CHPRC ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE: Annual Status Report (FY 2015): Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds	**OWNING ORGANIZATION/FACILITY:** CHPRC Environmental Programs & Strategic Planning, Risk Assessment & Modeling Integration
Document Number: DOE/RL-2015-67	**Revision/Change Number:** 0

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

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

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Annual Status Report (FY 2015): Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds

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A-6001-401 (REV 5)

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DOE/RL-2015-67
Revision 0

Annual Status Report (FY 2015): Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds

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

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DOE/RL-2015-67
Revision 0

Annual Status Report (FY 2015): Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds

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Date Published
February 2016

Prepared for the U.S. Department of Energy
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Executive Summary

This annual review provides the projected dose estimates of radionuclide inventories disposed in the active 200 West Area Low-Level Burial Grounds (LLBGs) since September 26, 1988. These estimates are calculated using the original dose methodology developed in the performance assessment (PA) analysis (WHC-EP-0645[1]). These estimates are compared with performance objectives defined in U.S. Department of Energy (DOE) requirements (DOE O 435.1 Chg 1[2] and its companion documents DOE M 435.1-1 Chg 1[3] and DOE G 435.1-1[4]). All performance objectives are currently satisfied, and operational waste acceptance criteria (HNF-EP-0063[5]) and waste acceptance practices continue to be sufficient to maintain compliance with performance objectives. Estimates of inventory and associated dose estimates from future waste disposal actions are unchanged from previous annual evaluations, which indicate potential impacts well below performance objectives. Therefore, future compliance with DOE O 435.1 Chg 1 is expected.

Within the active burial grounds, low-level waste and mixed low-level waste (MLLW) may be disposed in two lined trenches (Trenches 31 and 34) in the 218-W-5 Burial Ground. Trenches 31 and 34 will be used until they are filled or a decision is made to close these trenches. Some MLLW disposal is also occurring at the Environmental Restoration Disposal Facility in the 200 West Area (covered under a separate PA). In this reporting period (fiscal year 2015, which extends from October 1, 2014 through September 30, 2015), waste was disposed in Trench 31.

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[1] 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/scitech/servlets/purl/105099.

[2] 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-documents/400-series/0435.1-BOrder-chg1.

[3] 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-documents/400-series/0435.1-DManual-1-chg1.

[4] 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-documents/400-series/0435.1-EGuide-1-Chp01.

[5] HNF-EP-0063, 2011, *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.

As demonstrated through multi-year experimental results of saturated leaching tests, as well as unsaturated diffusion tests, concrete encasement of waste disposed at solid waste burial grounds under unsaturated and atmospheric (carbonated) conditions provide a significant delay in radionuclide release into the subsurface (PNNL-23841[6]). During the reporting period, a set of experiments was initiated to evaluate the effect of carbonation depth on contaminant migration. For these tests, concrete monoliths (with and without metallic iron) were carbonated by soaking in a super-saturated sodium bicarbonate solution for varying lengths of time (i.e., 1 week, 3 months, and 6 months). Petrographic and cracking analysis of the 1 week and 3 month cores was used to determine actual carbonation depths and extent of macro- and micro-cracking. Phenolphthalein was used as an indicator to establish the extent of carbonation within the concrete monolith.

Continued groundwater monitoring of the LLBGs indicates no groundwater contamination due to LLBG waste. Current assumptions about future land use at the Hanford Site are consistent with PA analysis assumptions of a post-closure facility that will not be degraded by human activity. That is, the LLBGs are located in an area identified for waste management and containment of residual contamination. This area will remain after final environmental remediation and the proposed shrinkage of Hanford Site boundaries to small areas within the 200 East Area and 200 West Area on the Central Plateau (DOE/EIS-0391[7]). Overall, there are no substantive changes to primary PA assumptions and no changes to the PA analysis conclusion that compliance with DOE O 435.1 Chg 1 is being maintained.

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[6] PNNL-23841, 2014, *Radionuclide Migration through Sediment and Concrete: 16 Years of Investigations*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23841.pdf.

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

Contents

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Terms

AEA	*Atomic Energy Act of 1954*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CY	calendar year
DOE	U.S. Department of Energy
DWS	drinking water standard
FY	fiscal year
HIC	high-integrity container
LLBG	low-level burial ground
LLW	low-level waste
LLWMA	low-level waste management area
MCL, Inc.	Materials and Chemistry Laboratory, Inc.
MLLW	mixed low-level waste
OU	operable unit
P&T	pump and treat
PA	performance assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
TC&WM EIS	*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (DOE/EIS-0391)
WMA	waste management area

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1 Overview

The 200 West Low-Level Burial Grounds (LLBGs) are operated by the U.S. Department of Energy (DOE) and its contractor to dispose of low-level waste (LLW) and mixed low-level waste (MLLW) largely generated by DOE activities. DOE requires such facilities to provide adequate protection to the surrounding environment from current or future releases of buried radioactive contaminants. To define adequate protection, facility performance requirements are currently specified in DOE O 435.1 Chg 1, *Radioactive Waste Management*, and its companion documents (DOE M 435.1-1 Chg 1, *Radioactive Waste Management Manual*; DOE G 435.1-1, *Implementation Guide for use with DOE M 435.1-1*). In the LLW chapter of DOE G 435.1-1 Chg 1 (Chapter IV, Section P. [2]), DOE specified that a site-specific performance assessment (PA) analysis be completed and maintained to demonstrate that LLW disposal practices comply with performance objectives defined in the Order (DOE G 435.1-1 Chg 1 Chapter IV, Section P. [1]). The PA analysis has been completed for the active 200 West Area LLBGs (WHC-EP-0645, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*). The LLBGs had initially received conditional approval (Cowan, 1996, "Conditional Acceptance of the Hanford 200 West Area Burial Ground Performance Assessment"). Subsequently, all conditions were satisfied, and disposal authorization was granted (Scott, 2001, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities-Revision 2"). An addendum to the PA analysis has also been completed (HNF-SD-WM-TI-798, *Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 West Area Active Burial Grounds*), and conditions for approval have been addressed.

Consequently, the PA effort supporting waste management is now focused on PA maintenance. The reporting period for this annual summary report is fiscal year (FY) 2015, which extends from October 1, 2014, through September 30, 2015.

1.1 Facility Overview

Figure 1 shows the location of the 200 West LLBGs in relation to the 200 East LLBGs, the Central Plateau, and the Hanford Site. Four LLBGs in the 200 West Area (218-W-5, 218-W-3A, 218-W-3AE, and 218-W-4C, as shown in Figure 2) received LLW and MLLW after September 26, 1988, and are, therefore, subject to the requirements of DOE O 435.1 Chg 1. A site map shows specific waste trench configuration for the 218-W-5 site (including active Trenches 31 and 34) in Figure 3.

WHC-EP-0645 notes that, in the 200 West Area, the general type of disposal facility is a shallow, unlined trench of variable width (approximately 3 to 10 m [10 to 33 ft]), length (50 to 100 m [165 to 330 ft]), and depth (5 to 10 m [17 to 33 ft]). Waste is typically packaged in containers (metal drums or wooden boxes) and placed in trenches that are up to 2 to 3 m (7 to 10 ft) below the ground surface. Once a trench is filled, a surface barrier (cover) is placed over the waste. Trenches are typically arranged, in parallel fashion, with the long axis running due east-west. Two types of disposal facilities are present. The first is a Category 1 waste facility, assumed to have no functional surface barrier and intended to contain very low concentrations and quantities of radionuclides in the inventory. The second is a Category 3 waste facility, planned to have a surface barrier (cover) that controls infiltration to the same degree as the natural soil and vegetation system, with the option to use waste-form physical and chemical properties to control radionuclide release from wastes containing high concentrations of long-lived mobile radionuclides (i.e., technetium-99 and carbon-14). Types of waste include paper, plastic, wood, concrete rubble, activated metal, and sludge. Commonly observed radionuclides in these wastes include strontium-90, cesium-137, and uranium. Lesser, but significant, activities of carbon-14, iodine-129, and technetium-99 are also present.

