1231004
[0080163H]

OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

SEP 14 2015

15-TF-0086

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION SUBMITS THE RETRIEVAL DATA REPORT FOR TANK 241-C-107

Reference: ORP letter from K.W. Smith to J.A. Hedges, Ecology, "The U.S. Department of Energy, Office of River Protection Submits the Retrieval Completion Certification and Report for Tank 241-C-107," 14-TF-0114, dated September 30, 2014.

1221013

The U.S. Department of Energy, Office of River Protection (ORP) is transmitting RPP-RPT-58295, *Retrieval Data Report for Single-Shell Tank 241-C-107*, Rev. 01, completed in accordance with the requirements of the Hanford Federal Facility Agreement and Consent Order Milestone M-045-86. RPP-RPT-58295, Rev. 01, documents completion of waste retrieval and post-retrieval sampling at Tank 241-C-107 using the Mobile Arm Retrieval System to deploy three technologies: modified sluicing as a first retrieval technology, high pressure water and a backstop as a second retrieval technology, and water-based chemical dissolution as a third technology. ORP previously provided a retrieval completion certification for Tank 241-C-107 (Reference).

If you have any questions, please contact Thomas Fletcher, Assistant Manager for Tank Farm Project, at (509) 376-3434.

Kevin W. Smith
Manager for

TF:REB

Attachment

Distribution: Page 2

RECEIVED
SEP 15 2015
EDMC

171

OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

SEP 1 4 2015

15-TF-0086

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION SUBMITS THE RETRIEVAL DATA REPORT FOR TANK 241-C-107

Reference: ORP letter from K.W. Smith to J.A. Hedges, Ecology, "The U.S. Department of Energy, Office of River Protection Submits the Retrieval Completion Certification and Report for Tank 241-C-107," 14-TF-0114, dated September 30, 2014.

The U.S. Department of Energy, Office of River Protection (ORP) is transmitting RPP-RPT-58295, *Retrieval Data Report for Single-Shell Tank 241-C-107*, Rev. 01, completed in accordance with the requirements of the Hanford Federal Facility Agreement and Consent Order Milestone M-045-86. RPP-RPT-58295, Rev. 01, documents completion of waste retrieval and post-retrieval sampling at Tank 241-C-107 using the Mobile Arm Retrieval System to deploy three technologies: modified sluicing as a first retrieval technology, high pressure water and a backstop as a second retrieval technology, and water-based chemical dissolution as a third technology. ORP previously provided a retrieval completion certification for Tank 241-C-107 (Reference).

If you have any questions, please contact Thomas Fletcher, Assistant Manager for Tank Farm Project, at (509) 376-3434.

Kevin W. Smith
Manager for

TF:REB

Attachment

Distribution: Page 2

cc w/attach:
TPA Administrative Record
Environmental Portal, LMSI
WRPS Correspondence

cc w/o attach:
S. Harris, CTUIR
J. Alzheimer, Ecology
J.L. Lyon, Ecology
J.B. Price, Ecology
C.L. Whalen, Ecology
D.A. Faulk, EPA
S.E. Hudson, HAB
R.E. Piippo, MSA
J.G. Woolard, MSA
G. Bohnee, NPT
K. Niles, ODOE
R. Buck, Wanapum
R.M. Allen, WRPS
S.J. Eberlein, WRPS
L.A. Fort, WRPS
R.D. Greenwell, WRPS
J.A. Joyner, WRPS
J.J. Luke, WRPS
K.M. Singleton, WRPS
R.S. Wiegman, WRPS
R. Jim, YN
D. Rowland, YN

ATTACHMENT
15-TF-0086

RPP-RPT-58295, *Retrieval Data Report for Single-Shell Tank 241-C-107*, Rev. 01

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

1a. Doc No: RPP-RPT-58295 **Rev.** 01

1b. Project Number: T2R16☐ N/A

TRADEMARK DISCLAIMER: Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America.

Release Stamp

DATE: Aug 06, 2015 HANFORD RELEASE

2. Document Title

Retrieval Data Report for Single-Shell Tank 241-C-107

3. Design Verification Required

☐ Yes ☒ No CGH. 8/6/15

4. USQ Number ☒ N/A

5. PrHA Number ☒ N/A
Rev.

6. USQ Screening:

a. Does the change introduce any new failure modes to the equipment? ☐ **Yes** ☒ **No**
Basis is required for Yes:_____

b. Does the change increase the probability of existing failure modes? ☐ **Yes** ☒ **No**
Basis is required for Yes:

c. For Safety Significant equipment, does the change require a modification to Chapter 4 of the DSA and/or FRED? ☐ **Yes** ☐ **No** ☒ **N/A**
Basis is required for Yes:

7. Description of Change and Justification (Use Continuation pages as needed)

Incorporated the residual waste volume update and all associated information.

8. Approvals

Title	Name	Signature	Date
Clearance Review	BRATTON, GAYLA E	BRATTON, GAYLA E	08/06/2015
Document Control Approval	HONEYCUTT, COLLEEN	HONEYCUTT, COLLEEN	08/06/2015
Originator	FORT, LES	FORT, LES	08/03/2015
Other Approver	ALLEN, RUTH M	ALLEN, RUTH M	08/04/2015
Responsible Manager	EBERLEIN, SUSAN J	EBERLEIN, SUSAN J	08/04/2015

9. Clearance Review:

Restriction Type:

☒ Public
☐ Undefined
☐ Unclassified Controlled Nuclear Information (UCNI)
☐ Export Control Information (ECI)
☐ Official Use Only Exemption 2-Circumvention of Statute (OUO-2)
☐ Official Use Only Exemption 3-Statutory Exemption (OUO-3)
☐ Official Use Only Exemption 4-Commercial/Proprietary (OUO-4)
☐ Official Use Only Exemption 5-Privileged Information (OUO-5)
☐ Official Use Only Exemption 6-Personal Privacy (OUO-6)
☐ Official Use Only Exemption 7-Law Enforcement (OUO-7)

DOCUMENT RELEASE AND CHANGE FORM

Doc No: RPP-RPT-58295 **Rev.** 01

10. **Distribution:**

Name	Organization
ALLEN, RUTH M	RETRVL & CLOSURE/PROJ ENV CMPL
BARTON, BLAINE	PROCESS ENGINEERING ANALYSIS
EBERLEIN, SUSAN J	CLOSURE & CORRECTIVE MEASURES
FORT, LES	CLOSURE & CORRECTIVE MEASURES
GREENWELL, DOUG	PROJECT OPERATIONS
JOYNER, JESSICA A	ENVIRONMENTAL PROTECTION
LAROCK, ERIC M	SST RETRIEVALS
LUKE, JEFFREY J	ENVIRONMENTAL PROTECTION
SINGLETON, KRISTIN M	CLOSURE & CORRECTIVE MEASURES
WIEGMAN, REBECCA S	RETRVL & CLOSURE/PROJ ENV CMPL

11. **TBDs or Holds** ☒ N/A

12. **Impacted Documents – Engineering** ☒ N/A

Document Number	Rev.	Title

13. **Other Related Documents** ☒ N/A

Document Number	Rev.	Title

14. **Related Systems, Structures, and Components:**

14a. **Related Building/Facilities** ☒ N/A	14b. **Related Systems** ☒ N/A	14c. **Related Equipment ID Nos. (EIN)** ☒ N/A

DOCUMENT RELEASE AND CHANGE FORM CONTINUATION SHEET	**Document No:** RPP-RPT-58295 **Rev.** 01

N/A

N/A

RPP-RPT-58295, Rev. 1

Retrieval Data Report for Single-Shell Tank 241-C-107

Author Name:
L. A. Fort, K. M. Singleton, R. S. Wiegman
Washington River Protection Solutions, LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DCRF UC:
Cost Center: Charge Code:
B&R Code: Total Pages: 168

Key Words: 241-C-107, Retrieval, modified sluicing, Mobile Arm Retrieval System, high-pressure water, water-based chemical dissolution

Abstract: This Retrieval Data Report presents information showing that waste retrieval operations in single-shell tank 241-C-107 used three retrieval technologies, each to its limits of technology, using the Mobile Arm Retrieval System (MARS) – Bulk retrieval technologies of modified sluicing (removing ~50% of the initial waste inventory) and the use of high-pressure water and backstop as delivered with the MARS Arm. The third retrieval technology was conducted using water-based chemical dissolution and modified sluicing as delivered with the MARS Arm. This Retrieval Data Report also summarizes the potential risk to human health from waste remaining in the tank, provides details on the technologies deployed and their respective performance during the waste removal campaigns, and describes measures taken to prevent and detect leaks during waste retrieval operations.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

APPROVED
By GE Bratton at 11:06 am, Aug 06, 2015

Release Approval Date

DATE:
Aug 06, 2015
HANFORD RELEASE

Release Stamp

Approved For Public Release

Tank Operations Contractor (TOC) RECORD OF REVISION	(1) Document Number: RPP-RPT-58295	Page 1
(2) Title: Retrieval Data Report for Single-Shell Tank 241-C-107		

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release	
		(5) Author. (print/sign/date)	(6) Resp. Mgr. (print/sign/date)
1	Incorporated the residual waste volume update and all associated information.	L. A. Fort LA Fort 8/3/15	S. J. Eberlein 08/03/15

RPP-RPT-58295
Revision 1

Retrieval Data Report for Single-Shell Tank 241-C-107

L. A. Fort
K. M. Singleton
R. S. Wiegman
Washington River Protection Solutions, LLC

Date Published
August 2015

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

washington river protection solutions

P.O. Box 850
Richland, Washington 99352

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

Approved for public release; distribution unlimited

EXECUTIVE SUMMARY

This Retrieval Data Report presents information in accordance with the requirements of Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989) Milestone M-045-86, due 12 months after the U.S. Department of Energy (DOE) certifies to the State of Washington Department of Ecology (Ecology) that DOE has completed retrieval of a single-shell tank covered by the Consent Decree in Washington v. DOE, Case No. CV-08-5085-FVS. The DOE submitted Revision 0 of its certification of retrieval, RPP-RPT-58150, "Retrieval Completion Certification Report for Tank 241-C-107," to Ecology on September 30, 2014 (Letter 14-TF-0114, "The U.S. Department of Energy, Office of River Protection Submits the Retrieval Completion Certification and Report for Tank 241-C-107").

This Retrieval Data Report presents information showing that single-shell tank 241-C-107 (C-107) has undergone waste retrieval using three retrieval technologies, each to its limits of technology, using the Mobile Arm Retrieval System (MARS) – Bulk retrieval technologies of modified sluicing and the use of high-pressure water and backstop as delivered with the MARS arm. The third retrieval technology was conducted using water-based chemical dissolution and modified sluicing as delivered with the MARS arm.

The first waste retrieval technology deployed was modified sluicing, which removed ~50% of the initial waste inventory (RPP-CALC-52903, Rev. 0, "Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System"). Additional waste retrieval was performed using the second and third technologies, high-pressure water and water-based chemical dissolution as delivered with the MARS arm. Three technologies have been deployed to the limits of technology as required by the Consent Decree. This Retrieval Data Report also summarizes the potential risk to human health from waste remaining in the tank, provides details on the technologies deployed and their respective performance during the waste removal campaigns, and describes measures taken to prevent and detect leaks during waste retrieval operations.

RPP-RPT-58150 documents that the three retrieval technologies deployed in tank C-107 retrieved the waste in tank C-107 to the limits of the technologies. The tank C-107 waste retrieval campaign began September 26, 2011 and was completed on August 7, 2014. The tank C-107 waste which was removed was transferred to double-shell tank 241-AN-106.

The tank C-107 leak detection, monitoring, and mitigation program used during retrieval operations consisted of high-resolution resistivity techniques along with readings from a combination of drywell moisture measurements, waste volume assessments (mass balances), and visual inspection to detect and control potential leaks. No leaks were detected during tank C-107 retrieval operations.

Prior to retrieval, the best estimate of waste volume was ~247,000 gal (33,000 ft^3). After initial MARS-arm sluicing phase (as of June 13, 2012, RPP-CALC-52903, Rev. 0), the estimated upper confidence volume of waste remaining in the tank was ~133,000 gal (~17,700 ft^3). Following deployment of three retrieval technologies, the best estimate of waste remaining in the tank was ~10,400 gal (~1,390 ft^3) (95% upper confidence level of waste volume, as described in

RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment," Rev. 1).

The inventory of constituents in the residual waste remaining in tank C-107 was determined by laboratory analysis of waste samples taken once it was determined that the Consent Decree had been met after the deployment of a third retrieval technology to the limits of the technology as described in Appendix C, Part 1 of the Consent Decree. The risk assessment for the residual waste in tank C-107 based on sampling analysis shows that for the groundwater pathway, the estimated risk impacts for tank C-107 are well below performance objectives. For all inadvertent intruder scenarios other than the suburban garden scenario (a sensitivity case) at 100 years after closure, the estimated risk impacts for tank C-107 were well below performance objectives. For the suburban garden scenario at 500 years after closure, the effects are below performance objectives.

TABLE OF CONTENTS

1.0 INTRODUCTION AND BACKGROUND 1-1

1.1 PURPOSE 1-3

1.2 REGULATORY REQUIREMENTS 1-3

1.3 DOCUMENT STRUCTURE 1-4

2.0 SINGLE-SHELL TANK 241-C-107 RESIDUAL WASTE VOLUME MEASUREMENT 2-1

2.1 RESIDUAL WASTE VOLUME MEASUREMENT PROCESS 2-1

2.1.1 Estimation of Waste Remaining on Tank Bottom 2-2

2.1.2 Estimation of Waste Remaining on Tank Surfaces 2-2

2.1.3 Estimation of Waste in Equipment 2-4

2.2 RESIDUAL WASTE VOLUME RESULTS 2-4

3.0 RESIDUAL TANK WASTE CHARACTERIZATION 3-1

3.1 SAMPLING AND ANALYSIS OF RESIDUAL WASTE 3-1

3.2 SAMPLING AT SINGLE-SHELL TANK 241-C-107 3-2

3.3 SAMPLE ANALYSES 3-4

3.4 CALCULATION OF RESIDUAL INVENTORY 3-5

3.4.1 Average Inventories 3-5

3.4.2 Bounding Inventories 3-7

3.4.3 Evaluation of Sample Data Usability 3-8

3.4.4 Inventory Calculation Assumptions and Clarifications 3-9

3.5 INVENTORY ESTIMATES 3-10

4.0 RETRIEVAL SYSTEM PERFORMANCE 4-1

4.1 WASTE RETRIEVAL PROCESS DESCRIPTION 4-1

4.2 RETRIEVAL SYSTEM PERFORMANCE 4-2

4.3 WASTE RETRIEVAL EFFICIENCY 4-3

4.4 RETRIEVAL DURATION 4-3

4.5 CONCLUSION 4-5

5.0 POST-RETRIEVAL SINGLE-SHELL TANK 241-C-107 RISK ASSESSMENT 5-1

5.1 CONSTITUENTS EVALUATED 5-3

5.2 RESULTS FOR INDIVIDUAL CONTAMINANTS FOR POST-RETRIEVAL SINGLE-SHELL TANK 241-C-107 5-7

5.3 CUMULATIVE ANALYSIS RESULTS FOR SINGLE-SHELL TANK 241-C-107 AND WASTE MANAGEMENT AREA C 5-8

5.4 INADVERTENT INTRUDER 5-13

5.5 COMPARISON OF TANK RESIDUALS WITH MODEL TOXICS CONTROL ACT SOIL CLEANUP LEVELS 5-16

5.5.1 WAC 173-340 Direct Contact and Soil Concentrations Protective of Groundwater 5-17

5.5.2 WAC 173-340 Ecological Risk 5-27

5.6 RISK ASSESSMENT SUMMARY 5-28

6.0 OPPORTUNITIES AND ACTIONS BEING TAKEN TO REFINE OR DEVELOP TANK WASTE RETRIEVAL TECHNOLOGIES, BASED ON LESSONS LEARNED 6-1

6.1 MOBILE ARM RETRIEVAL SYSTEM POTENTIAL ENHANCEMENTS ... 6-2

6.2 SLUICING EQUIPMENT AND OPERATION 6-3

6.3 OTHER POTENTIAL ENHANCEMENTS 6-3

7.0 LEAK DETECTION, MONITORING, AND MITIGATION 7-1

7.1 REQUIREMENTS 7-1

7.2 LEAK DETECTION AND TANK MONITORING 7-2

7.2.1 Drywell Logging and High-Resolution Resistivity 7-4

7.2.2 Single-Shell Tank 241-C-107 7-5

7.2.3 Double-Shell Tank 241-AN-106 7-6

7.2.4 Ancillary Equipment 7-7

7.3 MITIGATION 7-7

7.3.1 Single-Shell Tank 241-C-107 7-8

7.3.2 Double-Shell Tank 241-AN-106 7-8

7.4 CONCLUSION 7-9

8.0 REFERENCES 8-1

APPENDICES

A – SINGLE-SHELL TANK 241-C-107 INVENTORY PRE- AND POST-SLUICING TECHNOLOGY RETRIEVAL ..... A-i

B – MEAN CONCENTRATIONS AND RELATIVE STANDARD DEVIATIONS FOR TANK 241-C-107 RESIDUAL SOLIDS ..... B-i

C – COMPARISON OF SINGLE-SHELL TANK 241-C-107 FINAL INVENTORY TO SINGLE-SHELL TANK 241-C-107 INVENTORY USED IN DOE/ORP-2005-01, *INITIAL SINGLE-SHELL TANK SYSTEM PERFORMANCE ASSESSMENT FOR THE HANFORD SITE* ..... C-i

