DOE/RL-2017-63
Revision 0

Annual Status Report (FY2017): Performance Assessment for the Environmental Restoration Disposal Facility

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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Date Published
February 2018

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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APPROVED
By Mary P. Curry at 10:58 am, Apr 10, 2018

Release Approval | Date

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Executive Summary

In accordance with U.S. Department of Energy (DOE) requirements in DOE O 435.1 Chg 1[1] and DOE M 435.1-1 Chg 1,[2] a determination of continued adequacy of the performance assessment (PA), composite analysis (CA), and disposal authorization statement (DAS) is required on an annual basis. This determination must consider the results of data collection and analysis from research, field studies, and monitoring.

In 1996, the Environmental Restoration Disposal Facility (ERDF) began accepting low-level radioactive, hazardous, and mixed waste that was generated during Hanford Site cleanup activities. Designed to be expanded as needed, ERDF is comprised of a series of cells or disposal areas; currently there are a total of 10 cells. During this reporting period (fiscal year [FY] 2017, from October 1, 2016, through September 30, 2017), approximately 277,000 tons of waste were disposed at ERDF. As of September 30, 2017, an overall total of approximately 18.1 million tons of waste had been disposed at ERDF, which equates to approximately 86% of the facility's disposal volume.

As a condition of the DAS, disposal operations within ERDF must be in accordance with the waste acceptance criteria (ERDF-00011[3]) that provide specific radionuclide disposal limits, waste form restrictions, and descriptions of acceptable waste packages in compliance with the requirements of DOE M 435-1.1 Chg 1. The ERDF waste acceptance criteria stipulate that waste disposed at ERDF is to be controlled on the basis of source, physical form, and contaminant concentration and activity levels. Concentration limits included in the ERDF waste acceptance criteria were extracted from the ERDF PA (CP-60089[4]). A sum-of-fractions analysis of the ERDF inventory

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

[2] 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.

[3] ERDF-00011, 2016, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

[4] CP-60089, 2016, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford, Washington, formerly WCH-520 Rev. 1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

compared to the threshold concentration limits from inception through FY 2017 produces a result less than one, which confirms compliance with PA-imposed radionuclide limits.

The ERDF PA groundwater and air-pathway results are used to develop radionuclides of concern and associated inventory threshold limits. Inventory thresholds for the groundwater pathway are based on an effective dose equivalent limit of 25 mrem/yr, and the inventory thresholds for the air pathway are based on an effective dose equivalent of 10 mrem/yr. The sum-of-fractions analysis of the two scenarios produces results that are less than one, thus demonstrating compliance with the standards-based dose requirements.

Three unreviewed disposal question screenings were completed during this reporting period. One unreviewed disposal question evaluation was completed to evaluate potential impacts of the ERDF inventory exceeding forecasted inventory values. No special analyses were completed during FY 2017.

No research and development activities were completed or added during FY 2017. One research and development activity, “Long-Term Carbon-14 Release Rate,” remains to be completed when representative soil samples become available.

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Terms

CA	composite analysis
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CY	calendar year
DAS	disposal authorization statement
DOE-RL	U.S. Department of Energy, Richland Operations Office
ERDF	Environmental Restoration Disposal Facility
FY	fiscal year
PA	performance assessment
R&D	research and development
RCRA	*Resource Conservation and Recovery Act of 1976*
RWMB	radioactive waste management basis
SOF	sum of fractions
WMIS	Waste Management Information System

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1 Changes Potentially Affecting the Performance Assessment, Composite Analysis, Disposal Authorization Statement, or Radioactive Waste Management Basis

One aspect of demonstrating a reasonable expectation that performance objectives of the Environmental Restoration Disposal Facility (ERDF) continue to be met is a review of changes that have the potential to affect the performance assessment (PA) or disposal authorization statement (DAS). These changes include any discovered divergences from expected or planned conditions with regard to site characteristics or facility-related attributes that are potentially significant to facility performance, as well as any changes that result from voluntary design, construction, operations, or closure plans.

Proposed changes and/or activities that may affect the PA or DAS are evaluated in accordance with a procedure on Unreviewed Disposal Questions (UDQ), which implements the change processes used to ensure compliance with DOE O 435.1 Chg 1, *Radioactive Waste Management and* DOE-STD-5002-2017*, DOE Standard Disposal Authorization Statement and Tank Closure Documentation.*

This chapter summarizes all change control process evaluations and screenings used to evaluate proposed actions, changes, and new information to determine if these activities are within the boundaries analyzed in the approved ERDF PA (CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford, Washington, formerly WCH-520 Rev. 1*). Table 1 identifies the unreviewed disposal question evaluations and screenings. These evaluations and screenings invoke administrative actions; however, there is no indication of the need for a special analysis and there are no noted impacts to the PA, composite analysis (CA), DAS, or radioactive waste management basis (RWMB) resulting from the evaluations and screenings. Appendix A includes the screenings and the evaluation for this annual summary report.

Design changes have not been made to the ERDF since the issuance of DOE/RL-2016-57, *Annual Status Report (FY2016): Performance Assessment for the Environmental Restoration Disposal Facility*.

Table 1. Potential Changes Affecting the Performance Assessment

Disposal Facility Unit	UDQE/UCAQE or Change Control Process Identification Number	Change, Discovery, Proposed Action, New Information Description	Evaluation Results	Special Analysis Number (if applicable)	PA, CA, DAS, or RWMB Impacts
ERDF	UDQ-2017-001-S	ERDF inventory exceeded forecast	Positive UDQS; led to writing of UDQ-2017-001-E	N/A	None
ERDF	UDQ-2017-001-E	ERDF inventory exceeded forecast	Negative UDQE; special analysis is not required	N/A	None
ERDF	UDQ-2017-002-S	Hafnium-182 omitted from ERDF waste acceptance criteria (ERDF-00011)	Hafnium-182 added to ERDF waste acceptance criteria, Table B-1 (ERDF-00011)	N/A	None

Table 1. Potential Changes Affecting the Performance Assessment

Disposal Facility Unit	UDQE/UCAQE or Change Control Process Identification Number	Change, Discovery, Proposed Action, New Information Description	Evaluation Results	Special Analysis Number (if applicable)	PA, CA, DAS, or RWMB Impacts
ERDF	UDQ-2017-003-S	Elevated activated metal inventory values as identified in WCH-479	Negative UDQS, UDQE or Special Analysis is not required.	N/A	None

References:

ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*.

WCH-479, *Inventory Data Package for ERDF Waste Disposal*.

CA = composite analysis
DAS = design authorization statement
ERDF = Environmental Restoration Disposal Facility
N/A = not applicable
PA = performance analysis
RWMB = radioactive waste management basis
UCAQE = unreviewed composite analysis question evaluation
UDQE = unreviewed disposal question evaluation
UDQS = unreviewed disposal question screening
WMIS = Waste Management Information System

1.1 Unreviewed Disposal Question UDQ-2017-001-S

During of the fiscal year (FY) 2016 annual PA review, it was discovered that the radionuclide inventory disposed at the ERDF as of September 30, 2016, was greater than the inventory projected in the PA. The radionuclide inventory disposed exceeded the inventory projected for a number of radionuclides. A qualitative analysis to estimate dose at closure was performed to determine the effect of the increased inventory on projected dose. The analysis indicated that the all-pathways peak dose estimate would increase by 18% during the compliance period, and the acute and chronic inadvertent intruder dose estimates would increase by 8% and 6%, respectively. The increased dose estimates remained well below the performance objectives.

1.2 Unreviewed Disposal Question UDQ-2017-001-E

As indicated in the FY 2016 annual summary report (DOE/RL-2016-57), the radionuclide inventory disposed at ERDF at the end of FY 2016 exceeded the projected closure inventory (year 2035) for some radionuclides in the ERDF PA (CP-60089). Elevated disposed inventories were mainly attributed to three causes:

- **Excessive inventory values:** WCH-479, *Inventory Data Package for ERDF Waste Disposal*, identified exaggerated ERDF inventories for 22 radionuclides as of September 2010 and recommended adjustments to lower, more accurate values. The lower values were used in the PA. The most significant of these (uranium, carbon-14, and technetium-99) have since been adjusted in the Waste Management Information System (WMIS) database to match (or nearly match) the adjusted inventories recommended in WCH-479. Adjustments to the remaining 14 radionuclides are planned to be completed during calendar year (CY) 2018.

- **Intentional inflation of inventory occurring in the waste shipping process:** Concentrations of radionuclides in waste are biased toward the high sample values to ensure that shipping remains compliant with federal and state regulations. Due to the high volumes of waste transported to and disposed in the ERDF, remediation projects minimize the amount of sampling required in order to save sampling and analysis costs. This is generally done by sampling at outfalls and other process-based locations to collect worst-case scenario data that bounds the waste source. The ERDF PA (CP-60089) inventory forecast did not consider intentional inventory inflation.
- **Legitimate inventory increases:** Actual increases to the WCH-479 projected inventories (as opposed to intentional inventory inflation) due to increases in previous forecasts and the discovery of new waste sites.

An analysis was performed to determine the impact of an increased inventory projection (current disposed inventory plus remaining forecasted) to the performance objectives/measures and to the radionuclide concentration and inventory limits listed in ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*. For this analysis, the original forecasted inventory at closure (from 2011 through 2035) was added to the current inventory (disposal through September 30, 2016, and decay-corrected to the closure date. The results of the analyses indicated small increases in the peak all pathways (0.7% increase with respect to the performance standard) and the peak atmospheric pathway (1.8% increase with respect to the performance standard) doses from 1.02 to 1.2 mrem/yr within the compliance period, which is only 1.2% to 12% of the allowed performance objectives doses. The dose increase is primarily attributed to the increase in hydrogen-3 (tritium) inventory at closure, which results in an increase to the air-pathway dose; the groundwater pathway dose remains unchanged. The factor of 7 increase in radon flux (from 0.11 to 0.83 pCi/m^2/s) is due to a corresponding increase in the radium-226 inventory (parent radionuclide of radon-222) from 1.7 to 2.4 Ci at closure. The radon flux continues to remain negligibly small (approximately 5% of the allowed performance objectives dose) and well below the performance standard of 20 pCi/m^2/s.

It will be necessary to revise the forecasted inventory based on the discovered condition that the recorded facility inventory exceeds the inventory forecast at closure. Revision of the forecast will be documented and considered for a future PA revision.

1.3 Unreviewed Disposal Question UDQ-2017-002-S

Hafnium-182 was identified as a radionuclide potentially present in K East Reactor basin waste, yet this radionuclide was not included in the ERDF waste acceptance criteria (ERDF-00011). The concentration was calculated to be as high as 5.51E+01 pCi/g, and its half-life of 8.9E+06 years exceeded the waste acceptance criteria threshold criteria of 2 years. However, the total activity of hafnium-182 was projected to be 6.8E-05 Ci. Based on the projected activity being significantly below 1 Ci, hafnium-182 was added to Appendix B, Table B-1 of the ERDF waste acceptance criteria.

1.4 Unreviewed Disposal Question UDQ-2017-003-S

WCH-479 identified that the WMIS database showed elevated radionuclide activities for calcium-41, nickel-59, nickel-59 activated metal (AM), nickel-63, nickel-63AM, molybdenum-93, niobium-93m (metastable), zirconium-93, niobium-94, niobium-94AM, silver-108m, and barium-133. Table 2-8 in WCH-479 includes recommendations for adjusted activity values to align the inventory with historical inventory recorded for the waste sites sending waste to the ERDF. The adjusted activities were developed following a thorough evaluation of conservative bias, leading to the elevated inventory estimates for waste disposed at ERDF. Table 2-8 in WCH-479 provides rationale for the inventory. Activity reductions

evaluated in the screening are applicable for waste disposed between July 1, 1996, and September 30, 2010.

2 Cumulative Effects of Changes

This chapter includes an evaluation and discussion of the cumulative effects of all the changes identified in Chapter 1. The changes identified do not have a cumulative effect based on the variance in application of the event resolution. One change will lead to revision of the inventory forecast, one change simply adds a minor constituent to the ERDF waste acceptance criteria (ERDF-00011), and one change will lower the WMIS inventory for activated metals. Effectively, these changes are uniquely considered, thus, have no cumulative effect.

The CA supporting this PA is reported 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 CA is maintained separately under its own maintenance plan (DOE/RL-2000-29, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*). The concurrent annual status report for the CA is provided in DOE/RL-2017-55, *Annual Status Report (FY 2017): Composite Analysis for Low Level Waste Disposal in the Central Plateau of the Hanford Site.*

3 Waste Receipts

The ERDF is operated on behalf of the U.S. Department of Energy, Richland Operations Office (DOE-RL) for the disposal of *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) waste and specific non-CERCLA and *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice waste originating from within the Hanford Site boundary, as identified in EPA et al., 2007, *Amendment to the Record of Decision for the USDOE Hanford Environmental Restoration Disposal Facility* (issued in June 2007). Waste types received at the ERDF include contaminated soil from CERCLA cleanup activities at the Hanford Site, debris generated from Hanford Site decontamination and decommissioning activities, and activated metal from solid waste burial grounds and other locations.

The WMIS database provides actual waste disposal information for ERDF. According to WMIS database records, during FY 2017, a total of 2.77E+05 tons (2.51E+11 g) of waste containing 1.87E+04 Ci was disposed. Records also indicate that from inception through the end of FY 2017, a total of 1.81E+07 tons (1.65E+13 g) of waste containing 2.07E+05 Ci has been disposed. Table 2 shows the waste disposed from inception through FY 2017 and the estimated disposal capacity.

Table 3 shows the activity of waste received at ERDF during FY 2017 and from inception through FY 2017 (as reported in the WMIS database). The activity for each radionuclide in the disposed waste was converted to an activity density by dividing the activity by the mass and converting the curie values to picocurie values. Activity density from inception to date was compared to the waste acceptance criteria values to calculate the sum of fractions (SOF).

Table 2. Waste Receipts

Disposal Facility Unit	Waste Disposed to Date (tons)	PA Estimated Disposal Capacity (tons)	Percent Filled Volume (%)	Sum of Fractions or Total Curie versus PA Curie Limit	PA/CA Impacts
ERDF	18,149,642	21,000,000	86.4	1.75E-02*	None

* Sum of fractions based on comparing the waste received to date to the ERDF waste acceptance criteria (ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*).