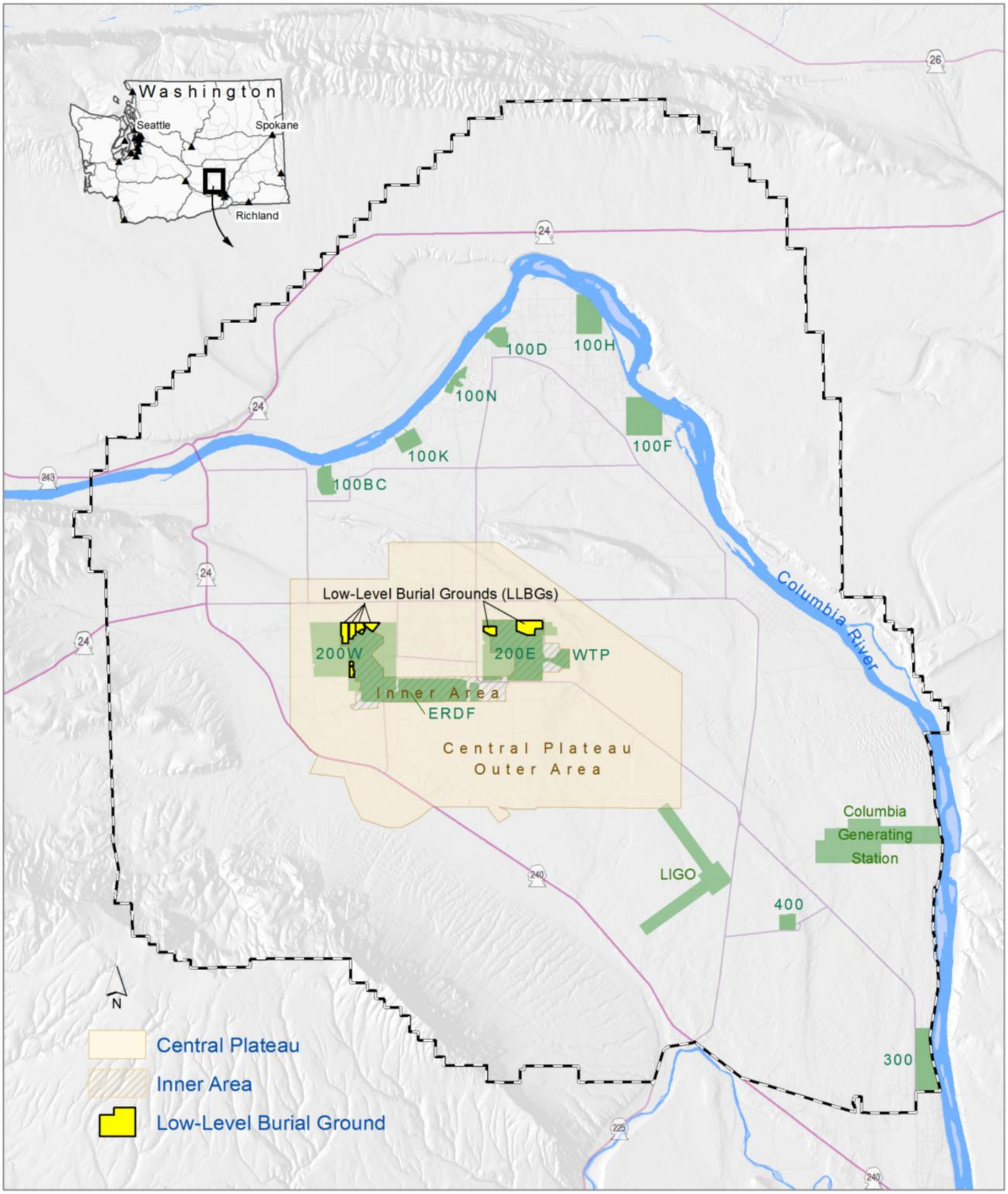
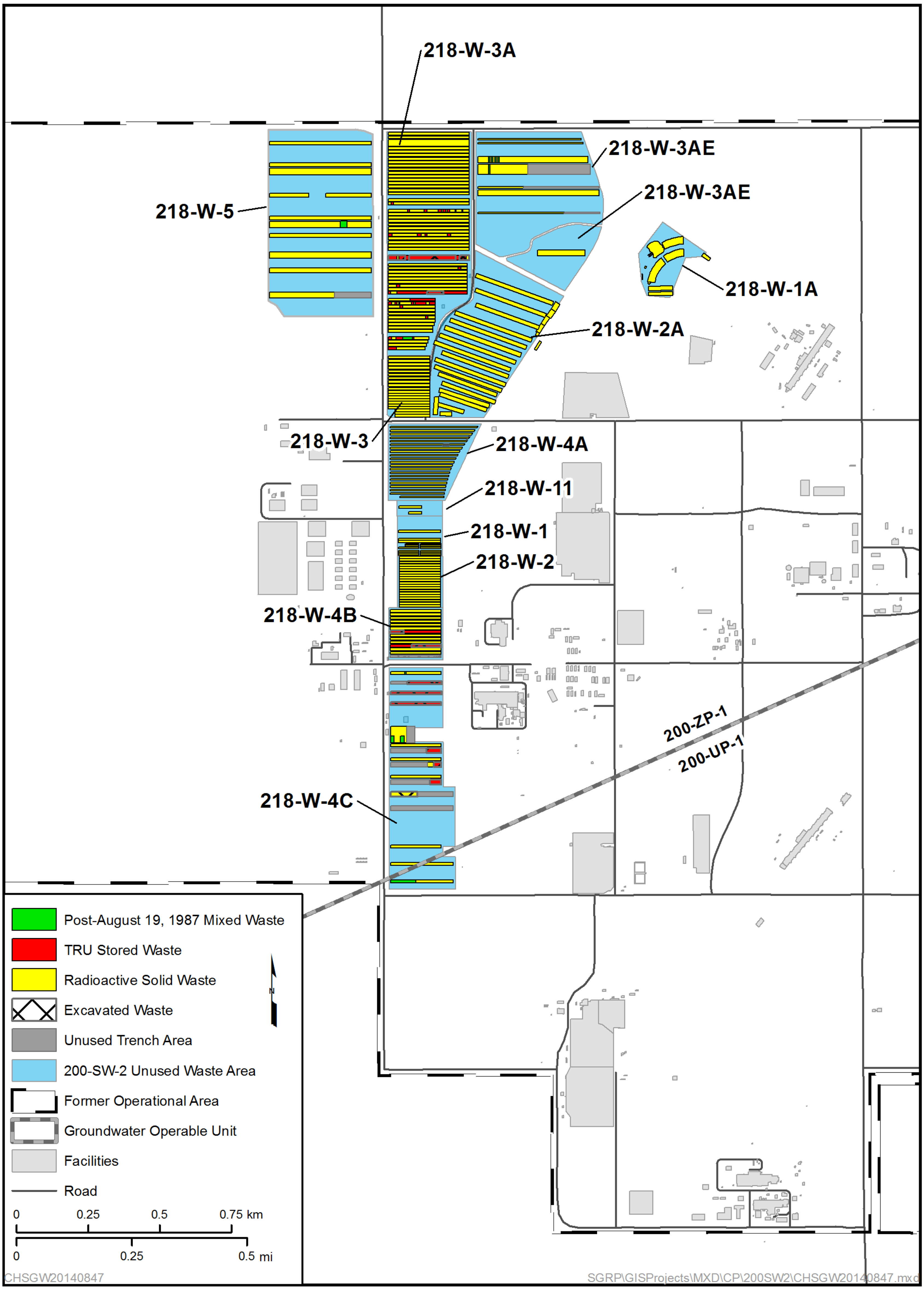


Figure 1. Location of the Low-Level Burial Grounds



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2 **Figure 2. Low-Level Burial Grounds in the 200 West Area**