D – RISK ASSESSMENT INFORMATION FOR RESIDUAL WASTES REMAINING IN SINGLE-SHELL TANK 241-C-107 ..... D-i

LIST OF FIGURES

Figure 2-1. Tank 241-C-107 Video Still Spherical Montage, Recorded August 14, 2014 2-3

Figure 3-1. Approximate Sample Locations in Tank C-107 Post-Heel Removal (not to scale). 3-2

Figure 3-2. Photograph of a Drag Sampler. 3-3

Figure 4-1. 241-C-107 Retrieval Performance Trends. 4-4

Figure 5-1. Single-Shell Tank 241-C-107 Residual Waste Inventory and Risk Assessment Process 5-2

Figure 7-1. Tank 241-C-107 Leak Detection Monitoring Timeline. 7-3

LIST OF TABLES

Table 2-1. Tank 241-C-107 Total Waste Volume and Component Waste Volumes. 2-1

Table 3-1. Description of Tank 241-C-107 Post-Heel Retrieval Samples 3-4

Table 3-2. Analytical Methods Used in Analysis of Post-Heel Removal Samples. 3-6

Table 3-3. Tentatively Identified Compounds in Tank 241-C-107 Residual Solids Samples.... 3-7

Table 3-4. Inventory Estimates for Selected Constituents in Tank 241-C-107 Residual Solids. 3-11

Table 5-1. List of Analytes and Available Toxicity Information. 5-4

Table 5-2. Estimated Maximum Incremental Lifetime Cancer Risk/Radiological Dose During the Modeling Period for Primary Radionuclides Related to Average Residual Waste Inventory in Single-Shell Tank 241-C-107. 5-9

Table 5-3. Estimated Maximum Value for Incremental Lifetime Cancer Risk and Hazard Quotient for Selected Non-Radiological Analytes Related to Average Residual Waste Inventory in Single-Shell Tank 241-C-107. 5-10

Table 5-4. Comparison of Cumulative Incremental Lifetime Cancer Risk, Hazard Index, Radionuclide Dose, and Groundwater Concentration at Peak Waste Management Area C Fenceline for Average and 95% Upper Confidence Level Residual Waste Inventories in Single-Shell Tank 241-C-107 5-11

Table 5-5. Comparison Summary of Cumulative Incremental Lifetime Cancer Risk, Hazard Index, Radionuclide Dose, and Groundwater Concentration at Peak Waste Management Area C Fenceline for Average and 95% Upper Confidence Level Residual Waste Inventories in Single-Shell Tank 241-C-107 5-13

Table 5-6. Comparison of Intruder Doses at 100 and 500 Years After Closure from Residual Waste for Single-Shell Tank 241-C-107. 5-14

Table 5-7. Potential Future Impact from Inadvertent Intrusion into Residual Waste for Average and 95% Upper Confidence Level Inventories. 5-15

Table 5-8. Impact Results of Key Analytes for an Inadvertent Intruder. 5-16

Table 5-9. Average and 95% Upper Limit Concentrations of Selected Constituents Estimated for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. 5-18

Table 5-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. 5-21

Table 5-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. 5-24

Table 5-12. Comparison of Hanford Tank Waste Operations Simulator Predicted Inventory Used in DOE/ORP-2005-01 with the Average and 95% Upper Confidence Level Post-Retrieval Inventories. 5-32

Table 7-1. Tank 241-C-107 Leak Detection and Monitoring Functions and Requirements. 7-2

Table 7-2. Leak Detection and Monitoring Methods for Each Waste Retrieval System Component. 7-4

Table 7-3. High-Resolution Resistivity Anomaly Evaluation During and After Sluicing. 7-5

LIST OF TERMS

Abbreviations and Acronyms

1C	Bismuth Phosphate (waste)
3D	three-dimensional
BBI	Best-Basis Inventory
BBIM	Best-Basis Inventory Maintenance
CAD	computer-aided design
CAS	Chemical Abstracts Service
CCMS	Camera/CAD Modeling System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CPF	cancer potency factor
DFR	dose factor
DOE	U.S. Department of Energy
DOE-ORP	U.S. Department of Energy Office of River Protection
DQO	Data Quality Objectives
DST	double-shell tank
Ecology	State of Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
HFFACO	Hanford Federal Facility Agreement and Consent Order
HRR	high-resolution resistivity
HTWOS	Hanford Tank Waste Operations Simulator
HWMA	Hazardous Waste Management Act
ILCR	incremental lifetime cancer risk
LDM	leak detection and monitoring
LDMM	leak detection, monitoring, and mitigation
MARS	Mobile Arm Retrieval System
MRT	Mobile Retrieval Tool

MTCA	*Model Toxics Control Act*
PA	performance assessment
PCB	polychlorinated biphenyl
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
RDR	Retrieval Data Report
Rfd	reference dose
RSD	relative standard deviation
SRR	Strontium recovery (waste)
SST	single-shell tank
SVOA	semivolatile organics analysis
TIC	tentatively identified compound
TSAP	tank sampling and analysis plan
TSR	Technical Safety Requirement
UCL	upper confidence level
VOA	volatile organic analysis
WAC	*Washington Administrative Code*
WMA	waste management area
WRPS	Washington River Protection Solutions, LLC
WRS	waste retrieval system
WTT	drywell-to-tank
WTW	drywell-to-drywell

Units

ft^3	cubic feet
gal	gallon
in.	inch
kgal	thousand gallons

1.0 INTRODUCTION AND BACKGROUND

Retrieval of single-shell tank (SST) 241-C-107 (C-107) waste occurred in three campaigns. At the start of retrieval operations, the tank was reported to contain 247,000 gal of sludge comprised of a mixture of ion exchange, concentrated phosphate waste from N-Reactor, Hanford Lab Operations, Battelle Northwest, Bismuth Phosphate (1C), tributyl phosphate waste, cladding waste, and the Hot Semiworks waste. The tank also contained about 6,000 gal of supernate from construction activities to support the installation of the Mobile Arm Retrieval System (MARS). These wastes are described in RPP-RPT-48745, "Derivation of Best-Basis Inventory for Tank 241-C-107 as of March 1, 2015."

The initial waste in tank C-107 was dominated by 1C and Strontium recovery (SRR) wastes. This composition, unlike many other 241-C Farm (C Farm) tanks, was not considered to have significant quantities of gibbsite ($Al[OH]_3$) and was considered unlikely to require caustic cleaning for the majority of the waste. The MARS sluicing waste retrieval process was established to remove waste primarily by mechanically impacting liquid upon the waste solids resulting in the fluidization and pumped retrieval of the size-reduced material. Supernatant liquor from tank 241-AN-106 (AN-106) and high-pressure water were used as part of this hydraulic mining operation.

Retrieval of tank C-107 stored waste was conducted between September 26, 2011, and August 7, 2014. The two main waste retrieval technologies used in tank C-107 for bulk retrieval were modified sluicing and the use of high-pressure water and pump backstop as delivered with the MARS arm. The third retrieval technology was conducted using water-based chemical dissolution and modified sluicing using the MARS arm. Tank C-107 was declared retrieved to the limit of these technologies with a preliminary volume estimate of 1,879 ft^3 (14,054 gal) of waste remaining based on liquid displacement measurement and visual evaluation (RPP-CALC-52903, "Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System"; RPP-RPT-54959, "Single-Shell Tank 241-C-107 Hard Heel and Third Technology Retrieval Completion Report").

The bulk of the tank C-107 waste was removed by MARS sluicing to tank AN-106; this was completed in March 2014. Subsequent actions were conducted using hot water to dissolve phosphate salts and to further sluice waste from the tank, culminating in retrieval completion in August 2014. Final waste retrieval activities in tank C-107 included a volumetric displacement to assess residual sludge inventory. That volumetric displacement measurement showed a reduction of estimated floor waste inventory volume from 56,235 gal to 23,337 gal on May 21, 2013. Following the volumetric displacement, supernate sluicing and high-pressure water scarification were employed to remove wastes. Supernate sluicing in early 2014, following slurry pump replacement, resulted in the introduction of saturated phosphate solutions into tank C-107. The high-phosphate supernatant liquor appears to have generated phosphate crystallization and consequent waste solids agglomeration within tank C-107. Waste sluicing activities were discontinued when retrieval rates repeatedly demonstrated insignificant value. No final volumetric displacement or fines washing were completed at that time.

The third waste retrieval technology occurred in July and August 2014 followed by a volumetric displacement measurement of waste residuals, and finalized with a water rinse of waste residuals. Two batched hot water rinses and three batched hot water recirculating flushes were conducted to remove residual and interstitial supernate and to dissolve natrophosphate, respectively. As the water rinses were pumped out, the liquid density was monitored; the final flush discharge displayed a density drop indicative of depletion of natrophosphate from the tank waste. The hot water washes removed phosphates initially present in the waste as well as the phosphates introduced by the supernatant liquor.

Following the water washes, the third technology retrieval activities returned to supernate sluicing. Although wastes were demonstrated to be mobilized, the particle size remained too large to be carried through the pump screen. On August 7, 2014, a volumetric displacement for the measurement of tank waste residuals was conducted. Supernate from tank AN-106 was used in the displacement measurement. The displacement activity is fully described and documented within RPP-CALC-52903, detailing an estimate of wastes upon the tank floor of 8,748 gal of wetted waste solids. In document RPP-CALC-52903 is the residual waste estimate of 14,054 gal (~1,880 ft^3).

A final water rinse of tank C-107 was conducted on August 9, 2014. The objective was to remove soluble supernate-based contaminants from the SST. The MARS enabled a continuous rinse and dilution rather than batched dilutions. As detailed in RPP-CALC-52903, 16,018 gal were used in the rinse and 13,998 gal were transferred to tank AN-106, leaving 2,020 gal of water in tank C-107.

The retrieval was discontinued upon the demonstration that the operation reached the limit of technology on August 8, 2014. The upper bound quantity of waste remaining in tank C-107 was estimated to be 10,400 gal or 1,390 ft^3 (95% upper confidence level [UCL] of waste volume, as described in Revision 1 of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment"). The tank C-107 MARS campaigns are described (and approved by the State of Washington Department of Ecology [Ecology]) in Revision 7 of RPP-22393, "241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan." The third technology (hot water dissolution deployed by MARS) is described in the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989) (HFFACO) Change Notice 2014-02 modifying Tank Waste Retrieval Work Plan (RPP-22393, Revision 7) and approved by Ecology on June 5, 2014.

Where information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the Atomic Energy Act of 1954, as amended) has been incorporated into this document, it is not incorporated for the purpose of regulating the radiation hazards of such components under the authority of Chapter 70.105, "Hazardous Waste Management," Revised Code of Washington (RCW) (known as the Hazardous Waste Management Act [HWMA]) and its implementing regulations, but is provided for information purposes only.

1.1 PURPOSE

This Retrieval Data Report (RDR) provides information required by HFFACO Milestone M-045-86. The report documents the following aspects of tank C-107 retrieval:

- Residual tank waste volume measurement, including associated calculations
- The results of residual tank waste characterization
- Retrieval technology performance documentation
- The U.S. Department of Energy (DOE)'s updated post-retrieval risk assessment
- Opportunities and actions being taken to refine or develop tank waste retrieval technologies based on lessons learned
- Leak detection monitoring and performance results.

1.2 REGULATORY REQUIREMENTS

Retrieval of waste from tank C-107 and submittal of this RDR (in accordance with conditions stated in the HFFACO) are necessary requirements for closing the Hanford SST system. The HFFACO Milestone M-045-86 provides in pertinent part:

> *Submit a retrieval data report to Ecology for the 19 tanks retrieved under the Consent Decree in Washington v. DOE, Case No. 08-5085-FVS, which report shall include the following elements only of Section 2.1.7 of Appendix I to the HFFACO:*
>
> 1) *Residual tank waste volume measurement, including associated calculations;*
> 2) *The results of residual tank waste characterization;*
> 3) *Retrieval technology performance documentation;*
> 4) *DOE's updated post-retrieval risk assessment;*
> 5) *Opportunities and actions being taken to refine or develop tank waste retrieval technologies, based on lessons learned and,*
> 6) *LDMM monitoring and performance results.*

The Tank Waste Retrieval Work Plan (RPP-22393) establishes the three retrieval technologies that are to be deployed to their respective "limits of technology" in an effort to obtain the Consent Decree waste residue goal of 360 ft^3 or less. The three technologies established by the Tank Waste Retrieval Work Plan for tank C-107 were deployed to their limits of technology as required by Appendix C, Part 1, of the Consent Decree, resulting in a waste residual volume of ~1,390 ft^3.

1.3 DOCUMENT STRUCTURE

This tank C-107 RDR is organized to present information required by Milestone M-045-86 of the HFFACO Action Plan.

- **Section 1,** *Introduction and Background* discusses the purpose and scope of tank C-107 waste retrieval, presents requirements applicable to this report, and outlines the report structure.

- **Section 2,** *Single-Shell Tank 241-C-107 Residual Waste Volume Measurement* describes the method for determining the volume of residual waste in tank C-107 and presents results of the volume measurement process.

- **Section 3,** *Residual Tank Waste Characterization* lists requirements for characterization of tank waste, describes methods and procedures used to sample and analyze the waste, and describes the results of laboratory analysis.

- **Section 4,** *Retrieval System Performance* provides an evaluation of how well the waste retrieval system (WRS) performed and provides a comparison of actual performance against predicted performance.

- **Section 5,** *Post-Retrieval Single-Shell Tank 241-C-107 Risk Assessment* describes the potential risk to human health from tank C-107 residual waste. This section identifies and discusses contaminants of potential concern in the waste, describes the effects of waste retrieval and closure on long-term human health risk, presents expected cumulative health effects of source terms, relates calculated risk to residual waste volume, and summarizes overall conclusions of the risk assessment. To satisfy recent requests by Ecology, this section also provides additional risk management information related to how concentrations of constituents remaining in waste residuals within tank C-107 compare against the Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act – Cleanup" cleanup standards. These soil cleanup standards are developed to be protective of direct contact exposures and groundwater use.

- **Section 6,** *Opportunities and Actions Being Taken to Refine or Develop Tank Waste Retrieval Technologies, Based on Lessons Learned* discusses recommendations for future actions associated with tank C-107 and actions being taken based on lessons learned.

- **Section 7,** *Leak Detection, Monitoring, and Mitigation* describes leak detection, monitoring, and mitigation (LDMM) methods and procedures, presents an LDMM chronology for tank C-107 waste retrieval, and summarizes LDMM results.

- **Section 8,** *References* contains references for material cited in the report.

2.0 SINGLE-SHELL TANK 241-C-107 RESIDUAL WASTE VOLUME MEASUREMENT

This section presents the residual waste volume measurement process and the results for tank C-107. The post-retrieval residual waste volume estimate was performed using a method described in RPP-CALC-59985, "Post-Retrieval Camera/CAD Modeling System Waste Volume Estimate for Tank 241-C-107." The total measured volume of residual waste in tank C-107 was the sum of volumes remaining in the tank dish, on the tank walls, on the stiffener rings, and in the void spaces in equipment left in the tank (Table 2-1). The residual waste volume used for all calculations in this RDR is the volume reported as the 95% UCL in RPP-RPT-58514.

Table 2-1. Tank 241-C-107 Total Waste Volume and Component Waste Volumes.

Waste Component	CCMS Waste Volume			Actual[1] Volume (ft^3)	95% UCL[2] Volume (ft^3)
	m^3	gal	ft^3		
On the bottom of the tank (solids)	5.547	1,466	196		
On the bottom of the tank (liquid pool)	17.821	4,708	629	929	951
On the stiffener ring and tank walls[3]	12.438	3,286	439	439	439
Waste in tank equipment[4]	0	0	0	0	0
Total	35.81	9,460	1,264	1,368	1,390

1 ft^3 = 7.481 gal, 1 m^3 = 264.2 gal, UCL = upper confidence level, CCMS = camera/computer-aided design modeling system

Notes:

[1] Per RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment," the actual residual waste volume of waste on the tank bottom is calculated by the formula = 1.125 × CCMS + 0.53 ft^3.

[2] Per RPP-RPT-58514, the 95% UCL waste residual waste volume of waste on the tank bottom is calculated by the formula = 1.132 × CCMS + 17.09 ft^3.

[3] The estimated volume for waste on the stiffener ring and on the tank wall is the upper bounding estimate.

[4] Negligible compared to other waste components.

