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Annual Summary of the Integrated Disposal Facility Performance Assessment 2011

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
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Revision 1

Annual Summary of the Integrated Disposal Facility Performance Assessment 2011

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

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Executive Summary

An annual summary of the adequacy of the Hanford Immobilized Low-Activity Waste (ILAW) Performance Assessment (PA) is required each year (DOE O 435.1 Chg 1,[1] DOE M 435.1-1 Chg 1,[2] DOE/ORP-2000-01[3]). The most recently approved PA is DOE/ORP-2000-24.[4] The ILAW PA evaluated the adequacy of the ILAW disposal facility, now referred to as the Integrated Disposal Facility (IDF), for the safe disposal of vitrified Hanford Site tank waste. More recently, a preliminary evaluation for the disposal of offsite low-level waste and mixed low-level waste was considered in RPP-15834.[5]

The first phase of the IDF construction was completed on April 28, 2006 and included the installation of the cell liners and leachate collection tanks. The IDF is now in a pre-active life mode and will not receive treated tank waste for several years. The actual date when the IDF is scheduled to open is expected to be established soon. In view of these circumstances, the Resource Conservation and Recovery Act of 1976 (RCRA)[6] Permit for the IDF has been modified to recognize that the facility will not be receiving waste in the near future. A subsequent modification indicated the transfer of the IDF from the U.S. Department of Energy (DOE) Office of River Protection (DOE-ORP) operations to the DOE Richland Operations Office (DOE-RL).

Plans for the IDF PA envision a scoping process to begin as early as calendar year 2012. This scoping will build on the experience and knowledge gained from a similar scoping process undertaken for the Hanford Single-Shell Tank System Waste Management Area C PA that was largely completed in 2011 but is not funded for fiscal year (FY) 2012. Once the IDF scoping process is completed, the record of decision for the

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[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 M 435.1 1 Chg 1, 1999, 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/viewhttps://www.directives.doe.gov/directives/current-directives/435.1-DManual-1c1/view.

[3] DOE/ORP-2000-01, 2004, Maintenance Plan for the Hanford Immobilized Low Activity Tank Waste Performance Assessment, Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

[4] 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 (Section 1 of 2) and http://www5.hanford.gov/arpir/?content=findpage&AKey=D8862892 (Section 2 of 2).

[5] RPP-15834, 2003, Integrated Disposal Facility Risk Assessment, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www.hanford.gov/docs/gpp/fieldwork/ilaw/RPP15834.pdf.

[6] Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/lawsregs/laws/rcra.htmlhttp://epw.senate.gov/rcra.pdf.

final Tank Closure and Waste Management Environmental Impact Statement is issued, and following delivery by DOE-ORP of the necessary computer codes to DOE-RL, modeling runs can be undertaken.

Preliminary waste acceptance criteria were developed for the IDF in RPP-8402,[7] and were approved by DOE-ORP on July 5, 2002 (DOE Letter 02-REQ-029[8]). Given that the final waste forms are not yet established, final waste acceptance criteria, closure plans, and other DOE M 435.1-1 and RCRA documentation requirements will be prepared after the IDF PA is completed.

Results of data collection and additional analyses do not change the conclusions of the 2001 ILAW PA with respect to ILAW disposal.

[7] RPP-8402, 2002, *Waste Acceptance Criteria for the Immobilized Low-Activity Waste Disposal Facility*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/pdwdocs/fsd0001/osti/2002/l0038165.pdf.

[8] 02-REQ- 029, 2002, RE: Contract Number DE AC27 99RL14047 – "Transmittal of Waste Acceptance Criteria, Immobilized Low Activity Waste (ILAW) Disposal Facility, RPP 8402, Rev. 0 for Approval", (letter to E.S. Aromi, CH2M HILL Hanford Group, Inc., from R.J. Schepens, (Manager, Office of River Protection) to E.S. Aromi (President of CH2M HILL Hanford Group, Inc.), Office of River Protection, U.S. Department of Energy, Office of River Protection) Richland, Washington, July 5, 2002.

Contents

Figures

Tables

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Terms

COC	contaminant of concern
CY	calendar year
DOE	U.S. Department of Energy
DOE-ORP	DOE Office of River Protection
DOE-RL	DOE Richland Operations Office
DWS	drinking water standard
EIS	environmental impact statement
eSTOMP	parallel implementation of Subsurface Transport Over Multiple Phases (STOMP) (software)
ETF	Effluent Treatment Facility
FBSR	fluidized bed steam reforming
HOP	high-level melter offgas treatment process
FY	fiscal year
IDF	Integrated Disposal Facility
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
LAW	low-activity waste
LDR	land disposal restrictions
LLW	low-level waste
LVP	LAW Facility secondary offgas/vessel vent process system
MLLW	mixed low-level waste
PA	performance assessment
PCT	product consistency test
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium-Uranium Extraction (Plant)
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	record of decision
SRNL	Savannah River National Laboratory
STOMP	Subsurface Transport Over Multiple Phases (software)

STORM	Subsurface Transport Over Reactive Phases (software)
TC&WM EIS	Tank Closure and Waste Management Environment Impact Statement
TCLP	toxicity characteristic leaching parameter
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WTP	Waste Treatment Plant

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 M 435.1-1 Chg 1, *Radioactive Waste Management Manual* and DOE/ORP-2000-01, Rev. 1, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment*, the DOE Richland Operations Office (DOE-RL), has prepared this annual status report for fiscal year (FY) 2011 for the most recently approved Performance Assessment (PA), DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*. The Immobilized Low-Activity Waste (ILAW) PA evaluated the adequacy of the ILAW disposal facility, now referred to as the Integrated Disposal Facility (IDF), for the safe disposal of vitrified Hanford Site tank waste. More recently, a preliminary evaluation for the disposal of offsite low-level waste (LLW) and mixed low-level waste (MLLW) was considered in RPP-15834, *Integrated Disposal Facility Risk Assessment*.