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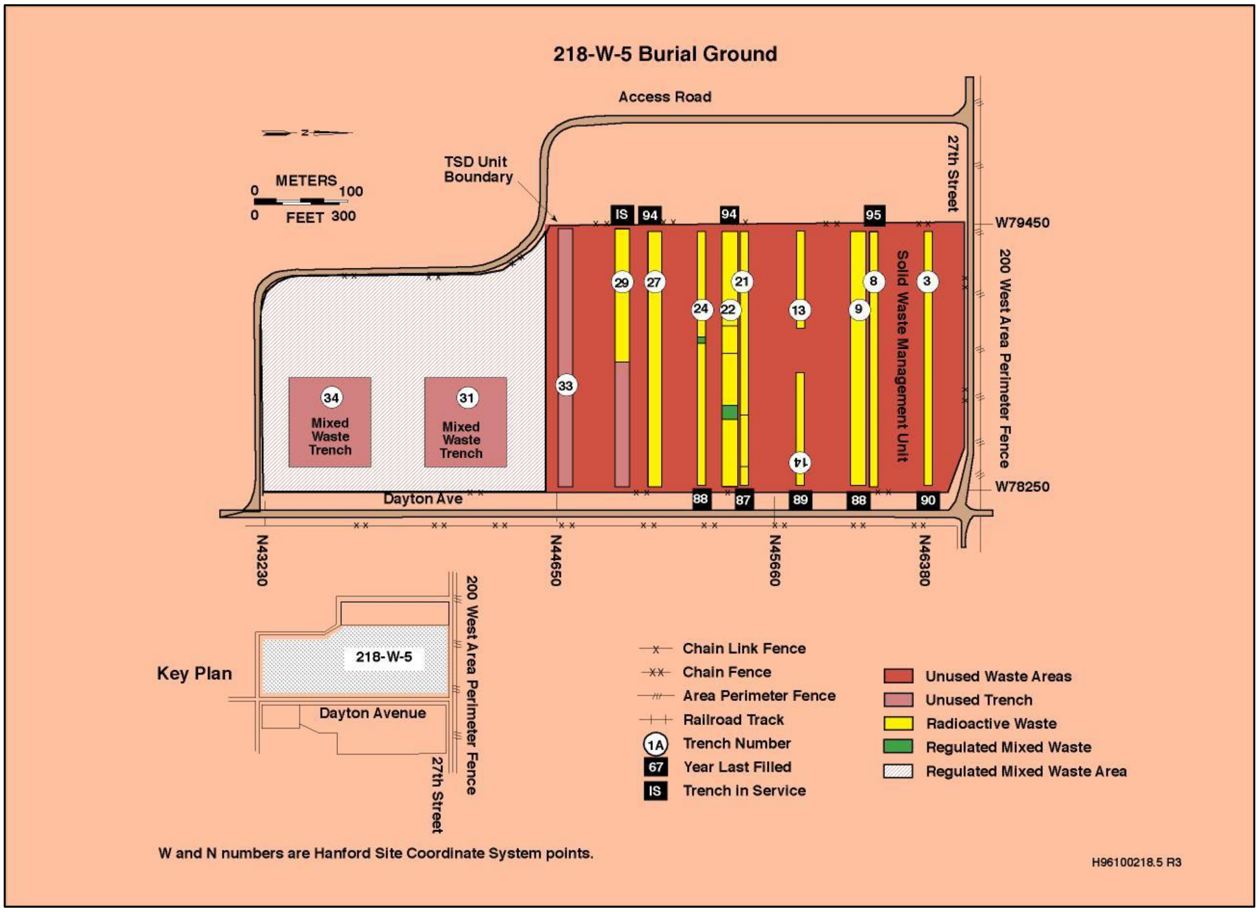

Figure 3. 218-W-5 Burial Ground Site Map

Currently, LLW and MLLW may be disposed in two active lined trenches in the 218-W-5 Burial Ground (Trenches 31 and 34). Trenches 31 and 34 will be used until they are filled or a decision is made to close them. During this reporting period, waste was disposed in Trench 31. There are no plans to increase disposal capacity at the current burial grounds. Some MLLW disposal is also occurring at the Environmental Restoration Disposal Facility in the 200 West Area that is covered under a separate PA. Long-term needs for disposal of LLW and MLLW at the Hanford Site are evaluated in DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC&WM EIS)*, in which three waste management alternatives are identified for the proposed actions, with the preferred alternative being Alternative 2, which would continue treatment of onsite LLW and MLLW in a single facility (Integrated Disposal Facility-East).

1.2 Performance Assessment Maintenance

Two guidance documents (DOE M 435.1-1 Chg 1; DOE, 1999, *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*) define the primary components of PA maintenance. A primary component of the PA maintenance effort is an annual review of the PA analysis. This annual review of the 200 West Area PA analysis is the latest in a series of annual reviews prepared and issued since 1997 (Table 1) to maintain these PAs. According to DOE guidance (DOE M 435.1-1 Chg 1), the primary function of this review is to evaluate the continued compliance of disposal actions in the previous year with the performance objectives and continued relevance of critical PA assumptions. A discussion of supporting research and development and monitoring results relevant to the PA analysis and disposal facility performance is also required.

1.3 Composite Analysis Maintenance

DOE O 435.1 Chg 1 requires that a composite analysis support a PA. The approved composite analysis for LLW at the Hanford Site is presented separately in PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, and PNNL-11800, Addendum 1, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*. The composite analysis is maintained separately because it supports multiple PAs, and it is maintained under its own maintenance plan (DOE/RL-2000-29, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*), and is compliant with the requirements of DOE M 435.1-1 Chg 1. The composite analysis annual summary for FY 2015 is presented in DOE/RL-2015-66, *Annual Status Report (Fiscal Year 2015): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*.

DOE deferred updates to the composite analysis from 2005 through 2012 during preparation of the TC&WM EIS (DOE/EIS-0391). Future updates to the composite analysis will incorporate any available, newer information for the LLBG PAs and will be prepared following the phased process specified in recently issued DOE guidance (Williams, 2012, "Modeling to Support Regulatory Decisionmaking at Hanford"). Planning is underway to update the Composite Analysis beginning in FY 2016 (DOE/RL-2015-66).

1.4 Annual Review Content

Chapter 2 summarizes the disposed LLW inventory and provides the estimated incremental dose from this inventory. Inventory and dose discussions are divided in terms of specific radionuclides (uranium versus others) because dose-estimating methods are distinct. Qualitative estimates of additional inventory in future waste disposals and associated dose estimates are unchanged from past reports, showing no potential for causing exceedance of performance objectives. Additional discussion of future inventory is not provided in this report. Chapter 3 discusses additional data or information being collected that has some bearing on the PA assumptions. These include multi-year experiments to quantify the efficacy of concrete waste forms in retaining key radionuclides (e.g., uranium-238, technetium-99, and iodine-129) while undergoing weathering. Chapter 4 summarizes the current environmental monitoring results. Chapter 5 provides a summary of any changes to disposal facility operations and PA assumptions and any planned changes to PA efforts. Chapter 6 provides the references cited in this report.

Table 1. Maintenance Documents for the Low-Level Burial Grounds Performance Assessments

Reporting Period*	Document
FY 1997	Wood, 1997, *Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses*, transmitted in RFSH-9755566, “Transmittal of Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses, that Fulfills Performance Agreement WM 1.8.1”
	HNF-1561, *1996-1997 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 1998	HNF-3762, *1997-1998 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 1999	HNF-7561, *1998-1999 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 2000	HNF-7562, *1999-2000 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 2001	FH-0105097, “Performance Assessment Review Report, 2000-2001 Annual Review of the 200 West and 200 East Area Performance Assessments”
FY 2002	FH-0204558, “Performance Assessment Review Report, 2001-2002 Annual Review of the 200 West and 200 East Area Performance Assessments”
FY 2003	FH-0304003, “Performance Assessment Review Report, 2002-2003 Annual Review of the 200 West and 200 East Area Performance Assessments”
FY 2004	FH-0501152, “Performance Assessment Review Report, 2003-2004 Annual Review of the 200 West and 200 East Area Performance Assessments”
FY 2005	FH-0600899, “Performance Assessment Review Report, 2004-2005 Annual Review of the 200 West and 200 East Area Performance Assessments”
CY 2005 (partial); CY 2006	FH-0700959, “Performance Assessment Review Report, Annual Review of the 200 West and 200 East Area Performance Assessments (12/1/2005-12/31/2006)”
CY 2007	FH-0802190, “Performance Assessment Review Report, Annual Review of the 200 West and 200 East Area Performance Assessments (1/1/2007 - 12/31/2007)”
CY 2008	DOE/RL-2009-99, *Annual Review of the 200 West and 200 East Area Performance Assessments (January 1, 2008 – December 31, 2008)*
CY 2009 (partial)	DOE/RL-2009-134, *Annual Review of the 200 West and 200 East Performance Assessments (January 1, 2009 – September 30, 2009)*
FY 2010	DOE/RL-2010-120, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2010)*
FY 2011	DOE/RL-2011-110, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2011)*
FY 2012	DOE/RL-2012-57, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2012)*
FY 2013	DOE/RL-2013-41, *Annual Status Report (FY 2013): 200 West and 200 East Performance Assessments*
FY 2014	DOE/RL-2014-47, *Annual Status Report (FY 2014): 200 West and 200 East Performance Assessments*
FY 2015	DOE/RL-2015-67 (this report), *Annual Status Report (FY 2015): Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*

* Reporting period has changed from fiscal year (FY) to calendar year and back to FY basis, during the maintenance history of these performance assessments in response to DOE directions, which is reflected by the maintenance documents listed.