2.1 RESIDUAL WASTE VOLUME MEASUREMENT PROCESS

RPP-CALC-59985 documents the video camera/computer-aided design (CAD) modeling system (CCMS) estimate for the post-hard heel retrieval waste volume in tank C-107. Although all solids were covered for Enraf®[1] volume displacement estimates (RPP-CALC-59985), the CCMS volume was obtained for comparison with liquid displacement values and to better estimate the volume of waste remaining on the tank walls and stiffener rings.

[1] Honeywell Enraf ® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

After the CCMS video was completed, the video was reviewed to develop an AutoCAD® Civil 3D®[2] drawing of tank C-107 and the tank waste residuals and to complete tank bottom volume estimates per TFC-ENG-FACSUP-CD-22, "Post-Retrieval Tank Waste Volume Determination." The AutoCAD® Civil 3D® software was tested and verified per RPP-52784, "Video Camera/CAD Modeling System for Retrieval: HISI #3254 Software Management Plan."

A template of the 100-series C Farm tanks was developed from tank construction drawings (BPF-73550, "Specifications For Construction of Composite Storage Tanks Bldg. No. 241 Hanford Engineer Works Project 9536," Drawing D-3). The area and depth of waste and equipment in the tank bottom was estimated based on tank features and the dimensions of equipment and debris observed in the CCMS video (Figure 2-1 shows a mosaic of tank C-107 post-retrieval). The waste contour information was then added to the template drawing to show waste remaining in the tank bottom. After completing the drawings, the AutoCAD® Civil 3D® software calculated a waste volume by integrating between the waste contour lines and the tank bottom profile. These processes are described in more detail below.

2.1.1 Estimation of Waste Remaining on Tank Bottom

The post retrieval waste consists of solids piles and a liquid pool. The volume of this waste was estimated using the CCMS method per TFC-ENG-FACSUP-CD-22, calculated using AutoCAD® Civil 3D® to be ~825 ft^3; 196 ft^3 + 629 ft^3 (Table 2-1). The estimated volume of waste on the tank bottom, calculated using AutoCAD® Civil 3D®, was 825.2 ft^3. The waste volume consists of an estimated 195.9 ft^3 (5.55 m^3) of solids piles and sand bars and 629.3 ft^3 (17.82 m^3) in pooled liquids (RPP-CALC-59985). The pool is entirely within the dish and is distributed, but mostly to the tank south and tank west. It was conservatively assumed that the waste on the tank bottom remains saturated, and the waste volume was not adjusted for porosity.

Since RPP-CALC-59985 was completed, the equations for actual and upper bound inventories based on CCMS estimates were revised (applied to the bottom of the tank measurements). Table 2-1 and RPP-RPT-58514 show the revised actual and 95% UCL equations and calculation results.

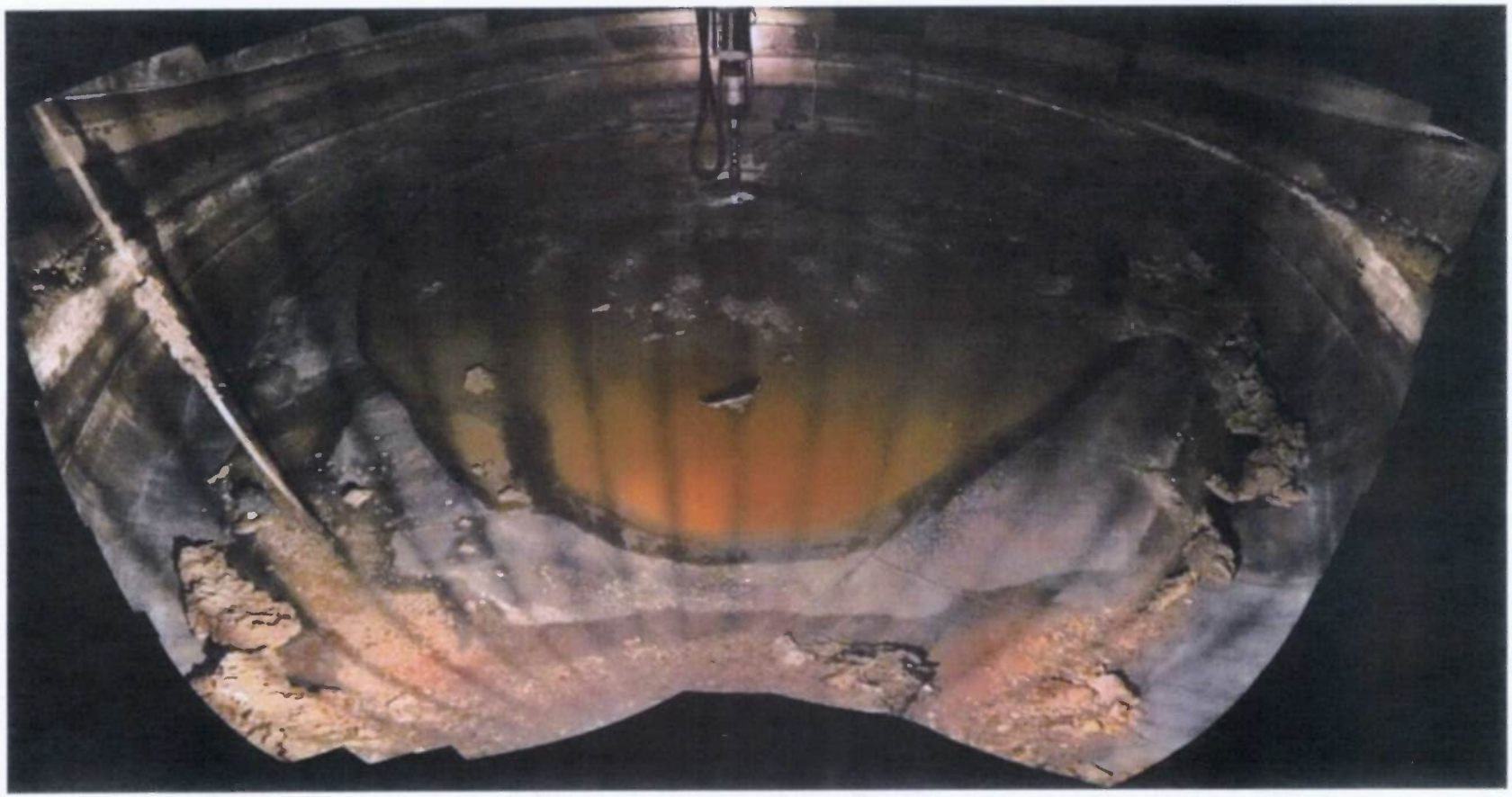
2.1.2 Estimation of Waste Remaining on Tank Surfaces

The estimated volume of waste on the stiffener rings and tank walls after hard heel retrieval was 439 ft^3 (~3,286 gal) (RPP-CALC-52903). This volume was estimated based on an average estimated thickness of 5 in. (the depth of the stiffener rings) over the wall height (4.5 ft) between the second and third stiffener rings from the top. As this volume was assessed as an upper bounding estimate, no uncertainty estimate is applied to it.

All walls and stiffener rings below the third stiffener ring from the top to the dish were observed to be free of waste.

[2] AutoCAD® and Civil 3D® are trademarks of Autodesk, Inc., 111 McInnis Parkway, San Rafael, California.

Figure 2-1. Tank 241-C-107 Video Still Spherical Montage, Recorded August 14, 2014.



2.1.3 Estimation of Waste in Equipment

Waste remaining in equipment was negligible compared to other volumes.

2.2 RESIDUAL WASTE VOLUME RESULTS

The total CCMS volume of post-retrieval residual waste in tank C-107 and the waste volumes associated with the various waste components are given in Table 2-1. The best estimate for the total post-retrieval 95% UCL waste volume in tank C-107 is 1,390 ft^3.

3.0 RESIDUAL TANK WASTE CHARACTERIZATION

This section describes the results of residual tank waste characterization for tank C-107. It presents the average and upper bounding estimates of residual waste inventory based on laboratory analysis of waste samples taken after waste removal actions were completed. The calculated inventories are used as input to estimate the potential risk to human health that arises from the residual waste. This risk assessment is discussed in Section 5.0.

3.1 SAMPLING AND ANALYSIS OF RESIDUAL WASTE

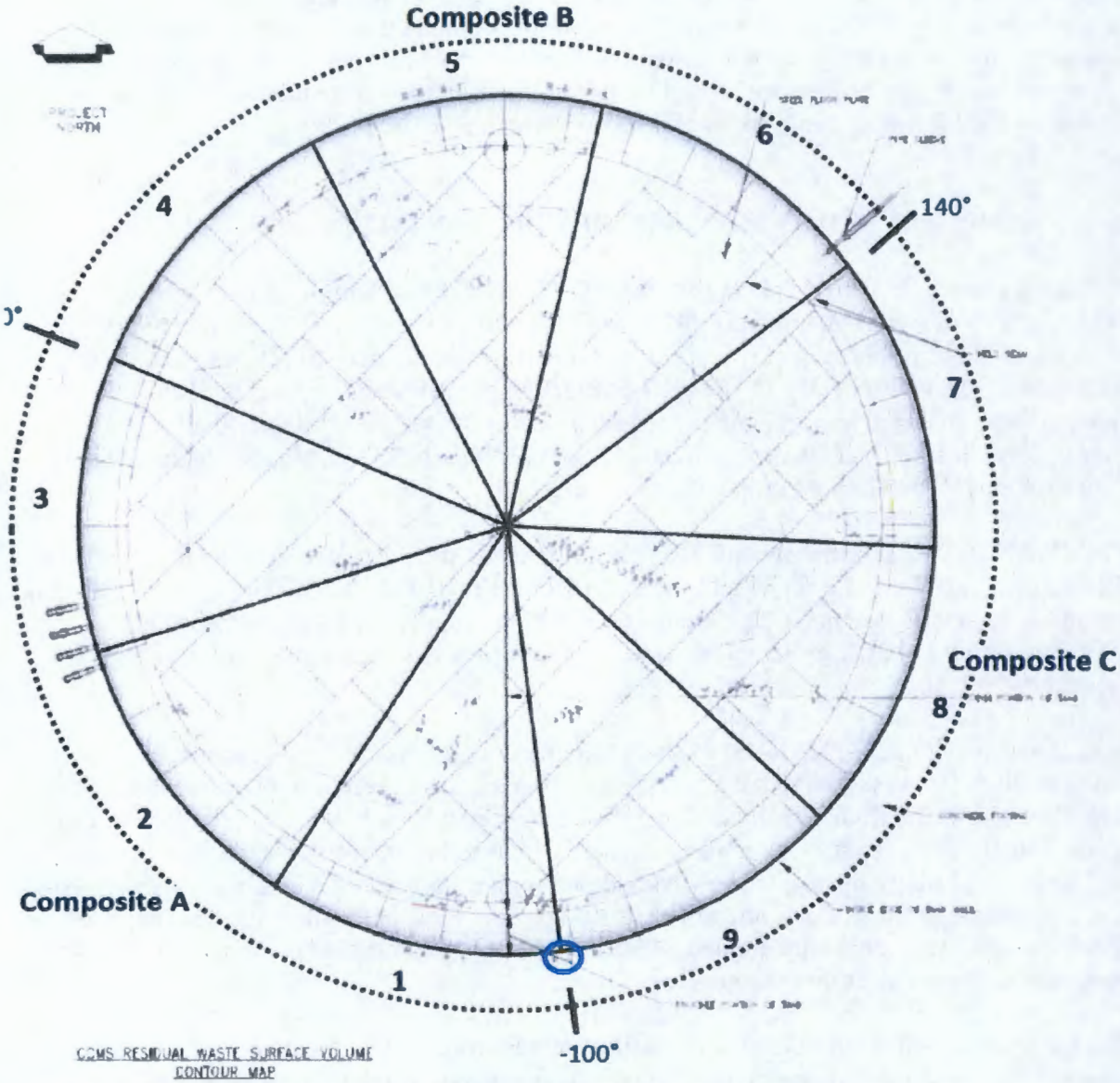
A tank sampling and analysis plan (TSAP) (RPP-PLAN-52884, "Sampling and Analysis Plan for Post-Retrieval Waste Solids in Tank 241-C-107") identified sample collection, laboratory analysis, quality assurance/quality control, and reporting requirements for the characterization of waste solids remaining in tank C-107 after completion of retrieval to support tank closure. The samples were analyzed according to the requirements in RPP-23403, "Single-Shell Tank Component Closure Data Quality Objectives" and RPP-PLAN-23827, "Sampling and Analysis Plan for Single-Shell Tanks Component Closure."

RPP-PLAN-23827 identifies two off-riser sampling methods for collecting residual solids in an SST: a drag sampler to be deployed by the MARS or the Off-Riser Sampling System. The drag sampler is expected to achieve significant reductions in sampling schedule and cost in comparison to the Off-Riser Sampling System; therefore, it has been selected for sampling the tank C-107 solids.

In accordance with RPP-PLAN-23827, the sampling design for tank C-107 consisted of nine samples. It was assumed that a thin layer of solids will be present throughout most of the tank floor. The tank floor was divided into nine equal sectors, with the outer arc of each sector approaching 26 ft in length. A sample was taken where solids are available within each sector. The tank C-107 sampling design for MARS-drag sampler post-heel removal samples directed that one sample be taken from nine different 40° sectors of the tank, where the boundary between Sectors 9 and 1 was arbitrarily aligned with Riser 2 (RPP-PLAN-52884). Figure 3-1 shows the approximate locations of these sectors.

The sampling consisted of obtaining one solids sample from each of the nine sectors. Sample composites were analyzed, each comprised of equal amounts of three solids samples. Samples 7C-14-1, 7C-14-2, and 7C-14-3 were combined to form Composite A; samples 7C-14-4, 7C-14-5, and 7C-14-6 to form Composite B; and samples 7C-14-7, 7C-14-8, and 7C-14-9 to form Composite C. Duplicate analyses were performed on Composite A. Representatives from Ecology and the U.S. Department of Energy Office of River Protection (DOE-ORP) concurred with the sampling design as documented by approval signatures in RPP-PLAN-52884 as shown in the document Signature Page.

Figure 3-1. Approximate Sample Locations in Tank 241-C-107 Post-Heel Removal (not to scale).



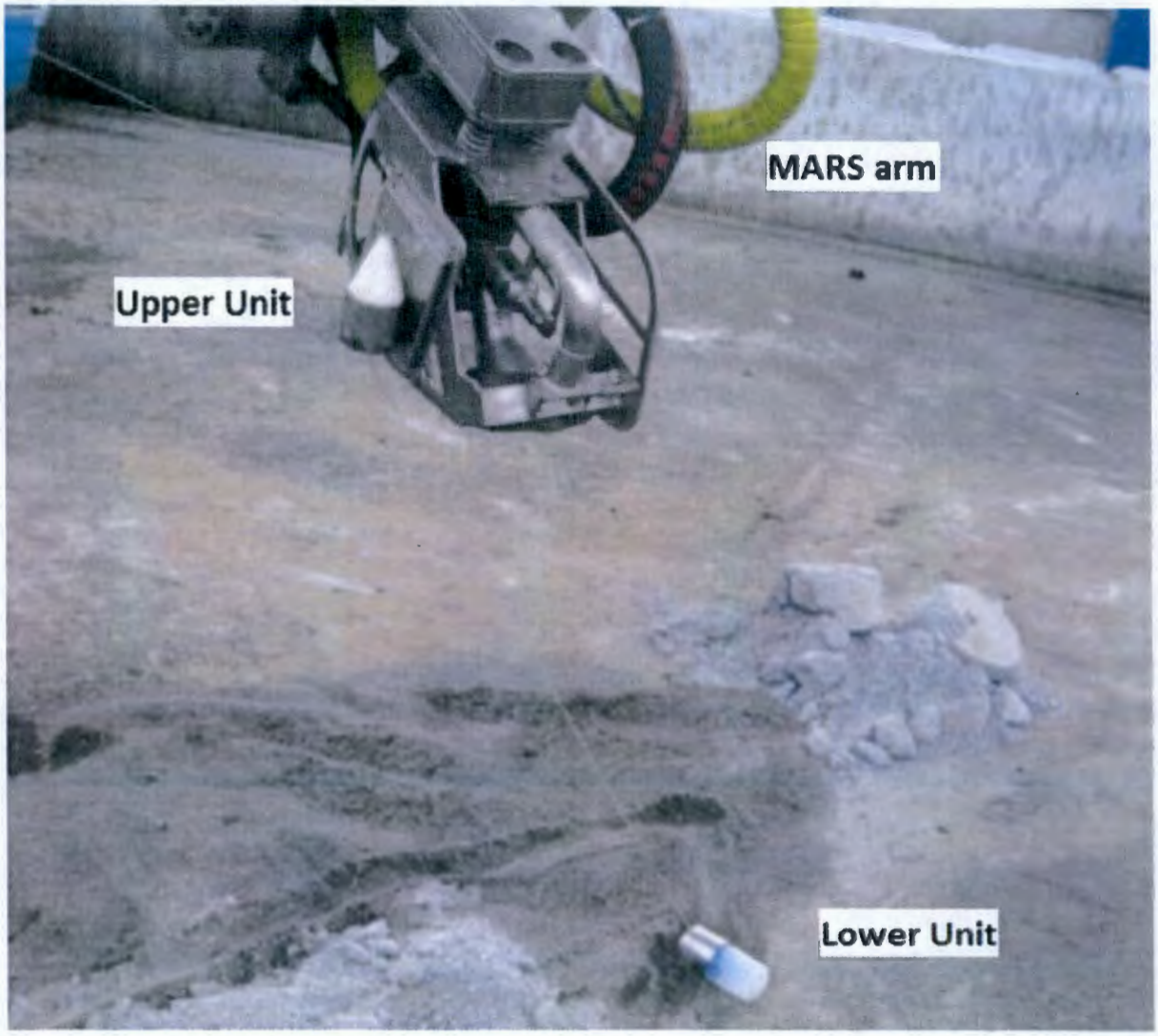
Adapted from H-14-109854, *CCMS Residual Waste Surface Volume Tank 241-C-107*, Rev. 1.

