU. This large plume originates from the BY Cribs and extends to the northwest, beyond the 200 East Area. Technetium-99 plumes also occur in association with the tank farms in both the 200 East and 200 West Areas. The maximum sample result on the Central Plateau during 2011 was 51,000 pCi/L at the SX Tank Farm in the 200 West Area.

RCRA and WAC-regulated groundwater monitoring continued in CY 2011 at facilities in all four groundwater interest areas. The results did not reveal any new impact to groundwater. Two sites, the 216-A-36B and 216-A-37-1 Cribs in the southern 200 East Area, changed from assessment monitoring to indicator evaluation monitoring beginning January 1, 2011. All the sites will continue to be monitored under existing requirements.

Of the radionuclide contaminant plumes present in groundwater at the Hanford Site, tritium and iodine-129 have the largest areas with concentrations above DWSs. The most expansive of these plumes have sources in the 200 East Area, extending east and southeast toward the Columbia River. Less expansive plumes of tritium, uranium, iodine-129, and technetium-99 are present in the 200 West Area. Table 4-1 provides a comparison of the areal extent of key radionuclide contaminant plumes in groundwater at levels above DWSs in 2011. Of the radionuclides, tritium and iodine-129 continue to have the largest areas where concentrations exceed DWSs. The largest plumes of these contaminants have sources in the 200 East Area and extend east and southeast. Extensive tritium and iodine-129 plumes are also present in the 200 West Area. Figure 4-2 shows the distribution of major contaminant plumes in the unconfined aquifer originating from the Central Plateau at concentrations above respective DWSs.

Table 4-1. Area of Radionuclide Contaminant Plumes at Levels Above DWSs

Radionuclide Contaminant	DWS	Area of Plume at Level Above DWS	
		CY 2010 (km^2)[a,c]	CY 2011 (km^2)[b,c]
Iodine-129	1 pCi/L	66.6	60.1
Strontium-90	8 pCi/L	1.6	1.51
Technetium-99	900 pCi/L	2.8	3.1
Tritium	20,000 pCi/L	129.1	103
Uranium	30 µg/L	1.4	1.7

a. From DOE/RL-2011-01, *Hanford Site Groundwater Monitoring and Performance Report for 2010*.

b. From DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

c. To obtain mi^2, multiply km^2 by 0.386.

CY = calendar year

DWS = drinking water standard

4.2 Remediation Science and Technology

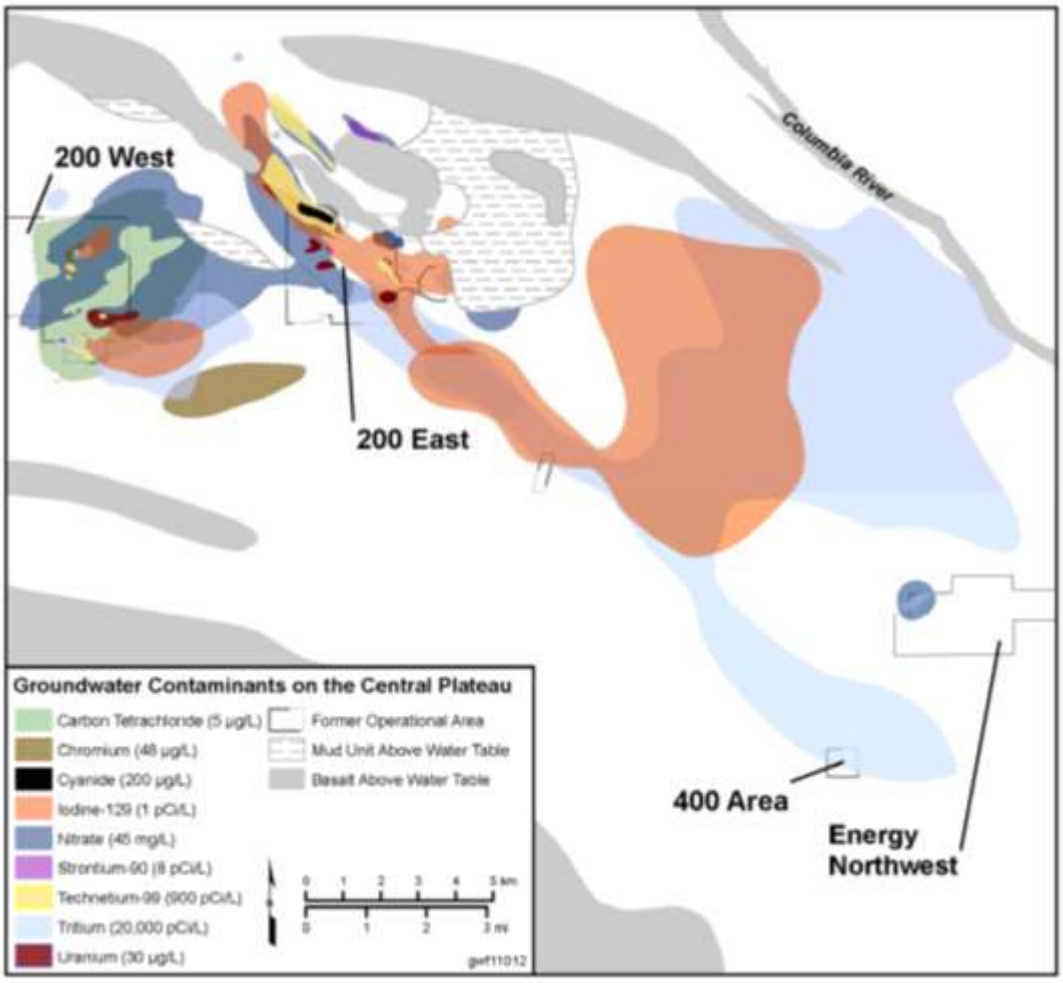
The Hanford Site uses science and technology investigations to provide new knowledge, data, and tools needed to accomplish the cleanup mission. This mission includes (1) investigating technologies to improve characterization and remediation of contaminated soil sites and groundwater, and (2) resolving key technical issues that help inform and influence decisions for remediation and closure. DOE-RL provided support for the Deep Vadose Zone Applied Field Research Initiative (DVZ-AFRI) and included a number of additional topics. A project funded by the DOE Office of Science continued to make progress on the study of uranium mass transfer and used the results to update the conceptual model of the 300 Area. Summaries of those science and technology efforts pertaining to radionuclide migration in the Central Plateau are summarized in the following subsections.