CA = composite analysis
ERDF = Environmental Restoration Disposal Facility
PA = performance assessment

Table 3. Summary of ERDF Radionuclide Inventory for FY 2017 and Since Facility Inception

Nuclide	ERDF Waste Acceptance Criteria	FY 2017		Inception through FY 2017		
	Activity Density (pCi/g)	Activity (Ci)	Activity Density[a] (pCi/g)	Activity[b] (Ci)	Activity Density[a] (pCi/g)	Waste Acceptance Criteria Fraction
Ac-227	2.83E+03	8.17E-05	3.25E-04	1.45E-02	8.83E-04	3.12E-07
Ag-108m	6.99E+04	4.85E-04	1.93E-03	1.13E+03	6.86E+01	9.82E-04
Am-241	8.25E+04	2.37E+01	9.44E+01	9.57E+02	5.81E+01	7.05E-04
Am-242m	N/A	4.58E-03	1.82E-02	2.14E-01	1.30E-02	—
Am-243	6.49E+04	3.54E-03	1.41E-02	8.36E-01	5.08E-02	7.82E-07
Ba-133	N/A	5.37E-05	2.14E-04	1.47E+01	8.93E-01	—
Be-7	N/A	6.93E-07	2.76E-06	2.90E-04	1.76E-05	—
Bi-207	N/A	—	—	7.02E-05	4.26E-06	—
C-14[c]	2.43E+05	1.26E+01	5.02E+01	2.01E+03	1.22E+02	5.03E-04
Ca-41	N/A	2.06E-04	8.19E-04	9.66E+00	5.87E-01	—
Cd-113m	1.00E+06	9.49E-03	3.78E-02	5.34E+00	3.24E-01	3.24E-07
Ce-144	N/A	—	—	5.05E-03	3.07E-04	—
Cf-249	N/A	—	—	8.91E-04	5.41E-05	—
Cf-252	N/A	—	—	1.63E-04	9.87E-06	—
Cl-36	4.32E+03	—	—	3.72E-05	2.26E-06	5.23E-10
Cm-242	N/A	2.21E-03	8.78E-03	2.85E+00	1.73E-01	—
Cm-243	8.98E+05	6.66E-03	2.65E-02	2.82E+00	1.71E-01	1.91E-07
Cm-244	4.76E+06	9.61E-01	3.82E+00	8.03E+00	4.88E-01	1.03E-07

Table 3. Summary of ERDF Radionuclide Inventory for FY 2017 and Since Facility Inception

Nuclide	ERDF Waste Acceptance Criteria	FY 2017		Inception through FY 2017		
	Activity Density (pCi/g)	Activity (Ci)	Activity Density[a] (pCi/g)	Activity[b] (Ci)	Activity Density[a] (pCi/g)	Waste Acceptance Criteria Fraction
Cm-245	N/A	8.61E-07	3.43E-06	3.39E-06	2.06E-07	—
Cm-246	N/A	7.59E-10	3.02E-09	8.75E-09	5.31E-10	—
Cm-247	N/A	—	—	2.81E-16	1.70E-17	—
Cm-248	N/A	—	—	2.91E-17	1.77E-18	—
Co-58	N/A	—	—	6.90E-01	4.19E-02	—
Co-60 [d]	7.18E+09	1.09E+01	4.32E+01	1.40E+04	8.52E+02	1.19E-07
Cs-134	N/A	1.54E-03	6.13E-03	2.22E+01	1.35E+00	—
Cs-135	N/A	4.81E-03	1.91E-02	5.42E-01	3.29E-02	—
Cs-137	8.47E+05	5.38E+02	2.14E+03	2.71E+04	1.65E+03	1.94E-03
Eu-150	N/A	—	—	1.11E-02	6.72E-04	—
Eu-152	1.23E+07	1.16E+01	4.60E+01	6.99E+03	4.24E+02	3.45E-05
Eu-154	1.75E+08	3.90E+00	1.55E+01	2.21E+03	1.34E+02	7.68E-07
Eu-155	N/A	7.07E+00	2.81E+01	2.81E+02	1.71E+01	—
Fe-55	N/A	7.15E-02	2.85E-01	4.63E+01	2.81E+00	—
Fe-59	N/A	—	—	3.35E-03	2.03E-04	—
H-3	2.34E+11	1.73E+04	6.88E+04	8.21E+04	4.98E+03	2.13E-08
I-129	3.63E+04	1.01E-03	4.00E-03	6.12E-02	3.72E-03	1.02E-07
K-40	N/A	8.25E-02	3.28E-01	2.16E+02	1.31E+01	—
Kr-85	N/A	3.86E+00	1.54E+01	6.96E+00	4.23E-01	—
Mn-54	N/A	2.21E-04	8.81E-04	2.16E-01	1.31E-02	—
Mo-93	3.35E+05	1.57E-03	6.26E-03	4.67E+00	2.84E-01	8.47E-07
Na-22	N/A	1.83E-05	7.28E-05	1.63E-02	9.87E-04	—
Nb-93m	2.82E+09	2.33E-01	9.26E-01	2.49E+01	1.51E+00	5.36E-10
Nb-94 [d]	5.90E+04	2.82E-05	1.12E-04	9.50E+00	5.77E-01	9.78E-06
Ni-59 [d]	2.48E+07	7.54E-01	3.00E+00	1.42E+03	8.64E+01	3.48E-06
Ni-63 [d]	1.97E+07	6.46E+01	2.57E+02	3.58E+04	2.17E+03	1.10E-04
Np-237	3.00E+04	4.95E-03	1.97E-02	6.97E-01	4.23E-02	1.41E-06
Pa-231	2.29E+03	1.06E-05	4.21E-05	1.07E-03	6.50E-05	2.84E-08
Pb-210	N/A	7.73E-06	3.07E-05	9.89E-01	6.01E-02	—
Pd-107	N/A	8.83E-04	3.51E-03	2.34E-02	1.42E-03	—
Pm-147	N/A	3.68E-01	1.46E+00	1.43E+02	8.69E+00	—

Table 3. Summary of ERDF Radionuclide Inventory for FY 2017 and Since Facility Inception

Nuclide	ERDF Waste Acceptance Criteria	FY 2017		Inception through FY 2017		
	Activity Density (pCi/g)	Activity (Ci)	Activity Density[a] (pCi/g)	Activity[b] (Ci)	Activity Density[a] (pCi/g)	Waste Acceptance Criteria Fraction
Po-209	N/A	—	—	1.09E-02	6.60E-04	—
Pu-238	1.41E+05	3.51E+00	1.40E+01	1.12E+02	6.77E+00	4.80E-05
Pu-239	5.87E+04	1.78E+01	7.10E+01	5.92E+02	3.60E+01	6.13E-04
Pu-240	5.92E+04	8.29E+00	3.30E+01	2.77E+02	1.68E+01	2.84E-04
Pu-241	3.65E+08	7.96E+01	3.17E+02	9.69E+03	5.89E+02	1.61E-06
Pu-242	6.15E+04	3.69E-03	1.47E-02	1.45E+00	8.83E-02	1.44E-06
Pu-244	N/A	—	0.00E+00	2.59E-08	1.57E-09	—
Ra-226	5.04E+03	8.05E+00	3.20E+01	1.98E+01	1.20E+00	2.38E-04
Ra-228	1.60E+03	1.46E-02	5.79E-02	7.12E+00	4.32E-01	2.70E-04
Re-187	N/A	2.56E-13	1.02E-12	1.59E-07	9.64E-09	—
Rn-222	N/A	—	—	—	0.00E+00	—
Ru-103	N/A	—	—	2.22E-03	1.35E-04	—
Ru-106	N/A	6.82E-05	2.71E-04	3.78E-02	2.30E-03	—
Sb-125	N/A	2.85E-02	1.13E-01	7.47E+01	4.54E+00	—
Sb-126	N/A	—	—	—	0.00E+00	—
Se-79	2.19E+05	1.19E-02	4.73E-02	1.66E-01	1.01E-02	4.60E-08
Sm-151	2.49E+08	1.48E+01	5.88E+01	9.16E+02	5.57E+01	2.24E-07
Sn-113	N/A	—	—	2.54E-03	1.54E-04	—
Sn-121m	3.16E+06	6.10E-01	2.43E+00	1.91E+01	1.16E+00	3.67E-07
Sn-126	2.59E+04	1.00E-02	3.99E-02	2.79E-01	1.69E-02	6.53E-07
Sr-90	1.05E+05	5.25E+02	2.09E+03	1.98E+04	1.20E+03	1.14E-02
Tc-99	2.38E+04	5.56E+00	2.21E+01	4.76E+01	2.89E+00	1.22E-04
Th-228	N/A	5.90E-02	2.35E-01	6.33E+00	3.85E-01	—
Th-229	5.13E+03	1.08E-07	4.31E-07	2.35E-01	1.43E-02	2.78E-06
Th-230	3.94E+04	4.30E-03	1.71E-02	2.64E-01	1.60E-02	4.07E-07
Th-232	2.26E+04	1.07E-01	4.24E-01	2.16E+01	1.31E+00	5.80E-05
Th-234	N/A	—	—	1.43E-08	8.69E-10	—
Ti-44	N/A	—	—	2.52E-05	1.53E-06	—
U-232	N/A	1.25E-03	4.98E-03	4.64E-03	2.82E-04	—
U-233	2.64E+05	2.35E-01	9.33E-01	5.89E+01	3.58E+00	1.36E-05
U-234	2.73E+05	5.09E+00	2.02E+01	2.58E+02	1.57E+01	5.74E-05
U-235	2.10E+05	7.08E-01	2.82E+00	4.08E+01	2.47E+00	1.18E-05

Table 3. Summary of ERDF Radionuclide Inventory for FY 2017 and Since Facility Inception

Nuclide	ERDF Waste Acceptance Criteria	FY 2017		Inception through FY 2017		
	Activity Density (pCi/g)	Activity (Ci)	Activity Density[a] (pCi/g)	Activity[b] (Ci)	Activity Density[a] (pCi/g)	Waste Acceptance Criteria Fraction
U-236	2.90E+05	6.43E-01	2.56E+00	2.50E+00	1.52E-01	5.24E-07
U-238	2.87E+05	3.54E+01	1.41E+02	4.65E+02	2.82E+01	9.84E-05
Zn-65	N/A	—	—	1.15E-03	7.01E-05	—
Zr-93	1.97E+07	2.64E-01	1.05E+00	7.18E+01	4.36E+00	2.21E-07
Total activity (Ci)		**1.87E+04**	—	**2.07E+05**	—	—
Waste acceptance criteria sum of fractions						**1.75E-02**

Reference: ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4.*

a. Activity densities (pCi/g) were calculated using the waste disposal mass values reported in Table A-2 of ERDF-00011.

b. Activity reported for inception through FY 2017 does not include inventory reductions identified in UDQ-2017-003-S.

c. Includes carbon-14, carbon-14i, and carbon-14a (activated metal).

d. Includes activated metal.

ERDF = Environmental Restoration Disposal Facility N/A = not applicable

FY = fiscal year

A total of 1.87E+04 Ci was disposed of in FY 2017. Over 95% of the disposed activity was contributed by eight radionuclides, which comprised at least 1% of the cumulative waste activity. Radionuclides contributing at least 1% include cobalt-60, cesium-137, europium-152, europium-154, tritium, iodine-129, nickel-63, plutonium-241, and strontium-90. Of this subset of radionuclides, the largest contributor is tritium.

From the period of inception through FY 2017, the SOF was 1.75E-02, which is an almost negligible increase over the previous FY. The SOF for FY 2016 was 1.73E-02.

Figure 1 shows the mass of waste disposed each FY since inception. Waste disposal at the ERDF has dropped off over the past 3 years. The 618-10 Project was the largest waste generator during FY 2017. With completion of the 618-10 Project in early FY 2018, waste disposed at the ERDF is projected to slightly decrease from the FY 2017 rate over the next few years. Though presently lower than the 2017 rates, waste disposed at the ERDF is eventually projected to increase based on the start of remediation operations at sites such as the 324 Building and the continuation of activities at facilities at sites such as the Plutonium Finishing Plant and the 100-K Area.

Figure 2 shows the total mass of waste received cumulatively. FY 2017 had the lowest increase year after year when compared to all previous years of operation. Quantitatively, the waste mass received in FY 2017 accounts for 1.53% of the total waste mass received since inception. The slowing of total mass receipt is consistent with completion of remediation activities at sites previously sending waste to the ERDF.