3.2 SAMPLING AT SINGLE-SHELL TANK 241-C-107

Sampling was conducted using a drag sampler deployed by the MARS. The drag sampler consists of two units connected with a cable. The lower unit is a sample jar attached to a heavy stainless steel shroud which acts as a funnel to collect solids as the sampler is dragged through the waste. The upper unit is primarily a metal piece that can be attached magnetically to a plate on the MARS arm. To collect a sample, the sampler is lowered into the tank through a riser, the MARS is moved to attach the upper unit to a magnetized plate on its arm, the MARS arm is used

to move the sampler to the desired location, the lower unit is lowered to the tank bottom, and the MARS arm is used to drag the lower unit to collect solids. A photograph of a drag sampler being used in training is shown in Figure 3-2.

Figure 3-2. Photograph of a Drag Sampler.



Sampling of the residual waste solids in tank C-107 was conducted from October 16, 2014 to October 28, 2014. The resulting tank C-107 solid samples were shipped to the 222-S Laboratory for analysis. The approximate sample locations are shown in Appendix B. The locations sampled are approximate, given the limitations of remote video viewing. All samples required by the TSAP were collected except for 7C-14-6 (Sector 6). This sample was the last one attempted and could not be collected due to sampler failure. Because of this, Composite B was formed from samples 7C-14-4 and 7C-14-5 only. Descriptions of the solids samples are provided in Table 3-1.

Table 3-1. Description of Tank 241-C-107 Post-Heel Retrieval Samples.

Sample Identification	Date Sampled	Date Received	Solid Weight (g)	Liquid Volume (mL)	Sample Description
7C-14-1	10/16/2014 9:28	10/16/2014 15:00	54.9	None	Partially full 240-mL bottle with tan and brown dry solids; no organic layer visible
7C-14-1A	10/16/2014 14:11	10/16/2014 15:00	79.7	None	Partially full 240-mL bottle with brown dry solids; no organic layer visible
7C-14-2	10/16/2014 14:06	10/20/2014 15:25	77.9	None	Partially full 240-mL bottle with tan, brown, and white dry solids; no organic layer visible
7C-14-2A	10/20/2014 14:38	10/20/2014 15:25	111.7	None	Partially full 240-mL bottle with tan, brown, and white dry solids; no organic layer visible
7C-14-3	10/21/2014 14:31	10/21/2014 15:15	149.6	20.5	Partially full 240-mL bottle with tan, brown, and white moist solids; no organic layer visible
7C-14-3A	10/22/2014 9:39	10/22/2014 13:25	101.1	None	Partially full 240-mL bottle with tan and brown dry solids; no organic layer visible
7C-14-4	10/28/2014 13:48	10/28/2014 15:30	188.6	None	Partially full 240-mL bottle with tan, brown, and white moist solids; no organic layer visible
7C-14-5	10/28/2014 14:38	10/28/2014 15:30	162.1	8.9	Partially full 240-mL bottle with tan, brown, and white moist solids; no organic layer visible
7C-14-7	10/22/2014 10:37	10/22/2014 13:25	218.1	None	Partially full 240-mL bottle with brown moist solids; no organic layer visible
7C-14-8	10/21/2014 13:40	10/21/2014 15:15	156.7	None	Partially full 240-mL bottle with tan, brown, and white dry solids; no organic layer visible
7C-14-9	10/20/2014 9:55	10/20/2014 15:25	253.9	157.3	Partially full 240-mL bottle with tan, brown, and white solids with clear liquid; no organic layer visible
7C-14-9A	10/20/2014 13:14	10/20/2014 15:25	102.6	None	Partially full 240-mL bottle with tan, brown, and white dry solids; no organic layer visible

Source: RPP-RPT-58494, "Final Report for Tank 241-C-107 Post-Retrieval Waste Solid Samples in Support of Tank Closure."

3.3 SAMPLE ANALYSES

The samples listed in Table 3-1 were analyzed for the constituents identified in RPP-23403 and RPP-PLAN-23827 as defined by RPP-PLAN-52884 and ATL-MP-1011, "ATL Quality

Assurance Project Plan for 222-S Laboratory." Analytical methods performed on the samples are identified in Table 3-2. The table also shows the corresponding analysis methods found in SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," where applicable. Sample analysis results are reported in RPP-RPT-58494, "Final Report for Tank 241-C-107 Post-Retrieval Waste Solid Samples in Support of Tank Closure." Electronic data were also loaded into the Tank Waste Information Network System.

3.4 CALCULATION OF RESIDUAL INVENTORY

The residual waste inventories were computed by following the Best-Basis Inventory (BBI) process as described in RPP-7625, "Guidelines for Updating Best-Basis Inventory." Two inventories were computed: an average inventory based on mean concentrations, density, and volume and an upper bounding inventory that is an estimate of an inventory at the 95% UCL. The inventories are discussed in the following sections.

3.4.1 Average Inventories

The average inventory for each waste constituent was calculated using the automated Best-Basis Inventory Maintenance (BBIM) tool [RPP-5945, "Best-Basis Inventory Maintenance Tool (BBIM): Database Description and User Guide"]. This tool calculates the average inventory by finding the product of the mean concentration, the mean density, and the waste volume (i.e., inventory = concentration × density × volume). The calculations by the BBIM tool are summarized below. Table 3-3 identifies the residual solids compounds in tank C-107.

As described earlier, tank C-107 solids were sampled in tank C-107 after the heel retrieval which removed more than half of the amount of waste after bulk retrieval. The mean concentrations were estimated as follows.

The BBIM used equations from Variance Components (Searle et al. 1992) to estimate the mean concentration and density and the associated standard deviation for all constituents that had 50% or more of their reported values greater than the detection limit. These equations compute means by weighting results based on the variance components. Some constituents had concentrations that were below the detection limits. In these cases, the analytical method detection limits were used for calculating the mean concentrations. For a constituent with a majority of the analytical results below the analytical method detection limit, a simple average of the detection limits was calculated as if they were the analytical results for the constituent. Note that in accordance with BBI protocol, the relative standard deviations (RSDs) for non-detected constituents were assumed to be "1" (RPP-6924, "Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories").

To calculate the average analyte inventories, the BBIM tool automatically used the mean concentrations from the samples taken after heel retrieval. The concentration means used by the BBIM tool to calculate the average inventories are provided in Appendix B.

Table 3-2. Analytical Methods Used in Analysis of Post-Heel Removal Samples.

Analysis Technique	SW-846 Reference Method
Inorganic Analyses	
Bulk Density – Gravimetric	Not applicable
pH	9045D
Weight percent water – Thermogravimetric Analysis	Not applicable
Cyanide – Spectrophotometric	9010C4
Mercury – Cold Vapor Atomic Absorption	7471B
Ammonium – Ion Chromatography	EPA 300.7*
Anions & Organic Acids – Ion Chromatography	9056A
Metals – Inductively Coupled Plasma/Atomic Emission Spectrometry	6010C
^{99}Tc – Inductively Coupled Plasma/Mass Spectrometry	3050B
Actinides – Inductively Coupled Plasma/Mass Spectrometry	3050B
Radiochemical Analyses	
Gamma Energy Analysis	Not applicable
^{90}Sr – Separation/Beta counting	Not applicable
^{14}C – Liquid Scintillation	Not applicable
^{129}I – Separation/Gamma Energy Analysis	Not applicable
^{79}Se – Liquid Scintillation	Not applicable
^{3}H – Liquid Scintillation	Not applicable
^{63}Ni – Liquid Scintillation	Not applicable
^{99}Tc – Liquid Scintillation	Not applicable
^{241}Am – Separation/Alpha Energy Analysis	Not applicable
$^{239/240}$Pu, ^{238}Pu – Separation/Alpha Energy Analysis	Not applicable
^{241}Pu – Separation/Liquid Scintillation	Not applicable
^{228}Th – Separation/Alpha Energy Analysis	Not applicable
Organic Analyses	
Volatile Organic Compound – Gas Chromatography-Mass Spectrometry	8260C
Semivolatile Organic Compound – Gas Chromatography-Mass Spectrometry	8270D
Polychlorinated Biphenyls – Gas Chromatography-Electron Capture Detection	8082A

EPA = U.S. Environmental Protection Agency

* EPA Method 300.7, "Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography."

Reference: SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Third Edition as amended.

Table 3-3. Tentatively Identified Compounds in Tank 241-C-107 Residual Solids Samples.

Laboratory Sample Number	Result Type	Tentatively Identified Compound	Result (µg/kg)	Retention Time (minutes)	CAS Number	Organic: SVOA or VOA
S14T002355	Primary	Chloroform	1.7E+04	2.96	67-66-3	SVOA
S14T002355	Primary	Amylene Hydrate	3.5E+03	3.10	75-85-4	SVOA
S14T002355	Primary	Unknown Ketone-1	7.4E+03	3.26	563-80-4	SVOA
S14T002355	Primary	Butane, 2-methoxy-2-me	6.6E+03	3.42	994-05-8	SVOA
S14T002355	Primary	Heptane	1.6E+03	3.61	142-82-5	SVOA
S14T002355	Primary	Propylene Glycol	2.6E+03	4.00	57-55-6	SVOA
S14T002384	Primary	Chloroform	1.4E+04	2.96	67-66-3	SVOA
S14T002384	Primary	Amylene Hydrate	3.2E+03	3.10	75-85-4	SVOA
S14T002384	Primary	Unknown Ketone	7.3E+03	3.26	N/A	SVOA
S14T002384	Primary	Unknown-1	5.9E+03	3.42	N/A	SVOA
S14T002384	Primary	Ethanol, 2-(2-ethoxyet	1.3E+03	7.12	111-90-0	SVOA
S14T002598	Primary	Chloroform	1.3E+04	2.97	67-66-3	SVOA
S14T002598	Primary	Amylene Hydrate	3.0E+03	3.10	75-85-4	SVOA
S14T002598	Primary	Unknown Ketone-1	6.8E+03	3.26	563-80-4	SVOA
S14T002598	Primary	Butane, 2-methoxy-2-me	5.8E+03	3.42	994-05-8	SVOA
S14T002598	Primary	Heptane	1.3E+03	3.62	142-82-5	SVOA
S14T002598	Primary	Propylene Glycol	2.2E+03	4.00	57-55-6	SVOA

µg/kg = microgram per kilogram
CAS = Chemical Abstracts Service
SVOA = semivolatile organics analysis
VOA = volatile organic analysis

As shown in Table 2-1, the total residual volume used for the average inventory estimates is 1,368 ft^3. The 95% UCL volume is 1,390 ft^3. There are 7.481 gal per ft^3 and 3.785 L per gal, therefore the solid volume is ~8 kL [(1,390 ft^3 × 7.481 gal/ft^3 × 3.785 L/gal) × 1 kL/1,000 L = 39 kL] used for the 95% UCL inventory.

3.4.2 Bounding Inventories

The 95% UCL inventory of each constituent was estimated based on a statistical method described in RPP-6924. This method is based on calculation of the average inventory (see Section 3.4.1) and a statistical uncertainty (quantified using a standard deviation) for the inventory. The standard deviation of the average inventory was calculated based on statistical uncertainties associated with the concentration, volume, and density measurements.

Standard deviations for the mean concentrations (provided in Appendix B) and density were calculated using the BBIM tool. The standard deviation for waste volume was estimated as described below.

RPP-RPT-58514 provides estimates of post-retrieval residual waste volumes on the tank bottom, on the tank wall, and on the tank stiffener rings (see Table 2-1). The total waste volume was estimated at 1,390 ft^3 (95% UCL). The estimated error for the total volume may be represented as ± 0.016 ([1,390-1,368]/1,368). Using a factor of 2 for a two-sided 95% confidence level based on a normal distribution with a known variance, the RSD for the total waste volume was estimated to be 0.008 (0.016/2). This RSD was used to approximate the RSD associated with the solids volume.

The BBIM tool calculated the inventory RSD using the equation:

$$RSD^2(\hat{I}) \cong RSD^2(\overline{C}) + RSD^2(\overline{D}) + RSD^2(\hat{V})$$

where $RSD^2(\hat{I})$ is the squared inventory RSD, $RSD^2(\overline{C})$ is the squared average concentration RSD, $RSD^2(\overline{D})$ is the squared average density RSD, and $RSD^2(\hat{V})$ is the squared total volume RSD.

According to RPP-6924, the Student's t distribution (or any other probability distribution) is not applicable for determining a confidence interval for the mean inventory because there are no degrees of freedom associated with the volume measurement. The 95% UCL inventory was approximated by the equation:

$$UCL = \hat{I} + 2 \times \hat{I} \times RSD(\hat{I})$$

where $\hat{I}$ is the average inventory estimate and $RSD(\hat{I})$ is the RSD of the average inventory estimate. The factor "2 times the standard deviation of the estimate" in this equation is analogous to the factor "1.96 times the standard deviation of the mean" for a two-sided 95% confidence interval on the mean based on a normal distribution with a known variance (in accordance with the BBI process which uses a two-sided 95% confidence interval for inventory). The 95% UCL inventories were calculated using the above equation and the average inventory estimates and associated RSDs that were calculated by the BBIM tool.

3.4.3 Evaluation of Sample Data Usability

Residual waste solids were sampled with the Off-Riser Sampling System after heel removal using an accepted sampling method described in the Data Quality Objectives (DQO) document (RPP-23403). The solids RSDs in Appendix B, Table B-1 represent the uncertainty in the estimates due to sampling and analysis errors and to the waste variability in the tank.

The 222-S Laboratory maintains a quality assurance program to ensure data quality. The waste samples were analyzed according to quality assurance plans established by the program. In

addition, the DQOs specify quality control criteria (e.g., standard recovery, matrix spike recovery, relative difference between duplicate analyses) that are specific to the closure project. The DQOs also provide direction for addressing data that do not meet the criteria. Results for most constituents satisfied the DQO criteria; those that did not meet the criteria were addressed according to the direction provided in the DQOs. Communications that were used to address data issues are included in the laboratory data report (RPP-RPT-58494).

Based on this evaluation, it was concluded that the sampling and analysis met the DQO objectives and, therefore, the sample results are acceptable for uses discussed in the DQO, including risk assessment calculations.

3.4.4 Inventory Calculation Assumptions and Clarifications

The inventories were calculated in accordance with the BBI creation rules documented in RPP-7625. The calculation includes the following assumptions and clarifications.

- Inventories were generated only for constituents specified in RPP-23403. Inventories for BBI analytes that are not included in RPP-23403 were not calculated. For the inventories of the BBI analytes, see RPP-RPT-48745, Revision 8.

- Only data from post-heel removal samples were used to calculate the inventories. Inventories of constituents not detected in the samples were calculated using the analytical method detection limits. Therefore, these specific inventories are considered conservative estimates.

- Concentration data are available only for solids on the bottom of the tank. Solids on the tank stiffener ring and the tank wall were not sampled and were assumed to have the same composition as the solids on the tank bottom.

- The average volume estimate for the residual waste on the tank bottom includes a 708 ft^3 pool of mostly liquids (Table 2-1). The volume of the submerged solids in the liquids is not known; therefore, the volume of the pool is included in the total residual solids volume in the tank.

- Thorium concentration was measured by inductively coupled plasma/atomic spectroscopy and ^{232}Th was measured by inductively coupled plasma/mass spectrometry. Analyses by inductively coupled plasma/mass spectrometry are generally more reliable at low concentration; therefore, the thorium inventory was calculated based on the inductively coupled plasma/mass spectrometry results.

- Uranium concentration was estimated from concentrations of uranium isotopes detected by inductively coupled plasma/mass spectrometry (^{234}U, ^{235}U, ^{236}U, and ^{238}U).

- Plutonium and curium (except for ^{242}Cm) isotopes were calculated from the $^{239/240}Pu$ and $^{243/244}Cm$ analytical results, using process knowledge of the isotopic distributions ratios of

tank C-107 (RPP-8847, "Best-Basis Inventory Template Compositions of Common Tank Waste Layers").