2 Summary of Disposed Inventory

This chapter includes the following sections:

- Description of disposed inventory (Section 2.1)
- Summary of groundwater and inadvertent intruder dose estimates associated with disposed inventory (Section 2.2)
- Evaluation of compliance with other performance objectives (Section 2.3)
- Statement of progress towards satisfying PA conditional approval requirements (Section 2.4)
- Summary statement of conclusions about compliance with performance objectives (Section 2.5)

2.1 Disposed Inventory Description

In this reporting period (FY 2015, from October 1, 2014, through September 30, 2015), nonreactor compartment LLW and MLLW have been disposed only in the 218-W-5 Burial Ground in Trench 31 and 34. Only the radioactive constituents of these wastes are reviewed in this report because they are the only contaminants evaluated in the PA analysis. Only wastes that originate at the Hanford Site are disposed in the 200 West LLBGs. Annual waste volume receipts continue to be in the range of about 100 to 1,000 m^3 (10,594 to 35,315 ft^3), with the annual waste volume for this reporting period being 254 m^3 (8,970 ft^3).

Performance-sensitive radionuclides disposed during this review period are summarized in Table 2 for uranium wastes and in Table3 for mobile radionuclide wastes. Both are reported in this manner to support evaluation of the all-pathways performance objective, wherein waste acceptance criteria are defined for mobile radionuclides as specific inventory limits. All contaminants were distributed in numerous waste packages.

2.2 Projected Dose Estimates from the Disposed Waste to Evaluate Compliance with DOE O 435.1 Chg 1

Among the performance objectives defined in DOE O 435.1 Chg 1, the primary objective is the all-pathways dose limit of 25 mrem/yr to an individual residing 100 m (328 ft) downgradient of the disposal facility. In the PA analysis, a multiple-exposure pathway agriculture scenario was used to generate dose estimates that were compared to the 25 mrem/yr limit. A single exposure groundwater consumption pathway was compared to a 4 mrem/yr drinking water limit. For all radionuclides except chlorine-36, the dose calculations showed higher doses with respect to the 4 mrem/yr drinking water limit for the same inventory, making the drinking water limit more stringent; hence, the drinking water dose results are presented in this report. Collective dose estimates for uranium and the combined inventories of mobile radionuclides are provided in Section 2.2.1 for comparison with the 25 mrem/yr all pathways limit and the 4 mrem/yr drinking water limit.

These analyses also show that waste acceptance criteria in HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, are satisfied; consequently, no special analyses or reviews were needed. For the all-pathways performance objective, waste acceptance criteria are defined for mobile radionuclides as specific inventory limits. These limits correspond to the inventory that is estimated to provide the maximum allowable dose when leached from the facility and transported to the 100 m (328 ft) downgradient well. The limits are expressed indirectly in the LLBG waste acceptance criteria document as trigger values (radionuclide-specific concentrations) that are calculated on a package-by-package

Table 2. Uranium Waste Mass and Activity Disposed during FY 2015 (10/1/2014–9/30/2015) in the 218-W-5 Burial Ground

Trench	U-232	U-233	U-234	U-235	U-236	U-238	Total Uranium
Mass (g) of Disposed Uranium Waste							
31 (HIC)	8.71E-05	1.58E-02	4.79E-01	4.32E+01	2.42E-01	2.62E+03	2.66E+03
31 (no HIC)	0.00E+00	8.50E-05	8.66E-02	1.13E+01	2.24E-01	1.67E+03	1.68E+03
34 (HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
34 (no HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	**8.71E-05**	**1.59E-02**	**5.66E-01**	**5.45E+01**	**4.66E-01**	**4.29E+03**	**4.34E+03**
Activity (Ci) of Disposed Uranium Waste							
31 (HIC)	1.92E-03	1.52E-04	2.98E-03	9.33E-05	1.56E-05	8.79E-04	6.04E-03
31 (no HIC)	0.00E+00	8.20E-07	5.38E-04	2.44E-05	1.45E-05	5.61E-04	1.14E-03
34 (HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
34 (no HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	**1.92E-03**	**1.53E-04**	**3.52E-03**	**1.18E-04**	**3.01E-05**	**1.44E-03**	**7.18E-03**

HIC = high-integrity container

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Table 3. Mobile Radionuclides Activity Disposed during FY 2015 (10/1/2014–9/30/2015) in the 218-W-5 Burial Ground

Trench	Tritium	C-14	Cl-36	Se-79	Tc-99	I-129	Np-237
Activity (Ci) of Disposed Mobile Radionuclide Waste							
31 (HIC)	1.27E+01	2.50E-02	2.40E-05	0.00E+00	2.62E-03	0.00E+00	0.00E+00
31 (no HIC)	5.74E-01	0.00E+00	0.00E+00	0.00E+00	1.20E-03	0.00E+00	0.00E+00
34 (HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
34 (no HIC)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	**1.32E+01**	**2.50E-02**	**2.40E-05**	**0.00E+00**	**3.82E-03**	**0.00E+00**	**0.00E+00**

HIC = high-integrity container

2

basis (HNF-EP-0063). If a package contains any radionuclides that exceed this value, a review of the disposal criteria is initiated to determine if additional disposal requirements beyond normal requirements are needed. Annual summaries (such as this one) are then completed to show that the performance objective and inventory limits have not been exceeded.

Compliance demonstration is based on dose estimates for the entire facility, as it now exists. Cumulative groundwater drinking dose estimates (Section 2.2.1) are provided for the 200 West Area LLBGs (Section 2.2.1.1) and for individual trenches in the 200 West Area LLBGs (Section 2.2.1.2).

The next most significant compliance requirement in DOE O 435.1 Chg 1 is the inadvertent intruder limit. A dose limit of 100 mrem/yr from chronic exposure or 500 mrem/yr from acute exposure was defined for an inadvertent intruder who might be exposed to waste in the disposal facility. In the PA analysis, it was shown that the 100 mrem/yr chronic dose limit was the more limiting alternative. Therefore, the chronic exposure standard was adopted for comparing dose results and establishing waste acceptance criteria. These criteria are quantified in the LLBG waste acceptance criteria (Table A-2 of HNF-EP-0063) as radionuclide-specific concentration limits (Ci/m^3) for two categories of waste (Category 1 and Category 3) and are compared against the average values for the disposed waste in a given trench. The waste acceptance criteria also specify that Category 3 waste, which contains radionuclides at higher concentrations, must be grouted or placed in high-integrity containers (HICs) or equivalent. The trench-by-trench breakdown was not provided in the PA, but a total burial ground dose was provided in which radionuclide concentrations were calculated based on total burial ground inventory and total waste volume disposed.

Dose estimates from the inventory listed in Table 2 and Table3 are summarized and explained in the following sections for each of the primary criteria. The dose estimates assume that Category 3 conditions will ultimately be the end-state condition (e.g., a final burial ground cap is placed over the disposal trenches to create a 5 m [16.4 ft] layer over waste and limit infiltration to no more than 0.5 cm/yr [0.2 in./yr]). Waste disposal configurations that have enhanced isolation from the hydrogeologic environment (primarily placement in HICs or equivalent) have also been incorporated into the calculations.

2.2.1 Groundwater Dose Estimates

In the PA analysis, a methodology was developed to evaluate groundwater dose for any size disposal facility of interest within the boundaries of the collective burial grounds (Section 3.2.3.1 in WHC-EP-0645). This was done by assuming any trench or set of trenches could be divided into a series of waste volume slices parallel to groundwater flow. Dose estimates from the waste configuration of interest were then derived from an average slice evaluation. This approach was taken to facilitate evaluation of future changes in disposal facility size that cannot be predicted. All aspects of the disposal configuration continue to be represented adequately with this representation. In addition to the burial ground dose estimates used to evaluate compliance with DOE O 435.1 Chg 1, the methodology has been used to evaluate doses on a trench-by-trench basis in the 200 West Area LLBGs as an aid to the routine day-to-day waste acceptance process. These results are provided in Section 2.2.1.2.

2.2.1.1 Burial Ground Drinking Water Dose Estimates

When calculating contaminant release and transport, it is necessary to make numerous averaging and simplifying assumptions because much of the environmental heterogeneity is present that cannot be characterized or modeled realistically. To calculate the groundwater drinking or all-pathways dose, a simplifying assumption of uniform radionuclide distribution across the disposal facility axis perpendicular to the general direction of groundwater flow was made, although it is acknowledged that specific waste volumes with much higher contaminant concentrations exist.