4.2.1 Deep Vadose Zone Remediation Treatability Test

A treatability test of soil desiccation is underway as part of the deep vadose zone treatability test (DVZTT) plan activities (DOE/RL-2007-56, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau*). Specific activities identified for treatability testing of desiccation included modeling analyses, laboratory analyses, and a field test. The active portion of the desiccation field test was completed in FY 2011. Monitoring of long-term performance metrics continued in FY 2012. DOE/RL-2011-104, *Characterization Sampling and Analysis Plan for the 200-DV-1 Operable Unit*, was issued in FY 2012.

4.2.2 Deep Vadose Zone Applied Field Research Initiative

The DVZ-AFRI was established to provide a framework for research investments and link directly to the remediation efforts associated with the 200-DV-1 deep vadose zone OU. The primary objective of the DVZ-AFRI is to provide long-term protection of water resources across the DOE Office of Environmental Management (DOE-EM) complex by developing and applying effective solutions to solve deep vadose zone challenges in characterization, prediction, remediation, and monitoring of hazardous and radioactive contaminants. The project is jointly funded by the DOE-EM Office of Technology Innovation and Development and DOE-RL.



Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*.

Figure 4-2. Distribution of Radionuclide Contaminant Plumes Originating on the Central Plateau for Concentrations above DWSs in the Unconfined Aquifer

During FY 2012, the DVZ-AFRI performed work in support of vadose zone remediation, including supporting shutdown of the SVE system, continued surface barrier monitoring, soil water extraction, mass-flux-based approaches, and geophysical characterization and monitoring methods.
A mass-flux-based approach was developed and applied to provide guidance for defining the end states for volatile contaminants in the vadose zone and to support termination of SVE operations. Continued monitoring and evaluation of surface barrier performance was conducted during FY 2012.
The DVZ-AFRI developed the following in FY 2012:

- An approach for pore water extraction was conducted in the laboratory that generated information needed for scale-up of the application to the SX Tank Farm.
- Methods were developed to collect and assess information from the vadose zone in terms of contaminant flux and the related controlling processes needed to support remedy evaluation, implementation, and monitoring in the vadose zone.

- A conceptual-model-based framework was developed that integrates flux-related measurements and predictive analyses to understand and quantify moisture and contaminant flux in the vadose zone, with a focus on supporting remediation assessment.

The DVZ-AFRI integrated investments from DOE and the U.S. Department of Defense to develop an advanced, high-performance geophysical imaging code that reconstructs subsurface images using electrical resistivity tomography. This technology provides advancements for site-specific customization that uses high-performance computing resources to "see" subsurface contaminant plumes in three dimensions and in unprecedented resolution. Critical applications of this code included the Hanford B Complex to delineate previously unknown details concerning contaminant distribution beneath former waste sites, and real-time monitoring of the spatial and temporal process performance of subsurface remedial activities.

The DVZ-AFRI performed studies of contaminants in Hanford Site groundwater including iodine, plutonium, americium, and technetium. The project evaluated iodine biogeochemistry under Hanford Site conditions to define endpoints for remediation and to identify remedial options for the 200-UP-1 Groundwater OU in the 200 West Area. The mobility and characterization of plutonium and americium were evaluated and summarized. Controlling processes of hydrogeology and biogechemistry on technetium mobility were also evaluated.

The DVZ-AFRI conducted investigations of several field sites at Hanford. The project evaluated deep excavation at the 100-C-7 Source OU and increases of chromate in nearby groundwater. The nature and extent of chromium contamination in groundwater was developed. The combined impacts of waste disposal, sediment, and pore water chemistry in the vadose zone were studied to understand processes controlling contaminant migration and to evaluate the impacts of uranium on remediation. A work plan was developed for evaluation of orchard operations (pre-date Hanford Site operations) on soil and groundwater contamination. Results from the DOE Office of Science investigations were summarized for use in refinement of the 300 Area conceptual site model.

4.2.3 Integrated Field Research Challenge Uranium Mobility Research

Uranium mass transfer is being investigated in the 300 Area for the Integrated Field Research Challenge (IFRC) Project, which is funded by the DOE Office of Science. The 300 Area is not located on the Central Plateau, but information obtained from this research has the potential to improve understanding of uranium contamination distribution and migration at Central Plateau locations, therefore, it is also included in this annual summary.

During FY 2012, a field experiment was continued to characterize sorption characteristics of uranium at the field site. The experiment included three separate injections of groundwater containing higher uranium concentrations in groundwater, which were collected from a nearby well during the spring runoff when the Columbia River is at high stage. The experiment included injection into an intermediate, lower permeability zone observed in the Hanford formation (saturated hydraulic conductivity $K_s \approx 2{,}000$ m/d [Vermeul et al., 2011, "River-Induced Flow Dynamics in Long-Screen Wells and Impact on Aqueous Samples"]). This lower permeability zone exhibits significant adsorption of uranium (retardation $R > 17$ and distribution coefficient $K_d > 2.4$) and can retain high concentrations of dissolved uranium for extended time periods in spite of considerable oscillations in flow directions in nearby higher permeability zones. Experience at the IFRC site indicates that these low-permeability zones are not evident in drilling logs or through grain-size analysis. However, these zones are directly visible to electrical resistance tomography and indirectly to electromagnetic borehole flow surveys in groundwater monitoring wells through their effects on local hydraulic conductivity. The low-permeability zone was a pervasive and relatively contiguous feature throughout the entire 1,600 m^2 (17,222.3 ft^2) footprint of the

IFRC site. This zone of higher uranium retention may contribute to longevity of the uranium plume. Progress for the IFRC Project is reported quarterly through the project web site (http://ifchanford.pnl.gov/documents/).

This page intentionally left blank.

5 Summary of Changes

This chapter summarizes changes affecting the Composite Analysis that have occurred during FY 2012. This summary includes any changes resulting from special analyses (DOE O 435.1, Section 3.4) and any expected changes to future conditions (e.g., site land-use plans or remediation plans).

Currently, there are no outstanding information needs (e.g., data gaps or uncertainties) identified in the Composite Analysis or in any of the prior annual reviews.

5.1 Special Analyses

No special analyses were conducted in FY 2012.