1.1 Facility Description

Reprocessing of irradiated nuclear reactor fuel for the production of special nuclear materials at the Hanford Site in southeastern Washington created a large amount of mixed radioactive hazardous waste currently stored in underground tanks. The DOE intends to separate these wastes into two main streams: a low-activity waste (LAW) fraction and a high-activity waste fraction. Both streams will be vitrified to make ILAW and immobilized high-level waste (IHLW) forms. ILAW is planned for disposal in the IDF on the Hanford Site, while IHLW will be stored onsite and eventually shipped offsite for disposal in a high-level waste repository. This document deals only with the disposal of ILAW in the IDF.

The IDF is located in the 200 East Area of the Hanford Site on what is known as the Central Plateau (Figure 1-1). Figure 1-2 shows a pre-excavation aerial photograph of the southeast quadrant of the 200 East, with the exact location of the IDF indicated in the image. The IDF consists of two disposal areas called cells, although the facility can be expanded as needed to a total capacity of six cells (Figure 1-3). One of these cells is designed to accept mixed low-level wastes, possibly including the treated low-level/low-activity waste that will have gone through the vitrification process at Hanford's Waste Treatment Plant (WTP). The second cell is being considered to accept LLW that has come from Hanford Site cleanup activities, but did not go through the WTP. The IDF is approximately 457 m (1,500 ft) wide by 233 m (765 ft) long by 12.8 m (42 ft) deep for the "first expansion" with a capacity of nearly 165,000 m^3 (215,000 yd^3). The design includes two *Resource Conservation and Recovery Act of 1976* (RCRA)-compliant leachate collection systems designed to catch any liquid that may seep through the waste, so that it will not have any possibility of contaminating the soil beneath the disposal cells. Once liquid reaches this liner, it is removed and taken to a facility where the liquid is treated, the contaminants removed, and the liquid is then able to be safely returned to the soil. The landfill liner system will comply with RCRA requirements for hazardous waste landfills. The IDF is designed to allow for future expansion. Each future liner construction project will connect to the previously constructed liner. The disposal landfill cover will be designed and located to satisfy the dangerous waste disposal requirements once a decision is made to construct the final cover over the landfill.

The first phase of IDF construction was completed on April 28, 2006 and included the installation of the cell liners and leachate collection tanks. The IDF is now in a preoperational maintenance mode and will not receive treated tank waste for several years. In view of these circumstances, the RCRA Part B Permit for the IDF has been modified to recognize that the facility will not be receiving waste in the near future. A subsequent modification indicated transfer of the IDF from the U.S. Department of Energy-Office of River Protection (DOE-ORP) operations to the DOE Richland Operations Office (DOE-RL).

The engineered surface barrier for the IDF has not yet been designed. The current pre-conceptual design is a modified RCRA Subtitle C compliant barrier with a 5 percent slope for the asphalt layer and a capillary break beneath the asphalt layer. The surface barrier will have a 2 percent slope. The final design will be described in the closure plans.