- In accordance with RPP-7625, the ^{137m}Ba inventory was equal to 0.944 times the ^{137}Cs inventory and the ^{90}Y inventory was equal to the ^{90}Sr inventory.

- As the name implies, tentatively identified compounds (TICs) from organic analyses were not identified with certainty. In addition, measured concentrations for these compounds are only semi-quantitative. Therefore, inventories were not computed for TICs. Only TICs that met the TIC evaluation criteria in RPP-23403 and were reported as a TIC in RPP-RPT-58494 are in Table 3-3. The samples contained numerous alkanes and their alterations to ketones.

- The laboratory was not able to measure xylene (m) and xylene (p) separately; therefore, these compounds were reported as xylene (m&p).

- Bulk density sample results had a range from 1.52 g/mL to 1.95 g/mL (RPP-RPT-58494) and a sample mean density of 1.69 g/mL.

3.5 INVENTORY ESTIMATES

The average and upper-bounding inventories for the residual solids are shown in Table 3-4 (RPP-RPT-58514). Note that the symbol "<" indicates the inventory was calculated based on the analytical method detection limit because the analyte was not detected in the samples. Radionuclide inventories were decay-corrected to January 1, 2008.

Table 3-4. Inventory Estimates for Selected Constituents in Tank 241-C-107 Residual Solids. (4 sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
1,2,4-Trichlorobenzene	120-82-1		1.29E-04	1.65E-04	kg
^{125}Sb	14234-35-6	<	9.69E+01	2.91E+02	Ci
^{126}Sn	15832-50-5	<	3.03E-01	9.09E-01	Ci
^{129}I	15046-84-1		2.98E-03	4.89E-03	Ci
^{137}Cs	10045-97-3		2.86E+02	3.99E+02	Ci
^{137m}Ba	N/A		2.70E+02	3.77E+02	Ci
^{14}C	14762-75-5	<	2.79E-02	8.37E-02	Ci
^{152}Eu	14683-23-9	<	2.65E+01	7.95E+01	Ci
^{154}Eu	15585-10-1	<	2.96E+01	8.88E+01	Ci
^{155}Eu	14391-16-3	<	4.73E+01	1.42E+02	Ci
^{228}Th	14274-82-9		1.23E-02	3.18E-02	Ci
^{230}Th	14269-63-7	<	4.37E+00	1.31E+01	Ci
^{231}Pa	14331-85-2	<	1.00E+01	3.00E+01	Ci
^{232}Th	N/A		7.87E-05	1.33E-04	Ci
^{233}U	13968-55-3	<	6.37E-02	1.91E-01	Ci
^{234}U	13966-29-5		2.51E-01	3.12E-01	Ci
^{235}U	15117-96-1		6.08E-03	8.40E-03	Ci
^{236}U	13982-70-2		3.96E-03	5.92E-03	Ci
^{237}Np	13994-20-2		2.40E-02	3.63E-02	Ci
^{238}Pu	13981-16-3		1.92E+00	2.66E+00	Ci
^{238}U	N/A		1.44E-01	1.92E-01	Ci
^{239}Pu	15117-48-3		1.60E+01	2.18E+01	Ci
^{240}Pu	14119-33-6		1.74E+00	2.37E+00	Ci
^{241}Am	14596-10-2		1.33E+01	1.86E+01	Ci
^{241}Pu	14119-32-5		1.76E+01	2.50E+01	Ci
^{242}Cm	15510-73-3		7.10E-02	1.24E-01	Ci
^{242}Pu	13982-10-0	<	6.77E-02	2.03E-01	Ci
^{243}Cm	15757-87-6		9.95E-02	1.60E-01	Ci
^{244}Cm	13981-15-2		2.11E+00	3.40E+00	Ci

Table 3-4. Inventory Estimates for Selected Constituents in Tank 241-C-107 Residual Solids. (4 sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
2-Butanone	78-93-3	<	1.11E-03	3.33E-03	kg
^{3}H	15086-10-9	<	2.77E-02	8.31E-02	Ci
^{60}Co	10198-40-0	<	1.43E+01	4.29E+01	Ci
^{63}Ni	13981-37-8		3.26E+02	4.24E+02	Ci
^{79}Se	15758-45-9	<	3.89E-03	1.17E-02	Ci
^{90}Sr	10098-97-2		1.12E+04	1.58E+04	Ci
^{90}Y	10098-91-6		1.12E+04	1.58E+04	Ci
^{99}Tc	14133-76-7		8.83E-02	1.15E-01	Ci
Acetate	10098-91-6	<	3.74E+00	1.12E+01	kg
Acetone	67-64-1	<	1.24E-03	3.72E-03	kg
Ag	7440-22-4		6.03E+01	8.79E+01	kg
Al	7429-90-5		1.79E+04	2.10E+04	kg
Aroclors (Total PCB)	1336-36-3	<	1.14E-03	5.95E-03	kg
As	7440-38-2		4.08E-01	5.26E-01	kg
B	7440-42-8		1.05E+00	2.10E+00	kg
Ba	7440-39-3		1.68E+00	2.58E+00	kg
Be	7440-41-7	<	6.61E-02	1.98E-01	kg
Benzene	71-43-2		1.05E-04	1.42E-04	kg
Bi	7440-69-9		2.24E+02	3.26E+02	kg
Br	24959-67-9	<	2.01E+00	6.03E+00	kg
Butylbenzylphthalate	85-68-7		3.49E-02	6.72E-02	kg
Ca	7440-70-2		2.33E+01	3.08E+01	kg
Cd	7440-43-9		2.46E-01	3.07E-01	kg
Ce	7440-45-1	<	1.65E+00	4.95E+00	kg
Cl	16887-00-6	<	2.54E+00	7.62E+00	kg
CN	57-12-5		3.96E-01	5.27E-01	kg
Co	7440-48-4		8.45E-02	1.11E-01	kg
Cr	7440-47-3		6.65E+00	9.08E+00	kg
Cu	7440-50-8		7.03E+00	8.36E+00	kg

Table 3-4. Inventory Estimates for Selected Constituents in Tank 241-C-107 Residual Solids. (4 sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
Di-n-octylphthalate	117-84-0	<	3.12E-02	9.36E-02	kg
Eu	7440-53-1	<	6.61E-02	1.98E-01	kg
F	16984-48-8		6.60E+01	8.86E+01	kg
Fe	7439-89-6		6.25E+02	8.86E+02	kg
Formate	12311-97-6	<	5.61E+00	1.68E+01	kg
Free OH	N/A		2.54E+00	5.16E+00	kg
Glycolate	666-14-8	<	2.14E+00	6.42E+00	kg
Hg	7439-97-6		1.28E+00	1.64E+00	kg
K	7440-09-7		1.88E+00	2.52E+00	kg
La	7439-91-0		3.22E-01	4.39E-01	kg
Li	7439-93-2		1.60E-01	1.87E-01	kg
Methylenechloride	75-09-2		8.51E-04	9.96E-04	kg
Mg	7439-95-4		9.34E+00	1.17E+01	kg
Mn	7439-96-5		1.03E+01	1.63E+01	kg
Mo	7439-98-7		3.90E-01	6.58E-01	kg
Na	7440-23-5		1.46E+03	2.10E+03	kg
Nb	7440-03-1	<	3.97E-01	1.19E+00	kg
Nd	7440-00-8		1.67E+00	2.14E+00	kg
NH_3	7664-41-7	<	5.01E-02	1.50E-01	kg
Ni	7440-02-0		7.94E+01	9.27E+01	kg
NO_2	14797-65-0		4.55E+01	6.46E+01	kg
NO_3	14797-55-8		6.74E+01	9.69E+01	kg
Oxalate	338-70-5		3.69E+00	4.45E+00	kg
Pb	7439-92-1		5.45E+01	6.66E+01	kg
Pd	7440-05-3	<	7.93E-01	2.38E+00	kg
PO_4	14265-44-2		1.01E+03	1.72E+03	kg
Pr	7440-10-0	<	1.72E+00	5.16E+00	kg
Rb	7440-17-7	<	3.77E+00	1.13E+01	kg
Rh	7440-16-6	<	5.95E-01	1.79E+00	kg

Table 3-4. Inventory Estimates for Selected Constituents in Tank 241-C-107 Residual Solids. (4 sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
Ru	7440-18-8		1.33E+00	2.42E+00	kg
Sb	7440-36-0	<	7.98E-02	2.39E-01	kg
Se	7782-49-2		9.90E-01	1.51E+00	kg
Si	7440-21-3		2.88E+02	3.89E+02	kg
Sm	7440-19-9		1.57E+00	1.98E+00	kg
Sn	7440-31-5		1.18E+00	1.84E+00	kg
SO_4	14808-79-8		2.51E+01	3.16E+01	kg
Sr	7440-24-6		4.71E+00	6.42E+00	kg
Ta	7440-25-7	<	3.31E-01	9.93E-01	kg
Te	13494-80-9		6.02E-01	7.24E-01	kg
Th	7440-29-1		7.16E-01	1.04E+00	kg
Ti	7440-32-6		1.81E+00	2.12E+00	kg
Tl	7440-28-0	<	2.64E-01	7.92E-01	kg
Toluene	108-88-3		2.89E-04	3.52E-04	kg
Tributyl phosphate	126-73-8	<	4.42E-02	1.33E-01	kg
Trichloroethene	79-01-6	<	6.83E-05	2.05E-04	kg
U	7440-61-1		4.33E+02	5.78E+02	kg
V	7440-62-2		4.83E-01	5.99E-01	kg
W	7440-33-7		1.25E+00	1.54E+00	kg
Xylene (m & p)	108-28-3M	<	9.46E-05	2.84E-04	kg
Xylene (o)	95-47-6	<	5.20E-05	1.56E-04	kg
Xylenes (total)	1330-20-7	<	1.15E-04	3.45E-04	kg
Y	7440-65-5		4.10E-01	6.36E-01	kg
Zn	7440-66-6		1.19E+01	1.41E+01	kg
Zr	7440-67-7		7.83E+00	1.21E+01	kg

Ci = curie kg = kilogram N/A = not applicable PCB = polychlorinated biphenyl

[1] Radionuclide concentrations are decay corrected to January 1, 2008.

4.0 RETRIEVAL SYSTEM PERFORMANCE

This section discusses the tank C-107 waste retrieval system performance in terms of residual waste, retrieval duration, and water use. In addition, this section compares the achieved waste retrieval results against predicted performance.

The DOE-ORP has deployed three technologies at tank C-107: (1) modified sluicing technology via the MARS using supernate from double-shell tank (DST) AN-106, including (2) high-pressure water technology, and (3) water-based chemical dissolution and modified sluicing using the MARS arm. Sluicing operations started on September 27, 2011 with an initial waste volume of ~247,000 gal (~33,000 ft^3), and completed on March 28, 2014, reaching the limits of technology. The supernatant liquor was the primary carrier fluid during this period with a total of 4,100,000 gal of supernate recirculated from tank AN-106 to tank C-107. A total of ~220,000 gal (~29,400 ft^3) of waste, adjusted, were removed by the first two retrieval technologies, leaving ~20,600 gal (~2,750 ft^3) on the tank floor. The third retrieval technology (water-based chemical dissolution) reached the limits of technology on August 7, 2014. The residual waste solids volume remaining in the tank was estimated at 10,660 gal (1,426 ft^3) (95% UCL, RPP-CALC-59985). This estimate was subsequently modified to 1,390 ft^3 (95% UCL) based on an update to the CCMS volume correction method as described in RPP-RPT-58514.

4.1 WASTE RETRIEVAL PROCESS DESCRIPTION

The WRSs deployed at tank C-107 using the MARS were designed to mobilize, size reduce, and dissolve portions of the sludge waste so it could be transferred to tank AN-106. Descriptions of WRSs may be found in RPP-22393. The bulk WRS used supernate from the DST to break up and fluidize the waste, and transfer it to tank AN-106. Supernate from tank AN-106 was recycled continuously. The volume of supernate transferred to tank C-107 was monitored and balanced by the volume pumped out of tank C-107. The flow rate of the recycled supernate was roughly the same as the flow rate of the slurry pumped to the DST. The bulk sluicing operation directed the supernate toward the tank C-107 waste using the MARS sluicer end effector, eroding and moving the waste toward the center transfer pump so pumpable material could be transferred to the DST.

The initial waste retrieval operation in tank C-107 was by sluicing via the MARS and the waste was transferred to tank AN-106. This initial retrieval operation was completed in March 2014. Subsequent retrieval operations (Hard Heel) comprised of using hot water dissolution of the phosphate salts and sluicing actions, were completed in August 2014. Final Hard Heel waste retrieval activities included a volumetric displacement to reassess residual sludge inventory. That volumetric displacement showed a reduction of floor waste from an estimated 56,235 gal to 23,337 gal on May 21, 2013. Following the volumetric displacement, supernate sluicing and high-pressure water scarification were employed to remove wastes. Supernate sluicing in early 2014, following slurry pump replacement, resulted in the introduction of saturated phosphate solutions into tank C-107. The high-phosphate supernatant liquor appears to have generated phosphate crystallization and consequent waste solids agglomeration within

tank C-107. Waste sluicing activities were discontinued when retrieval rates repeatedly demonstrated insignificant value.

It was determined that a limiting factor in waste transfer was attributable to natrophosphate crystallization resulting in the agglomeration of waste particles. A third retrieval method was selected and conducted (RPP-PLAN-57604, "Single-Shell Tank 241-C-107 Retrieval Third Technology Selection"). The third retrieval technology activities in July and August 2014 were conducted and followed by a volumetric displacement measurement of waste residuals, and finalized with a water rinse of waste residuals.

As part of the third tank C-107 waste retrieval technology, two batched hot water rinses and three batched hot water recirculation flushes were conducted to remove residual and interstitial supernate and to dissolve natrophosphate, respectively. As the waters were pumped out, the liquid density was monitored; the final flush discharge displayed a density drop indicating a depletion of natrophosphate in the tank waste being transferred. With the natrophosphate depleted, retrieval activities returned to supernate-based sluicing. Although wastes were demonstrated to be re-mobilized, the remaining waste particle size was too large to be carried through the pump screen. The retrieval operations were discontinued when MARS waste recovery rates demonstrated the limits of technology criteria.

On August 7, 2014, a volumetric displacement tank waste residuals measurement was conducted. Supernatant liquor from tank AN-106 was used and prior to the introduction of the liquor, an Enraf® measurement of the elevation of the steel tank floor indicated that Enraf® measurements had been in error by 1.67 inches. As described in RPP-CALC-52903, the estimated waste volume on the tank floor was 8,748 gal of wetted waste solids. RPP-CALC-52903 further assesses waste crusted in a ring on the tank wall as 3,286 gal, and residual rinse waters as 2,020 gal. The estimated residual waste volume at that time was 14,054 gal. The final water rinse of the tank was conducted on August 9, 2014. The objective of the rinse was to remove soluble supernatant-based contaminants from the SST. The design of the MARS sluicing system allowed a continuous rinse and dilution rather than batched dilutions. As a result 16,018 gal were used in the rinse and 13,998 gal were transferred to tank AN-106, leaving 2,020 gal of water in tank C-107.

4.2 RETRIEVAL SYSTEM PERFORMANCE

The sluicing retrieval system effectively removed most of the sludge from tank C-107; essentially, the small particle size waste that could be removed and transferred. The waste in tank C-107 was comprised of 1C, SRR waste solids. Such a waste composition was unlike other C Farm tanks, in that the waste was not dominated by gibbsite ($Al[OH]_3$) and thus unlikely to require caustic cleaning for the majority of the waste. For this reason the MARS sluicing retrieval was established to conduct the waste retrieval primarily through mechanical impact of liquid upon the waste solids resulting in the fluidization and pumped retrieval of the size-reduced material. Supernatant liquor from tank AN-106 and high-pressure water were provided for an hydraulic mining operation.

The MARS provided multiple technologies to be deployed for waste retrieval within one tool set. The MARS end effector had two types of supernate sluicing nozzles as well as high-pressure water nozzles. The slurry pump mast had a re-deployable backstop designed to provide a waste solids collection, suspension, and breakup with high-pressure water nozzles and supernate nozzles within the backstop.

Trends and specific operations during the retrieval are depicted in Figure 4-1. The retrieval trend displayed in Figure 4-1 indicates a good retrieval rate to ~450 hours of operations, using a combination of MARS sluicing and high-pressure water retrieval technologies. Upon the failure of the tank C-107 slurry pump, retrieval operations efforts were redirected by conducting the retrieval of tank 241-C-110 wastes into tank AN-106. Subsequent tank C-107 operations demonstrated no significant performance yields following the introduction of the high-phosphate supernate from tank AN-106, originating from retrieval operations at tank 241-C-110.

Based on the performance metrics examined with the implementation of the MARS sluicing, high-pressure water, and chemical retrieval technologies and consideration of the factors specified in the Consent Decree, DOE-ORP concluded that these retrieval technologies had been deployed to the limits of technology at tank C-107 (RPP-RPT-58150, "Retrieval Completion Certification Report for Tank 241-C-107").