5.2 Changes in Site Land-Use and Remediation Plans

DOE/RL-2009-10, issued in November 2012, describes the overall strategy for cleanup of the Central Plateau. This strategy is the result of thousands of hours of work that considered input from the regulatory agencies, Tribal Nations, the public, and stakeholders. DOE, EPA, and Ecology negotiated Tri-Party Agreement (Ecology et al., 1989) change packages that use elements of the Central Plateau cleanup strategy following issuance of DOE/RL-2009-81, *Central Plateau Cleanup Completion Strategy*. Together, these documents describe the approach that DOE intends to use to clean up nearly 195 km^2 (75 mi^2) of the Central Plateau near the center of the Hanford Site. Land use is one of the foundational elements in the CERCLA and DOE strategy. The strategy calls for cleanup on the Central Plateau to be organized into the following three major components:

- **Inner Area:** The final footprint area of the Hanford Site that will be dedicated to waste management and containment of residual contamination.
- **Outer Area:** All of the Central Plateau beyond the boundary of the Inner Area.
- **Groundwater:** Contaminant plumes underlying the Central Plateau and originating from waste sites on the Central Plateau.

These components are consistent with land uses designated for the Central Plateau in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*; the subsequent ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)"); and the 2008 supplement analysis (DOE/EIS-0222-SA-01, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement*) and subsequent ROD (73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement"). The designated land uses on the Central Plateau are industrial-exclusive for 50 km^2 (20 mi^2) at the core of the Central Plateau and conservation (mining) in the surrounding 145 km^2 (55 mi^2) area.

This page intentionally left blank.

6 Recommended Changes

This chapter advises of planned or contemplated changes in relevant site programs that could affect the Composite Analysis, as well as changes in the Composite Analysis maintenance program.

6.1 Monitoring and Research and Development Activities

The current monitoring and the research and development activities associated with the Composite Analysis remains adequate. No changes are recommended.

6.2 Composite Analysis Maintenance Program

The Hanford Site has deferred revision of the Composite Analysis since 2006 while awaiting issuance of the Final TC&WM EIS (DOE/EIS-0391) and the associated ROD. This deferral continued through the reporting period for this FY 2012 summary.

Direction received from DOE Headquarters (Williams, 2012) on October 2, 2012 (shortly after the end of the reporting period for this FY 2012 summary), indicated that with the upcoming issuance of the TC&WM EIS, modeling to support regulatory decision making at the Hanford Site could resume, subject to a set of requirements to ensure consistency with the EIS analyses. This direction stated that modeling will be conducted following a phased approach, to include planning, scoping, and analysis phases, with clear identification of any departures from the EIS analysis, especially for analyses tied directly to decisions made in the EIS.

On November 21, 2012, several weeks after the end of the reporting period for this annual FY 2012 summary, the Final TC&WM EIS (DOE/EIS-0391) was issued. The associated ROD for the TC&WM EIS has not yet been issued at the time this annual summary report was prepared.

Based on the DOE Headquarters direction, the issue of the Final TC&WM EIS (DOE/EIS-0391), and information reported in this and prior annual summaries (listed in Table 1-1), it is planned that the maintenance program for the Composite Analysis will be evaluated and updated beginning in FY 2013.

This page intentionally left blank.

7 References

10 CFR 1021, "National Environmental Policy Act Implementing Procedures," *Code of Federal Regulations*. Available at: http://ceq.hss.doe.gov/nepa/regs/nepa1021_rev.pdf.40 CFR 1500-1508, "Purpose, Policy, and Mandate," through "Terminology and Index," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfrv31_08.html.

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

69 FR 50176, "Notice of Intent to Prepare an Environmental Impact Statement for the Decommissioning of the Fast Flux Test Facility at the Hanford Site, Richland, Washington," *Federal Register*, Vol. 69, No. 156, pp. 50176-50180, August 13, 2004. Available at: http://www.gpo.gov/fdsys/pkg/FR-2004-08-13/pdf/04-18535.pdf.

73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement," *Federal Register*, Vol. 73, No. 188, pp. 55824-55826, September 26, 2008. Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-09-26/pdf/E8-22676.pdf.

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/v1/sr0980v1.pdf#page=13.

BHI-00169, 1995, *Environmental Restoration Disposal Facility Performance Assessment*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://epw.senate.gov/cercla.pdf.

DOE, 1999, *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*, Rev. 4, U.S. Department of Energy, Washington, D.C. Transmittal with proposed guide available at: http://www.hss.doe.gov/deprep/1999/tb99n24a.pdf.

DOE G 435.1-1, 1999, *Implementation Guide for Use with DOE M 435.1-1*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-EGuide-1ch1/view.

Note: See https://www.directives.doe.gov/directives/current-directives/directives-current-400-series for a list of chapters within this document.

DOE M 435.1-1 Chg 1, 2001, *Radioactive Waste Management Manual*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-DManual-1c1/view.

DOE O 435.1 Chg 1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-BOrder-c1/view.

DOE O 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. (superseded by DOE O 435.1). Available at: https://www.directives.doe.gov/directives/archive-directives/5820.2-BOrder-a/at_download/file.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158842.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158843.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158844.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158845.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158846.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158847.

DOE/EIS-0222-SA-01, 2008, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/SAwith_signed-R1.pdf.

DOE/EIS-0391, 2009, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at:
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180376.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180377.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180378.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180379.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180380.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180381.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180382.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180383.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180384.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180385.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180386.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180387.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180388.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180389.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180390.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180391.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180392.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180393.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180394.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180395.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180396.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180397.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180398.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180373.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180374.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180375.

DOE/EIS-0391, 2012, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://energy.gov/nepa/downloads/eis-0391-final-environmental-impact-statement.

DOE/ORP-2000-01, 2004, *Maintenance Plan for the Hanford Integrated Disposal Facility Performance Assessment*, Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/ORP-2000-24, 2001, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D8862887. http://www5.hanford.gov/arpir/?content=findpage&AKey=D8862892.

DOE/RL-93-99, 1994, *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196061256.

DOE/RL-95-02, 1995, *Treatability Test Report for the 200-UP-1 Operable Unit – Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196008296.

DOE/RL-97-36, 2010, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1003100445.

DOE/RL-2000-29, 2000, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 0, U.S. Department of Energy Richland Operations Office, Richland, Washington.

DOE/RL-2000-29, 2000, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 1, U.S. Department of Energy Richland Operations Office, Richland, Washington.

DOE/RL-2000-29, 2003, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-59, 2004, *Hanford Site Groundwater Strategy – Protection, Monitoring, and Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084084.

DOE/RL-2002-68, 2003, *Hanford's Groundwater Management Plan: Accelerated Cleanup and Protection*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2003-26, 2003, *Annual Status Report: Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-12, 2004, *Annual Status Report (FY 2003): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-36, 2004, *Action Memorandum for Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0014/D6731933/D6731933_24622_34.pdf.