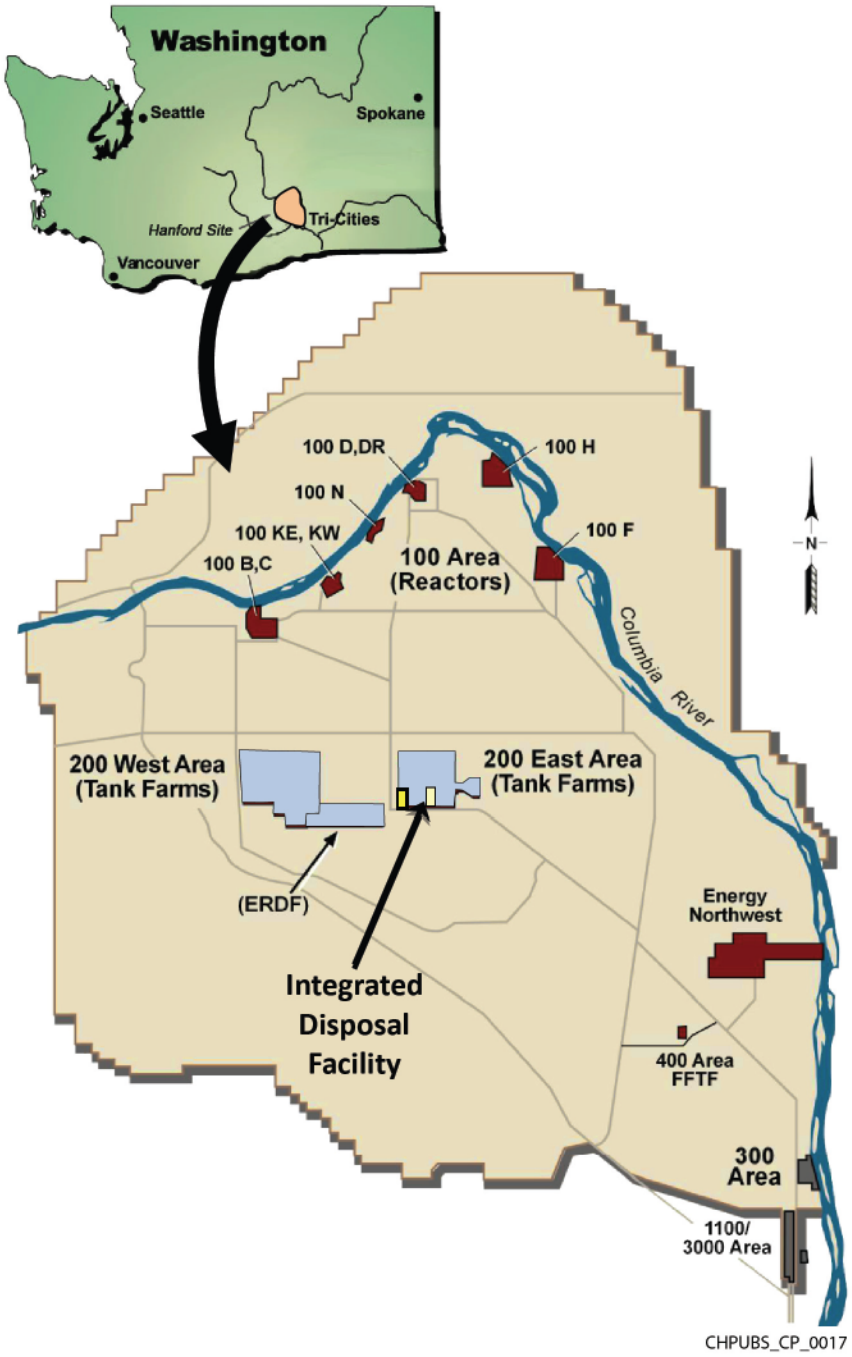
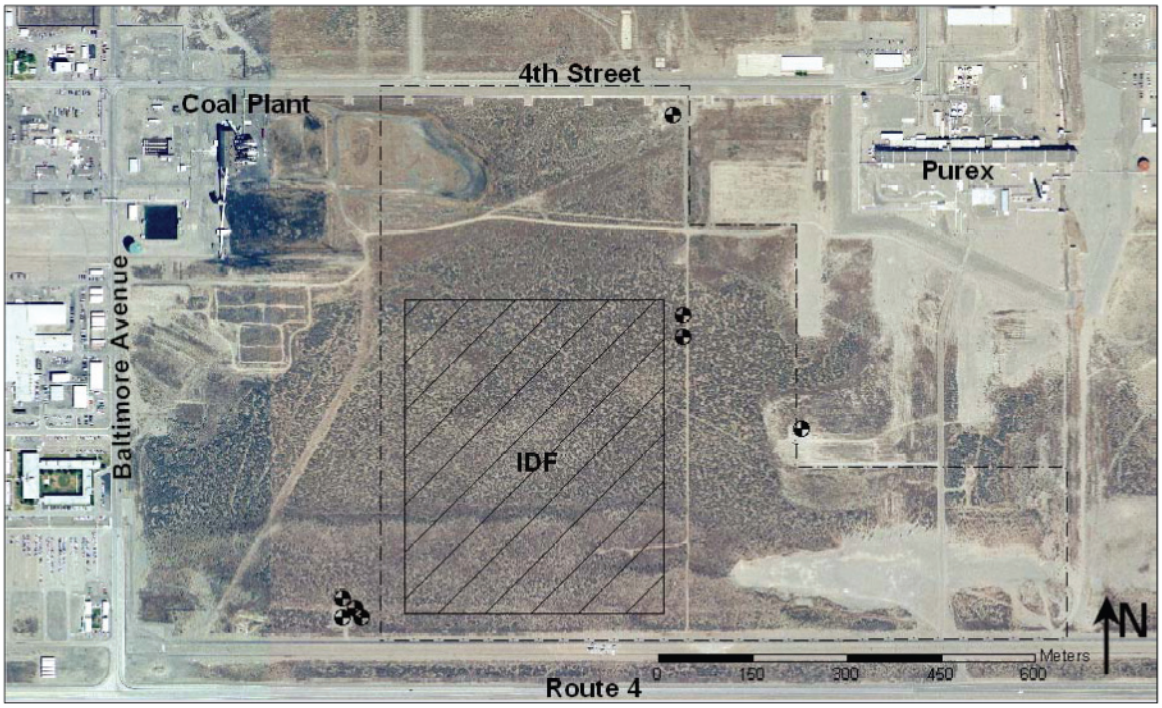


Figure 1-1. Location of Integrated Disposal Facility (IDF)



Source: Fluor Hanford, Inc. Central Mapping, 2002.