4.3 WASTE RETRIEVAL EFFICIENCY

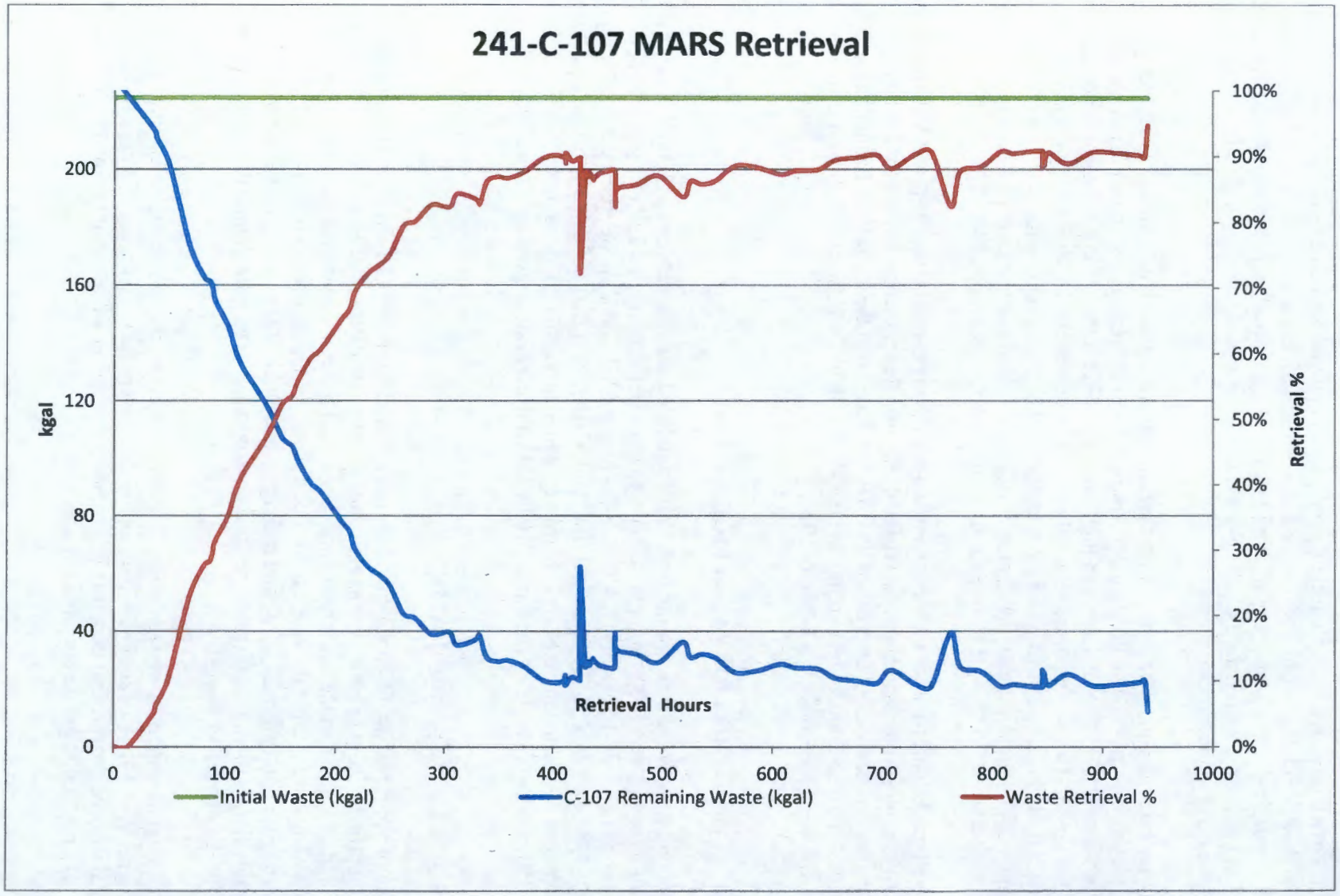
The preliminary estimate for the tank C-107 modified sluicing rate campaign indicated that it would require over 9,000,000 gal of slurry to transfer the estimated 247,000 gal of tank C-107 waste to tank AN-106 (RPP-PLAN-40145, "Single-Shell Tank Waste Retrieval Plan"). In the first 425 hours of the slurry pumped from tank C-107, over 220,000 gal of waste was transferred from tank C-107 to tank AN-106. However, when the campaign had transferred ~85% (~350 hours of operation) the tank C-107 waste retrieval rate slowed appreciably.

4.4 RETRIEVAL DURATION

The pre-retrieval modified sluicing duration estimate for tank C-107, if the retrieval system used a modified sluicing platform, was estimated to take ~90 days based on a progression of waste per gallon of slurry and the expected slurry per shift. Retrieval operations were performed, removing over 90% of the corrected waste volume during 81 operating days and 845 hours starting on September 27, 2011 and ending on March 28, 2014. Early in the MARS sluicing retrieval operation, progress was better than expected. After ~300 hours of sluicing, sluicing efficiency began to fall off.

Retrieval operations restarted on July 21, 2014 to remove the remaining solids; they ended on August 9, 2014. A total of ~500,000 gal of slurry were pumped during this period. During the final rinse of the residual tank waste, ~16,000 gal of water were added to tank C-107. Of this amount, ~14,000 gal was received in tank AN-106.

Figure 4-1. 241-C-107 Retrieval Performance Trends.



The tank C-107 WRS campaigns consisted of a sluicing operation over a 913-calendar-day period starting on September 27, 2011 and ending on March 28, 2014. The final waste retrieval campaign extended over a 17-calendar-day period from July 21, 2014 to August 9, 2014.

4.5 CONCLUSION

Based on the information contained in Section 4.2 above, DOE-ORP concluded that waste retrieval operations were performed to the limits of the MARS sluicing technology, the high-pressure water retrieval technology, and the water-based chemical dissolution and modified sluicing (RPP-RPT-58150). The waste residual volume estimate of 1,390 ft^3 at the 95% UCL (RPP-RPT-58514) is greater than the goal of 360 ft^3 after deploying the three technologies.

This page intentionally left blank.

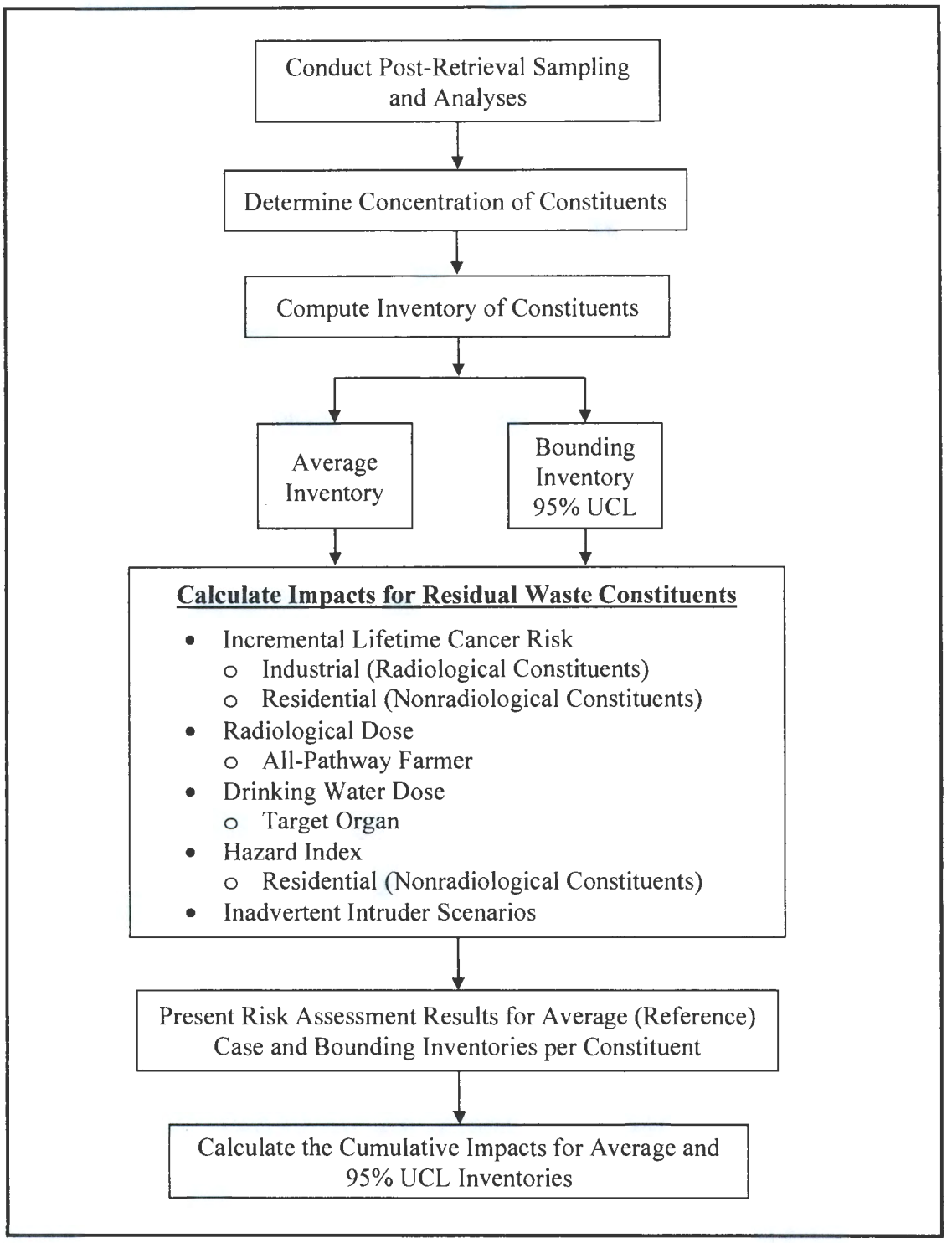
5.0 POST-RETRIEVAL SINGLE-SHELL TANK 241-C-107 RISK ASSESSMENT

The potential impacts to human health posed by the residual waste in SST C-107 were evaluated using the methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site. Figure 5-1 provides a schematic of the process used for the tank C-107 risk assessment, and this methodology is described in detail in Chapter 3 of DOE/ORP-2005-01. The SST performance assessment (PA) methodology represents the current approach being used to support the assessment of long-term impacts to human health from tank residuals left in individual SSTs in RDRs. Decisions on final closure of tank C-107, all other SSTs, and ancillary facilities and equipment within Waste Management Area (WMA) C will be supported by a site-specific PA as outlined in Appendix I of the HFFACO. That single PA will evaluate whether closure conditions at WMA C will be protective of human health and the environment for all contaminants of concern, both radiological and non-radiological. The DOE intends that PA will document by reference relevant performance requirements defined by Resource Conservation and Recovery Act of 1976 (RCRA), RCW 70.105, Federal Water Pollution Control Act (Clean Water Act), Safe Drinking Water Act of 1974, and the Atomic Energy Act of 1954, as well as any other performance requirements that might be Applicable or Relevant and Appropriate Requirements under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The inventory used in this tank C-107 risk assessment was derived from post-retrieval residual inventory samples (see Section 3.0). A comparison of post-retrieval inventory to the inventory used in DOE/ORP-2005-01 is provided in Appendix C for information purposes. The inventory used in DOE/ORP-2005-01 is based on RPP-RPT-23412, "Hanford Tank Waste Operations Simulator Model Data Package for the Development Run for the Refined Target Case." The post-retrieval inventory used in this RDR provides a more accurate representation of tank residuals than RPP-RPT-23412, and will be incorporated in the WMA C PA.

Results of the potential impacts to human health were calculated using the average and 95% UCL inventories. Results show that for the groundwater pathway, the effects associated with tank C-107 are one to two orders of magnitude below current incremental lifetime cancer risk (ILCR) performance objectives (1.0E-06 to 1.0E-4) for radioactive analytes, and six to seven orders of magnitude below the ILCR performance objectives (1.0E-05) for non-radioactive analytes. The hazard indices for the tank C-107 groundwater pathway are three to four orders of magnitude below the performance objective (1.0). For all inadvertent intruder scenarios other than the suburban garden scenario (a sensitivity case) at 100 years after closure, the effects associated with tank C-107 were below both the 100 mrem/yr performance objective for chronic exposure and the 500 mrem performance objective for acute exposure. For comparison, at 500 years after closure, the effects estimated for the suburban garden scenario are about four times less than the 100 mrem/yr performance objectives for chronic exposure. Details of these results are provided in Sections 5.2 through 5.4.

Figure 5-1. Single-Shell Tank 241-C-107 Residual Waste Inventory and Risk Assessment Process.



UCL = upper confidence level

This section also provides additional risk management information related to concentrations of constituents remaining in waste residuals within tank C-107 compared against the WAC 173-340 cleanup standards. The soil cleanup standards evaluated are developed for direct contact exposures and for groundwater protection. Selected constituent concentrations estimated for the average and 95% UCL inventories of tank residuals are specifically compared against soil direct contact cleanup levels for unrestricted land use (Method B), soil direct contact cleanup levels for industrial land use (Method C), and soil cleanup levels protective of groundwater using the fixed parameter three-phase partitioning model given in WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection," subsection (4), "Fixed parameter three-phase partitioning model." Results of these comparisons are found in Section 5.5.1.

Section 5.5 also includes a discussion of the appropriateness of comparisons for constituent concentrations remaining in waste residuals within tank C-107 against cleanup standards protective of ecological risk found in WAC 173-340. Because footnotes in tables containing the cleanup standards protective of ecological concerns indicate these standards are not intended to be used for evaluation of sludges or wastes, specific comparisons of concentrations of constituents remaining in waste residuals within tank C-107 against the WAC 173-340 cleanup standards related to ecosystem risk are not provided.

5.1 CONSTITUENTS EVALUATED

Following retrieval, the residual waste was sampled and analyzed. This risk assessment is based on the analytical results from the post-retrieval sample (Section 3.0).

Analytical data for tank C-107 were collected and analyzed as defined by the closure DQOs. The post-retrieval samples were analyzed for 112 constituents (i.e., radionuclides, volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls, and inorganics [including metals and conventional parameters]) in accordance with approved 222-S Laboratory procedures based on U.S. Environmental Protection Agency (EPA) approved methods. However, analytes flagged as a non-detect were evaluated at one-half the detection limit in accordance with EPA/540/1-89/002, "Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final." Table 5-1 presents a complete listing of the analytes evaluated, whether the analyte was detected, and whether a cancer potency factor (also called a cancer slope factor), dose factor, or reference dose is published for that analyte.