DOE/RL-2004-60, 2011, *200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility Investigation/Corrective Measures Study/Remedial Investigation/Feasibility Study Work Plan*, Rev. 1 Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-68, 2005, *Action Memorandum for the Non-Time-Critical Removal Action for the 224-T Plutonium Concentration Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=DA428391.

DOE/RL-2005-58, 2004, *Annual Status Report: Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2006-28, 2006, *Annual Status Report (FY 2005): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-20, 2007, *Hanford Integrated Groundwater and Vadose Zone Management Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0098519.

DOE/RL-2007-56, 2008, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0804160110.

DOE/RL-2008-43, 2008, *Annual Status Report (FY 2007): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2009-10, 2010, *Hanford Site Cleanup Completion Framework*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1008190506.

DOE/RL-2009-81, 2009, *Central Plateau Cleanup Completion Strategy*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1002180676.

DOE/RL-2009-82, 2009, *Annual Status Report (FY 2008): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2009-85, 2012, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0091415.

DOE/RL-2009-122, 2012, *Remedial Investigation/Feasibility Study for the 200-UP-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0092247.

DOE/RL-2009-132, *Annual Status Report (FY 2009): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2010-05, 2012, *Proposed Plan for Remediation of the 200-UP-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0092248.

DOE/RL-2010-49, 2011, *Remedial Investigation/Feasibility Study Work Plan 200-WA-1 and 200-BC Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093514.

DOE/RL-2010-74, 2011, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093994.

DOE/RL-2010-93, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=1108241345.

DOE/RL-2010-105, 2011, *Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2010-114, 2011, *200-IS-1 Operable Unit Pipeline System Waste Sites RFI/CMS/RI/FS Work Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093547.

DOE/RL-2011-01, 2011, *Hanford Site Groundwater Monitoring and Performance Report for 2010*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/c.cfm/sgrp/GWRep10/start.htm.

DOE/RL-2011-40, 2011, *Field Test Plan for the Perched Water Pumping/Pore Water Extraction Treatability Test*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093355.

DOE/RL-2011-104, 2012, *Characterization Sampling and Analysis Plan for the 200-DV-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1202020261.

DOE/RL-2011-108, 2012, *Annual Status Report (Fiscal Year 2011): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2011-118, 2012, *Hanford Site Groundwater Monitoring for 2011*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0091795.

DOE/RL-2012-57, 2012, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2011)*, Decisional Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2012-58, 2012, *Annual Review of the 200 West and 200 East Performance Assessments* (*FY 2012*), Decisional Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Dronen, V.R., 1996, "Environmental Restoration Disposal Facility CERCLA/DOE Order 5820.2a Roadmap" (letter to O. Robertson, U.S. Department of Energy, Richland Operations Office from V. R. Dronen, Bechtel Hanford, Inc., Richland, Washington), November 8.

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

Einan, D.R., 2011, "Approval of the Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility, WCH-426, Revision 0, October 2010" (letter to J.R. Franco, U.S. Department of Energy, Richland Operations Office, from D.R. Einan, U.S. Environmental Protection Agency), Richland, Washington, February 3. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=1102081317.

EPA/AMD/R10-02/030, 2002, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1002030.pdf.

EPA/AMD/R10-97/101, 1997*, Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1097101.pdf.

EPA/AMD/R10-99/038, 1999, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1099038.pdf.

EPA/ROD/R10-95/100, 1995, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1095100.pdf.

EPA/ROD/R10-95/114, 1995, *Record of Decision for the USDOE Hanford 200-ZP-1 Operable Unit, 200 Area NPL Site Interim Remedial Measure*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1095114.pdf.

EPA/ROD/R10-97/048, 1997, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1097048.pdf.

EPA/ROD/R10-99/039, 1999, *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 (100 Area Remaining Sites)*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1099039.pdf.

EPA, Ecology, and DOE, 2005, *Record of Decision 221-U Facility (Canyon Disposition Initiative) Hanford Site, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=DA01060264.

EPA, Ecology, and DOE, 2007, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington Amended Record of Decision, Decision Summary and Responsiveness Summary*, U.S. Environmental Protection Agency, Region 10, U.S. Department of Energy, and Washington State Department of Ecology, Olympia, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0093772.

EPA, Ecology, and DOE, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=00098825.

EPA, Ecology, and DOE, 2009a, *Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit Hanford Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0903310669.

EPA, Ecology, and DOE, 2009b, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site 200 Area Benton County, Washington, Amended Record of Decision and Explanation of Significant Differences*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0908030975.

EPA, Ecology, and DOE, 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093644.

EPA, Ecology, and DOE, 2012, *Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit*, United States Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0091413.

Frei, 2002, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1" (memorandum to R. Schepens, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from M.W. Frei, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., July 24.

Frei, 2003, "Review of the Annual Summary of the Hanford Immobilized Low-Activity Waste Performance Assessment for 2003," (memorandum to R.J. Schepens, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from M.W. Frei, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., December 12.

Hildebrand, R.D. and M.P. Bergeron, 2002, *Annual Status Report: Composite Analysis for Low-Level Waste Disposal in the 200 Area of the Hanford Site*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

HNF-EP-0063, 2010, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 16, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/HNF-EP-0063_Rev16_041111_Website.pdf.

Klein, 2000, "Environmental Restoration Disposal Facility (ERDF) Crosswalk to DOE Order 435.1 Requirements" (letter to J.J. Fiore and M.W. Frei from K.A. Klein), U.S. Department of Energy, Richland Operations Office, Richland, Washington, July 17.

National Environmental Policy Act of 1969, 42 USC 4321, et seq. Available at: http://ceq.hss.doe.gov/Nepa/regs/nepa/nepaeqia.htm.

PNNL-11216, 1997, *STOMP: Subsurface Transport Over Multiple Phases Application Guide*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://stomp.pnl.gov/documentation/application.pdf.

PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/594543-mUGcOH/webviewable/594543.pdf.

PNNL-11800, 2001, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Addendum 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-11800-adden-1.pdf.

PNNL-12030, 2000, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: Theory Guide*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://stomp.pnl.gov/documentation/theory.pdf.

PNNL-13043, 2001, *Waste Form Release Data Package for the 2001 Immobilized Low-Activity Waste Performance Assessment*, Rev. 2, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13043rev2.pdf.

PNNL-15070, 2005, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15070.pdf.

PNNL-15782, 2006, *STOMP: Subsurface Transport Over Multiple Phases Version 4.0: User's Guide*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://stomp.pnl.gov/documentation/userguide.pdf.

PNNL-20683, 2011, *Diffusion and Leaching Behavior of Radionuclides in Category 3 Waste Encasement Concrete and Soil Fill Material – Summary Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20683.pdf.