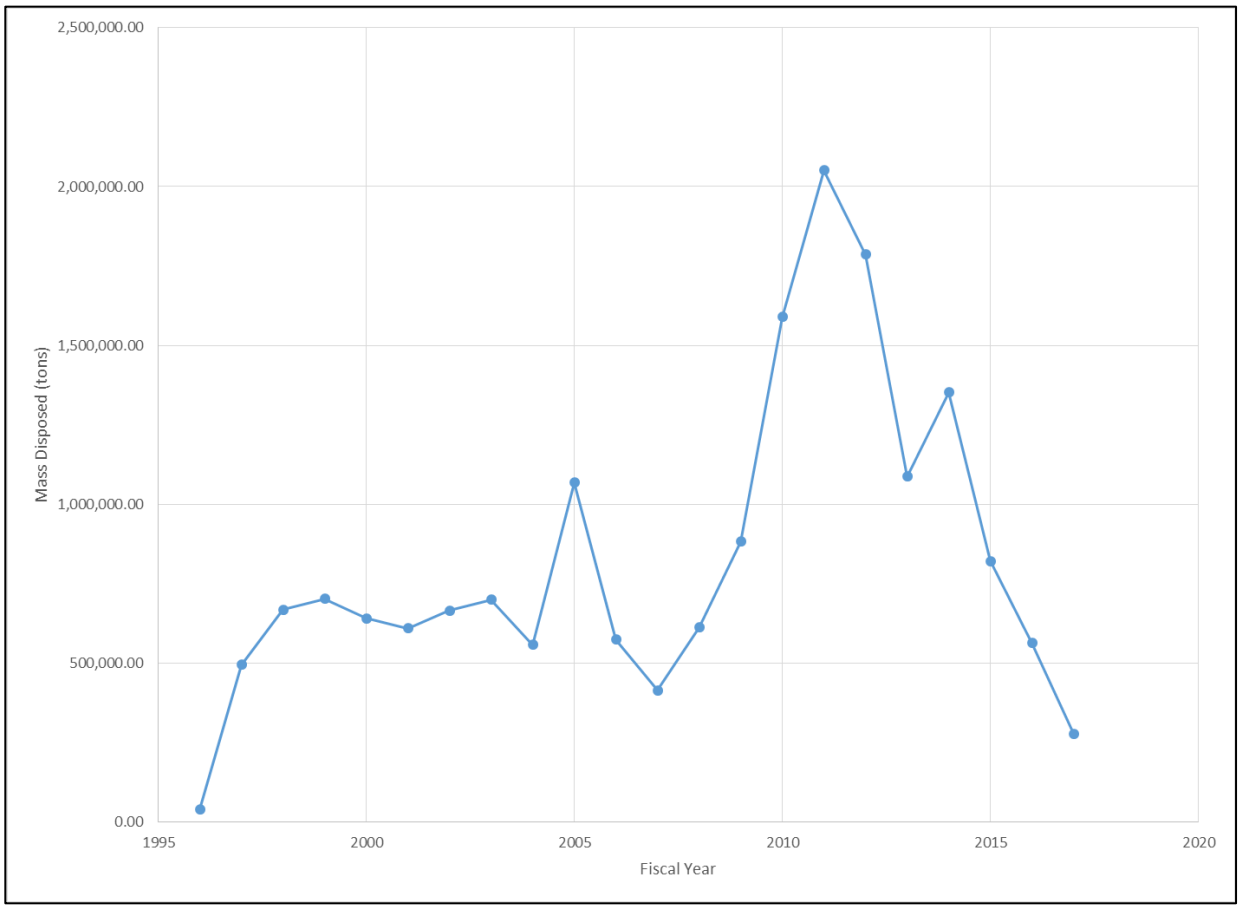

Figure 1. Waste Material Disposed (tons) Each FY

4 Monitoring

DOE M 435.1-1 Chg 1, *Radioactive Waste Management Manual*, requires that monitoring results be compared to expected performance to determine consistency with conceptual models, evaluating other site monitoring activities for significant results, determining if better methodologies or technologies are available for monitoring, and evaluating the results of special studies or experiments. Monitoring associated with the ERDF PA (CP-60089) is specified in CP-60152, *Performance Assessment Monitoring Plan for the Environmental Restoration Disposal Facility, formerly WCH-579 Rev. 1*, and consists of near-field air monitors that are incorporated into the Hanford Site air monitoring system and groundwater wells that are incorporated into the Hanford Site groundwater monitoring system.

Based on the dose calculations in the ERDF PA (CP-60089), the pathways of interest are air and groundwater for both operational and post-closure conditions at ERDF. The ERDF PA monitoring plan prioritizes data collection associated with these pathways (CP-60152).

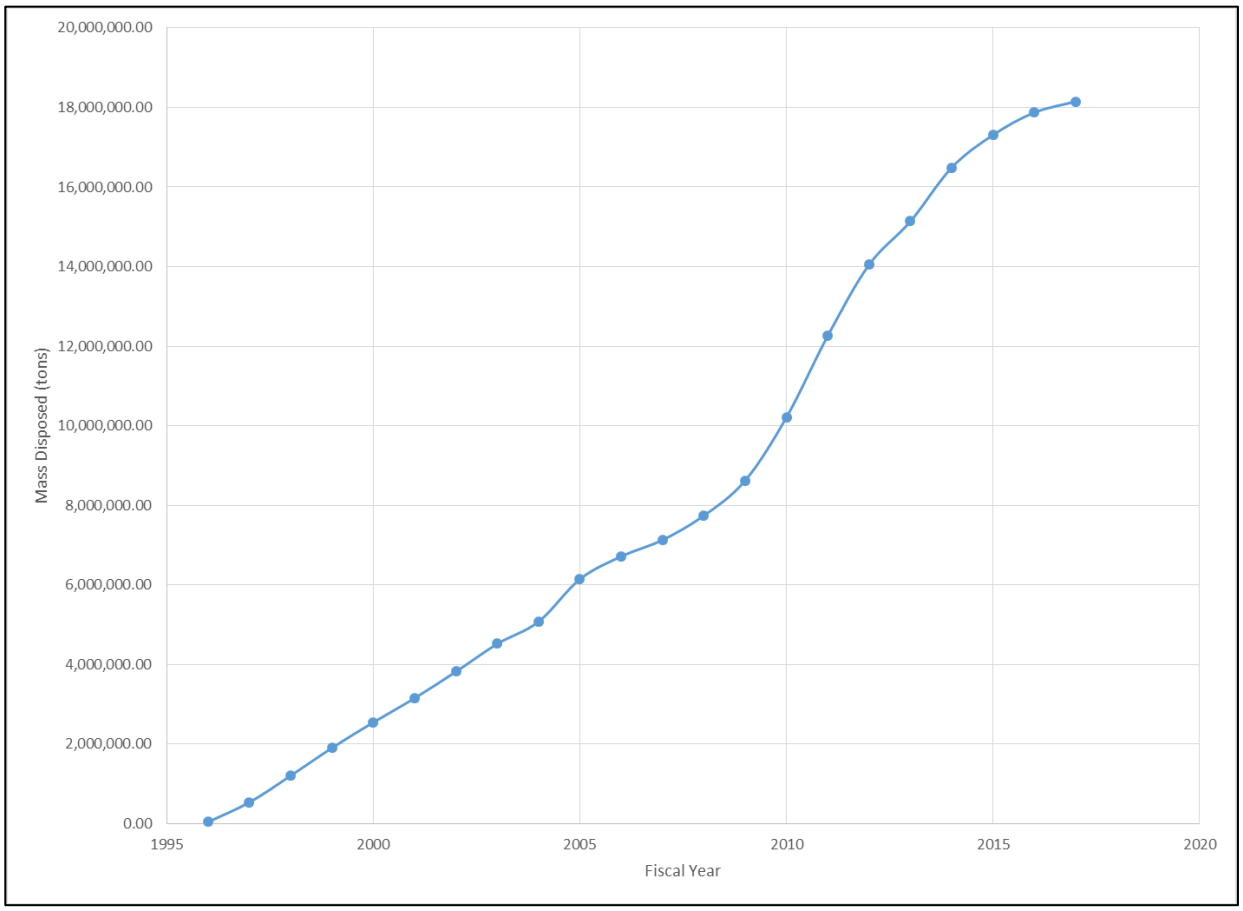

Figure 2. Total Waste Material Disposed (tons) Each FY

The only volatile radionuclides identified in the ERDF PA (CP-60152) as relevant to the post-closure air-pathway dose calculations are carbon-14, tritium, and iodine-129. Radionuclide-specific air-pathway inventory thresholds are calculated in the PA according to the maximum predicted air-pathway effective dose equivalent and 10 mrem/yr performance criterion for the purpose of developing ERDF waste acceptance criteria. The inventory threshold provides the maximum allowable inventory for a single radionuclide disposed in the facility. Table 4 provides the thresholds for the air-pathway radionuclides of interest.

The ERDF PA (CP-60152) discusses the groundwater pathway dose assessment results for compliance case radionuclides. These results, combined with performance measures for the groundwater pathway, are used to derive generally applicable total inventory thresholds (i.e., waste acceptance criteria) for ERDF. Total inventory thresholds are provided only for those radionuclides that arrive at the compliance location in the saturated zone within the 10,000-year time period. These radionuclides are technetium-99, niobium-94, molybdenum-93, chlorine-36, and iodine-129.

The thresholds are based on the predicted maximum concentrations in groundwater and the predicted maximum groundwater pathway dose at the compliance location 100 m (328 ft) downgradient of ERDF. An inventory threshold based on dose for a given radionuclide is calculated by taking the maximum effective dose equivalent contribution from that radionuclide within the time period of interest and calculating a corresponding inventory that is equivalent to 25 mrem/yr effective dose limit. Table 4 provides the regulatory limits for the groundwater pathway.

Table 4. Air Pathway and All-Pathway Inventory versus Threshold Limits

Disposal Facility Unit	Monitoring Type	Monitoring Results and Trends[a] (Ci)	Performance Objective Measure[b] (Ci)	Action Level	Action Taken	PA/CA Impacts
ERDF[c]	C-14 (air pathway)	2.01E+03 (8.3% of threshold[b])	2.43E+04	N/A	None	None
ERDF[c]	H-3 (air pathway)	8.21E+04 (7.1% of threshold[b])	1.15E+06	N/A	None	None
ERDF[c]	I-129 (air pathway)	6.12E-02 Ci (1.5% of threshold[b])	4.00E+00	N/A	None	None
ERDF[d]	Tc-99 (groundwater pathway)	4.76E+01 (6.6% of threshold[b])	7.24C+02	N/A	None	None
ERDF[d]	Nb-94 (groundwater pathway)	9.50E+00 (2.7% of threshold[b])	3.49E+02	N/A	None	None
ERDF[d]	Mo-93 (groundwater pathway)	4.67E+00 (0.6% of threshold[b])	8.11E+02	N/A	None	None
ERDF[d]	Cl-36 (groundwater pathway)	3.72E-05 (negligible % of threshold[b])	3.42E+02	N/A	None	None

a. Disposed inventory from Waste Management Information System database as of September 30, 2017.

b. Table 7-5 in CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford, Washington, formerly WCH-520 Rev. 1*.

b. Inventory thresholds were calculated based on U.S. Department of Energy air-pathway effective dose limit of 10 mrem/yr.

c. Inventory thresholds were calculated based on all-pathway effective dose equivalent of 25 mrem/yr based on peak dose.

CA = composite analysis
ERDF = Environmental Restoration Disposal Facility
N/A = not applicable
PA = performance assessment

The ERDF air-pathway dose calculations are predicated on post-closure carbon-14, tritium, and iodine-129 gases diffusing through the waste soil and cap. For the air pathway, inventory thresholds for carbon-14, tritium, and iodine-129 are the only volatile radionuclides requiring evaluation by the ERDF PA (CP-60089) for air-pathway dose calculations. Iodine-129 is the only radionuclide that is present in both the groundwater-pathway and air-pathway inventory threshold calculations. However, the air-pathway inventory thresholds for iodine-129 are much lower than for the groundwater-pathway inventory thresholds and, therefore, are considered the ultimate inventory threshold for iodine-129.

Tracking the WMIS reported inventory against the threshold limits for a given radionuclide provides a confirmatory assessment of compliance with DOE O 435.1 Chg 1.

Because the waste disposed at the ERDF forms a mixture of the radionuclides of concern, it is also prudent to compute an SOF for the air and groundwater pathways. This is accomplished by dividing each monitored result by the corresponding limit and then summing the results. For the air pathway, the SOF computes to 0.169, and for the groundwater pathway the SOF computes to 0.099.

Table 5 provides a comparison of the updated total inventory at closure to the performance objectives and measures.

Table 5. Results of Evaluating the Updated Total Inventory at Closure for the Compliance Period

Disposal Facility Unit	Monitoring Purpose	Monitoring Results and Trends[a]	PA Expected Behavior	Action Taken	PA/CA Impacts
ERDF	All pathways	1.20 mrem/yr	<25 mrem/yr EDE	None	None
ERDF	Atmospheric	1.20 mrem/yr	<10 mrem/yr EDE	None	None
ERDF	Atmospheric	0.83 pCi/m^2/s	<20 pCi/m^2/s	None	None
ERDF	Acute inadvertent intruder	5.94 mrem[b]	<500 mrem EDE	None	None
ERDF	Chronic inadvertent intruder	9.82 mrem/yr[b]	<100 mrem/yr EDE	None	None
ERDF	Groundwater protection	0 mrem/yr	Beta-gamma dose ≤4 mrem/yr	None	None
ERDF	Groundwater protection	0 pCi/L	Gross alpha activity concentration (excluding radon and uranium) ≤15 pCi/L	None	None
ERDF	Groundwater protection	0 pCi/L	Combined Ra-226 and Ra-228 concentration ≤5 pCi/L	None	None
ERDF	Groundwater protection	0 μg/L	Uranium concentration ≤30 μg/L	None	None
ERDF	Groundwater protection	N/A	Sr-90 concentration ≤8 pCi/L[c]	None	None
ERDF	Groundwater protection	0 pCi/L	H-3 concentration ≤20,000 pCi/L	None	None

a. Compliance at 100 m downgradient of ERDF, except for inadvertent intruder scenarios.

b. Calculated at 100 years after closure.

c. Not applicable; strontium-90 was screened out during evaluation of the groundwater pathway due to its relatively short half-life and its low mobility in the subsurface.

CA = composite analysis
EDE = effective dose equivalent
ERDF = Environmental Restoration Disposal Facility
N/A = not applicable
PA = performance assessment

5 Research and Development

The research and development (R&D) activities considered for the ERDF are described in CP-60150, *Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan formerly WCH-562 Rev. 1*.

This chapter summaries the R&D, field studies, and other activities that could potentially impact the basis of the ERDF PA (CP-60089). Table 6 summarizes the R&D activities for this reporting period.

No R&D activities were completed or added during FY 2017. One R&D activity, “Long-Term Carbon-14 Release Rate,” remains to be completed when representative soil samples become available.

Table 6. R&D Activities

Document Number	Results	PA/CA Impacts
No research and development activities to report this period.		

CA = composite analysis
PA = performance assessment

6 Planned or Contemplated Changes

This chapter identifies any changes in facility operations, waste receipts, waste form behavior, monitoring data, R&D data, or land-use decisions during the reporting period that have affected PA assumptions and conclusions. If such changes exist, potential impacts are addressed, and recommended changes that are needed to address the impact of the reported change are identified.