Table 5-1. List of Analytes and Available Toxicity Information. (3 sheets)

Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]	Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]
^{241}Am	Americium-241		DFR/CPF	7440-48-4	Cobalt		RfD/CPF
^{125}Sb	Antimony-125*	U	DFR/CPF	7440-50-8	Copper		RfD
^{137m}Ba	Barium-137m*		--	57-12-5	Cyanide*		RfD
^{14}C	Carbon-14	U	DFR/CPF	75-09-2	Dichloromethane (methylene chloride)*		RfD/CPF
^{137}Cs	Cesium-137 + Daughters		DFR/CPF	117-84-0	Di-n-octylphthalate*	U	RfD
^{60}Co	Cobalt-60	U	DFR/CPF	7440-53-1	Europium	U	--
^{242}Cm	Curium-242		DFR/CPF	16984-48-8	Fluoride		RfD
^{243}Cm	Curium-243		DFR/CPF	12311-97-6	Formate+A2	U	--
^{244}Cm	Curium-244		DFR/CPF	Glycolate	Glycolate C2H3O3	U	--
^{152}Eu	Europium-152	U	DFR/CPF	OHDEMAND	Hydroxide OH		--
^{154}Eu	Europium-154	U	DFR/CPF	7439-89-6	Iron		RfD
^{155}Eu	Europium-155	U	DFR/CPF	7439-91-0	Lanthanum		--
^{129}I	Iodine-129		DFR/CPF	7439-92-1	Lead*		--
^{237}Np	Neptunium-237 + D		DFR/CPF	7439-93-2	Lithium		RfD
^{63}Ni	Nickel-63*		DFR/CPF	7439-95-4	Magnesium		--
^{238}Pu	Plutonium-238		DFR/CPF	7439-96-5	Manganese		RfD
^{239}Pu	Plutonium-239		DFR/CPF	7439-97-6	Mercury*		RfD
^{240}Pu	Plutonium-240		DFR/CPF	7439-98-7	Molybdenum		RfD
^{241}Pu	Plutonium-241 + D		DFR/CPF	108-38-3	m-Xylene	U	RfD
^{242}Pu	Plutonium-242	U	DFR/CPF	7440-00-8	Neodymium		--
^{231}Pa	Protactinium-231	U	DFR/CPF	7440-02-0	Nickel*		RfD
^{79}Se	Selenium-79*	U	DFR/CPF	7440-03-1	Niobium	U	--

Table 5-1. List of Analytes and Available Toxicity Information. (3 sheets)

Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]	Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]
^{90}Sr	Strontium-90 + D		DFR/CPF	14797-55-8	Nitrate		RfD
^{99}Tc	Technetium-99		DFR/CPF	14797-65-0	Nitrite		RfD
^{228}Th	Thorium-228 + D		DFR/CPF	338-70-5	Oxalate		--
^{230}Th	Thorium-230	U	DFR/CPF	95-47-6	o-Xylene	U	RfD
^{232}Th	Thorium-232		DFR/CPF	7440-05-3	Palladium	U	--
^{126}Sn	Tin-126	U	DFR/CPF	14265-44-2	Phosphate		--
^{3}H	Tritium	U	DFR/CPF	1336-36-3	Polychlorinated Biphenyls*	U	CPF
^{233}U	Uranium-233	U	DFR/CPF	7440-09-7	Potassium		--
^{234}U	Uranium-234		DFR/CPF	7440-10-0	Praseodymium	U	--
^{235}U	Uranium-235 + D		DFR/CPF	7440-16-6	Rhodium	U	--
^{236}U	Uranium-236		DFR/CPF	7440-17-7	Rubidium	U	--
^{238}U	Uranium-238 + D		DFR/CPF	7440-18-8	Ruthenium		--
^{90}Y	Yttrium-90		--	7440-19-9	Samarium		--
79-01-6	1, 1, 2-Trichloroethylene	U	RfD/CPF	7782-49-2	Selenium*		RfD
120-82-1	1, 2, 4-Trichlorobenzene*		RfD	7440-21-3	Silicon		--
78-93-3	2-Butanone(MEK)	U	RfD	7440-22-4	Silver*		RfD
67-64-1	2-Propanone (Acetone)	U	RfD	7440-23-5	Sodium		--
71-50-1	Acetate	U	--	7440-24-6	Strontium		RfD
7429-90-5	Aluminum		RfD	14808-79-8	Sulfate		--
7429-90-5	Aluminum		RfD	14808-79-8	Sulfate		--
7664-41-7	Ammonia	U	RfD	7440-25-7	Tantalum	U	--
7440-36-0	Antimony*	U	RfD	13494-80-9	Tellurium		--

Table 5-1. List of Analytes and Available Toxicity Information. (3 sheets)

Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]	Isotope/ CAS	Analyte[a]	Detect	Available Toxicity Information[b]
7440-38-2	Arsenic*		RfD/CPF	7440-28-0	Thallium*	U	RfD
7440-39-3	Barium*		RfD	7440-29-1	Thorium		--
71-43-2	Benzene*		RfD/CPF	7440-31-5	Tin		RfD
7440-41-7	Beryllium*	U	RfD/CPF	7440-32-6	Titanium		--
7440-69-9	Bismuth		--	108-88-3	Toluene*		RfD
7440-42-8	Boron		RfD	126-73-8	Tributyl phosphate	U	RfD/CPF
24959-67-9	Bromide	U	--	7440-33-7	Tungsten		--
85-68-7	Butylbenzylphthalate*		RfD	7440-61-1	Uranium		--
7440-43-9	Cadmium*		RfD/CPF	7440-62-2	Vanadium		RfD
7440-70-2	Calcium		--	1330-20-7	Xylenes	U	RfD
7440-45-1	Cerium	U	RfD	7440-65-5	Yttrium		--
16887-00-6	Chloride	U	--	7440-66-6	Zinc		RfD
7440-47-3	Chromium, Total*		--	7440-67-7	Zirconium		--

[a] RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."
[b] HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

CAS = Chemical Abstracts Service
CPF = Cancer potency factor
-- = No available toxicity value (dose factor, reference dose, or cancer potency factor)
DFR = Dose factor
RfD = Reference dose
U = Analyte not detected in residual wastes

Gray shaded area indicates non-detect for this analyte.

*Dangerous waste constituent per Washington Administrative Code 173-303-9905, "Dangerous Waste Constituents List."

5.2 RESULTS FOR INDIVIDUAL CONTAMINANTS FOR POST-RETRIEVAL SINGLE-SHELL TANK 241-C-107

Table 5-2 identifies the main contributors to the ILCR (industrial and residential scenarios), groundwater dose (all-pathways farmer scenario), and drinking water dose for radiological components of the residual waste remaining in tank C-107. Table 5-3 identifies the primary hazardous chemicals that contribute to ILCR and the Hazard Quotient. These results are provided for the average residual waste inventory for SST C-107. A more complete listing of all analytes for the same average inventory is provided in Tables D-1 and D-2 of Appendix D. A similar set of tables based on the 95% UCL inventory is provided in Tables D-3 and D-4 of Appendix D. In each of these tables, the following columns are provided.

a. **Analyte Name**.

b. **Detected in Residual Wastes** is an indicator as to whether an analyte was detected in the laboratory.

c. **Inventory** as shown here for non-detects is calculated at one-half the detection limit.

d. **WMA C Fenceline Concentration** is the maximum modeled concentration for a constituent at the WMA C fenceline over the modeling period. In the methodology used in DOE/ORP-2005-01, this concentration was estimated using cross-sectional modeling of vadose zone and groundwater flow and transport. In some cases, individual analytes may not have a corresponding concentration at the fenceline because short-lived radionuclides will decay away before the contaminant can arrive at the WMA C fenceline. Relatively immobile contaminants (i.e., K_d greater than 0.6 mg/L) will also result in a zero concentration at the fenceline as they will not reach the fenceline within 10,000 years (based on assumptions and transport modeling approach used).

e. **Peak Year** is the year in which the simulation estimates that peak concentration for a given analyte arrives at the fenceline.

f. **K_d** is the mobility factor used in the groundwater modeling for the analyte. The smaller the K_d, the more mobile the contaminant; if the K_d is zero, the contaminant moves with the groundwater.

g. **Half-life** is the duration in years for a radionuclide to decay to half its activity. Organic compounds were assumed not to decay (radionuclides only).

h. **Incremental Lifetime Cancer Risk** (groundwater) is described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments" for the industrial and residential exposure scenarios [including WAC 173-340, Method B (residential)].

i. **Radiological Dose** is the estimated drinking water dose for the all-pathways farmer exposure scenario (radionuclides only).

j. **Radiological Dose – Beta/Photon** is the drinking water dose from beta/photon emitting radionuclides using equivalent dose (radionuclides only).

k. **Hazard Quotient** (groundwater) – Hazard quotients calculated for residential and industrial scenarios described in HNF-SD-WM-TI-707.

5.3 CUMULATIVE ANALYSIS RESULTS FOR SINGLE-SHELL TANK 241-C-107 AND WASTE MANAGEMENT AREA C

The cumulative analysis (i.e., sum of the risk metrics) for tank C-107 residual average and 95% UCL risk levels was calculated and results are provided in this section.

- **Average Inventory**—best estimate of the residual waste inventory computed using mean sample concentrations, mean sample density, and best estimate of the residual volume.

- **95% UCL Inventory**—considered the bounding inventory. The 95% UCL of the average inventory was calculated based on uncertainties associated with the concentration, volume, and density (for solids) measurements (see Section 3.0).

The impacts for the groundwater pathway associated with each residual waste inventory are evaluated with a variety of performance metrics. The ILCRs are evaluated for radiological analytes using the average and 95% UCL inventories and industrial and residential exposure scenarios. The ILCR and hazard indices are examined for the same inventories using a residential exposure scenario.

Radiological doses using the same two inventories are also evaluated for an all-pathways farmer and a drinking water only exposure scenario. Estimated concentration levels of some selected analytes are also provided and compared against current maximum concentration levels.

A comparison of impacts from the average and the 95% UCL inventories and current performance metrics for ILCR, hazard indices, and maximum concentration limits are summarized in Table 5-4.

Table 5-2. Estimated Maximum Incremental Lifetime Cancer Risk/Radiological Dose During the Modeling Period for Primary Radionuclides Related to Average Residual Waste Inventory in Single-Shell Tank 241-C-107.

Analyte	Above Detection Limits in Residual Waste	Inventory (Ci)	Waste Management Area C Fenceline Concentration (pCi/L)	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Lifetime Cancer Risk		Radiological Dose (mrem/yr) All-Pathways Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
^{14}C	No	1.40E-02	2.15E-02	9.78E+03	0.00E+00	5.73E+03	1.67E-10	1.21E-09	1.04E-04	4.30E-05
^{99}Tc	Yes	8.83E-02	3.53E-01	1.05E+04	0.00E+00	2.11E+05	4.86E-09	1.18E-07	6.18E-04	1.57E-03
^{129}I	Yes	2.98E-03	<1.00E-03	1.20E+04	2.00E-01	1.57E+07	NE	NE	NE	NE
^{234}U	Yes	2.51E-01	0.00E+00	DNA	6.00E-01	2.46E+05	NE	NE	NE	N/A
^{235}U	Yes	6.08E-03	0.00E+00	DNA	6.00E-01	7.04E+08	NE	NE	NE	N/A
^{236}U	Yes	3.96E-03	0.00E+00	DNA	6.00E-01	2.34E+07	NE	NE	NE	N/A
^{238}U	Yes	1.44E-01	0.00E+00	DNA	6.00E-01	4.47E+09	NE	NE	NE	N/A
Performance Objective[d]							**1-0E-6 to 1.0E-4[e]**	**1-0E-6 to 1.0E-4[e]**	**25[f]**	**4[g]**

[a] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, for the basis for the K_d values listed for the radionuclides.

[b] All exposure scenarios are described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

[c] Simulation predicted contaminant arrives at the fence line, but at a concentration (<0.001 pCi/L) that is much below the minimum detection limit for standard analytical methods.

[d] Performance objectives apply to the cumulative (i.e., all contaminants) for the entire waste management area.

[e] EPA 540/R/99/006, "Radiation Risk Assessment At CERCLA Sites: Q & A," Directive 9200.4-31P.

[f] DOE O 435.1, Radioactive Waste Management.

[g] 65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule."

DNA = did not arrive at fenceline within the modeling period
NE = constituent analyzed, but this risk metric was not calculated because the analyte was predicted to have a concentration less than 0.001 pCi/L, which is well below the ability of standard laboratory methods to detect it

Shaded cell indicates non-detects in sludge or supernate, and the inventory used in the risk assessment is calculated at one-half the minimum detection limit.

Table 5-3. Estimated Maximum Value for Incremental Lifetime Cancer Risk and Hazard Quotient for Selected Non-Radiological Analytes Related to Average Residual Waste Inventory in Single-Shell Tank 241-C-107.

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[a]	Incremental Lifetime Cancer Risk Scenarios (Groundwater)[b]	Hazard Quotient (Groundwater)[b]
						WAC 173-340 Method B	
Chromium, Total*	Yes	6.65E+00	2.73E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Fluoride	Yes	6.60E+01	2.71E-01	1.05E+04	0.00E+00	No CPF	2.82E-04
Nitrate	Yes	6.74E+01	2.77E-01	1.05E+04	0.00E+00	No CPF	1.08E-05
Nitrite	Yes	4.55E+01	1.87E-01	1.05E+04	0.00E+00	No CPF	1.17E-04
Uranium	Yes	4.33E+02	0.00E+00	DNA	6.00E-01	NE	NE
Performance Objective[c]						**1.0E-06[d]**	**1.0[e]**

[a] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, for the basis for the K_d values listed for chromium and nitrate. The K_d values listed for the organic chemical compounds are determined from the chemicals' organic carbon/water partitioning coefficient and an estimate of 0.03% for the Hanford Site sediments fraction of organic content (PNNL-13895, Rev. 1, page 11, paragraph 3).

[b] All exposure scenarios are described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

[c] Single Analyte Performance objectives apply to entire waste management area, not just a single component of the waste management area.

[d] Washington Administrative Code (WAC) 173-340-705, "Use of Method B," subsection (2)(c)(ii).

[e] WAC 173-340-705 (2)(c)(i).

DNA = did not arrive at fenceline within the modeling period
NE = constituent analyzed, but this risk metric was not calculated because the analyte was predicted to have a concentration less than 0.001 µg/L, which is well below the ability of standard laboratory methods to detect it
No CPF = no cancer potency factor available
No Rfd = no reference dose available

* Dangerous waste constituent per WAC 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III) insoluble salts.

Reference: WAC 173-340, "Model Toxics Control Act – Cleanup."

Table 5-4. Comparison of Cumulative Incremental Lifetime Cancer Risk, Hazard Index, Radionuclide Dose, and Groundwater Concentration at Peak Waste Management Area C Fenceline for Average and 95% Upper Confidence Level Residual Waste Inventories in Single-Shell Tank 241-C-107. (2 sheets)

Metric[a]	Industrial Receptor		Residential Receptor		Performance Objective[b]
	Average Inventory	95% Upper Confidence Level Inventory	Average Inventory	95% Upper Confidence Level Inventory	
Incremental Lifetime Cancer Risk from Radioactive Analytes (unitless)					
Total without non-detects[c]	4.86E-09	6.33E-09	1.18E-07	1.54E-07	1.0E-06 to 1.0E-4[e]
Total with non-detects[d]	5.02E-09	6.81E-09	1.19E-07	1.58E-07	
Incremental Lifetime Cancer Risk from Non-Radioactive Analytes (unitless)					
Total without non-detects[c]	6.43E-13	8.27E-13	1.68E-12	2.14E-12	1.0E-5[f]
Total with non-detects[d]	2.02E-12	5.05E-12	4.40E-12	1.05E-11	
Hazard Index (unitless)					
Total without non-detects[c]	6.51E-05	8.91E-05	4.45E-04	6.08E-04	1.0[f]
Total with non-detects[d]	6.54E-05	8.99E-05	4.45E-04	6.09E-04	
Radiological Dose (mrem/yr)	**All-Pathways**		**Drinking Water**		**Performance Objective[b]**
	Average Inventory	95% Upper Confidence Level Inventory	Average Inventory	95% Upper Confidence Level Inventory	
Total without non-detects[c]	6.18E-04	8.04E-04	1.57E-03	2.04E-03	25[g] and 4[h] mrem
Total with non-detects[d]	7.18E-04	1.11E-03	1.61E-03	2.16E-03	

Table 5-4. Comparison of Cumulative Incremental Lifetime Cancer Risk, Hazard Index, Radionuclide Dose, and Groundwater Concentration at Peak Waste Management Area C Fenceline for Average and 95% Upper Confidence Level Residual Waste Inventories in Single-Shell Tank 241-C-107. (2 sheets)

Waste Management Area C Fenceline Concentration[c, d]				
Analyte	**Detected In Residual Wastes**	**Average Inventory**	**95% Upper Confidence Level Inventory**	**Maximum Concentration Limit**
Technetium-99	Yes	3.53E-01	4.59E-01	900 pCi/L
Iodine-129	Yes	<1.00E-03	<1.00E-03	1 pCi/L
Carbon-14	No	2.15E-02	6.45E-02	2,000 pCi/L
Chromium, Total*	Yes	2.73E-02	3.73E-02	100 µg/L

[a] Incremental lifetime cancer risks of radioactive analytes were evaluated using industrial and residential land use scenarios described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments." Incremental lifetime cancer risks and hazard indices for non-radiological analytes were evaluated using Washington Administrative Code (WAC) 173-340-705, "Use of Method B," subsection (4) "Multiple hazardous substances or pathways" (residential).

[b] Performance objectives apply to entire waste management area, not just a single component of the waste management area.

[c] If detected, fenceline concentration is based on an inventory that is calculated from actual laboratory results. Analytes with a fenceline concentration of less than either 0.001 pCi/L (radioactive) or 0.001 µg/L (nonradioactive), which is a value that is well below the minimum detection limit for standard analytical methods, are reported as less than 1.00E-03 pCi/L or µg/L.

[d] If not detected, fenceline concentration is based on an inventory that is calculated at half the detection limits of analytical results. Concentrations that are less than either 0.001 pCi/L (radioactive) or 0.001 µg/L (nonradioactive), which is a value that is well below the minimum detection limit for standard analytical methods, are reported as less than 1.00E-03 pCi/L or µg/L.

[e] EPA 540/R/99/006, "Radiation Risk Assessment At CERCLA Sites: Q & A," Directive 9200.4-31P.

[f] WAC 173-340-705 (4).

[g] DOE O 435.1, Radioactive Waste Management.

[h] 65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides, Final Rule."

Gray shaded cells are nondetects and the inventory used in the risk assessment is calculated at one-half the minimum detection limit.

* Dangerous waste constituent per WAC 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III) insoluble salts.

Results of a comparison done on Table 5-4 are summarized in Table 5-5.

Table 5-5. Comparison Summary of Cumulative Incremental Lifetime Cancer Risk, Hazard Index, Radionuclide Dose, and Groundwater Concentration at Peak Waste Management Area C Fenceline for Average and 95% Upper Confidence Level Residual Waste Inventories in Single-Shell Tank 241-C-107.