PNNL-20726, 2011, *Summary of Uranium Solubility Studies in Concrete Waste Forms and Vadose Zone Environments*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20726.pdf.

PNNL-20781, 2011, *Integrated Disposal Facility FY 2011 Glass Testing Summary Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20781.pdf.

PNNL-21369, pending, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau Final Report*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-21656, pending, *Secondary Liquid Waste Cast Stone Waste Form Qualification Testing Plan*, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/lawsregs/laws/rcra.html.

RPP-15834, 2003, *Integrated Disposal Facility Risk Assessment*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/pdwdocs/fsd0001/osti/2003/I0040839.pdf.

RPP-51790, 2012, *Secondary Liquid Waste Treatment Cast Stone Technology Development Plan*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-PLAN-39114, 2008, *RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*, Rev. 0, Washington River Protection Solutions, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0812290634.

RPP-RPT-50052, 2011, *Surface Geophysical Exploration of UPR-200-E-82 Near the C Tank Farm*, Rev. 0, Washington River Protection Solutions, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0092845.

RPP-RPT-50758, 2011, *Three-Dimensional Surface Geophysical Exploration of the Eastern Portion of the BY Tank Farm*, Rev. 0, Washington River Protection Solutions, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0092873.

RPP-RPT-51770, 2012, *Cast Stone Engineering Test Plan for Secondary Liquid Waste Treatment Project (T3W08)*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

RPP-RPT-53570, 2012, *Technical Basis for Soil Moisture and Soil Pore Pressure Head Measurement Frequency Reduction at T and TY Farm Interim Surface Barriers*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

Scott, 2001, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2" (memorandum to H.L. Boston, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from R.S. Scott, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., November 1.

Talarico, 2004, "Low-Level Disposal Facility Federal Review Group Review of Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington, April 2003" (memorandum to R. Schepens, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from J. Talarico, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., May 11.

Vermeul, V.R., J.P. McKinley, D.R. Newcomer, R.D. Mackley, and J.M. Zachara, 2011, "River-Induced Flow Dynamics in Long-Screen Wells and Impact on Aqueous Samples," *Groundwater* 49(4):515-524. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.2010.00769.x/pdf.

WCH-173, 2007, *Environmental Restoration Disposal Facility Leachate Sampling and Analysis Plan*, Rev. 0, Washington Closure Hanford, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=DA05651180.

WCH-179, 2010, *Environmental Restoration Disposal Facility Operations Plan*, Rev. 1, Washington Closure Hanford, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=DA05848996.

WCH-191, 2010, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 2, Washington Closure Hanford, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084183.

WCH-426, 2010, *Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility*, Rev. 0, Washington Closure Hanford, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0084118.

WCH-426, 2011, *Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility*, Rev. 1, Washington Closure Hanford, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0093365.

WCH-455, 2010, *Groundwater and Leachate Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year 2010*, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH-462, 2012, *ERDF Performance Assessment Modeling Approach*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-463, 2012, *Hydrogeologic Model for the Environmental Restoration Disposal Facility*, Hanford Site, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-464, 2012, *Hydrologic Data Package in Support of Environmental Restoration Disposal Facility Performance Assessment Modeling*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-475, 2012, *Biota Description Data Package for the Post Closure Environmental Restoration Disposal Facility Location*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-476, 2012, *Chemical Reactivity of Radionuclides with Waste Material and Subsurface Soils During Release and Migration from the Environmental Restoration Disposal Facility*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-477, 2012, *Conceptual Models for Release and Transport of Environmental Restoration Disposal Facility Waste Contaminants through the Near Field Environment*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-478, 2012, *Exposure and Inadvertent Scenarios for the Environmental Restoration Disposal Facility*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-479, 2012, *Inventory Data Package for ERDF Waste Disposal*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-515, 2012, *Parameter Uncertainty for the ERDF Performance Assessment Uncertainty and Sensitivity Analysis*, Draft A, Washington Closure Hanford, Richland, Washington.

WCH-536, 2012, *Groundwater and Leachate Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year (CY) 2011*, Rev. 0, Washington Closure Hanford, Richland, Washington.

WHC-EP-0645, 1995, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.osti.gov/bridge/servlets/purl/105099-XRRk1W/webviewable/105099.pdf.

WHC-SD-WM-TI-730, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=657436.

Williams, 2012, "Modeling to Support Regulatory Decisionmaking at Hanford" (memorandum to M.S. McCormick, U.S. Department of Energy, Richland Operations Office, and S.L. Samuelson, U.S. Department of Energy, Office of River Protection) from A.C Williams, Deputy Assistant Secretary for Environmental Management, U.S. Department of Energy, Washington, D.C., October 9.

VSL-11R2270-1, 2011, *ILAW Glass Testing for Disposal at IDF: Phase 1 Testing*, Vitreous State Laboratory, The Catholic University of America, Washington, D.C.

VSL-12R2640-1, 2012, *Technetium Retention in WTP LAW Glass with Recycle Flow-Sheet: DM10 Melter Testing*, Rev. 0, Vitreous State Laboratory, The Catholic University of America, Washington, D.C.

This page intentionally left blank.

Appendix A

Environmental Restoration Disposal Facility Inventory

This page intentionally left blank.

Tables

This page intentionally left blank.

Table A-1. Summary of ERDF Annual Radionuclide Inventory, CY 2008 and FY 2009 through FY 2012