This approach does not explicitly model the current period in which the LLBGs are only covered with an interim cover that likely permits greater average recharge than that assumed for Category 3 conditions. Qualitative arguments have been made in the PA analysis (Section 3.2.2.1 of WHC-EP-0645) that conservative assumptions used in the model accommodate this potentially nonconservative condition. Further, most waste packages used since September 26, 1988, are sufficiently sturdy to delay contact of infiltrating water with radionuclides through the operational period such that minimal release is expected before placement of the final cover several decades from now. This is particularly the case with Category 3 wastes that are placed in sealed or grouted concrete boxes and contain the majority of the PA-sensitive inventory. Finally, in the composite analysis for the Hanford Site (PNNL-11800), a sensitivity case was considered in which an enhanced recharge rate of 7.5 cm/yr (3 in./yr) through the LLBGs was assumed during the operations period (approximately 40 years) followed by infiltration rates controlled by a final cover (0.5 cm/yr [0.2 in./yr]). It was concluded that the brief period of increased infiltration had no significant effect on estimated downstream groundwater concentrations and, therefore, the dose estimates.

In Table4, the drinking water dose estimates are divided into two different periods, and uranium dose versus other radionuclides dose. The two different periods distinguish between inventory disposed from facility inception (September 27, 1988) through FY 2014 (September 30, 2011; prepared in the previous annual report [DOE/RL-2014-47, *Annual Status Report (FY 2014): 200 West and 200 East Performance Assessments*), from inventory disposed in FY 2015 (this reporting period). Summing the dose estimates from these two periods yields the total dose estimate that are also reported in Table4.

Table 4. Category 3 Groundwater Dose Estimates (mrem/yr) by Burial Ground for Disposed Inventory

Burial Ground	Uranium Dose	Mobile Radionuclide Dose		Estimated Total Dose[c]
		Reported[a]	Estimated[b]	
Dose from Waste Disposal from Inception through FY 2014 (September 27, 1988–September 30, 2014)				
200 West Area	1.37E-01	5.33E-02	2.54E-02	2.16E-01
Dose from Waste Disposal during FY 2015 (October 1, 2014–September 30, 2015)				
200 West Area	5.84E-06	2.25E-05	3.43E-06	3.18E-05
Dose from Total Waste Disposal from Inception through FY 2015 (September 27, 1988–September 30, 2015)				
200 West Area	1.37E-01	5.34E-02	2.54E-02	2.16E-01

a. Reported dose is calculated for the reported inventory of mobile radionuclides.

b. Estimated dose is calculated for estimates of mobile radionuclide inventory that may be present in disposed waste at trace levels but have not been reported or measured, using a scaling factor derived from reactor production ratios of cesium-137 concentrations to other contaminants (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Appendix B). The concept is that in lieu of direct characterization information, the unknown mobile radionuclide inventory can be conservatively estimated by assuming that reactor production ratios are maintained in waste.

c. Estimated total dose is the sum of uranium dose, reported mobile radionuclide dose, and estimated radionuclide dose.

FY = fiscal year

Dose estimates from waste disposed in this reporting period are minimal. The largest dose comes from the disposal of mobile radionuclides. The estimated dose values for mobile radionuclides listed in Table 4 were generated with the inclusion of estimates of mobile radionuclide inventory (not including uranium) for radionuclides that may be present in disposed waste at trace levels but have not been reported or measured. Using these disposed cesium-137 inventories during this reporting period, estimated inventories of mobile contaminants and associated doses were calculated. Dose contribution from disposed uranium has frequently been larger than that from disposed mobile radionuclides; however, in this reporting period, low inventory disposal reduced the estimated uranium dose to incidental levels.

The total dose for each burial ground group, when compared to a 4 mrem/yr limit, shows that compliance with the performance goal has been maintained. The following observations are made regarding the groundwater drinking dose estimates for this reporting period:

- Groundwater drinking dose estimates from disposed waste were negligible in this reporting period.
- The overall dose estimate from this year's disposal is small compared to the 4 mrem/yr limit. If dose from reported waste alone is considered, the dose increments as a result of waste disposed this year compared to cumulative waste inventories disposed between September 1988 and the beginning of the reporting period are negligible for the 200 West Area.

These dose estimates for the less stringent all-pathways scenario (not reported) show the same trends as the groundwater drinking scenario; in both cases, the total estimates fall below performance objective values of 4 mrem/yr and 25 mrem/yr, respectively. Table4 shows the drinking water doses for comparison to the 4 mrem/yr limit.

2.2.1.2 Trench-by-Trench Dose Calculations for the 200 West Area Low-Level Burial Grounds

Dose estimates are also divided by trench for the 200 West Area LLBGs, with the goal of preventing potential dose estimates in excess of the 4 mrem/yr limit for any trench. The trench-by-trench calculations are completed as part of the waste acceptance process. They are not a part of compliance demonstration, but they are a means of ensuring that day-to-day waste disposal will not cause a cumulative disposal that exceeds the overall LLBG limit. This strategy works because dose calculations are proportional to inventory distribution assumptions and become larger as the assumed inventory distribution becomes more restrictive (e.g., when the trench-by-trench analysis is performed, rather than all trenches considered as one large unit).

Table5 summarizes the trench-by-trench groundwater dose projections. Incremental dose increases occurred in Trench 31 within the 200-W-5 Burial Ground. Other 200 West Area LLBG trenches are also provided to indicate final trench dose estimates and primary mobile radionuclide contributors. The dose calculation methodology is identical to the whole burial ground calculations discussed previously, except that trench-specific waste inventories, waste volumes, and waste areas are considered one trench at a time. Doses are provided for each trench for the two periods that include all disposed waste, and a total dose is also provided. Uranium doses are provided separately from other mobile radionuclides.

All trenches have projected dose estimates that fall below the 4 mrem/yr goal, and most of the trenches are full. Overall LLBG groundwater-related dose estimates are dominated by uranium, technetium-99, and carbon-14.

2.2.2 Inadvertent Intruder Dose Estimates

Compliance with the inadvertent intruder waste acceptance limits is determined by comparing projected intruder dose from a trench waste volume and inventory with a 100 mrem/yr chronic dose limit. Occasionally, individual waste packages are received that approach or exceed the Category 3 limits. In these cases, written justification for alternative waste concentration averaging is provided to the waste disposal organization by the PA contact. The likelihood that an inadvertent intruder would exhume such a particular package with the higher-concentration inventory is low; consequently, averaging over a trench volume is a reasonable approach to compliance evaluation. As with the groundwater dose evaluation, the Category 3 conditions are assumed to exist in the post-closure period. Separate periods are not considered for these estimates because the calculated doses apply to cumulative inventories and waste volumes.

Table6 provides trench volumes, activities of the largest contributors, and dose fractions for the inadvertent intruder dose estimates. Dose estimates are 100 times the sum of the dose fractions. In most trenches, dose estimates are less than 1 mrem/yr, which are far below the 100 mrem/yr limit. Where uranium is present in significant quantities, it usually provides the largest projected dose. The clearest examples of uranium waste influence on the intruder dose estimate are in 218-W-3AE, Trench 8; 218-W-4C, Trench 14; and 218-W-5, Trench 34. Otherwise, cesium-137 and/or strontium-90 provide the largest dose.

The projected total burial ground inadvertent intruder dose provided in Table6 is consistent with those provided in the PA analysis and similar to individual trench dose estimates. On this scale of waste volume averaging, the estimated doses for each burial ground are well below the compliance limit.

2.3 Other Performance Objectives

Two other limits were considered in the PA analysis: the air emissions dose limit (10 mrem/yr), and the radon flux limit (20 pCi/m^2/s). Table7 provides the estimated doses for comparison to these two limits, along with the summary of the groundwater contamination and inadvertent intruder doses. In the PA analysis, the potential sources of air contamination were concluded to be carbon-14 and tritium. Given the limited inventory of carbon-14, the decay of tritium, and the partitioning of both elements between liquid and gas, it was shown that dose estimates would be very small (Section 4.3.1 of WHC-EP-0645). In the case of a Category 3 closure condition assumption (exposure at 500 years), it was concluded that the conditions needed for carbon-14 to provide an atmospheric dose (e.g., delayed beyond 100 years followed by complete and instantaneous release) were unrealistic, and tritium would have decayed to trivial amounts (40 half-lives would reduce the tritium inventory by a factor of about a trillion). Therefore, no dose from an atmospheric release was projected. Negligible increases in estimated radon flux were calculated from parent isotopes of uranium disposed in this reporting period. All increases in dose and flux during this reporting period are negligible with respect to those reported for the previous reporting period.

Other criteria in the LLBG waste acceptance criteria (HNF-EP-0063) address disposal in a physically stable configuration with minimal void space, minimal gas emission, and elimination of pyrophoric characteristics. These criteria are also used to minimize long-term subsidence. These requirements are being administered by LLBG operations and typically involve solidification or void-fill processes. As necessary, waste packages are grouted or placed in concrete boxes that are judged to be HICs or equivalent. Surveillance for local subsidence is performed routinely by LLBG staff, and cavities that form are filled in with dirt or grout.