Figure 1-2. Location of the Integrated Disposal Facility within the Southeast Corner of the 200 East Area

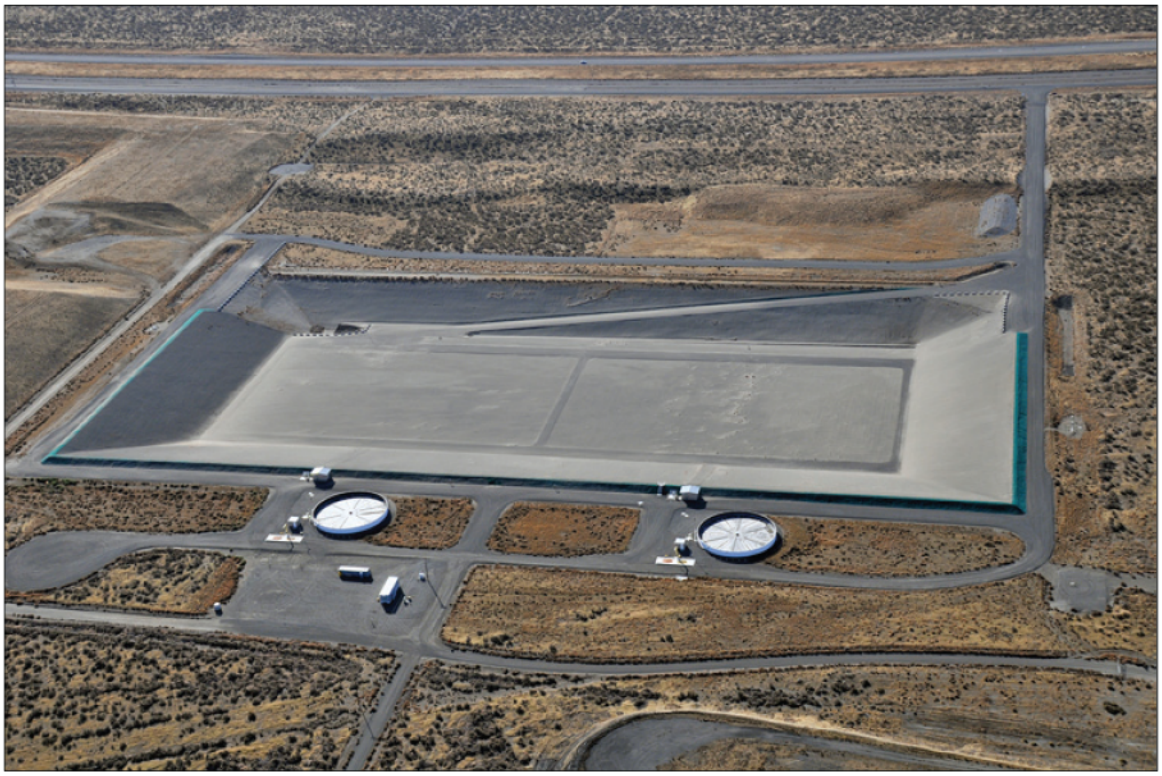


Figure 1-3. Photograph of the Integrated Disposal Facility "First Expansion" (Current Configuration)

1.2 Performance Assessment Maintenance

The IDF will be operated as an LLW disposal facility. To receive DOE authorization to dispose of waste in the IDF, an approved PA analysis is required for both its construction and operation per DOE M 435.1-1 Chg 1. The PA analysis evaluates potential environmental impacts and associated health impacts caused by the release of radioactive contaminants from the disposal facility. The estimated health impacts are compared against performance objectives in DOE M 435.1-1 and, if the estimated impacts are below those set forth in DOE M 435.1-1, disposal authorization from DOE can be granted. Two PA analyses (DOE/RL-97-69, *Hanford Immobilized Low-Activity Tank Waste Performance Assessment*; DOE/ORP-2000-24) have been completed that permitted construction of the facility and evaluated the facility's performance assuming disposal of the proposed vitrified waste material. Both analyses estimated that adequate performance can be achieved. They were accepted by DOE, and disposal authorization statements were issued (Scott, 2001, "Disposal Authorization for the Department of Energy Hanford Site Low-Level Radioactive Waste Disposal Facilities – Revision 2").

Since issuance of the 2001 PA analysis, disposal of other LLW and MLLW is also being considered at the IDF. Potential environmental impacts from LLW and MLLW disposal in the IDF are being evaluated in the Tank Closure and Waste Management (TC&WM) Environmental Impact Statement (EIS), which was released in draft (DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*) on October 30, 2009, for a 140-day public comment period. A PA revision will incorporate these wastes as part of the facility inventory in the analysis. Also, alternate waste material treatment is being considered in addition to vitrification. If such waste forms become viable, their performance will also be evaluated in a revised IDF PA.