Radionuclide	CY 2008 (Ci)	FY 2009 (Ci)[a]	FY 2010 (Ci)	FY 2011 (Ci)	FY 2012 (Ci)
Ac-227	1.60E-09	3.33E-06	4.08E-07	1.19E-04	2.34E-05
Ag-108m	5.04E+01	4.98E+01	2.92E+02	4.36E+02	5.52E+01
Am-241	4.13E+00	2.74E+02	1.47E+02	1.73E+02	1.00E+02
Am-242m	2.30E-04	4.34E-02	6.45E-03	7.33E-02	6.29E-02
Am-243	1.87E-04	2.45E-02	4.09E-03	6.36E-02	1.53E-01
Ba-133	4.91E-01	7.62E-01	4.51E+00	6.74E+00	8.54E-01
Be-7	2.58E-06	6.60E-06	0.00E+00	0.00E+00	7.35E-07
Bi-207	N/A	N/A	N/A	6.79E-06	5.49E-05
C-14[b]	3.06E-02	5.35E-01	4.93E+00	2.69E+02	1.93E+01
C-14A[b]	3.70E+01	4.74E+00	2.76E+02	3.40E+00	3.41E-01
C-14 (insoluble)	3.17E+01	1.01E+02	2.81E+02	3.39E+03	5.90E+00
Ca-41	3.12E-01	3.15E-02	6.99E-04	9.62E-04	0.00E+00
Cd-113m	1.01E+00	2.69E+00	2.39E-01	1.34E+00	5.33E-02
Ce-144	2.55E-04	3.58E-05	3.96E-03	1.20E-07	0.00E+00
Cf-249	4.63E-06	8.91E-04	0.00E+00	0.00E+00	0.00E+00
Cf-252	N/A	N/A	N/A	1.57E-04	0.00E+00
Cm-242	3.63E-03	6.11E-02	3.33E-02	2.58E+00	1.38E-03
Cm-243	1.17E-03	6.94E-02	6.91E-02	6.93E-01	1.78E+00
Cm-244	6.59E-02	4.12E-01	8.14E-01	2.83E+00	1.94E+00
Cm-245	0.00E+00	0.00E+00	0.00E+00	5.29E-07	3.08E-08
Cm-246	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-247	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-248	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	1.60E-06	1.55E-06	3.23E-04	6.19E-01	0.00E+00
Co-60	2.26E+03	4.00E+02	1.09E+03	1.04E+03	2.68E+02
Cs-134	1.56E-02	8.14E+00	4.04E-01	9.30E-01	9.25E-02
Cs-135	2.22E-04	1.01E-01	3.75E-03	4.27E-01	1.98E-03
Cs-137	4.44E+02	5.91E+03	3.13E+03	7.64E+03	7.23E+02
Eu-150	N/A	1.98E-04	0.00E+00	6.85E-04	6.40E-07

Table A-1. Summary of ERDF Annual Radionuclide Inventory, CY 2008 and FY 2009 through FY 2012

Radionuclide	CY 2008 (Ci)	FY 2009 (Ci)[a]	FY 2010 (Ci)	FY 2011 (Ci)	FY 2012 (Ci)
Eu-152	1.23E+02	2.65E+02	6.62E+02	3.44E+02	5.91E+01
Eu-154	5.04E+01	1.73E+02	2.30E+02	1.23E+02	2.66E+01
Eu-155	5.89E+00	7.83E+01	2.29E+01	2.17E+01	3.89E+00
Fe-55	1.30E+01	1.54E+01	1.33E+01	3.68E+00	7.39E+00
Fe-59	4.31E-06	4.15E-06	8.69E-04	0.00E+00	0.00E+00
H-3	2.59E+02	8.28E+02	3.10E+03	2.18E+03	5.45E+03
I-129	1.49E-02	1.89E-03	2.16E-03	3.63E-02	1.10E-01
K-40	1.32E+01	1.79E+01	2.42E+01	7.58E+00	4.73E+00
Kr-85	1.21E-04	1.63E-01	0.00E+00	0.00E+00	0.00E+00
Mn-54	8.54E-02	9.38E-02	1.54E-02	5.00E-03	8.36E-03
Mo-93	3.32E-01	8.04E-02	2.36E-01	2.58E-01	2.87E-03
Na-22	0.00E+00	7.48E-07	9.71E-06	6.91E-04	6.40E-07
Nb-93m	3.93E-01	9.42E-01	3.74E+00	2.86E-01	7.08E-02
Nb-94	1.36E+00	2.50E+00	9.78E-04	6.53E-02	8.73E-04
Nb-94A	1.53E-01	4.47E-02	1.57E-02	1.78E-02	3.09E-03
Ni-59	8.44E+00	7.32E+00	9.87E+01	3.88E+01	7.96E+00
Ni-59A	6.63E+01	1.36E+01	1.14E+01	1.36E+01	2.24E+00
Ni-63	1.27E+04	6.98E+03	1.81E+03	1.09E+02	1.63E+02
Ni-63A	3.37E+03	1.30E+03	1.06E+03	1.23E+03	2.07E+02
Np-237	9.37E-02	1.74E-02	9.63E-02	1.33E-01	9.89E-02
Pa-231	0.00E+00	3.40E-07	3.95E-07	1.06E-04	8.69E-07
Pb-210	0.00E+00	1.52E-05	8.88E-05	2.28E-01	6.93E-01
Pb-212	N/A	N/A	N/A	1.78E+01	2.86E+00
Pd-107	5.97E-05	1.65E-02	7.73E-04	4.33E-03	3.73E-04
Pm-147	1.63E-01	1.18E+02	7.52E+00	1.32E+01	3.50E+00
Po-209	N/A	N/A	N/A	6.85E-04	6.40E-07
Pu-238	2.34E-01	9.37E+00	8.38E+00	2.36E+01	1.18E+01
Pu-239	1.08E+00	5.12E+01	3.94E+01	9.37E+01	8.42E+01
Pu-240	3.92E-01	2.75E+01	3.18E+01	6.99E+01	2.14E+01

Table A-1. Summary of ERDF Annual Radionuclide Inventory, CY 2008 and FY 2009 through FY 2012

Radionuclide	CY 2008 (Ci)	FY 2009 (Ci)[a]	FY 2010 (Ci)	FY 2011 (Ci)	FY 2012 (Ci)
Pu-241	1.25E+01	9.45E+02	2.43E+03	1.52E+03	1.00E+03
Pu-242	2.96E-02	1.88E-02	4.94E-01	7.37E-01	3.72E-02
Pu-244	0.00E+00	0.00E+00	8.44E-04	0.00E+00	0.00E+00
Ra-226	3.49E-01	1.33E-01	1.16E-01	9.84E-01	2.32E+00
Ra-228	9.83E-02	1.02E-01	1.16E-01	2.06E-01	4.65E-01
Ru-103	N/A	0.00E+00	9.60E-08	6.25E-08	0.00E+00
Ru-103	0.00E+00	N/A	2.22E-03	0.00E+00	0.00E+00
Ru-106	1.49E-02	1.28E-02	1.94E-02	3.06E-07	0.00E+00
Sb-125	2.09E+00	4.40E+01	6.84E+00	2.13E+01	1.08E+00
Se-79	1.37E+01	2.91E+01	8.23E-03	3.71E-02	1.58E-03
Sm-151	2.96E+00	2.26E+02	4.16E+01	5.87E+02	5.96E+00
Sn-113	0.00E+00	0.00E+00	1.38E-03	1.00E-03	0.00E+00
Sn-121m	2.02E-04	3.20E+00	1.49E+01	7.68E-02	5.46E-03
Sn-126	1.26E-01	7.12E-02	2.44E-02	3.55E-02	2.73E-03
Sr-90	2.94E+02	4.50E+03	1.91E+03	1.92E+03	2.21E+03
Tc-99	2.50E-01	2.96E+00	4.07E+00	1.60E+01	1.12E+00
Th-228	3.00E-01	8.16E-02	1.08E-01	1.42E-01	4.84E-02
Th-229	N/A	1.06E-06	9.80E-09	8.04E-04	4.01E-05
Th-230	5.37E-04	1.51E-03	4.82E-05	2.11E-01	2.22E-03
Th-232	4.73E-01	2.70E-01	1.50E-01	3.37E-01	6.61E-01
Th-234	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ti-44	N/A	N/A	2.52E-05	0.00E+00	0.00E+00
U-232	5.35E-06	6.57E-04	8.09E-05	2.22E-04	6.84E-04
U-233/234	1.10E+01	5.66E+00	8.73E+00	2.40E+01	4.10E+01
U-235	1.09E+00	6.93E-01	9.88E-01	6.87E-01	2.83E-01
U-236	3.04E-01	7.30E-01	9.05E-02	3.43E-01	4.28E-02
U-238	2.88E+01	1.20E+01	1.41E+01	9.94E+00	1.49E+01
Y-90	N/A	N/A	1.96E-04	2.47E+00	1.32E-07
Zn-65	0.00E+00	0.00E+00	1.15E-03	0.00E+00	0.00E+00