2.4 Conditional Approval Requirements

All conditional approval requirements have been completed (Scott, 2001).

Table 5. Category 3 Groundwater Dose Estimates by Trench for Disposed Inventory, 9/27/1988 through 9/30/2015

Burial Ground	Trench[a]	Uranium Dose (mrem/yr)		Mobile Radionuclide Dose (mrem/yr)				Total Dose (mrem/yr)
		9/27/1988 to 9/30/2014	10/01/2014 to 9/30/2015	9/27/1988 to 9/30/2014	Key Radionuclides[b]	10/01/2014 to 9/30/2015	Key Radionuclides[b]	
W-3A	19	3.39E+00	—	4.50E-02	C-14	—	—	3.44E+00
	3S	1.50E-01	—	5.60E-04	Tc-99	—	—	1.51E-01
	46	2.20E-01	—	5.30E-14	C-14	—	—	2.20E-01
	49	5.00E-01	—	4.29E-02	Tc-99	—	—	5.43E-01
	6S	1.50E-03	—	2.20E-04	I-129	—	—	1.72E-03
W3AE	3	2.23E-02	—	2.90E -03	Tc-99	—	—	2.52E-02
	8[c]	1.26E-01	—	6.03E -01	Tc-99, C-14	—	—	7.30E-01
	13	1.38E-03	—	3.72E -04	Tc-99, C-14	—	—	1.75E-03
	16	2.61E+00	—	2.27E -02	Tc-99, C-14	—	—	2.63E+00
	26	1.10E+00	—	1.69E -02	Tc-99	—	—	1.12E+00
W4-C	14[c]	5.25E-01	—	1.61E-01	C-14, Tc-99	—	—	6.88E-01
	20	2.12E-04	—	4.60E-02	Tc-99	—	—	4.62E-02
	33	5.63E-02	—	1.58E-02	C-14, Tc-99, I-129	—	—	7.21E-02
	48	7.00E-04	—	1.10E-09	Tc-99	—	—	7.00E-04
	53	2.00E-03	—	7.80E-04	Tc-99	—	—	2.78E-03
	NC	1.10E-02	—	6.95E-01	C-14	—	—	7.06E-01

Table 5. Category 3 Groundwater Dose Estimates by Trench for Disposed Inventory, 9/27/1988 through 9/30/2015

Burial Ground	Trench[a]	Uranium Dose (mrem/yr)		Mobile Radionuclide Dose (mrem/yr)				Total Dose (mrem/yr)
		9/27/1988 to 9/30/2014	10/01/2014 to 9/30/2015	9/27/1988 to 9/30/2014	Key Radionuclides[b]	10/01/2014 to 9/30/2015	Key Radionuclides[b]	
W-5	3	1.00E-04	—	5.40E-03	C-14, I-129	—	—	5.50E-03
	8	3.80E-01	—	8.80E-05	Tc-99	—	—	3.80E-01
	13	3.00E-03	—	1.53E-01	I-129, C-14	—	—	1.56E-01
	14	5.40E-01	—	8.00E-03	C-14	—	—	5.48E-01
	22	1.08E+00	—	4.41E-01	I-129, Tc-99	—	—	1.52E+00
	24	8.47E-04	—	3.00E-03	C-14	—	—	3.85E-03
	27	1.32E+0	—	1.11E-01	I-129, C-14	—	—	1.43E+00
	29	8.52E-01	—	1.83E-01	C-14, Tc-99	—	—	1.04E+00
	31	2.00E-03	1.00E-04	1.01E-01	Tc-99, I-129, C-14	3.87E-04	Tc-99, I-129	1.03E-01
	33	3.00E-02	—	1.04E-01	C-14, Tc-99	—	—	1.34E-01
	34[c]	6.32E-02	0.00E+00	8.02E-02	Tc-99, I-129	0	—	1.43E-01

a. All trenches are closed, except for Trenches 31 and 34 in the 200-W-5 Burial Ground.

b. Key radionuclides are those that contribute substantially to the mobile radionuclide dose (other contributors comprise less than 1 percent of total radiological dose).

c. Trench contains high-integrity containers or stabilized waste.

Table 6. Estimated Intruder Dose Fraction by Trench for Waste Disposed from 9/27/1988 through 9/30/2015

Burial Ground	Trench	Volume (m^3)	Inventory (Ci)			Concentration (Ci/m^3)			Fraction of Category 3 Limit			Total Dose Fraction
			Cs-137	Sr-90	U	Cs-137	Sr-90	U	Cs-137	Sr-90	U	
W3A	19	1,616	1.91E+01	1.27E+00	1.70E-02	1.18E-02	7.86E-04	1.05E-05	9.84E-07	1.46E-08	2.10E-05	2.20E-05
	35	138	5.83E+01	1.04E+02	9.18E-02	4.22E-01	7.50E-01	6.66E-04	3.52E-05	1.39E-05	1.33E-03	1.38E-03
	46	98	2.60E-03	2.90E-03	1.10E-03	2.65E-05	2.96E-05	1.12E-05	2.21E-09	5.48E-10	2.24E-05	2.25E-05
	49	2,522	1.05E+03	2.75E+02	1.34E-01	4.16E-01	1.09E-01	5.30E-05	3.47E-05	2.02E-06	1.06E-04	1.43E-04
	65	63	1.01E-01	5.00E-06	8.76E-04	1.60E-03	7.94E-08	1.39E-05	1.34E-07	1.47E-12	2.78E-05	2.79E-05
W3AE	3	397	2.29E+04	2.26E+04	7.68E-01	5.76E+01	5.69E+01	1.94E-03	4.80E-03	1.05E-03	3.87E-03	9.72E-03
	5	30	2.65E-02	0.00E+00	0.00E+00	8.83E-04	0.00E+00	0.00E+00	7.36E-08	0.00E+00	0.00E+00	7.36E-08
	8	8,301	3.37E+03	2.01E+03	2.30E+02	4.05E-01	2.43E-01	2.77E-02	3.38E-05	4.49E-06	5.55E-02	5.55E-02
	13	2,143	9.12E+04	1.46E+04	1.47E-02	4.26E+01	6.81E+00	6.88E-06	3.55E-03	1.26E-04	1.38E-05	3.69E-03
	16	852	3.40E+04	2.23E+04	4.75E+00	3.99E+01	2.62E+01	5.58E-03	3.33E-03	4.84E-04	1.12E-02	1.50E-02
	26	2,985	7.36E+02	3.76E+02	7.55E-02	2.47E-01	1.26E-01	2.53E-05	2.05E-05	2.33E-06	5.06E-05	7.35E-05
W4C	14	22,154	3.86E+01	1.31E+02	8.63E+01	1.74E-03	5.91E-03	3.89E-03	1.45E-07	1.09E-07	7.79E-03	7.79E-03
	20	15	3.68E-01	3.62E-01	1.00E-04	2.45E-02	2.42E-02	6.67E-06	2.05E-06	4.47E-07	1.33E-05	1.58E-05
	33	621	1.09E-01	1.09E-01	1.23E-02	1.76E-04	1.76E-04	1.98E-05	1.46E-08	3.25E-09	3.96E-05	3.96E-05
	48	526	4.40E-03	7.50E-02	8.61E-04	8.37E-06	1.43E-04	1.64E-06	6.97E-10	2.64E-09	3.27E-06	3.28E-06
	53	1,034	2.15E+02	8.32E+01	1.34E-03	2.08E-01	8.05E-02	1.30E-06	1.73E-05	1.49E-06	2.60E-06	2.14E-05
	58	292	2.15E+02	2.13E+02	0.00E+00	7.36E-01	7.30E-01	0.00E+00	6.14E-05	1.35E-05	0.00E+00	7.49E-05
	NC	905	2.40E-01	3.10E-02	1.30E-02	2.65E-04	3.43E-05	1.44E-05	2.21E-08	6.34E-10	2.88E-05	2.88E-05

Table 6. Estimated Intruder Dose Fraction by Trench for Waste Disposed from 9/27/1988 through 9/30/2015