This annual summary is the latest of a series of annual summaries prepared since 2001 (see Table 1-1) that are generated as part of the IDF PA maintenance program (DOE/ORP-2000-01, Rev. 0 and Rev. 1) as required under DOE M 435.1-1. The format for this annual summary follows that required by the maintenance plan as directed by the DOE guidance on PA maintenance plans (DOE, 1999, *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*). The annual summaries through FY 2008 (refer to Table 1-1) were approved by the DOE-ORP Field Manager (e.g., DOE Letter 05-TPD-016, The U.S. Department of Energy (DOE), Office of River Protection (ORP) Submittal of the Annual Summary of the Integrated Disposal Facility (IDF) Performance Assessment for 2004 and Supporting Documents"). The annual summaries starting with FY 2009 have been approved by the DOE-RL Field Manager (e.g., DOE Letter 10-AMCP-0071, "Contract No. DE-AC06-08RL14788 – Annual Reporting for the Hanford Site Composite Analysis, the Integrated Disposal Facility Performance Assessment, and the 200 West And 200 East Performance Assessments For 2009"). This annual summary for FY 2011 compares new data collected during FY 2011 with DOE/ORP-2000-24, which has been approved by DOE (Frei, 2003, "Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version DOE/ORP-2000-24, Rev. 0"). Most of the data collected during FY 2011 pertained to groundwater monitoring or to research on long-term contaminant release from ILAW packages to be made at the WTP. Additionally, a contract to evaluate secondary waste form performance was continued.

1.3 Composite Analysis Maintenance

DOE O 435.1 requires a composite analysis to support a PA. The approved composite analysis for LLW at the Hanford Site is presented in PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, and its Addendum, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*. That composite analysis supports multiple PAs and 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 in compliance with the requirements of DOE M 435.1-1. The composite analysis annual summary for FY 2011 is presented in DOE/RL-2011-108, *Annual Status Report (FY 2011); Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site.*

Table 1-1. Maintenance Documents for the Integrated Disposal Facility Performance Assessment

Reporting Period	Document
FY 2000	DOE/ORP-2000-01, Rev. 0, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment*
FY 2001	DOE/ORP-2000-19, Rev. 0, *Annual Summary of ILAW Performance Assessment*
FY 2002	DOE/ORP-2000-19, Rev. 2, *Annual Summary of ILAW Performance Assessment for 2002*
FY 2003	DOE/ORP-2000-19, Rev. 3, *Annual Summary of the Immobilized Low-Activity Waste Performance Assessment for 2003, Incorporating the Integrated Disposal Facility Concept*
FY 2004	DOE/ORP-2000-01, Rev. 1, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment*
	DOE/ORP-2000-19, Rev. 4, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2004*
FY 2006	DOE/ORP-2000-19, Rev. 5, *Annual Summary of Integrated Disposal Facility Performance Assessment for 2006*
FY 2007	DOE/ORP-2000-19, Rev. 6, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2007*
FY 2008	DOE/RL-2009-47, Rev. 1, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2008*
FY 2009	DOE/RL-2009-131, Rev. 1, *Annual Summary of the Integrated Disposal Facility Performance Assessment 2009*
FY 2010	DOE/RL-2010-121, Rev. 0, *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2010*
FY 2011	DOE/RL-2011-109 (this report), *Annual Summary of the Integrated Disposal Facility Performance Assessment for 2011*

DOE is deferring updates to the composite analysis until it issues a record of decision (ROD) for the final TC&WM EIS. An updated composite analysis would include the IDF Facility. While updates of the composite analysis are deferred, annual status reports are being completed in accordance with the composite analysis maintenance plan (DOE/RL-2000-29).

1.4 Preliminary Closure Plan

Several revisions have also been made to the Preliminary Closure Plan for the ILAW facility, including RPP-6911, Rev. 0 and Rev. 1, *Preliminary Closure Plan for the Immobilized Low-Activity Waste Disposal Facility*, and RPP-21633, *Preliminary Closure Plan for the Integrated Disposal Facility*. These closure plans were prepared in accordance with "Format and Content Guide for U.S. Department of

Energy Low-Level Waste Disposal Facility Closure Plans." These closure plans will be updated periodically and prior to accepting waste in the facility.

1.5 Preliminary Waste Acceptance Criteria

Preliminary waste acceptance criteria were developed for the IDF in RPP-8402, *Waste Acceptance Criteria for the Immobilized Low-Activity Waste Disposal Facility*, and were approved by DOE-ORP on July 5, 2002 (DOE Letter 02-REQ-029, "Transmittal of Waste Acceptance Criteria, Immobilized Low Activity Waste (ILAW) Disposal Facility, RPP 8402, Rev. 0 for Approval"). Because the final waste forms are not yet established, final waste acceptance criteria, closure plans, and other DOE M 435.1-1 and RCRA documentation requirements will be prepared after the IDF PA is completed.

2 Program Developments

The disposal authorization statement (DOE Memorandum, 2001) imposes the following facility-specific condition on the IDF:

> *A detailed design for the Immobilized Low-Activity Tank Waste disposal facility is not yet available. Since the 1998 Immobilized Low-Activity Tank Waste Performance Assessment, the design of the facility has been changed from underground concrete vaults to trenches. The current designs have the disposal facility as a series of large, covered trenches containing glass waste forms from the vitrification of low-activity waste from treatment of Hanford tank waste. This combination of disposal unit and waste form has been analyzed in the 2001 Hanford Immobilized Low-Activity Tank Waste performance assessment. The design feature of each disposal unit constructed in the field shall conform to the design limits derived from the conceptual models used in the performance assessment or special analysis. Any changes in disposal technology, disposal unit or waste form must be analyzed according to the performance assessment and composite analysis maintenance plans & and approved by DOE.*

Construction to date has conformed to this condition. Changes in waste form are being analyzed in the research and development program (Chapter 5).