Table A-1. Summary of ERDF Annual Radionuclide Inventory, CY 2008 and FY 2009 through FY 2012

Radionuclide	CY 2008 (Ci)	FY 2009 (Ci)[a]	FY 2010 (Ci)	FY 2011 (Ci)	FY 2012 (Ci)
Zr-93	1.70E+01	3.25E+01	4.82E+00	5.36E-01	7.95E-02
Total Activity	**1.99E+04**	**2.24E+04**	**1.68E+04**	**2.14E+04**	**1.05E+04**

a. Reporting changed from CY to FY basis beginning in FY 2009; thus, three months (October, November, and December 2008) are double reported (values are summed in both CY 2008 and FY 2009).

b. C-14 and C-14A (activated metal) inventories have been adjusted per CCN 088793, "White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices."

CY = calendar year

ERDF = Environmental Restoration Disposal Facility

FY = fiscal year

N/A = not applicable

Table A-2. Summary of ERDF Radionuclide Inventory, FY 2012 and Total Since Inception

Radionuclide	ERDF WAC	FY 2012		Inception through FY 2012	
	(Ci/m^3)	(Ci)	(Ci/m^3)[a]	(Ci)	(Ci/m^3)[a]
Ac-227	7.60E+04	2.34E-05	3.00E-11	1.48E-04	2.41E-11
Ag-108m	N/A	5.52E+01	7.08E-05	8.98E+02	1.46E-04
Am-241	5.40E-02	1.00E+02	1.29E-04	7.76E+02	1.26E-04
Am-242m	4.00E-01	6.29E-02	8.06E-08	1.86E-01	3.04E-08
Am-243	5.60E-02	1.53E-01	1.96E-07	3.94E-01	6.42E-08
Ba-133	N/A	8.54E-01	1.09E-06	1.31E+01	2.14E-06
Be-7	N/A	7.35E-07	9.42E-13	9.91E-06	1.62E-12
Bi-207	3.60E+02	5.49E-05	7.04E-11	6.17E-05	1.01E-11
C-14[b]	5.10E+00	1.93E+01	2.48E-05	2.49E+02	4.06E-05
C-14A[b]	5.10E+01	3.41E-01	4.37E-07	1.55E+03	2.53E-04
C-14 (insoluble)	N/A	5.90E+00	7.56E-06	3.84E+03	6.25E-04
Ca-41	N/A	0.00E+00	0.00E+00	4.12E+00	6.71E-07
Cd-113m	N/A	5.33E-02	6.84E-08	5.33E+00	8.70E-07
Ce-144	N/A	0.00E+00	0.00E+00	4.26E-03	6.94E-10
Cf-249	N/A	0.00E+00	0.00E+00	8.91E-04	1.45E-10
Cf-252	N/A	0.00E+00	0.00E+00	1.57E-04	2.56E-11
Cm-242	3.20E+01	1.38E-03	1.78E-09	2.70E+00	4.40E-07
Cm-243	8.60E+01	1.78E+00	2.29E-06	2.62E+00	4.27E-07

Table A-2. Summary of ERDF Radionuclide Inventory, FY 2012 and Total Since Inception

Radionuclide	ERDF WAC	FY 2012		Inception through FY 2012	
	(Ci/m^3)	(Ci)	(Ci/m^3)[a]	(Ci)	(Ci/m^3)[a]
Cm-244	3.90E+01	1.94E+00	2.49E-06	6.18E+00	1.01E-06
Cm-245	5.60E-02	3.08E-08	3.95E-14	5.60E-07	9.12E-14
Cm-246	1.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-247	3.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-248	2.70E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	N/A	0.00E+00	0.00E+00	1.41E+00	2.29E-07
Co-60	N/A	2.68E+02	3.43E-04	1.18E+04	1.92E-03
Cs-134	N/A	9.25E-02	1.19E-07	2.29E+01	3.73E-06
Cs-135	8.80E+00	1.98E-03	2.53E-09	5.34E-01	8.70E-08
Cs-137	3.20E+01	7.23E+02	9.27E-04	2.51E+04	4.09E-03
Eu-150	1.70E+02	6.40E-07	8.21E-13	8.83E-04	1.44E-10
Eu-152	2.10E+07	5.91E+01	7.57E-05	6.97E+03	1.14E-03
Eu-154	N/A	2.66E+01	3.42E-05	2.22E+03	3.63E-04
Eu-155	N/A	3.89E+00	4.99E-06	2.69E+02	4.39E-05
Fe-55	N/A	7.39E+00	9.47E-06	3.98E+01	6.49E-06
Fe-59	N/A	0.00E+00	0.00E+00	8.73E-04	1.42E-10
H-3	N/A	5.45E+03	6.99E-03	1.72E+04	2.80E-03
I-129	8.00E-02	1.10E-01	1.41E-07	1.65E-01	2.70E-08
K-40	1.20E-03	4.73E+00	6.07E-06	6.21E+01	1.01E-05
Kr-85	N/A	0.00E+00	0.00E+00	1.93E-01	3.15E-08
Mn-54	N/A	8.36E-03	1.07E-08	1.23E-01	2.00E-08
Mo-93	5.10E+01	2.87E-03	3.68E-09	1.57E+00	2.57E-07
Na-22	N/A	6.40E-07	8.21E-13	1.02E+01	1.66E-06
Nb-93m	N/A	7.08E-02	9.08E-08	6.97E+00	1.14E-06
Nb-94	1.20E-02	8.73E-04	1.12E-09	6.61E+00	1.08E-06
Nb-94A	1.20E-01	3.09E-03	3.96E-09	6.44E-01	1.05E-07
Ni-59	2.10E+02	7.96E+00	1.02E-05	1.75E+02	2.85E-05
Ni-59A	2.20E+02	2.24E+00	2.87E-06	5.95E+02	9.70E-05
Ni-63	7.00E+02	1.63E+02	2.09E-04	1.94E+04	3.16E-03