During this reporting period, no changes have occurred to cause substantive changes in disposal facility operations, disposal facility performance, or PA assumptions. Table 7 shows the proposed change of modifying the waste inventory forecast, as well as subsequent revisions to other PA-related documents (e.g., waste acceptance criteria or maintenance plan), so the inventory forecast is no longer exceeded and the disposed inventory may be assessed against the forecasted inventory.

7 Status of Disposal Authorization Statement Conditions and Key and Secondary Issues

This chapter provides a status update for any DAS conditions and key or secondary issues resulting from review by the Low-Level Waste Disposal Facility Federal Review Group of the ERDF PA (CP-60089) and other technical basis documents (e.g., monitoring plan and closure plan). As shown in Table 8, there are no outstanding conditions or issues to update in this annual summary report.

Table 7. Planned or Contemplated Changes

Planned or Contemplated Changes	Change Basis	PA/CA Impacts	Schedule
Update radionuclide inventory forecast Affected documents: • Waste acceptance criteria • Maintenance plan	UDQ-2017-001-E (disposed inventory exceeds the forecasted inventory)	Special analysis expected to be performed to evaluate the increased inventory forecast. Results expected to continue to be well below the performance standards.	FY 2019 (projected)
Update waste acceptance criteria (ERDF-00011)	UDQ-2017-002-S (hafnium-182 omitted from the ERDF waste acceptance criteria; add hafnium-182 to waste acceptance criteria, Table B-1)	None	FY 2018 (projected)
Update maintenance plan (CP-60150)	Editorial corrections to: • Section 3.2, "Research and Development" • Appendix B, "Maintenance Plan Schedule of Activities"	None	FY 2018 (projected)

References:

CP-60150, *Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan formerly WCH-562 Rev. 1.*

ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4.*

CA = composite analysis
ERDF = Environmental Restoration Disposal Facility
FY = fiscal year
PA = performance analysis

Table 8. Status of DAS Conditions and Key and Secondary Issues

Disposal Facility/Unit	Key/Secondary Issue or DAS Condition Number	Issue Description	Initial Resolutions Schedule Date	Projected Resolution Scheduled Date	Disposition Documentation and Date Completed	PA/DAS Impact
ERDF	None	N/A	N/A	N/A	N/A	N/A

DAS = disposal authorization statement
ERDF = Environmental Restoration Disposal Facility
N/A = not applicable
PA = performance assessment

8 Certification of the Continued Adequacy of the Performance Assessment, Composite Analysis, Disposal Authorization Statement, and Radioactive Waste Management Basis

DOE M 435.1-1 Chg 1, Section IV.P (4)(c) states, "Annual summaries of low-level waste disposal operations shall be prepared with respect to the conclusions and recommendations of the performance assessment and composite analysis and a determination of the need to revise the performance assessment or composite analysis."

Chapter 1 of this annual summary report outlines that no changes have occurred to cause substantive changes in disposal facility operations, disposal facility performance, and PA assumptions or results (Table 1), resulting in no additional cumulative effects. In summary, the information reviewed in this annual summary report resulted in no change to the PA or the DAS for the ERDF low-level waste disposal facility.

8.1 Certification by the FEM or Designee

I certify, to the best of my knowledge, that information in this annual summary report is true, accurate, and complete and that any proposed or implemented changes associated with the ERDF provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 Chg 1 will be met.

D. Shoop, Manager
U.S. Department of Energy, Richland Operations Office

4/4/18
Date

9 References

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

CP-60089, 2016, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford, Washington, formerly WCH-520 Rev. 1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-60150, 2016, *Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan formerly WCH-562 Rev. 1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-60152, 2016, *Performance Assessment Monitoring Plan for the Environmental Restoration Disposal Facility, formerly WCH-579 Rev. 1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

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.

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.

DOE/RL-2000-29, 2018, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 3 (in publication), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2016-57, 2017, *Annual Status Report (FY2016): Performance Assessment for the Environmental Restoration Disposal Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.osti.gov/scitech/servlets/purl/1364350.

DOE/RL-2017-55, 2018, *Annual Status Report (FY 2017): Composite Analysis for Low Level Waste Disposal in the Central Plateau of the Hanford Site*, Rev. 0 (in publication), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-STD-5002-2017, May 2017 *DOE Standard Disposal Authorization Statement and Tank Closure Documentation, U.S. Department of Energy, Washington, D.C. 20585*

EPA, Ecology, and DOE, 2007, *Amendment to the Record of Decision for the USDOE Hanford Environmental Restoration Disposal Facility*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA04316406.

ERDF-00011, 2016, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079141H.

PNNL-11800, Addendum 1, 2001, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084085.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

WCH-479, 2013, *Inventory Data Package for ERDF Waste Disposal*, Rev. 1, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083702.

Appendix A

Unreviewed Disposal Questions – Fiscal Year 2017

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A Unreviewed Disposal Questions – Fiscal Year 2017

Proposed changes and/or activities that may affect the PA or DAS are evaluated in accordance with a procedure on Unreviewed Disposal Questions (UDQ), which implements the change processes used to ensure compliance with DOE O 435.1 Chg 1, *Radioactive Waste Management and* DOE-STD-5002-2017*, DOE Standard Disposal Authorization Statement and Tank Closure Documentation.* The procedure contains a three-tiered process:

1. UDQ screening
2. UDQ evaluation
3. Special analysis

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ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA (ERDF-PRO-EN-54046)

UDQS No.: UDQ-2017-001-S

Proposed Activity:

During performance of the FY 2016 annual periodic review, required by the Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan,WCH-562, Rev. 1, it was discovered that the radionuclide inventory disposed at ERDF as of 9/30/2016 is greater than the inventory projected in the WCH-520, Rev. 1, Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington, (ERDF PA).

REVIEW the following questions against the proposed activity:	Yes	No	N/A
1. Does the proposed activity or new information involve a change to the disposal facility from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
2. Does the proposed activity or new information involve a change to the disposal process from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
3. Does the proposed activity or new information involve a change to the radionuclide disposal limits from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
4. Does the proposed activity or new information involve a change to the Waste Acceptance Criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations	☐	☒	☐
5. Does the proposed activity or new information involve a change to what has been previously described or analyzed in the most recent Performance Assessment (CP-60089) or approved Special Analysis, inputs, and assumptions?	☒	☐	☐
6. Does the proposed activity or new information involve a change to the facility closure design or criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
7. Does the proposed activity or new information involve a test or experiment not described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
8. Does the proposed activity or new information involve any analytical errors, omissions, or deficiencies in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐

Provide Explanation/Justification for all "Yes" answers:

Radionuclide inventory Disposed in ERDF exceeded the inventory projected in the ERDF PA, CP-60154 for a number of radionuclides. A qualitative analysis to estimate dose at closure was performed to determine the effect of the increased inventory on projected dose. The qualitative analysis showed that the All Pathways peak dose estimate would increase by 18% during the compliance period and the Acute and Chronic inadvertent intruder dose estimates would increase by 8% and 6 %, respectively. The increased dose estimates remain well below the Performance Objectives.

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

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A-6007-288 (REV 0)

ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA (Continued)
(ERDF-PRO-EN-54046)

UDQS No.: UDQ-2017-001-S

If all questions above are answered "No" or "N/A" *(defined by an "X" in the box provided)*, then a UDQ Evaluation is not required, implement the proposed activity. If any of the questions above are answered "Yes" *(defined by an "X" in the box provided)*, then complete a UDQ Evaluation.

Is a UDQ Evaluation required? ◉ Yes ○ No

Originator: Michael Casbon *Print First and Last Name*	Michael Casbon *Signature*	5/3/17 *Date*
Reviewer: SUNIL MEHTA *Print First and Last Name*	[illegible] *Signature*	5/3/17 *Date*
Supervisor Review: W.A. BORLAUG *Print First and Last Name*	W.A. Borlaug *Signature*	1/8/2018 *Date*

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

A-6007-288 (REV 0)

ERDF UNREVIEWED DISPOSAL QUESTION EVALUATION (UDQE)
(ERDF-PRO-EN-54046)

UDQE No.: UDQ-2017-001-E

1. Unreviewed Disposal Question Evaluation	Yes	No	N/A
a. Is the proposed activity or new information outside the bounds of the most recent Performance Assessment (CP-60089) *(e.g., does the proposed activity or new information involve a change to the basic disposal concept as described in the Performance Assessment such as critical inputs/ assumption)*?	○	◉	○
b. If implemented, would the proposed activity, the new information, or discovery, call into question the reasonable expectation presumption that the PA performance objectives will be met?	○	◉	○
c. Would the radionuclide threshold concentration limits in the approved WAC (ERDF-00011) need to be changed to implement the proposed activity?	○	◉	○
d. Does the new information result in a change in the total inventory limits in the approved WAC (ERDF-00011)?	○	◉	○
e. If implemented, would the proposed activity or the new information potentially impact any conditions or limitations in the Disposal Authorization Statement (DAS)?	○	◉	○

If all questions above are answered "No" or "N/A" *(defined by an "X" in the box provided)*, then implement the proposed activity. If any of the questions above are answered "Yes" *(defined by an "X" in the box provided)*, then complete a special analysis.

Is a Special Analysis required? ○ Yes ◉ No

Comments: *(If Comments are included as a separate attachment, check here ☒)*

Attachments:
- A. Comments
- B. Fact Sheet
- C. Analysis

Originator: S. Mehta (*Print First and Last Name*)	(*Signature*)	01/23/2018 (*Date*)
Reviewer: D. B. Teachout (*Print First and Last Name*)	Douglas B. Teachout (*Signature*)	01/24/2018 (*Date*)
ERDF Engineering: W. A. Borlaug (*Print First and Last Name*)	W.A. Borlaug (*Signature*)	1/24/2018 (*Date*)

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

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A-6007-289 (REV 0)

The radionuclide inventory disposed in ERDF at the end of FY2016 exceeded the projected closure inventory (at Year 2035) for some radionuclides in the ERDF PA (CP-60089). The source of the additional inventory is described in Attachment B. An analysis (see Attachment C, ECF-ERDF-17-0198, Rev. 0, *Evaluation of Increased Inventory Disposed at ERDF on the Post-Closure ERDF Performance Assessment*) was performed to determine the impact of an increased inventory projection (current disposed inventory plus remaining forecast) to the performance objectives/measures and to the radionuclide concentration and inventory limits listed in the Waste Acceptance Criteria (ERDF-00011). For this analysis, the original forecasted inventory at closure (from 2011 through 2035) was added to the current inventory (as disposed through 9/30/2016) and decay corrected to the closure date. The results of the analysis (see Attachment C, Table 7-1) show a small increase in the peak All Pathways (0.7% increase with respect to the Performance Standard) and the peak Atmospheric pathway (1.8% increase with respect to the Performance Standard) doses from 1.02 mrem/year to 1.20 mrem/year within the compliance period; still only 4.8%-12% of the allowed performance objectives doses. This dose increase is primarily attributed to the increase in tritium inventory at closure that results in an increase to the air-pathway dose; the groundwater pathway dose remains unchanged. The increase in radon flux (from 0.11 to 0.83 pCi/m2/s) is due to corresponding increase in inventory of Ra-226 (parent radionuclide of Rn-222) from 1.7 Ci to 12.4 Ci at closure. The radon flux continues to remain negligibly small (~4.2% of the allowed performance objectives dose) and well below the performance standard of 20 pCi/m2/s.

While small increases in the PA results have occurred due to projected inventory adjustments, there is no impact on the radionuclide threshold concentrations and inventory threshold limits documented in the approved Waste Acceptance Criteria (ERDF-00011). As a result, the disposal requirements as per the current DAS remain unchanged and no Special Analysis is required.

The estimate of future disposed inventory is highly uncertain; however, the analysis demonstrates that performance objectives and measure are still maintained with significant increases in inventory. The PA acknowledges this uncertainty and provides an inventory limit for disposal for dose contributing radionuclides that are included in the Waste Acceptance Criteria. Similarly, the radionuclide threshold concentrations are not impacted as they are calculated based on the maximum acceptable concentrations that can be disposed in ERDF. The inventory disposal limits and concentration thresholds are evaluated on an annual basis using the sum of fractions and all criteria are currently met.

To improve waste inventory tracking, the "Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan" (CP-60150) was revised to incorporate the activities identified in Attachment B.

ERDF UNREVIEWED DISPOSAL QUESTION EVALUATION (UDQE) (ERDF-PRO-EN-54046)
UDQE No.: UDQ-2017-001-E Attachment B – Fact Sheet

ERDF FY2016 Performance Assessment Annual Review

During performance of the FY 2016 annual periodic review, required by the *WCH-562, Rev. 1, Environmental Restoration Disposal Facility Performance Assessment Maintenance Plan*, it was discovered that the radionuclide inventory disposed at ERDF as of 9/30/2016 is greater than the inventory projected in the *WCH-520, Rev. 1, Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington*, (ERDF PA). Following is a summary of the annual review, additional details will be included in the ERDF FY2016 Performance Assessment Annual Review.