Burial Ground	Trench	Volume (m^3)	Inventory (Ci)			Concentration (Ci/m^3)			Fraction of Category 3 Limit			Total Dose Fraction
			Cs-137	Sr-90	U	Cs-137	Sr-90	U	Cs-137	Sr-90	U	
W5	3	608	1.58E+02	1.86E+02	7.21E-03	2.60E-01	3.06E-01	1.19E-05	2.17E-05	5.67E-06	2.37E-05	5.10E-05
	8	1,892	2.03E+03	8.33E+02	3.34E-03	1.07E+00	4.40E-01	1.76E-06	8.92E-05	8.16E-06	3.53E-06	1.01E-04
	13	839	8.18E-01	1.85E-01	4.82E-03	9.75E-04	2.21E-04	5.74E-06	8.12E-08	4.08E-09	1.15E-05	1.16E-05
	14	412	2.50E-01	3.24E-01	8.90E-01	6.07E-04	7.86E-04	2.16E-03	5.06E-08	1.46E-08	4.32E-03	4.32E-03
	22	6,972	5.80E+01	3.45E+01	7.70E+01	8.32E-03	4.95E-03	1.11E-02	6.93E-07	9.16E-08	2.21E-02	2.21E-02
	24	153	1.10E-02	0.00E+00	4.00E-04	7.19E-05	0.00E+00	2.61E-06	5.99E-09	0.00E+00	5.23E-06	5.23E-06
	27	11,788	7.20E+01	1.79E+02	1.70E+01	6.11E-03	1.51E-02	1.44E-03	5.09E-07	2.81E-07	2.88E-03	2.88E-03
	29	19,671	1.71E+02	8.55E+01	5.35E+00	8.70E-03	4.35E-03	2.72E-04	7.25E-07	8.05E-08	5.44E-04	5.45E-04
	31*	5,062	5.19E+03	5.27E+02	2.23E+00	1.03E+00	1.04E-01	4.41E-04	8.54E-05	1.93E-06	8.81E-04	9.68E-04
	33	25,406	1.56E+00	1.44E+00	7.64E-02	6.15E-05	5.66E-05	3.01E-06	5.12E-09	1.05E-09	6.01E-06	6.02E-06
	34	7208	1.08E+02	1.03E+05	6.85E+02	1.50E-02	1.42E+01	9.51E-02	1.25E-06	2.64E-04	1.90E-01	1.90E-01

* Trench 31 contains 1.42 Ci of radium-226, yielding a current concentration of 2.81×10^{-4} Ci/m^3, which is 0.67 mrem (a total fraction of 6.7×10^{-3}).

Table 7. Comparison of Dose or Flux Estimates with Performance Objectives

Performance Objective	Exposure Pathway	Estimated Dose or Flux* 200 West Area
25 mrem/yr	Groundwater, all pathways	0.4
4 mrem/yr	Groundwater, drinking	0.2
100 mrem/yr at 500 yr	Post-drilling intruder	1.8
20 pCi/m^2/s at 10,000 yr	Radon emission	0.3
10 mrem yr	Air contaminant	Nil

* All estimates are made assuming Category 3 conditions as the final state of the low-level burial grounds. Potential doses from current and projected inventory are summed. All projected inventory and associated dose is assumed to go into the 200 West Area low-level burial grounds. Units of measure of dose/flux values are the same as the corresponding performance objective.

2.5 Conclusions

This review concludes that disposal practices and waste inventories disposed in the active LLBGs, as of September 30, 2015, comply with performance objectives. The current waste disposal procedures and waste management practices are sufficient to maintain compliance with the performance objectives. None of the information presented in this report indicates that the PA must be changed to demonstrate compliance with DOE O 435.1 Chg 1. However, information collected across the Hanford Site on key assumptions affecting performance estimates (e.g., engineered barrier control of infiltration and rates and sorption of key radionuclides) over the last two decades suggests some substantially conservative assumptions in the currently approved version of the PA analysis. Thus, better facility performance is expected.

3 Review of Additional Research and Development Information Pertinent to Performance Assessment Assumptions and Analysis

During the reporting period (FY 2015), a set of experiments was initiated to evaluate the effect of carbonation depth on contaminant migration. For these tests, concrete monoliths (with and without metallic iron) were carbonated by soaking in a super-saturated sodium bicarbonate solution for varying lengths of time (i.e., 1 week, 3 months, and 6 months). Petrographic and cracking analysis of the 1-week and 3-month cores was completed at Materials and Chemistry Laboratory, Inc. (MCL, Inc.) to determine actual carbonation depths and extent of macro- and micro-cracking. Phenolphthalein was used as an indicator to establish the extent of carbonation within the concrete monolith. After exposure to the indicator solution, the specimens were documented by color photography and low-magnification optical microscopy. These measurements will be compared to the petrographic analysis of the 6-month and 9-month cores in FY 2016.

Additionally, compressive strength measurements using ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*, were made on concrete specimens that had been carbonated for varying lengths of time to evaluate the effect of carbonation on concrete stability.

During FY 2015, concrete monoliths carbonated for 1 week, 3 months, and 6 months were tested. The 9-month specimens were not done with the carbonation period prior to the end of FY 2015. Testing of those specimens will occur in FY 2016 and compared to FY 2015 results.

At the end of the 1-week, 3-month, and 6-month carbonation periods, sediment-concrete half-cells were prepared with unsaturated sediment spiked with iodine and technetium. Half-cell preparation was staggered as the carbonation period of monoliths was completed resulting in a staggered completion of half-cell experiments allowing all tests will have consistent test durations. In FY 2016, half-cell diffusion experiments will be initiated for the 9-month carbonated monoliths.

In FY 2015, sets of half-cell diffusion experiments, initiated in FY 2006 and FY 2008, with simulated waste concrete monoliths were opened and monolith characterization was initiated. The concrete monoliths used within the half-cells had been prepared with and without metallic iron and half were carbonated using a super-saturated carbonate solution. Upon opening, it was found that in half of the experiments the monoliths had crumbled. Diffusion of technetium, iodine, and uranium was quantified by sampling the half-cells and measuring technetium and uranium concentrations in water extracts using inductively coupled plasma-mass spectrometry and inductively coupled plasma-optical emission spectrometry. Additionally, selected monoliths were sent to MCL, Inc. for characterization. Carbonation and cracking analyses were completed. Techniques for phase identification included scanning electron microscopy with associated energy dispersive spectrometry and X-ray diffraction.

4 Environmental Monitoring

Monitoring of water and air for contaminants, both radiological and chemical, is an ongoing program that occurs across the Hanford Site. In certain locations, vadose zone characterization is also being conducted, primarily at remediation sites and soil columns contaminated by tank leaks. Groundwater monitoring wells and air sampling stations are present near the 200 West Area LLBGs that are routinely monitored for contaminants as part of the Hanford Sitewide monitoring program. With respect to the requirements of DOE O 435.1 Chg 1, particular attention is paid to the following mobile contaminants: technetium-99, uranium, iodine-129, and tritium. In this program, the 200 West Area LLBGs are divided into two monitoring groups or low-level waste management areas (LLWMAs): LLWMA-3 (218-W-3, 218-W-3AE, and 218-W-5) and LLWMA-4 (218-W-4C). Summary documents are issued annually that describe and interpret the collected information. The latest summary of groundwater monitoring information (DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2014*) describes data collected in calendar year (CY) 2014 (i.e., from January 1, 2014, through December 31, 2014). The groundwater monitoring program maintains a real-time database that is updated as well samples are collected and analyzed. Data from these sources are summarized in the following subsections: LLWMA-3 (Section 4.1) and LLWMA-4 (Section 4.2). The reporting period for the groundwater monitoring program is by CY, so the following information reported by LLWMA is for CY 2014, representing the latest available information for purposes of this FY 2015 annual summary report.

4.1 Low-Level Waste Management Area 3

Groundwater monitoring of the well network at LLWMA-3 (Figure 4), within the 200-ZP-1 Groundwater OU in the 200 West Area, continued during CY 2014 under *Resource Conservation and Recovery Act of 1976* (RCRA) and *Atomic Energy Act of 1954* (AEA) requirements (DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*). Because the wells are RCRA monitoring wells, the network is screened at the water table. Because of water level declines, the only previously upgradient well on the western side of the waste management area (WMA) (299-W9-1) went dry in 2000. DOE drilled and installed a new upgradient well (299-W9-2) in 2011. The 200 West Area pump and treat

(P&T) system is impacting local gradients substantially, including notably injection wells located near Trenches 31 and 34. Evaluation of these gradients is in progress to revise local monitoring plans.