Table A-2. Summary of ERDF Radionuclide Inventory, FY 2012 and Total Since Inception

Radionuclide	ERDF WAC	FY 2012		Inception through FY 2012	
	(Ci/m^3)	(Ci)	(Ci/m^3)[a]	(Ci)	(Ci/m^3)[a]
Ni-63A	7.00E+03	2.07E+02	2.65E-04	1.60E+04	2.60E-03
Np-237	1.50E-03	9.89E-02	1.27E-07	6.62E-01	1.08E-07
Pa-231	7.40E-03	8.69E-07	1.11E-12	1.07E-04	1.75E-11
Pb-210	5.10E+05	6.93E-01	8.89E-07	9.21E-01	1.50E-07
Pb-212	N/A	2.86E+00	3.67E-06	2.07E+01	3.37E-06
Pd-107	8.20E+02	3.73E-04	4.78E-10	2.20E-02	3.59E-09
Pm-147	N/A	3.50E+00	4.49E-06	1.42E+02	2.32E-05
Po-209	7.90E+00	6.40E-07	8.21E-13	6.85E-04	1.12E-10
Pu-238	1.50E+00	1.18E+01	1.51E-05	7.75E+01	1.26E-05
Pu-239	2.90E-02	8.42E+01	1.08E-04	4.22E+02	6.88E-05
Pu-240	2.90E-02	2.14E+01	2.75E-05	2.09E+02	3.41E-05
Pu-241	5.60E+00	1.00E+03	1.28E-03	9.02E+03	1.47E-03
Pu-242	1.10E-01	3.72E-02	4.77E-08	1.43E+00	2.33E-07
Pu-244	3.20E-02	0.00E+00	0.00E+00	8.44E-04	1.38E-10
Ra-226	1.40E-04	2.32E+00	2.98E-06	4.20E+00	6.84E-07
Ra-228	2.20E-04	4.65E-01	5.97E-07	1.03E+00	1.68E-07
Re-187	N/A	0.00E+00	0.00E+00	1.59E-07	2.58E-14
Ru-103	N/A	0.00E+00	0.00E+00	2.22E-03	3.61E-10
Ru-106	N/A	0.00E+00	0.00E+00	3.72E-02	6.07E-09
Sb-125	N/A	1.08E+00	1.38E-06	7.42E+01	1.21E-05
Se-79	2.70E+01	1.58E-03	2.03E-09	3.51E+01	5.72E-06
Sm-151	5.30E+04	5.96E+00	7.64E-06	8.63E+02	1.41E-04
Sn-113	N/A	0.00E+00	0.00E+00	2.38E-03	3.88E-10
Sn-121m	5.60E+03	5.46E-03	7.00E-09	1.82E+01	2.97E-06
Sn-126	8.40E-03	2.73E-03	3.50E-09	2.60E-01	4.24E-08
Sr-90	7.00E+03	2.21E+03	2.83E-03	1.70E+04	2.78E-03
Tc-99	1.30E+00	1.12E+00	1.44E-06	1.01E+02	1.65E-05
Th-228	1.20E-04	4.84E-02	6.20E-08	1.55E+00	2.53E-07
Th-229	2.50E-02	4.01E-05	5.14E-11	8.45E-04	1.38E-10

Table A-2. Summary of ERDF Radionuclide Inventory, FY 2012 and Total Since Inception

Radionuclide	ERDF WAC	FY 2012		Inception through FY 2012	
	(Ci/m^3)	(Ci)	(Ci/m^3)[a]	(Ci)	(Ci/m^3)[a]
Th-230	3.80E-02	2.22E-03	2.85E-09	2.15E-01	3.50E-08
Th-232	5.80E-03	6.61E-01	8.47E-07	2.11E+00	3.45E-07
Th-234	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ti-44	N/A	0.00E+00	0.00E+00	2.52E-05	4.10E-12
U-232	1.20E+00	6.84E-04	8.77E-10	1.65E-03	2.69E-10
U-233/234	7.40E-02	4.10E+01	5.26E-05	1.60E+02	2.61E-05
U-235	2.70E-03	2.83E-01	3.63E-07	2.88E+01	4.70E-06
U-236	5.10E-01	4.28E-02	5.48E-08	1.34E+00	2.19E-07
U-238	1.20E-02	1.49E+01	1.91E-05	2.69E+02	4.39E-05
Y-90	N/A	1.32E-07	1.69E-13	2.47E+00	4.03E-07
Zn-65	N/A	0.00E+00	0.00E+00	1.15E-03	1.88E-10
Zr-93	1.40E+02	7.95E-02	1.02E-07	4.53E+01	7.38E-06
Total		**1.05E+04**		**1.36E+05**	

a. Activity densities (Ci/m^3) were calculated using the waste disposal volumes reported in Table A-3.

b. C-14 and C-14A (activated metal) inventories have been adjusted per CCN 088793, "White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices."

ERDF = Environmental Restoration Disposal Facility

FY = fiscal year

N/A = not applicable

WAC = waste acceptance criteria

Table A-3. Summary of ERDF Waste Weight and Volume Disposed in FY 2012 and Total Since Inception

Period	Weight (U.S. tons)[a]	Volume (m^3)[b]
Disposed in FY 2012	1.79E+06	7.801E+05
Disposed from inception through FY 2012	1.405E+07	6.135E+06

a. To obtain metric tons from U.S. tons, multiply by 0.90718474.

b. To obtain cubic yards (yd^3) from cubic meters (m^3), multiply by 1.30795062.

ERDF = Environmental Restoration Disposal Facility

FY = fiscal year

Reference

CCN 088793, 2001, "White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices," Bechtel Hanford, Inc., Richland, Washington.