1. **ERDF FY2016 Inventory Review**
   - Inventory was being tracked with respect to the Performance Standards (e.g. DOE O 435.1 Chronic Inadvertent Intruder 100 mrem/year EDE) rather than with respect to the ERDF Performance Assessment Results. The dose generated by ERDF's inventory at closure is estimated to be less than 15% of the Performance Standards.
   - Current ERDF Inventory (inception to 9/30/2016) + Forecasted Inventory is greater than the inventory projected in the ERDF PA at closure for some radionuclides. The additional inventory is due to:
     - Adjustments to the current ERDF inventory identified in *WCH-479, Rev. 1, Inventory Data Package for ERDF Waste Disposal*, Table 2-1, have not yet been completed. Inventory adjustments that have been completed are documented in the published FY2014 and FY2015 ERDF annual summary reports and the adjustments completed during FY2016 will be documented in the FY2016 ERDF annual summary report.
     - Intentional overestimation as described in *WCH-479, Rev. 1, Inventory Data Package for ERDF Waste Disposal*, Section 2.1. The radionuclide inventory in waste shipments is intentionally overestimated to ensure that the concentration for each radionuclide is bounded by the maximum radionuclide concentration encountered during characterization. The radionuclide concentrations are not homogenously distributed at waste sites and selection of the maximum bounding values tends to represent the more concentrated waste zones rather than a true average value.
     - The additional waste characterization (e.g. additional uranium in the waste from 618-10 and 316-3) information was identified for the waste sources covered in the ERDF PA.
     - Use of undecayed radionuclide inventory tracked in the ERDF waste management information system (WMIS) database in comparisons to decayed inventory projections in the ERDF PA.
2. **Effect of Additional Inventory on the ERDF PA Performance Objectives**
   - A qualitative analysis of the increased inventory with respect to the ERDF PA performance objectives, summarized on the following table, indicates that there will be no appreciable increase in the peak dose values with respect to the Performance Standards and only minor increases with respect to the dose estimated in the ERDF PA (WCH-520, Rev. 1, Table 7-1). A quantitative analysis will be performed as part of the Unreviewed Disposal Question Evaluation (UDQE).
3. **Revise the Maintenance Plan to Improve Waste Inventory Tracking**
   - Clarify the requirement to evaluate the waste received inventory with respect to the ERDF Performance Assessment Results rather than to the performance standards.
   - Increase the frequency of periodic reviews specified in Section 3.3.1. Results of the reviews will be documented in the annual summary report.
   - Prioritize and complete outstanding inventory adjustments identified in *WCH-479, Rev. 1, Inventory Data Package for ERDF Waste Disposal*, Table 2-1.
   - Increase the projected inventory at closure to account for additional waste inventory identified by the availability of additional waste characterization data, encountered during remediation, due to the overestimation of inventory in waste shipments, etc.
   - Consider decaying the inventory obtained from WMIS to be more representative of the decayed inventory presented in the ERDF PA.

Summary of Qualitative Analysis to Estimate Dose due to Inventory Increase at Closure
(Quantitative Analysis will be performed as part of the Unreviewed Disposal Question Evaluation)

Comparison of
Performance Objectives / ERDF Performance Assessment Results / Actual ERDF Inventory (@ end of FY2016) + Remaining Forecasted Inventory (@2035)
for the Compliance Period (2035-3035)[a]

Performance Objective and/or Measure	Standard	DOSE Estimates during Compliance Period (2035-3035)[a]					
		Performance Assessment Results[g]			ERDF Actual as of 9/30/16 + Remaining Forecast Inventory		
		ERDF PA Dose Estimate[g]		% of Standard[g]	Actual + Forecast Dose Estimate		% of ERDF PA Dose Estimate[g]	% of Standard[g]
All pathways (DOE O 435.1 Chg 1)	25 mrem/yr EDE	1.02	mrem/yr	5%	1.2	mrem/yr	118%	5%
Atmospheric (40 CFR 61, Subpart H)	10 mrem/yr EDE	1.02	mrem/yr	11%	1.2	mrem/yr	118%	12%
Atmospheric (40 CFR 61, Subpart Q)	20 pCi.m-2.s-1 radon flux *(at surface of disposal facility)*	0.11	pCi.m-2.s-1	1%	0.83	pCi.m-2.s-1	755%	5%
Acute inadvertent intruder (DOE O 435.1 Chg 1)	500 mrem EDE[b]	5.51	mrem[f]	2%	5.9	mrem[f]	108%	2%
Chronic inadvertent intruder (DOE O 435.1 Chg 1)	100 mrem/yr EDE[b]	9.27	mrem/yr[f]	10%	9.81	mrem[f]	106%	10%

Notes:

[a] Compliance at 100 m downgradient of ERDF except for inadvertent intruder scenarios.

[b] Not applicable for post-compliance; dose estimate at 100 years was used to determine inventory threshold.

[f] Calculated at 500 years after closure, which represents the Class C waste protection criteria against an inadvertent intrusion.

[g] Performance Objectives, Standards, and ERDF PA dose estimates are listed in ERDF PA (WCH-520, Rev. 1, Table 7-1)

EDE = effective dose equivalent

ERDF UNREVIEWED DISPOSAL QUESTION EVALUATION (UDQE) (ERDF-PRO-EN-54046)
UDQE No.: UDQ-2017-001-E Attachment C – Analysis

ECF-ERDF-17-0198
Revision 0

Evaluation of Increased Inventory Disposed at ERDF on the Post-Closure ERDF Performance Assessment

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
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Approved for Public Release;
Further Dissemination Unlimited

ECF-ERDF-17-0198
Revision 0

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ENVIRONMENTAL CALCULATION COVER PAGE

Section 1: Completed by the Responsible Manager

Project: Environmental Restoration Disposal Facility Performance Assessment Support

Date: 11/27/2017

Calculation Title & Description: Evaluation of Increased Inventory Disposed at ERDF on the Post-Closure ERDF Performance Assessment

RELEASE / ISSUE

DATE: Dec 11, 2017 HANFORD RELEASE

Section 2: Completed by Preparer

Calculation No.: ECF-ERDF-17-0198 **Revision No.:** 0

Revision History

Revision No.	Description	Date	Affected Pages ADD ROW
0	Initial issue		All

Section 3: Completed by the Responsible Manager

Document Control:

Is the document intended to be controlled within the Document Management Control System (DMCS)? ☒ Yes ☐ No

Does document contain scientific and technical information intended for public use? ☒ Yes ☐ No

Does document contain controlled-use information? ☐ Yes ☒ No

Section 4: Document Review & Approval

	Name /Position	Signature	Date
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Senior Reviewer:	S Mehta/Principal Hydrogeologist		11/27/2017
Responsible Manager:	AH Aly/Risk & Modeling Integr. Mngr		11/29/17

Section 5: Applicable if calculation is a risk assessment or uses an environmental model

PRIOR TO INITIATING MODELING:

Required training for modelers completed:

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CALCULATION APPROVED:

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A-6005-812 (REV 5)

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Amena Mayenna's professional experience has focused on numerical modeling of groundwater in the vadose and saturated zones, model calibration, groundwater management, and geostatistics analysis. Her work has been performed primarily to support performance assessment at a large federal restoration site. She uses her numerical modeling skills in support of risk assessment and determination of preliminary remediation goals. Amena is an experienced programmer and has applied multiple languages and modeling codes including Fortran, MODFLOW, MT3D, MODPATH, Ground Water Vistas, STOMP, ArcGIS, and Leapfrog Hydro.

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MS, Geology, University of Poona, India, 1990

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Sunil Mehta's professional experience as a hydrogeologist has been focused on flow and transport modeling under variably saturated conditions, reactive transport modeling, performance assessment, and uncertainty analysis. He has gained this experience on projects involving deep geologic isolation of high-level radioactive wastes, shallow disposal of low-level radioactive waste, and environmental restoration activities in accordance with local and federal regulations. Sunil's experience includes designing, developing, and applying numerical models to evaluate the performance of radioactive waste storage and disposal facilities. His work has encompassed developing flow

and reactive transport models for transuranics, conducting process and component modeling (e.g., unsaturated and saturated zone flow, colloid facilitated transport, and waste form degradation) and combining these models into a comprehensive probabilistic assessment tool used to forecast post-closure performance of a storage facility. In the area of environmental restoration, he has performed hydrogeological studies and groundwater flow and contaminant transport modeling to support the design of remedial systems to sequester and capture contaminants such as uranium and hexavalent chromium in periodically rewetted zones influenced by aquifer-river interactions. In addition, Sunil's water resources experience includes evaluating aquifer resource potential for agricultural needs through the interpretation of geophysical logs and analysis of pumping test data, and using remote sensing techniques to support groundwater exploration.

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Attachments

A. Software Installation and Checkout Form for GoldSim

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
DOE	U.S. Department of Energy
ECF	environmental calculation file
EDE	effective dose equivalent
ERDF	Environmental Restoration Disposal Facility
EMMA	Environmental Model Management Archive
FY	fiscal year
HEIS	Hanford Environmental Information System (environmental database)
HISI	Hanford Information System Inventory (software database)
MCL	maximum contaminant level
PA	Performance Assessment
STOMP	Subsurface Transport Over Multiple Phases
UDQ	Unreviewed Disposal Question
VPU	vertical pipe unit
WAC	waste acceptance criteria
WCH	Washington Closure Hanford
WMIS	Waste Management Information System

1 Purpose

DOE/RL-2016-57, *Annual Status Report (FY 2016): Performance Assessment for the Environmental Restoration Disposal Facility*, identified that the currently disposed Environmental Restoaration Disposal Facility (ERDF) inventory exceeds the inventory estimated at closure used in the ERDF performance assessment (PA) calculations (CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington, formerly WCH-520, Rev. 1*[1]). A qualitative evaluation performed in DOE/RL-2016-57 indicated that the effective dose will increase marginally but will remain significantly below the performance objectives of the DOE O 435.1, *Radioactive Waste Management*. The purpose of this environmental calculation file (ECF) is to provide a quantitative evaluation of the increased inventory estimates at closure and compares the new dose estimates against those documented in CP-60089.

2 Background

One aspect of demonstrating a reasonable expectation that performance objectives of ERDF continue to be met is a review of changes that will potentially affect the results of ERDF PA. These include any discovered divergences from expected or planned conditions, with regard to site characteristics or facility-related attributes that are potentially significant to facility performance. An unreviewed disposal question (UDQ) process is followed to assess the impact of discovered divergences on the ERDF PA results. This process is described in a procedure ERDF-PRO-EN-54046, *Unreviewed Disposal Question (UDQ)*. The evaluation of inventory exceedance is performed to meet the needs of this procedure through completion of the UDQ screening and UDQ evaluation.

The current inventory increase (beyond that estimated to be present in ERDF PA at closure) can be attributed to following causes:

1. Intentional overestimation of disposed inventory occurs in the waste shipping process to ERDF. Concentrations of radionuclides in waste are biased towards the high concentration samples (instead of a more representative average concentration) to ensure that shipping remains compliant with the federal and state regulations.

2. Unanticipated increase in waste received from 618-10 burial ground due to remedial activities. The 618-10 remediation project began processing concrete drums and vertical pipe units (VPUs) while submerged in a box of liquid grout. This allowed some of the waste to be classified as low-level waste.

3. The remediation of 316-3 Trench was not planned during preparation of CP-60089. However, subsequent excavations at this site encountered soil contamination that resulted in increased inventory that was disposed at ERDF. Remediation of some waste sites in the 300 Area (including 618-10) increased the uranium inventory by approximately 333 metric tons.

4. Increased tritium inventory from recent disposal of exit signs at ERDF. This type of waste was not anticipated during preparation of CP-60089.

[1] With the transition of ERDF from Washington Closure Hanford (WCH) to CH2M HILL Plateau Remediation Company (CHPRC), the original document number for the ERDF PA (WCH-520, Rev. 1, Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington) has been changed to CP-60089, Rev. 0 (the document is otherwise unchanged).

5. Use of undecayed radionuclide inventory recorded in the ERDF Waste Management Information System (WMIS) database.

It should be noted that any increase in estimated inventory at closure will not impact the current waste acceptance criteria (WAC) (ERDF-00011, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*) as none of the safety limits are exceeded in terms of total disposed inventory or concentrations of the disposed waste.

3 Methodology

The ERDF PA analysis was based on the inventory value reported in *WCH-479 Rev. 1, Inventory Data Package for ERDF Waste Disposal,* which considered inventory disposed in ERDF as of 08/24/2010 recorded in ERDF WMIS database. This cumulative inventory is decayed to 01/01/2011 and reported in Table 2-1 of WCH-479. Inventory disposed after 08/24/2010 is reported in WMIS and below listed steps are followed to evaluate the impact of this additional inventory:

1. Cumulative inventory disposed at the end of each fiscal year (09/30/2010, 09/30/2011, 09/30/2012, 09/30/2013, 09/13/2014, 09/30/2014, 09/30/2015 and 09/30/2016) is obtained from WMIS (ERDF Inventory Tracking_Inception-FY2016_11-17-16.xlsx file).

2. Inventory added in each fiscal year is calculated by taking the difference of cumulative inventory between two successive years. For example, added inventory in fiscal year 2012 is obtained by deducting cumulative inventory as of 09/30/2011 from cumulative inventory as of 09/30/2012. Inventory added between 08/24/2010 and 09/30/2010 is added to the fiscal year 2011 inventory for simplification of the calculation.

3. The cumulatve inventory as of 08/24/2010 (decayed to 2011) and additional inventory for each fiscal year (2011 – 2016) is decayed to 01/01/2035 (assumed ERDF closure date) using a GoldSim model (*ERDF_PA_Inventory_UDQE_Closure_Decay_Calculation.gsm*) to estimate the currently disposed (as of 09/30/2016) inventory at ERDF.

4. The disposed inventory as of 9/30/2016 is added to the forecasted inventory given in Table 3-2 of CP-60089 (decayed to 01/01/2035) to calculate the updated total inventory at closure (i.e., disposed inventory by 9/30/16 + forecasted inventory decay corrected to 01/01/2035).

5. ERDF PA system model (described in CP-60089) is run using this updated total inventory at closure and results are compared to the performance objectives (Table 1-1 CP-60089). The Goldsim model file *ERDF_PA_Inventory_UDQE_Performance_Evaluation.gsm* is used for this calculation.

In ERDF PA (CP-60089), the groundwater pathway compliance calculations were performed using a process model while a system model was developed for performing uncertainty and sensitivity analyses, due to much shorter run times. The results of the system model closely match the process model results (see Figure 4-25 and 4-26 of CP-60089) and the peak concentrations at the 100-m compliance boundary is practically the same between the two models. Furthermore, the system model was used for atmospheric pathway and intruder analysis in the ERDF PA calculations. Thus, usage of ERDF PA system model is justified in estimating the impact of updated inventory and comparison against the performance objectives.

4 Assumptions and Inputs

All the assumptions and inputs remain the same as documented in ERDF PA system model (CP-60089), except for the currently (as of 9/30/2016) disposed inventory that was updated based on available information at the end of 09/30/2016. Table 4-1 presents the inventory disposed on a fiscal year basis from 2010 through 2016. The third column in Table 4-1 (right of the radionuclide list column) that provides the ERDF inventory in August 2010 is taken from WCH-479, where the inventory has been decay corrected to January 1, 2011. All subsequent columns present the inventory disposed in that fiscal year (based on information available in WMIS). No decay corrections have been applied as reported in this table.