As part of Hanford Site contract changes due to contract transition on October 1, 2008, a modification to the RCRA Part A Permit Application transferred the facility from DOE-ORP to the DOE-RL. In FY 2010, a permit modification removed the specific date for the delivery of the IDF PA and the Risk Budget Tool to be as soon as possible after the issuance of the final TC&WM EIS, but no later than 180 days prior to the disposal of waste.

There were no program developments for the IDF PA in FY 2011.

3 Changes in Operations, Waste Receipts, or Analyses

There have been no waste receipts during FY 2011 because the IDF has not begun facility operations. RPP-20692, *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment* provides the estimated inventory to be disposed of in the IDF. Additional inventory information was published in the draft TC&WM EIS (DOE/EIS-0391) in 2009. No new analyses were undertaken or completed in FY 2011.

4 Monitoring

The initial preoperational monitoring plan (RPP-6877, *Integrated Disposal Facility Preoperational Monitoring Plan*) has been issued and approved (00-PRD-071 [0005748], 2000, "Approval and Implementation of the Hanford Site Remote-Handled Immobilized Low-Activity Waste (ILAW) Disposal Facility Preoperational Monitoring Plan"). It called for drilling groundwater monitoring wells and subsequent monitoring per RCRA requirements. A revision (RPP-PLAN-26534, *Integrated Disposal Facility Operational Monitoring Plan to Meet DOE Order 435.1*) was issued to cover operational monitoring and was approved (DOE Letter 05-TPD-016). The revised plan also calls for monitoring of air resources and the identification of any vadose zone contamination. All eight groundwater wells for IDF have been completed. The preoperational monitoring plan has been implemented.

In July 2010, the frequency of sampling required by the RCRA Permit was reduced from twice a year to once a year with the number of samples being reduced from eight to one. This is because no waste is planned to be disposed for several years and no contaminants other than those expected from regional activities have been detected. DOE will evaluate the need for, and a location of, new downgradient wells. New wells will be installed, as needed, at least one year before the IDF receives waste. Sampling and analysis will be increased to quarterly (or eight times per year if groundwater chemistry changes during pre-active life) at least one year prior to the IDF receiving waste to establish background conditions and for compliance monitoring after the background level is established.

The Hanford Site Groundwater Monitoring Report for calendar year (CY) 2010 (DOE/RL-2011-01, *Hanford Site Groundwater Monitoring and Performance Report for 2010*) provides the latest monitoring results available for the FY 2011 reporting period (due to the lag in publication dates). DOE/RL-2011-01 indicated that there were a total of seven wells in the IDF water level network and semiannual samplings were collected during CY 2010. The report further stated that in 2011 sampling would be reduced to annually 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 network is no longer considered adequate. A revised monitoring network has been provided in a plan that is undergoing review by the Washington State Department of Ecology. The average groundwater flow direction is to the east at 80 degrees (± 17 degrees).

Previous discharges from Hanford Site operations, primarily liquid discharges to cribs associated with the Plutonium-Uranium Extraction (PUREX) Plant have impacted groundwater underneath the IDF. Although these cribs are currently downgradient from the proposed disposal site, the plumes from these cribs hydraulically spread upgradient to locations underneath the proposed disposal site due to hydraulic pressures caused by the large volumes of liquids disposed in the cribs. Crib-derived groundwater contamination levels from contaminants of concern (COCs) (mainly tritium, iodine-129, and nitrate) were found in CY 2009 sampling results. In CY 2010, nitrate in the wells at the IDF exceeded the drinking water standards (DWSs) of 45 mg/L, and the results are comparable to previous years. The maximum nitrate concentration was 68.6 mg/L in Well 299-E24-24. This well is located to the west of the IDF in the regional 200 East Area nitrate plume that is presumed to originate from the PUREX cribs east of the IDF.

5 Research and Development

The disposal authorization statement (DOE Memorandum, 2001) notes that the detailed design for this disposal facility is not yet available and requires that

> *The Immobilized Low-Activity Tank Waste disposal facility glass waste form characteristics were important assumptions used in the performance assessment to demonstrate compliance with performance criteria; As a result of the need for short and long term waste form integrity it is imperative that appropriate and sufficient glass testing, including product consistency tests, be carried out prior to disposal to confirm that the assumptions used in the performance assessment are representative of the final waste form.*

The IDF PA research and development activities for FY 2011 are described in Sections 5.1 (Glass Dissolution Rate Research), 5.2 (Supplemental Immobilization Waste Form Research), and 5.3 (Secondary Liquid Waste Form Testing).