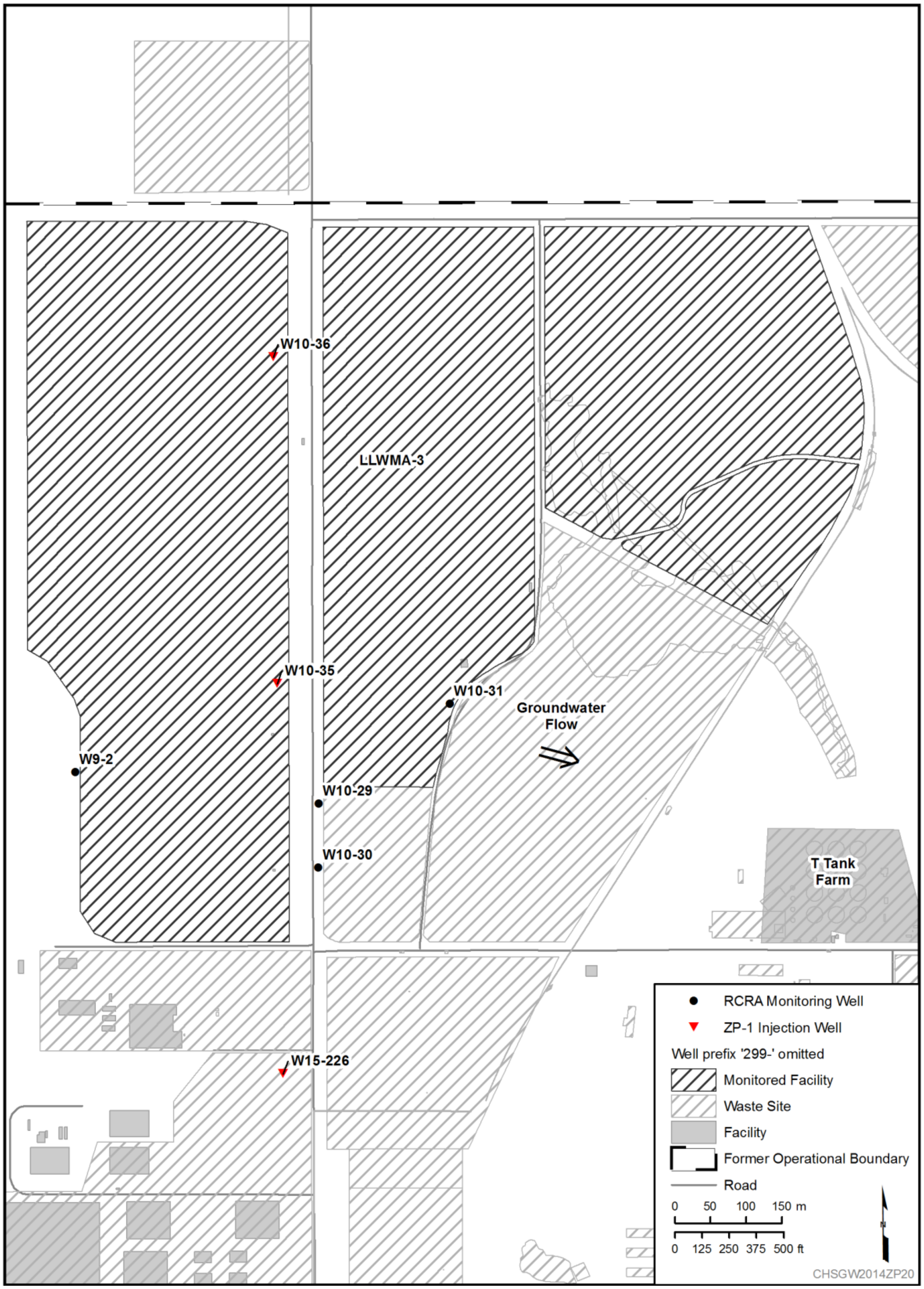
DOE monitors the LLWMAs for AEA radionuclides, as described in DOE/RL-2015-56, *Hanford Atomic Energy Act Sitewide Groundwater Monitoring Plan*. Iodine-129, technetium-99, and uranium are monitored semiannually in the three downgradient wells. Iodine-129 was undetected, and technetium-99 was at detection level in all three wells. Uranium was detected in all of the wells, with a maximum concentration of 1.40 µg/L (background) in 299-W10-31. No radionuclides were detected at concentrations above the drinking water standard (DWS). Based on the results, there is no evidence of LLWMA-3 contaminating groundwater downgradient of the WMA.

4.2 Low-Level Waste Management Area 4

Groundwater monitoring of the well network at LLWMA-4 (Figure5), within the 200-ZP-1 OU in the 200 West Area, continued during CY 2014 under RCRA and AEA requirements (DOE/RL-2009-69, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-4*). The monitoring network at LLWMA-4, within the 200-ZP-1 OU in the 200 West Area, includes six downgradient wells and one upgradient well (299-W18-22). The well network complies with RCRA groundwater monitoring requirements. Upgradient Wells 299-W15-15 and 299-W18-23 went sample dry in 2008. Upgradient Well 299-W18-21 also went sample dry in CY 2011, but water levels have risen in the area, which will allow sampling of this well to continue. Upgradient Well 299-W18-22 (screened at the bottom of the unconfined aquifer) is located at the southwestern corner of LLWMA-4 and currently is not truly upgradient; the well was upgradient until the 200-ZP-1 OU interim P&T system began injecting water into five injection wells located just west (upgradient) of the LLWMA. This injection caused groundwater to flow toward the southeast at the location of this well. No new wells are expected to be drilled at LLWMA-4 until the effects of the 200 West P&T system are known.

Except for the upgradient well and downgradient, deep-screened Well 299-W15-17, all of the wells in the network are screened across the water table. These water table wells have adequate water columns in the screened interval (from 4 to 8 m [13 to 26 ft]) available for sampling.

Similar to other LLWMAs, DOE monitors for AEA radionuclides, as described in DOE/RL-2015-56 and in DOE/RL-91-50, *Hanford Site Environmental Monitoring Plan*. In CY 2013, iodine-129, technetium-99, and uranium were monitored semiannually at LLWMA-4. Iodine-129 was undetected in all wells, technetium-99 was undetected in Wells 299-W15-17 and 299-W18-22 and detected at very low levels in the remaining five wells (maximum detected was 240 pCi/L in 299-W15-152), and uranium was detected in all wells with a maximum of 2.13 µg/L in Well 299-W15-152. Detection of technetium-99 is consistent with observed levels in the aquifer and does not indicate contamination from LLWMA-4. No radionuclides were present in LLWMA-4 wells above the DWS during CY 2014.



Source: DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014* (Figure 12-27).

Figure 4. Groundwater Monitoring Well Locations at LLWMA-3

Source: DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014* (Figure 12-28).

Figure 5. Groundwater Monitoring Well Locations at LLWMA-4

5 Summary of Current and Projected Changes

The purpose of this chapter (in accordance with DOE M 435.1-1 Chg 1) is to identify any changes in facility operations, waste receipts, waste form behavior, monitoring data, research and development data, or land-use decisions over the reporting period that have affected PA assumptions and conclusions. If such changes exist, their potential impacts are to be assessed, and recommended changes that are needed to address the impact of the reported changes are to be identified.

In this reporting period (FY 2015), no changes have occurred that have caused substantive changes in disposal facility operations, disposal facility performance, and PA assumptions or results. Research efforts to understand the mobility of radionuclides in concrete encasement under unsaturated conditions continue to reduce uncertainty in PA inputs, indicating that embedded assumptions are conservative. Groundwater monitoring activities will continue on a routine basis. Despite the lack of change in significant impacts, the potential need for a revision to the PA analysis should be evaluated, given the length of time that has elapsed since completion and acceptance of the current PA analysis. Through FY 2012, any revision of the LLBG PAs was deferred, awaiting issue of the Final TC&WM EIS (DOE/EIS-0391), which was issued on November 21, 2012. DOE issued formal direction (Williams, 2012) specifying how modeling may be performed to support regulatory compliance efforts at the Hanford Site under a phased approach meant to ensure consistency with the modeling that supports the Final TC&WM EIS.

Two documents (Wood, 1997, *Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses*; DOE/RL-2000-70, *Closure Plan for Active Low-Level Burial Grounds*) may require updating because of the time that has elapsed since completion and acceptance of the initial PA analysis. Both maintenance and closure activities will be strongly affected by *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remediation efforts for past-practice burial grounds and trenches. This is particularly the case for the unlined trenches that received DOE O 435.1 Chg 1 waste, have been retired permanently, and could begin the closure process. These trenches are intermingled with past-practice trenches such that their closure will be essentially directed by the CERCLA remediation process. Development of the CERCLA remediation process is ongoing and will eventually enter the public comment phase. Once the development process has matured and the effects of remediation decisions for past-practice units on unlined trench closure actions have been clarified, any necessary additional DOE O 435.1 Chg 1 closure actions can be identified, and the maintenance and closure plans will require updates.

During this reporting period (FY 2015), there are no current outstanding information needs (e.g., data gaps and uncertainties) identified in the 200 West Area PA, the subsequent addendum, or previous annual reviews.

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