Table 4-2 compares the total inventory at closure using the updated inventory and that used in the ERDF PA (Table 3.2 of CP-60089). The total inventory at closure is calculated by taking the disposed inventory as of 9/30/2016 and adding the forecasted inventory at closure and performing a decay correction to the assumed closure date of January 1, 2035. The forecasted inventory remains unchanged from what is estimated in ERDF PA (Table 3.2 of CP-60089).

Comparing the closure inventories, some increases in key radionuclides are observed for the updated total inventory case — a factor of 3 increase for H-3; a factor of 1.4 increase for Tc-99; a factor of 3 increase for I-129; a factor of 7 increase for Ra-226; and a factor of 5 increase for U-238.

Table 4-1. Actual ERDF Radionuclide Inventory for Fiscal Years 2010 to 2016

	Radionuclide	Inventory on 08/24/2010 (decay corrected to Jan 1, 2011 for ERDF PA calculations) (WCH-479)	WMIS Inventory: Disposed FY2011 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2012 (No Decay Correction Applied)	WMIS Inventory: Disposed FY 2013 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2014 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2015 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2016 (No Decay Correction Applied)
		Ci	Ci	Ci	Ci	Ci	Ci	Ci
1	Ac-227	5.00E-06	1.19E-04	2.34E-05	3.35E-03	2.37E-03	5.08E-03	3.51E-03
2	Ag-108m	2.48E+02	4.37E+02	5.50E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Am-241	5.45E+02	1.73E+02	1.14E+02	1.48E+01	4.42E+01	5.02E+01	3.33E+01
4	Am-243	6.00E-01	6.40E-02	1.53E-01	8.30E-03	3.00E-04	1.50E-03	4.90E-03
5	C-14	1.89E+03	1.99E+01	2.56E+01	2.70E+00	6.07E+01	6.30E+00	6.00E+00
6	Cd-113m	3.00E+00	1.35E+00	5.30E-02	5.00E-03	1.00E-03	5.00E-03	2.00E-03
7	Cl-36	0.00E+00	0.00E+00	0.00E+00	3.72E-05	0.00E+00	0.00E+00	0.00E+00
8	Cm-243	1.00E-01	6.94E-01	1.78E+00	1.15E-01	1.20E-02	9.20E-02	2.00E-03
9	Cm-244	1.60E+00	2.84E+00	1.94E+00	1.69E-01	2.10E-02	1.31E-01	3.10E-01
10	Co-60	5.45E+03	1.05E+03	2.70E+02	2.01E+01	2.11E+03	4.00E+01	0.00E+00
11	Cs-137	1.46E+04	7.65E+03	7.30E+02	5.10E+02	4.20E+02	4.00E+02	3.50E+02
12	Eu-152	4.84E+03	3.44E+02	5.90E+01	5.00E+00	3.08E+02	1.00E+00	3.00E+00
13	Eu-154	1.35E+03	1.24E+02	2.70E+01	2.00E+00	2.60E+01	2.00E+00	1.00E+00
14	H-3	7.79E+03	2.18E+03	5.45E+03	1.84E+04	7.11E+03	1.43E+04	7.00E+03
15	I-129	1.90E-02	7.67E-03	2.58E-02	6.26E-03	4.90E-04	6.20E-04	4.10E-04
16	K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
17	Mo-93	5.00E-01	2.58E-01	3.00E-03	2.32E+00	0.00E+00	0.00E+00	1.00E-03

Table 4-1. Actual ERDF Radionuclide Inventory for Fiscal Years 2010 to 2016

	Radionuclide	Inventory on 08/24/2010 (decay corrected to Jan 1, 2011 for ERDF PA calculations) (WCH-479)	WMIS Inventory: Disposed FY2011 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2012 (No Decay Correction Applied)	WMIS Inventory: Disposed FY 2013 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2014 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2015 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2016 (No Decay Correction Applied)
		Ci	Ci	Ci	Ci	Ci	Ci	Ci
18	Nb-93m	4.80E+00	2.90E-01	7.00E-02	2.70E-01	0.00E+00	1.00E-02	1.10E-01
19	Nb-94	3.00E-01	8.30E-02	5.00E-03	5.79E-01	3.00E-02	1.00E-03	0.00E+00
20	Ni-59	1.90E+02	5.18E+01	1.09E+01	5.00E-01	0.00E+00	0.00E+00	4.00E-01
21	Ni-63	1.45E+04	1.35E+03	3.70E+02	2.20E+02	8.00E+01	1.10E+02	3.00E+01
22	Np-237	4.00E-01	1.33E-01	9.89E-02	5.20E-03	9.10E-03	2.10E-03	1.60E-02
23	Pa-231	0.00E+00	1.06E-04	9.00E-07	1.80E-06	1.42E-05	1.10E-05	9.26E-04
24	Pu-238	4.20E+01	2.37E+01	1.18E+01	1.08E+00	9.24E+00	1.21E+01	6.80E+00
25	Pu-239	2.60E+02	9.41E+01	1.16E+02	2.03E+01	2.22E+01	3.17E+01	3.66E+01
26	Pu-240	1.20E+02	7.04E+01	2.35E+01	2.60E+00	1.51E+01	2.34E+01	1.45E+01
27	Pu-241	5.10E+03	1.53E+03	1.00E+03	7.50E+01	1.91E+02	2.27E+02	1.27E+02
28	Pu-242	7.00E-01	7.37E-01	3.70E-02	3.00E-03	0.00E+00	1.00E-03	4.00E-03
29	Ra-226	9.00E-01	9.84E-01	2.32E+00	7.42E-01	2.37E+00	3.48E+00	9.30E-01
30	Ra-228	2.00E-01	2.06E-01	4.23E-02	1.68E-02	1.93E+00	4.01E+00	5.46E-01
31	Rn-222	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
32	Se-79	1.00E-01	3.72E-02	1.60E-03	7.00E-04	3.50E-03	4.70E-03	8.10E-03
33	Sm-151	2.59E+02	5.89E+02	5.90E+00	8.00E+00	1.00E+00	1.72E+01	9.10E+00
34	Sn-121m	1.70E+01	8.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-01

Table 4-1. Actual ERDF Radionuclide Inventory for Fiscal Years 2010 to 2016

	Radionuclide	Inventory on 08/24/2010 (decay corrected to Jan 1, 2011 for ERDF PA calculations) (WCH-479)	WMIS Inventory: Disposed FY2011 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2012 (No Decay Correction Applied)	WMIS Inventory: Disposed FY 2013 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2014 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2015 (No Decay Correction Applied)	WMIS Inventory: Disposed FY2016 (No Decay Correction Applied)
		Ci	Ci	Ci	Ci	Ci	Ci	Ci
35	Sn-126	2.00E-01	3.55E-02	2.70E-03	8.00E-04	2.00E-04	3.00E-03	6.30E-03
36	Sr-90	1.14E+04	1.92E+03	2.21E+03	4.40E+02	3.30E+02	1.09E+03	3.40E+02
37	Tc-99	2.10E+01	1.61E+01	1.12E+00	1.55E+00	3.10E-01	8.80E-01	1.08E+00
38	Th-229	0.00E+00	8.04E-04	4.01E-05	2.32E-01	1.40E-03	3.00E-04	1.00E-04
39	Th-230	2.00E-02	2.11E-01	2.20E-03	1.87E-02	6.00E-04	2.10E-03	2.70E-03
40	Th-232	1.10E+00	3.37E-01	9.16E-01	1.06E-01	7.78E+00	1.09E+01	4.20E-01
41	U-233	1.46E+01	2.94E+00	2.80E-01	9.50E-01	1.23E+00	3.54E+01	2.00E-02
42	U-234	1.35E+01	2.11E+01	4.07E+01	9.92E+00	4.37E+01	1.12E+02	3.20E+00
43	U-235	7.60E+00	6.90E-01	2.80E-01	1.20E-01	2.11E+00	1.14E+01	9.16E+00
44	U-236	4.00E-01	3.44E-01	4.40E-02	1.70E-02	2.50E-02	1.79E-01	1.60E-02
45	U-238	6.75E+01	9.96E+00	1.49E+01	9.30E-01	4.65E+01	2.06E+02	8.42E+01
46	Zr-93	1.60E+01	5.40E-01	8.00E-02	1.00E-02	0.00E+00	1.00E-02	1.30E-01

FY = fiscal year

Table 4-2. Comparison of Total Inventory at Closure for the Updated Total Inventory Case compared to the Total Inventory at Closure Evaluated in the ERDF PA Calculations. Inventory Values Decay Corrected to Assumed Closure Date of January 1, 2035

	Radionuclide	Total Inventory at Closure Evaluated in ERDF PA (CP-60089) (Inventory as of 8/24/2010 + Forecasted) Decayed to Year 2035 Ci	Updated Total Inventory at Closure (Inventory as of 9/30/2016 + Forecasted) Decayed to Year 2035 Ci	Ratio (Updated Inventory / ERDF PA Inventory)
1	Ac-227	1.20E-03	1.18E-02	9.85
2	Ag-108m	2.39E+02	7.48E+02	3.13
3	Am-241	8.42E+02	1.45E+03	1.72
4	Am-243	8.00E-01	1.03E+00	1.29
5	C-14	2.34E+03	2.46E+03	1.05
6	Cd-113m	1.37E+00	1.86E+00	1.36
7	Cl-36	2.00E-02	2.00E-02	1.00
8	Cm-243	5.20E-01	2.10E+00	4.03
9	Cm-244	1.18E+01	1.42E+01	1.20
10	Co-60	1.54E+03	1.75E+03	1.14
11	Cs-137	2.56E+05	2.62E+05	1.02
12	Eu-152	1.42E+03	1.66E+03	1.17
13	Eu-154	2.20E+02	2.50E+02	1.14
14	H-3	7.96E+03	2.52E+04	3.17
15	I-129	2.00E-02	6.06E-02	3.03
16	K-40	0.00E+00	0.00E+00	—
17	Mo-93	5.30E-01	3.10E+00	5.85
18	Nb-93m	1.78E+00	2.08E+00	1.17
19	Nb-94	3.80E-01	1.10E+00	2.88
20	Ni-59	3.00E+02	3.81E+02	1.27
21	Ni-63	1.27E+04	1.47E+04	1.16
22	Np-237	4.30E-01	7.14E-01	1.66
23	Pa-231	4.00E-03	1.47E-02	3.67
24	Pu-238	7.61E+01	1.31E+02	1.72
25	Pu-239	1.46E+03	1.78E+03	1.22
26	Pu-240	4.19E+02	5.69E+02	1.36

Table 4-2. Comparison of Total Inventory at Closure for the Updated Total Inventory Case compared to the Total Inventory at Closure Evaluated in the ERDF PA Calculations. Inventory Values Decay Corrected to Assumed Closure Date of January 1, 2035

	Radionuclide	Total Inventory at Closure Evaluated in ERDF PA (CP-60089) (Inventory as of 8/24/2010 + Forecasted) Decayed to Year 2035 Ci	Updated Total Inventory at Closure (Inventory as of 9/30/2016 + Forecasted) Decayed to Year 2035 Ci	Ratio (Updated Inventory / ERDF PA Inventory)
27	Pu-241	1.86E+03	2.97E+03	1.60
28	Pu-242	7.20E-01	1.54E+00	2.14
29	Ra-226	1.68E+00	1.24E+01	7.39
30	Ra-228	1.44E+00	2.06E+01	14.33
31	Rn-222*	1.68E+00	1.24E+01	7.39
32	Se-79	1.50E-01	2.07E-01	1.38
33	Sm-151	2.67E+02	8.08E+02	3.03
34	Sn-121m	1.26E+01	1.20E+01	0.95
35	Sn-126	2.70E-01	3.21E-01	1.19
36	Sr-90	1.18E+05	1.22E+05	1.03
37	Tc-99	5.30E+01	7.41E+01	1.40
38	Th-229	3.20E-02	3.36E-01	10.49
39	Th-230	2.31E-02	3.24E-01	14.01
40	Th-232	1.30E+00	2.17E+01	16.71
41	U-233	1.46E+01	5.54E+01	3.80
42	U-234	1.75E+01	2.48E+02	14.19
43	U-235	7.90E+00	3.16E+01	4.01
44	U-236	5.00E-01	1.13E+00	2.25
45	U-238	8.75E+01	4.50E+02	5.15
46	Zr-93	1.80E+01	1.88E+01	1.04

*Inventory of Rn-222 is assumed to be same as the parent Ra-226 based on secular equilibrium that will get established within a very short time period (less than one year).

5 Software Applications

GoldSim© was the primary software used for the ERDF PA system models calculation. GoldSim is also the software used to perform this calculation is approved, managed, and used in compliance with the

CH2M HILL Plateau Remediation Company (CHPRC) requirements of PRC-PRO-IRM-309, *Controlled Software Management*.

5.1 APPROVED SOFTWARE - GoldSim©

5.1.1 Description

GoldSim Pro version 11.1.5 (including the Radionuclide Transport module) is registered in the Hanford Information Systems Inventory (HISI) under identification number 2461. The simulation software is qualified for use and controlled by CH2M Hill Plateau Remediation Company. The HISI registration information lists the documents associated with software grading (it is graded as Level C Safety Software), minimum system requirements, software functional requirements, software management, software testing, and software installation plans. The identification for the software package used in the calculation are as follows:

- Software: GoldSim© Pro
- Version: 11.1.5
- Hanford Information System Inventory Identification (HISI) Number: 2461
- Workstation type and property number: INTERA-00606

GoldSim software use in this ECF is compliant with the following software quality assurance documents:

- CHPRC-00180, *GoldSim Pro Functional Requirements Document*
- CHPRC-00175, *GoldSim Pro Software Management Plan*
- CHPRC-00224, *GoldSim Pro Software Test Plan*
- CHPRC-00262, *GoldSim Pro Acceptance Test Report: Version 11.1.5*
- CHPRC-00256, *GoldSim Pro Requirements Traceability Matrix: Version 11.1.5*

5.1.2 Software Installation and Checkout

The software installation and checkout form for GoldSim© is provided in Attachment A to this ECF.

5.1.3 Statement of Valid Software Application

The following validates that GoldSim© is a valid software application and was applied in this ECF within its range of intended uses for which it was tested and approved.