5.1 Glass Dissolution Rate Research

The ILAW glass testing program is conducting experimentation and modeling to provide the technical basis for estimating radionuclide releases from the ILAW glass waste form (i.e., borosilicate glass melted at 1100 to 1200°C) to support future IDF PAs. The program is being conducted as part of the IDF PA maintenance plan (DOE/ORP-2000-01, Rev. 1), which is intended to allow for IDF PA revisions to reflect new scientific information that reduces the technical uncertainty associated with critical aspects of the IDF PA. The emphasis in FY 2011 was on transitioning from the use of the Subsurface Transport Over Reactive Multi-phases (STORM) code (PNNL-14783, *Subsurface Transport Over Reactive Multiphases (STORM): A Parallel, Coupled, Nonisothermal Multiphase Flow, Reactive Transport, and Porous Medium Alteration Simulator, Version 3.0 User's Guide*) to instead using the Subsurface Transport Over Multiple Phases (STOMP) 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*). This transition requires that the STORM code's reactive transport capabilities be incorporated into STOMP for near-field calculations. The STORM code was used in previous PAs before DOE O 414.1D, *Quality Assurance*, was applicable. This STORM code was never qualified as safety software under that Order. In contrast, STOMP has been qualified as safety software under DOE O 435.1 Chg 1 by Pacific Northwest National Laboratory (PNNL) through a rigorous testing program (PNNL-SA-54022, *STOMP Software Test Plan*). This qualification process included STOMP-W-R, the water-reactive-transport operational mode of STOMP.

In FY 2011, a STOMP simulation was developed that incorporated the geochemical reaction network needed to model the weathering of the glass. The reaction network includes the kinetic reactions, equilibrium reactions, mineral species, and aqueous species used previously in the STORM sensitivity analysis base case. A one-dimensional simulation was used for the initial STOMP modeling framework development. This one-dimensional model was successfully benchmarked against the previous STORM model. These modifications must next be incorporated into the parallel processing version of STOMP (eSTOMP) and validated to meet the demands for more complex modeling required for the revised IDF PA.

The laboratory scale experiments (single-pass flow-through, pressurized unsaturated flow, and product consistency tests [PCT]) are being used to develop kinetic rate law parameters and to determine the type of alteration products that form as the glass corrodes over time.

The STOMP code requires as input a series of reaction networks leading to the secondary phases that form during the weathering of the ILAW glasses. Geochemical modeling is being conducted to determine the reaction network. PCT data for 128 glasses were used in the geochemical modeling effort. For a majority of these glasses, a secondary-phase reaction network previously developed for an ILAW glass produced good model fits for the major glass components. There were some exceptions and alternative secondary-phase reaction networks were proposed for these cases (PNNL-20781, *Integrated Disposal Facility Glass Testing FY 2011 Summary Report*).

5.2 Supplemental Immobilization Waste Forms

Work was performed in FY 2011 to generate data to support selection of a potential alternate waste form for Supplemental Immobilization of Hanford LAW. This work ultimately supports Tri-Party Agreement (Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*) Milestone M62-40, which calls for a one-time Hanford Tank Waste Supplemental Treatment Technologies Report to include waste form performance data (compared against the performance of borosilicate glass) for the treatment technologies being considered. Technologies considered in addition to borosilicate glass include bulk vitrification, fluidized bed steam reforming (FBSR), and cast stone. In late FY 2010, DOE recognized that the FBSR waste form had the least amount of waste form performance data available of the technologies being considered and initiated a program to evaluate the technology with samples of actual Hanford 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. Longer term performance tests, i.e., Single-Pass Flow-Through and Pressurized Unsaturated Flow, 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 to confirm results from previous tests) and to determine the type of alteration products that form as the waste form corrodes over time. The data from these tests will be used with the STOMP 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 will continue in FY 2012.

5.3 Secondary Liquid Waste Form Testing

The LAW at Hanford will be vitrified in a joule-heated ceramic melter to produce a stable product for disposal. Technetium is an important radioactive component in the Hanford tank waste because of its high mobility in the environment and 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 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 fluidized bed steam reforming 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 four 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 was a multi-faceted approach to waste form testing, which included performing screening tests on the monolithed fluidized bed steam reforming product and optimization testing on the three low-temperature solidification waste forms. Optimized waste form formulations were used for performing waste acceptance testing on test samples of Ceramicrete, DuraLith, and Cast Stone to determine performance in the toxicity characteristic leaching procedure (TCLP), compressive strength, 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 provide short-term leach data that can be used to understand long-term waste performance. Also, 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.

The other part of Phase 2 testing focused on radionuclide retention studies and data package preparation. The radionuclide tests were aimed at determining how each waste form holds on to or encapsulates the waste, and 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 have 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.

The data from Phase 2 were presented to the same expert panel that was convened in Phase 1. The panel provided their assessment of the waste forms and recommendations for follow-on Phase 3 testing and development work.

6 Summary of Changes

There are no standing key or secondary issues with regard to the IDF PA.

There have been major programmatic changes in this activity since the IDF PA was prepared in 2001. These were reported in the previous annual summaries (DOE/ORP-2000-19; DOE/RL-2009-47) and are repeated here for convenience:

The decision from the ROD for the Hanford Solid Waste EIS to create one integrated disposal site at Hanford at the former ILAW site.