- GoldSim© Pro was utilized for DOE to assist in performing simulation of radioactive mass conservation including decay and ingrowth, contamination mass transport in subsurface environment and to perform human health dose and risk assessment for the Hanford Site.
- GoldSim© Pro as it is used in this ECF has been implemented within the range of its limitations.

6 Calculation

The decay calculations for the disposed inventory (decayed to 01/01/2035) is performed and checked in ERDF_PA_Inventory_UDQE_Closure_Decay_Calculation.gsm file. The performance assessment related calculations are performed using the updated disposed inventory in the

ERDF_PA_Inventory_UD*QE_Performance_Evaluation.gsm* file. The calculation methodology remains the same as described in CP-60089 for the ERDF PA system model.

7 Results/Conclusions

Figure 7-1 presents results of the all-pathway total dose for the updated total inventory at closure and compares it to the results presented using ERDF PA inventory (CP-60089) for both the process model (used in the compliance calculations for the groundwater pathway) and the system model. Figure 7-2 and Figure 7-3 present similar comparisons for the air pathway dose and radon flux calculations, respectively, using the system model.

Table 7-1 presents the newly calculated results using the updated total inventory at closure and compares it with the ERDF PA results (CP-60089) along with the performance objectives. The results of the analyses show that the peak for the all-pathway dose increases from 1.02 mrem/year to 1.2 mrem/year within the compliance period and from 1.88 mrem/year to 2.80 mrem/year within the post-compliance period due to increased inventory. This reflects an increase by a factor of about 1.2 during the compliance time period and about 1.5 during the post-compliance period. The increase during the compliance time period is due to air pathway and results from increased inventory of H-3 and I-129. The increase in post-compliance time period is primarily from increase in Tc-99 inventory. These small increases in peak dose are consistent with the observed increase in inventory for dose contributing radionuclides.

The factor of 7 increase in radon flux (from 0.11 to 0.83 pCi/m2/s) is due to corresponding increase in inventory of Ra-226 (parent radionuclide of Rn-222). The radon flux continues to remain negligibly small (~5% of the allowed performance objectives dose) and well below the performance standard of 20 pCi/m2/s. Minor increases are noticeable in the peak dose for the acute and chronic intruder scenarios.

Groundwater protection is evaluated by comparing predicted concentrations in groundwater 100 m downgradient from the ERDF boundary during the compliance and post-compliance time periods with the National Primary Drinking Water Regulations for MCLs for radionuclides listed in 40 CFR 141, Subpart G, *National Primary Drinking Water Regulation: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels* (40 CFR 141.66). Peak predicted radionuclide groundwater concentrations are summarized and compared to applicable groundwater protection criteria in Table 6-4. For beta-gamma-emitting radionuclides (technetium-99, niobium-94, molybdenum-93, chlorine-36, and iodine-129), an assessment of compliance with the radionuclides' respective MCLs was conducted by computing the dose equivalent and comparing the sum of the dose over time to the 4-mrem/yr dose equivalent limit. Tc-99 accounts for almost all of the dose (>96%) during the post-compliance period. Other minor contributors to dose are Nb-94, Mo-93, and Cl-36. The peak Tc-99 concentration is calculated to be 1,043 pCi/L that occurs 7,240 years after closure. This peak Tc-99 concentration exceeds the 900 pCi/L MCL value and therefore the Beta-gamma dose equivalent of 4.6-mrem/yr exceeds the 4 mrem/yr standard. Since the small exceedance occurs in the post-compliance time period there is no need to take any action. During the compliance time period the Beta-gamma dose is 0 mrem/yr.

In summary, although the peak dose estimates have increased slightly due to increased inventory disposed at ERDF than that estimated at the time of ERDF PA calculations, they remain significantly below the performance objectives indicating that the disposal activities at ERDF continue to comply with the performance objectives of DOE O 435.1 requirements.

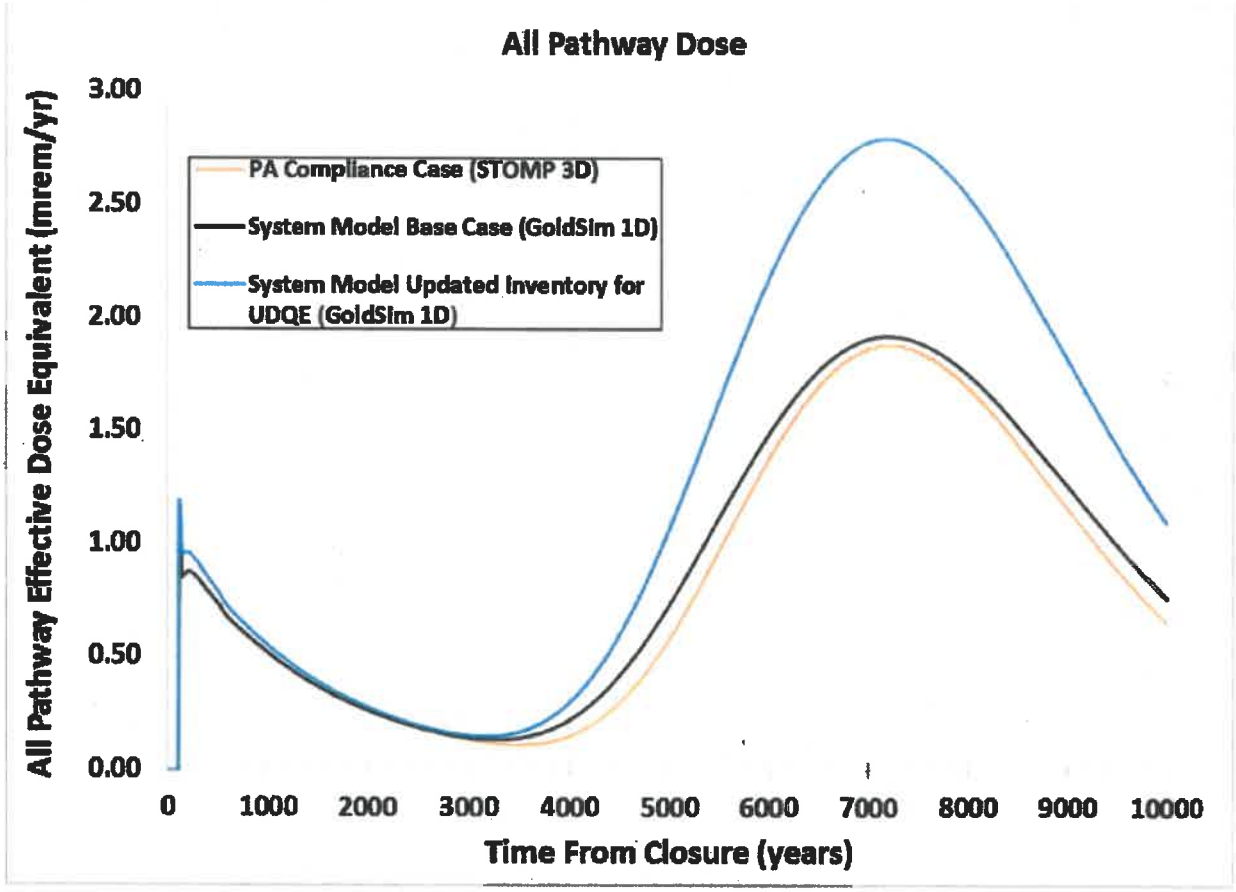

Figure 7-1. All Pathways Effective Dose Comparison

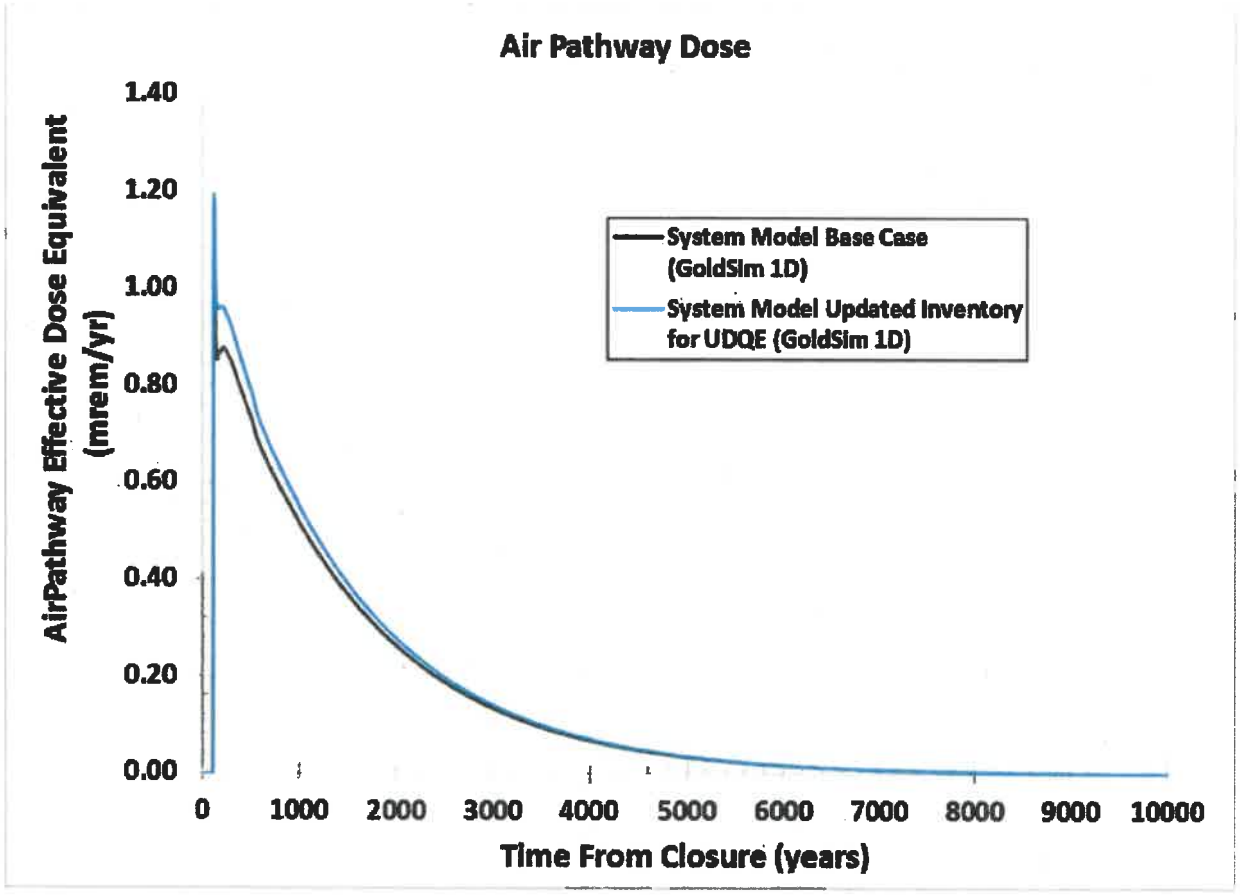

Figure 7-2. Air Pathway Dose Comparison

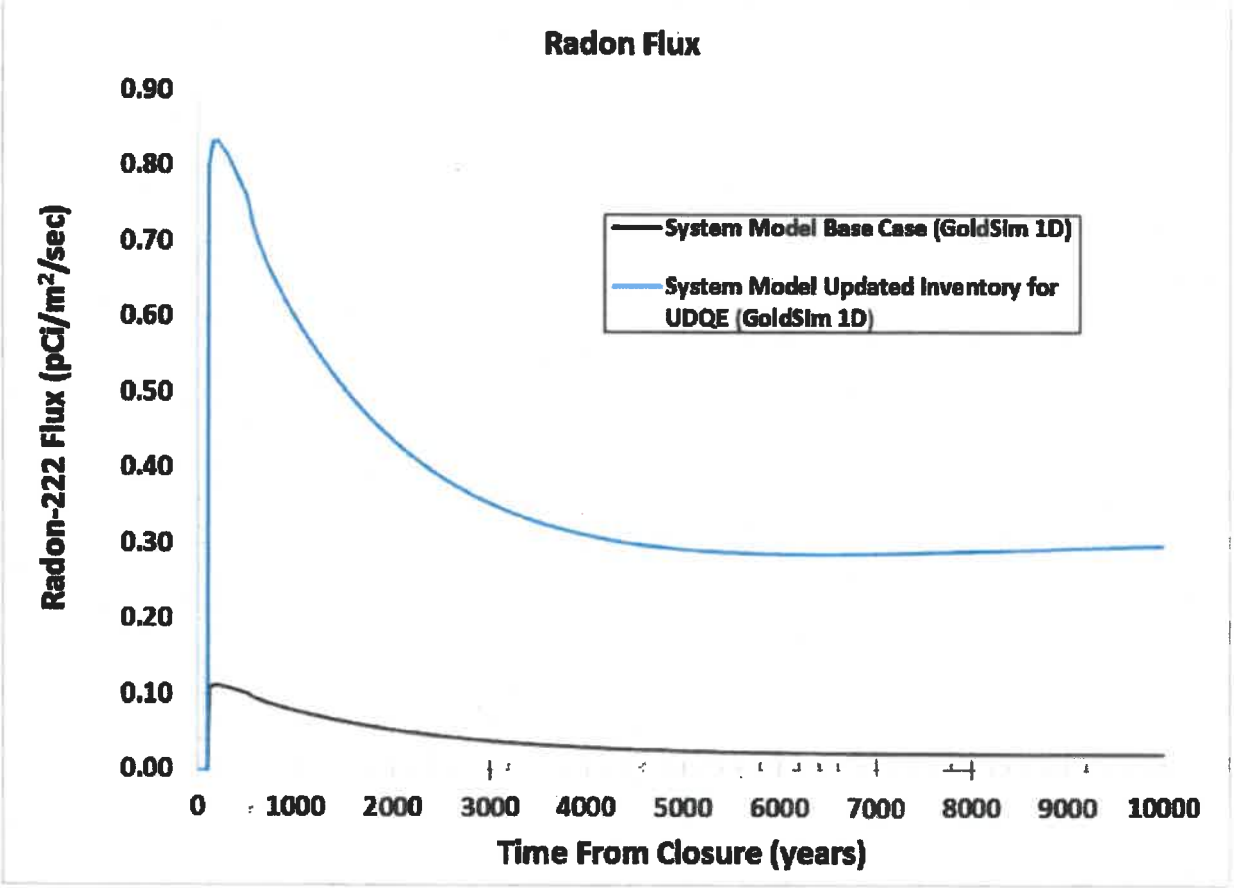

Figure 7-3. Radon Flux Comparison

Table 7-1. Comparison of the Total Inventory at Closure Evaluated in the ERDF PA to the Updated Total Inventory at Closure for the Compliance and Post-Compliance Periods

Performance Objectives and/or Measures	Compliance Period Standard	Total Inventory at Closure Evaluated in the ERDF PA (CF-60089)		Updated Total Inventory at Closure		Change for the Updated Total Inventory Case Compared to ERDF PA Inventory Case	
		Compliance Period (2035-3035) [a]	Post-Compliance Period (3035-12035) [a]	Compliance Period (2035-3035) [a]	Post-Compliance Period (3035-12035) [a]	Compliance Period (2035-3035) [a]	Post-Compliance Period (3035-12035) [a]
All pathways (DOE O 435.1)	25 mrem/yr EDE	1.02 mrem/yr (4.1% of Standard)	1.88 mrem/yr (7.5% of Standard)	1.20 mrem/yr (4.8% of Standard)	2.80 mrem/yr (11.2% of Standard)	1.18 (+0.7% wrt Standard)	1.49 (+3.7% wrt Standard)
Atmospheric (40 CFR 61, Subpart H)	10 mrem/yr EDE	1.02 mrem/yr (10.2% of Standard)	0.51 mrem/yr (5.1% of Standard)	1.20 mrem/yr (12.0% of Standard)	0.55 mrem/yr (5.5% of Standard)	1.18 (+1.8% wrt Standard)	1.08 (+0.4% wrt Standard)
Atmospheric (40 CFR 61, Subpart Q)	20 $pCi.m^{-2}.s^{-1}$ radon flux (at surface of disposal facility)	0.11 $pCi.m^{-2}.s^{-1}$ (0.6% of Standard)	0.08 $pCi.m^{-2}.s^{-1}$ (0.4% of Standard)	0.83 $pCi.m^{-2}.s^{-1}$ (4.2% of Standard)	0.6 $pCi.m^{-2}.s^{-1}$ (3.0% of Standard)	7.5 (+3.6% wrt Standard)	7.5 (+2.6% wrt Standard)
Acute inadvertent intruder (DOE O 435.1)	500 mrem EDE [b]	5.51 mrem [f] (1.1% of Standard)	NA	5.94 mrem [f] (1.2% of Standard)	NA	1.07 (+0.1% wrt Standard)	NA
Chronic inadvertent intruder (DOE O 435.1)	100 mrem/yr EDE [b]	9.27 mrem/yr [f] (9.3% of Standard)	NA	9.82 mrem [f] (9.8% of Standard)	NA	1.06 (+0.5% wrt Standard)	NA
Groundwater protection (40 CFR 141)	Beta-gamma dose equivalent ≤ 4 mrem/yr	0 mrem/yr (0% of Standard)	3.3 [c] mrem/yr (82.5% of Standard)	0 mrem/yr (0% of Standard)	4.6 [c] mrem/yr (115% of Standard)	No Change	1.4 (+32.5% wrt Standard)
	Gross alpha activity concentration (excluding radon and uranium) ≤ 15 pCi/L	0 pCi/L (0% of Standard)	1E-10[d] pCi/L (0% of Standard)	0 pCi/L (0% of Standard)	1E-10[d] pCi/L (0% of Standard)	No Change	No Change
	Combined Ra-226 and Ra-228 concentration ≤ 5 pCi/L	0 pCi/L (0% of Standard)	1E-10 [d] pCi/L (0% of Standard)	0 pCi/L (0% of Standard)	1E-10 [d] pCi/L (0% of Standard)	No Change	No Change
	Uranium concentration ≤ 30 µg/L	0 µg/L (0% of Standard)	1E-10 [d] µg /L (0% of Standard)	0 µg/L (0% of Standard)	1E-10 [d] µg /L (0% of Standard)	No Change	No Change
	Sr-90 concentration ≤ 8 pCi/L[e]	NA	NA	NA	NA	No Change	No Change
	H-3 concentration ≤ 20,000 pCi/L	0 pCi/L (0% of Standard)	1E-10 [d] pCi/L (0% of Standard)	0 pCi/L (0% of Standard)	1E-10 [d] pCi/L (0% of Standard)	No Change	No Change

[a] Compliance at 100 m downgradient of ERDF except for inadvertent intruder scenarios.

[b] Not applicable for post-compliance; dose estimate at 100 years was used to determine inventory threshold.

[c] Beta-gamma dose equivalent ≤4 mrem/yr (based on federal MCL) and calculated as $(C_{Peak}/MCL)^*$ 4 mrem/yr. For example in ERDF PA, Tc-99, which contributes almost the entire dose, C_{Peak}=731 pCi/L and MCL=900 pCi/L, so the equivalent dose is calculated to be 3.3 mrem/yr.

[d] Concentrations less than 1E-10 pCi/L are essentially zero.

[e] Not applicable; Sr-90 was screened out during evaluation of the groundwater pathway due to its relatively short half-life and its low mobility in the subsurface.

[f] Calculated at 100 years after closure

EDE = effective dose equivalent

MCL = maximum contaminant level

NA = not applicable

8 References

CHPRC-00175, 2015. *GoldSim Pro Software Management Plan*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-00180, 2015, *GoldSim Pro Functional Requirements Document*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland.

CHPRC-00256, 2016, *GoldSim Pro Requirements Traceability Matrix: Version 11.1,5*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland.

CHPRC-00224, 2015, *GoldSim Pro Software Test Plan*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland.

CHPRC-00262, 2016, *GoldSim Pro Acceptance Test Report: Version 11.1.5*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-60089 (formerly WCH-520, Rev. 1), 2014, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

DOE O 435.1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

ERDF-00011, 2016, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, formerly WCH-191 Rev. 4*, CH2M HILL Plateau Remediation Company, Richland, Washington.

ERDF-PRO-EN-54046, 2017, *Unreviewed Disposal Question (UDQ)*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

WCH-479, 2013, *Inventory Data Package for ERDF Waste Disposal*, Rev. 1, 0Washington Closure Hanford, Richland, Washington.

Attachment A

Software Installation and Checkout Form for GoldSim

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM

Software Owner Instructions:
Complete Fields 1-13, then run test cases in Field 14. Compare test case results listed in Field 15 to corresponding Test Report outputs. If results are the same, sign and date Field 19. If not, resolve differences and repeat above steps.

Software Subject Matter Expert Instructions:
Assign test personnel. Approve the installation of the code by signing and dating Field 21, then maintain form as part of the software support documentation.

GENERAL INFORMATION:

1. Software Name: GoldSim Pro — Software Version No.: 11.1.5

EXECUTABLE INFORMATION:

2. Executable Name (include path):

   \GoldSim.exe

3. Executable Size (bytes): 3,138 KB

COMPILATION INFORMATION:

4. Hardware System (i.e., property number or ID):

   Compiled by vendor

5. Operating System (include version number):

   Compiled by vendor

INSTALLATION AND CHECKOUT INFORMATION:

6. Hardware System (i.e., property number or ID):

   Dell Optiplex 9020/INTERA-00606

7. Operating System (include version number)

   Windows 10 Pro

8. Open Problem Report? ◉ No ○ Yes PR/CR No.

TEST CASE INFORMATION:

9. Directory/Path:

   \General Examples\FirstModel.gsm

10. Procedure(s):

    per CHPRC-00224 Rev 1, GoldSim Pro Software Test Plan

11. Libraries:

    N/A

12. Input Files:

    FirstModel.gsm

13. Output Files:

    FirstModel.gsm

14. Test Cases:

    GS-ITC-1

15. Test Case Results:

    Match expected results as presented in CHPRC-00224, GoldSim Pro Software Test Plan

16. Test Performed By: Randy Dockter

17. Test Results: ◉ Satisfactory, Accepted for Use ○ Unsatisfactory

18. Disposition (include HISI update):

    Installation on Windows 10 added to HISI

Page 1 of 2 — A-6005-149 (REV 0)

CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: GoldSim Pro — Software Version No.: 11.1.5

Prepared By:

19. William E. Nichols — Software Owner (Signature) — WE Nichols — Print — Date

20. Test Personnel:

Randy Dockter — Sign — Randy Dockter — Print — 8-1-2016 — Date

Sign — Print — Date

Sign — Print — Date

Approved By

21. Software SME (Signature) — N/R per SMP — Print — Date

Page 2 of 2 — A-6005-149 (REV 0)

ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA
(ERDF-PRO-EN-54046)

UDQS No.: UDQ-2017-002-S

Proposed Activity:

Add Hf-182 to Table B-1 in the ERDF Waste Acceptance Criteria, ERDF-00011. This radionuclide has been identified as potentially present in K-East Reactor Basin waste. The calculated concentration of Hf-182 may be has high as 5.51E+01 pCi/g and its half-life of 8.9E6 years exceeds the ERDF WAC threshold criteria of 2 years. However, the total activity of Hf-182 is projected to be only 6.8E-5 Ci. Because its projected quantity is much less than 1 Ci Hf-182 will be added to Table B-1, 'Half-Life Greater Than 6 Years' in Appendix B, 'Non-Inventory Data Package Waste Management Information System Radionuclides'.

REVIEW the following questions against the proposed activity:	Yes	No	N/A
1. Does the proposed activity or new information involve a change to the disposal facility from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
2. Does the proposed activity or new information involve a change to the disposal process from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
3. Does the proposed activity or new information involve a change to the radionuclide disposal limits from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
4. Does the proposed activity or new information involve a change to the Waste Acceptance Criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations	☐	☒	☐
5. Does the proposed activity or new information involve a change to what has been previously described or analyzed in the most recent Performance Assessment (CP-60089) or approved Special Analysis, inputs, and assumptions?	☐	☒	☐
6. Does the proposed activity or new information involve a change to the facility closure design or criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
7. Does the proposed activity or new information involve a test or experiment not described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
8. Does the proposed activity or new information involve any analytical errors, omissions, or deficiencies in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐

Provide Explanation/Justification for all "Yes" answers:

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA (Continued) (ERDF-PRO-EN-54046)		
UDQS No.: UDQ-2017-002-S		
If all questions above are answered "No" or "N/A" *(defined by an "X" in the box provided)*, then a UDQ Evaluation is not required, implement the proposed activity. If any of the questions above are answered "Yes" *(defined by an "X" in the box provided)*, then complete a UDQ Evaluation.		
Is a UDQ Evaluation required? ◯ Yes ◉ No		
Originator: Douglas Teachout *Print First and Last Name*	Douglas B. Teachout *Signature*	01/09/2018 *Date*
Reviewer: Bill Borlaug *Print First and Last Name*	W.A. Borlaug *Signature*	1/9/2018 *Date*
Supervisor Review: Bill Borlaug *Print First and Last Name*	W.A. Borlaug *Signature*	1/9/2018 *Date*

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA
(ERDF-PRO-EN-54046)

UDQS No.: UDQ-2017-003-S

Proposed Activity:

The proposed activity is to reduce the Waste Management Information System (WMIS) database radionuclide activity (curies) values for calcium-41, nickel-59, nickel-59 activated metal (AM), nickel-63, nickel-63AM, molybdenum-93, niobium-93m (metastable), zirconium-93, niobium-94, niobium-94AM, silver-108m, and barium-133. Recommended adjusted activity values are included in Table 2-8 of WCH-479, "Inventory Data Package for ERDF Waste Disposal." These adjusted activities were developed following a thorough evaluation of conservative bias leading to elevated inventory estimates for waste disposed at the ERDF. A rational for the inventory in Table 2-8 is provided in Section 2.2.4.1 of WCH-479. Activity reductions evaluated in this screening are applicable for waste disposed between 7/1/1996 and 9/30/2010 (inclusive).

REVIEW the following questions against the proposed activity:	Yes	No	N/A
1. Does the proposed activity or new information involve a change to the disposal facility from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
2. Does the proposed activity or new information involve a change to the disposal process from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
3. Does the proposed activity or new information involve a change to the radionuclide disposal limits from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations?	☐	☒	☐
4. Does the proposed activity or new information involve a change to the Waste Acceptance Criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved Special Analyses, or approved UDQ Evaluations	☐	☒	☐
5. Does the proposed activity or new information involve a change to what has been previously described or analyzed in the most recent Performance Assessment (CP-60089) or approved Special Analysis, inputs, and assumptions?	☐	☒	☐
6. Does the proposed activity or new information involve a change to the facility closure design or criteria from what has been previously described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
7. Does the proposed activity or new information involve a test or experiment not described or analyzed in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐
8. Does the proposed activity or new information involve any analytical errors, omissions, or deficiencies in the most recent Performance Assessment (CP-60089), approved special analyses, approved UDQ evaluations, or associated closure plan (CP-60151)?	☐	☒	☐

Provide Explanation/Justification for all "Yes" answers:

cc: DOE-RL LFRG Representative
DOE-RL Project Representative

ERDF UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) CRITERIA (Continued) (ERDF-PRO-EN-54046)		
UDQS No.: UDQ-2017-003-S		
If all questions above are answered "No" or "N/A" *(defined by an "X" in the box provided)*, then a UDQ Evaluation is not required, implement the proposed activity. If any of the questions above are answered "Yes" *(defined by an "X" in the box provided)*, then complete a UDQ Evaluation.		
Is a UDQ Evaluation required? ○ Yes ◉ No		
Originator: Douglas Teachout *Print First and Last Name*	Douglas B Teachout *Signature*	01/09/2018 *Date*
Reviewer: Bill Borlaug *Print First and Last Name*	W.A. Borlaug *Signature*	1/9/2018 *Date*
Supervisor Review: Bill Borlaug *Print First and Last Name*	W.A. Borlaug *Signature*	1/9/2018 *Date*

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DOE-RL Project Representative