The potential of immobilizing LAW using different processes other than vitrification at the WTP. The decision as to which waste forms to place in production has not yet been made. However, the current Disposal Authorization Statement does not include the new waste forms and will necessitate revisiting the current Disposal Authorization Statement.

An inner industrial exclusive use zone has been defined in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* and associated ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement [HCP EIS]"), and the 2008 supplemental analysis (DOE/EIS-0222-SA-01, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement)* and associated ROD (73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement"). According to the final ROD for the Supplement Analysis (73 FR 55824), exclusive use zones will shrink and migrate inward to the Central Plateau as the cleanup mission progresses.

As a result of the creation of the TC&WM EIS, there will be no further action on the 2005 IDF PA. After the ROD for the TC&WM EIS is issued, a revised IDF PA will be prepared. The scoping process for development of the revised IDF PA is planned to begin as early as FY 2012.

The TC&WM EIS utilizes the MODFLOW software (Harbaugh, et al., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process) for saturated zone flow simulation together with a particle tracking method for contaminant transport simulation. Flow and transport in the unsaturated zone is modeled using the STOMP software. Use of the MODFLOW and STOMP simulation software has been required for groundwater and vadose zone assessments, respectively, at the Hanford Site since 2006 (e.g., Klein, 2006, "MEMO: Contract No. DE-AC06-96RL13200 - Hanford Groundwater Modeling Integration"). All previous IDF PAs have used the VAM-3D software (HydroGeoLogic Inc., 1992) to simulate groundwater flow and transport and coupled this with use of the STORM software for reactive chemistry and glass dissolution simulation and vadose zone transport. Until recently, it has been envisioned that the STOMP software would be utilized in future IDF PAs for flow and transport and the reactive chemistry would be performed using the STORM software. However, considering the effort required to meet the quality assurance requirements imposed by DOE O 414.1D for the STORM software (which has never been qualified as safety software), and considering the progress PNNL has recently made in incorporating the reactive chemistry features found in the STORM code into the STOMP code (which is qualified under DOE O 414.1D), a change in the planned modeling approach for the revised IDF PA has been adopted. The STOMP software (including eSTOMP parallel implementation) is now planned to be the single tool to meet all of the computational needs for flow and transport simulation including reactive chemistry processes.

DOE-ORP shares responsibilities with the DOE-RL for the IDF. In terms of developing the nonvitrified waste forms that will be disposed at the IDF, DOE-ORP is responsible for developing waste forms and

determining the inventories contained within those waste forms. DOE-ORP issued a report in FY 2010 to the Washington State Department of Ecology in order to meet a WTP permit requirement on secondary waste streams (DOE Letter 10-ESQ-203 REISSUE, "Submittal of 'Evaluation of WTP Secondary Mixed Wastes for Dangerous Waste Treatment and Disposal,' 24590-WTP-RPT-ENS-10-003, Revision 1"). This report identifies seven WTP dangerous waste streams that are anticipated to require land disposal restrictions (LDR) treatment prior to disposal, and two challenging radioactive waste streams. The seven streams that may require LDR treatment include:

- Cesium ion exchange resin
- ILAW glass debris from the melter consumable bagging station
- LAW Facility secondary offgas/vessel vent process system (LVP) high-efficiency particulate air filters
- LVP and high-level melter offgas treatment process system (HOP) carbon bed absorber media
- HOP silver mordenite media
- Radioactive liquid waste disposal system effluent discharged to the Liquid Effluent Retention Facility and ETF
- Spent melters (a radioactive waste, representing a unique waste stream).

A down-select for one or more waste forms was expected to have been made in FY 2011 but has been delayed into FY 2012. Contracts for collecting data on release rates for various waste forms are also being conducted by DOE-ORP. The results of these tests are not expected until 2012 or 2013. Coordination meetings are underway with DOE-ORP and DOE-RL to ensure that the information is provided to the IDF PA modeling team in a timely fashion.

The annual summary for 2004 (DOE/ORP-2000-19, Rev. 4) documented how the data collected since the 2001 ILAW PA (DOE/ORP-2000-24) may affect the analysis in that PA. The formal incorporation of such analysis awaits the creation of a revised PA.

7 Conclusions

As noted in the previous annual summaries (listed in Table 1-1), new information has been obtained since the preparation of the 2001 ILAW PA. The new information is documented in a series of peer-reviewed data packages. Considering the results of data collection and analysis, the conclusions of the 2001 version of the ILAW PA (DOE/ORP-2000-24) for the WTP glass remain valid (i.e., the disposal of ILAW glass is protective of long-term human health and the environment).

Consideration is being given to a change in the disposal facility mission to include disposal of LLW and MLLW from additional generators. The feasibility of this mission expansion is being considered in the TC&WM EIS. Also, the development of waste forms for tank waste continues to evolve, and some aspects of facility design have changed since the issuance of the 2001 PA. Consequently, a revised IDF PA analysis is anticipated following issuance of the TC&WM EIS (DOE Letter 06-TPD-058, "Contract No. DE-AC27-99RL14047 – U.S. Department of Energy (DOE) Office of River Protection Notification to CH2M HILL Hanford Group, Inc. (CH2M HILL) to Terminate Work on the Hanford Integrated Disposal Facility (IDF) Performance Assessment (PA) for 2005").

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