Performance Metric	Comparison(s) with Performance Objective
Incremental Lifetime Cancer Risk (ILCR) for Radioactive Analytes (1.0E-06 to 1.0E-04 ILCR)	• Estimated ILCRs for all radionuclides are between one to two orders of magnitude below performance objective range of 1.0E-06 to 1.0E-04 ILCR.
ILCR for Non-Radiological Analytes (1.0E-05 ILCR)	• Estimated ILCRs for all non-radionuclides are six to seven orders of magnitude lower than the upper end of the performance objective of 1.0E-05 ILCR.
Hazard Indices (1.0)	• Estimated hazard indices for all analytes are three to four orders of magnitude below performance objective of 1.0.
Radiological Dose • 25 mrem/yr All-Pathways • 4 mrem/yr Drinking Water Only	• Estimated doses for all radionuclides are between o Four to five orders of magnitude below the performance objective for the all-pathways dose of 25 mrem/yr o Three to four orders of magnitude below the performance objective for drinking water dose of 4 mrem/yr.
Maximum Concentration Limits of Key Analytes • ^{99}Tc – 900 pCi/L • ^{129}I – 1 pCi/L • ^{14}C – 2,000 pCi/L • Cr – 100 µg/L	• Estimated concentrations for ^{99}Tc are three orders of magnitude below 900 pCi/L maximum contaminant level. • Predicted concentration levels of other constituents of potential concern (e.g., ^{129}I, ^{14}C, and Cr) are significantly lower than their respective maximum contaminant levels.

5.4 INADVERTENT INTRUDER

The DOE recognizes that an inadvertent intruder may be onsite and not be discovered until after exposure has occurred. The radiological dose to an inadvertent intruder is therefore estimated as a part of this risk assessment.

The scenarios considered in this assessment for radiological doses from inadvertent intrusions included: 1) a well driller scenario that was used as a reference case for acute exposure in the SST PA and 2) a rural pasture scenario that was used as a reference case for chronic exposure in the SST PA. This assessment of doses from inadvertent intrusions also evaluated chronic exposure scenarios that included: 1) a suburban garden scenario and 2) a commercial farm scenario that were used as sensitivity cases for chronic exposure in the SST PA.

A summary of doses calculated for each of the intruder scenarios for the average and 95% UCL inventories remaining at SST C-107 at 100 years and 500 years after closure for tank C-107 are provided in Table 5-6. A summary of doses calculated for each of the intruder scenarios for the average and 95% UCL inventories at 100-year intervals between 100 and 1,000 years after

closure for tank C-107 are provided in Table 5-7. Tables and plots of doses related to individual radioactive analytes are provided in Tables D-5 through D-8 and Figures D-1 through D-4 in Appendix D.

Table 5-6. Comparison of Intruder Doses at 100 and 500 Years After Closure from Residual Waste for Single-Shell Tank 241-C-107.

Years after Closure[1]	Inventory	SST PA Reference Case		SST PA Sensitivity Cases	
		Well Driller[2] (mrem)	Rural Pasture[3] (mrem/yr)	Suburban Garden[3] (mrem/yr)	Commercial Farm[3] (mrem/yr)
100	Average	7.8	70	993	4.81E-02
	95% UCL	15	99	1,422	9.78E-02
500	Average	4.2	1.107	23.70	3.11E-02
	95% UCL	10.5	2.673	56.75	7.52E-02

PA = performance assessment SST = single-shell tank UCL = upper confidence level

Notes:
[1] Site closure is assumed to occur on January 1, 2032.
[2] Performance Objective (Acute Exposure) – 500 mrem.
[3] Performance Objective (Chronic Exposure) – 100 mrem/yr.

A review of detailed results and plots in Appendix D (Tables D-5 through D-8 and Figures D-1 through D-4) resulted in observations about key analytes for inadvertent intruder impacts as given in Table 5-8.

At 100 years after closure (see Table 5-6 and 5-7), doses for the well driller scenario were estimated to be ~1.6% and 3.0% of the 500 mrem acute exposure performance objective for the average and the 95% UCL inventories, respectively. At 100 years after closure, doses with the rural pasture scenario were estimated to be ~70% and 99% of the 100 mrem/yr chronic exposure performance objective for the average and 95% UCL inventories, respectively. However, doses resulting from chronic exposure in the suburban garden scenario were ~993% and 1,422% of the 100 mrem/yr chronic exposure performance objective for the average and 95% UCL inventories, respectively (see Table 5-6). Doses resulting from the commercial farm were well below (e.g., 0.05% and 0.1%) the 100 mrem/yr chronic exposure performance objective for the average and 95% UCL inventories, respectively (see Table 5-6).

By 500 years after closure (see Tables 5-6 and 5-7), the estimated doses for the well driller scenario for the average and 95% UCL inventories was ~0.85% and 2.1% of the acute exposure performance objective of 500 mrem, respectively. At 500 years after closure, doses for all inadvertent intruder scenarios used to evaluate the doses from chronic exposure were well below the chronic exposure performance objective of 100 mrem/yr. The highest estimated dose at 500 yrs after closure was for the suburban garden scenario using the 95% UCL inventory, which yielded a dose that was estimated to be ~57% of the 100 mrem/yr performance objective (see Table 5-6).

Table 5-7. Potential Future Impact from Inadvertent Intrusion into Residual Waste for Average and 95% Upper Confidence Level Inventories.

Years After Closure[1]	100	200	300	400	500	600	700	800	900	1,000
Inadvertent Intrusion Acute Dose[2] (mrem) – Well Driller Scenario										
Average Inventory	7.8	4.7	4.4	4.3	4.2	4.2	4.2	4.2	4.2	4.1
95% Upper Confidence Level Inventory	15	11	11	10	10	10	10	10	11	11
Inadvertent Intrusion Chronic Dose[3] (mrem/yr) – Rural Pasture Scenario										
Average Inventory	70	7.0	1.6	1.2	1.1	1.1	1.1	1.1	1.1	1.1
95% Upper Confidence Level Inventory	99	11	3.4	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Inadvertent Intrusion Chronic Dose[3] (mrem/yr) – Suburban Garden Scenario										
Average Inventory	993	107	31	25	24	23	23	23	23	23
95% Upper Confidence Level Inventory	1,422	174	67	58	57	57	57	57	57	57
Inadvertent Intrusion Chronic Dose[3] (mrem/yr) – Commercial Farm Scenario										
Average Inventory	4.8E-02	3.4E-02	3.2E-02	3.2E-02	3.1E-02	3.1E-02	3.0E-02	3.0E-02	3.0E-02	3.0E-02
95% Upper Confidence Level Inventory	9.8E-02	7.9E-02	7.6E-02	7.6E-02	7.5E-02	7.5E-02	7.5E-02	7.4E-02	7.4E-02	7.4E-02

[1] Site closure is assumed to occur on January 1, 2032.

[2] Performance Objective (Acute Exposure) – 500 mrem.

[3] Performance Objective (Chronic Exposure) – 100 mrem/yr.

Table 5-8. Impact Results of Key Analytes for an Inadvertent Intruder.

Inadvertent Intrusion Scenario	Key Radionuclides			
	^{137}Cs	^{90}Sr	^{239}Pu	^{241}Am
Well Driller	Primary contributor to dose up to ~150 yrs after closure	Secondary contributor to dose up to ~120 yrs after closure	Primary contributor to dose after ~150 yrs after closure	Secondary contributor to dose ~160 yrs after closure
Rural Pasture	Secondary contributor to dose up to ~140 yrs after closure	Primary contributor to dose up to ~320 yrs after closure	Secondary contributor to dose between ~140 and ~320 yrs after closure; primary contributor to dose after ~320 yrs post-closure	Secondary contributor to dose after ~360 yrs
Suburban Gardener	Secondary contributor to dose up to ~100 yrs after closure	Primary contributor to dose up to ~300 yrs after closure	Secondary contributor up to ~300 yrs after closure; primary contributor to dose after ~300 yrs post-closure	Secondary contributor to dose after ~530 yrs
Commercial Farm	Contributor before 100 year post-closure analysis	Contributor before 100 year post-closure analysis	Primary contributor to dose after ~100 years post-closure	Secondary contributor to dose after ~150 yrs

5.5 COMPARISON OF TANK RESIDUALS WITH MODEL TOXICS CONTROL ACT SOIL CLEANUP LEVELS

This section provides additional risk management information related to concentrations of constituents remaining in waste residuals within tank C-107 compared against the Model Toxics Control Act (MTCA) (RCW 70.105D, "Hazardous Waste Cleanup — Model Toxics Control Act") WAC 173-340 cleanup standards. In this section, specific comparisons are made between the concentrations of constituents remaining in tank C-107 against the MTCA cleanup standards for soil direct contact unrestricted land use (Method B), industrial land use (Method C), and soil concentrations protective of groundwater using the fixed parameter three-phase partitioning model given in WAC 173-340-747(4).

Per WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," for soil cleanup levels based on human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the pathway, the point of compliance shall be established in the soils throughout the site from the ground surface to 15 ft below the ground surface. Under a closure configuration, waste residuals left in tank C-107 and other SSTs in WMA C would be expected to be below 15 ft below ground surface.

Implicit in the use of the fixed parameter three-phase partitioning model given in WAC 173-340-747 deriving soil cleanup levels for groundwater protection is the assumption that constituents of interest are found in soils and are immediately available to be leached by

infiltrating precipitation. Under a closure configuration, constituents associated with waste residuals left in tank C-107 and other SSTs in WMA C would be contained within a grout-filled tank, a steel tank liner, and an underlying concrete pad below the liner and would not be immediately available for leaching by infiltrating water.

5.5.1 WAC 173-340 Direct Contact and Soil Concentrations Protective of Groundwater

Table 5-9 contains the average and 95% UCL concentrations of detected constituents estimated in residual waste for tank C-107 on a mass basis for comparison against WAC 173-340 cleanup levels for soil direct contact unrestricted land use (Method B), industrial land use (Method C), and soil concentration protective of groundwater. Table 5-9 also provides Hanford Site-specific 90th percentile background concentrations, and identifies analytes that are dangerous waste constituents per WAC 173-303-9905, "Dangerous Waste Constituents List." A more detailed list of background concentrations and references is provided in Table D-11 of Appendix D.

Ratios of the average and 95% UCL concentrations to cleanup levels for soil direct contact (Method B and Method C) and soil concentrations protective of groundwater are provided in Tables 5-10 and 5-11, respectively. The ratios are obtained by dividing the analyte concentration by the soil direct contact cleanup level or the soil concentration protective of groundwater. The level of exceedance (ratio) corresponds to the level of residual waste concentration remaining in tank C-107 above or below the cleanup level. A level of exceedance greater than 1 corresponds to a residual waste concentration greater than the cleanup level. Tables 5-10 and 5-11 also identify analytes that are dangerous waste constituents per WAC 173-303-9905 and analytes with concentrations that exceed 90th percentile background concentrations. Expanded lists of non-radioactive analytes that were not detected are provided in Tables D-10 and D-11 in Appendix D.

The results for waste residual concentrations estimated for the average residual waste inventory from detected analytes are briefly summarized below.

- For direct contact under an unrestricted land use scenario, only aluminum, arsenic, silver, and uranium are above the cleanup levels. Arsenic had a concentration more than 9 times the soil cleanup level. Arsenic is listed as a dangerous constituent per WAC 173-303-9905.

- For direct contact under an industrial land use scenario, all constituents are reported at concentrations less than the soil cleanup level.

- For soil concentrations protective of groundwater, arsenic, cadmium, cyanide, iron, mercury, nitrate, nitrite, silver, and uranium are all above the concentration predicted by the MTCA fixed parameter three-phase model. The estimated average arsenic concentration was 182 times above the concentration protective of groundwater. Arsenic, cadmium, cyanide, mercury, and silver are listed as dangerous constituents per WAC 173-303-9905.

Table 5-9. Average and 95% Upper Limit Concentrations of Selected Constituents Estimated for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Lognormal 90 Percentile Background Value (mg/kg)[d,e,f]	Above Detection Limits
1, 2, 4-Trichlorobenzene*	1.95E-03	2.40E-03	3.45E+01	4.53E+03	5.63E-02	--	Yes
Aluminum	2.71E+05	2.89E+05	8.00E+04	3.50E+06	4.80E+05	1.10E-03	Yes
Arsenic*	6.19E+00	7.66E+00	6.67E-01	8.75E+01	3.41E-02	3.30E-05	Yes
Barium*	4.09E+00	5.55E+00	--	--	--	--	Yes
Benzene*	1.59E-03	2.08E-03	1.82E+01	2.39E+03	4.48E-03	--	Yes
Bismuth	3.39E+03	4.81E+03	--	--	--	--	Yes
Boron	1.59E+01	3.12E+01	1.60E+04	7.00E+05	2.05E+02	3.80E-06	Yes
Butylbenzylphthalate*	5.30E-01	1.00E+00	5.26E+02	6.91E+04	1.29E+01	--	Yes
Cadmium*	3.74E+00	4.43E+00	8.00E+01	3.50E+03	6.90E-01	2.50E-05	Yes
Calcium	3.54E+02	4.51E+02	--	--	--	1.70E-02	Yes
Chromium, Total*	1.01E+02	1.34E+02	1.20E+05	5.25E+06	2.00E+03	1.72E+04	Yes
Cobalt	1.28E+00	1.62E+00	2.40E+01	1.05E+03	4.34E+00	1.80E-04	Yes
Copper	1.07E+02	1.18E+02	3.20E+03	1.40E+05	2.84E+02	1.30E-03	Yes
Cyanide*	6.02E+00	7.73E+00	4.80E+01	2.10E+03	9.70E-01	--	Yes
Dichloromethane (methylene chloride)*	1.29E-02	1.37E-02	4.80E+02	2.10E+04	2.18E-02	--	Yes
Fluoride	1.00E+03	1.30E+03	4.80E+03	2.10E+05	2.88E+03	7.06E+03	Yes
Hydroxide OH	3.86E+01	7.71E+01	--	--	--	--	Yes
Iron	9.48E+03	1.31E+04	5.60E+04	2.45E+06	5.64E+03	1.80E-04	Yes
Lanthanum	4.88E+00	6.45E+00	--	--	--	--	Yes
Lead*	8.27E+02	9.54E+02	--	1.00E+03	3.00E+03	1.10E-03	Yes

Table 5-9. Average and 95% Upper Limit Concentrations of Selected Constituents Estimated for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Lognormal 90 Percentile Background Value (mg/kg)[d,e,f]	Above Detection Limits
Lithium	2.43E+00	2.59E+00	1.60E+02	7.00E+03	1.92E+02	1.10E-03	Yes
Magnesium	1.42E+02	1.69E+02	--	--	--	1.10E-04	Yes
Manganese	1.56E+02	2.41E+02	1.12E+04	4.90E+05	5.01E+02	1.18E+04	Yes
Mercury*	1.93E+01	2.37E+01	2.40E+01	1.05E+03	2.09E+00	1.30E-01	Yes
Molybdenum	5.91E+00	9.78E+00	4.00E+02	1.75E+04	3.23E+01	6.47E+00	Yes
Neodymium	2.53E+01	3.11E+01	--	--	--	--	Yes
Nickel*	4.95E+00	6.19E+00	--	--	--	--	Yes
Nitrate	1.02E+03	1.43E+03	5.68E+05	2.49E+07	1.80E+02	5.12E+02	Yes
Nitrite	6.90E+02	9.54E+02	2.40E+04	1.05E+06	1.32E+01	--	Yes
Oxalate	5.60E+01	6.34E+01	--	--	--	--	Yes
Phosphate	1.53E+04	2.55E+04	--	--	--	1.30E-02	Yes
Potassium	2.86E+01	3.71E+01	--	--	--	1.51E+00	Yes
Ruthenium	2.02E+01	3.61E+01	--	--	--	--	Yes
Samarium	2.39E+01	2.87E+01	--	--	--	--	Yes
Silicon	4.37E+03	5.71E+03	--	--	--	--	Yes
Silver*	9.15E+02	1.30E+03	4.00E+02	1.75E+04	1.36E+01	5.63E-01	Yes
Sodium	2.21E+04	3.10E+04	--	--	--	1.72E+04	Yes
Strontium	7.15E+01	9.45E+01	4.80E+04	2.10E+06	6.76E+03	--	Yes
Sulfate	3.81E+02	4.58E+02	--	--	1.00E+03	4.70E-01	Yes
Tellurium	9.14E+00	1.03E+01	--	--	--	--	Yes
Thorium	1.09E+01	1.55E+01	--	--	--	--	Yes

Table 5-9. Average and 95% Upper Limit Concentrations of Selected Constituents Estimated for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Lognormal 90 Percentile Background Value (mg/kg)[d,e,f]	Above Detection Limits
Tin	1.79E+01	2.72E+01	4.80E+04	2.10E+06	4.80E+04	--	Yes
Titanium	2.74E+01	2.92E+01	--	--	--	--	Yes
Toluene*	4.39E-03	5.04E-03	6.40E+03	2.80E+05	4.65E+00	--	Yes
Tungsten	1.90E+01	2.22E+01	--	--	--	--	Yes
Uranium	6.56E+03	8.45E+03	2.40E+02	1.05E+04	2.70E+02	1.57E+01	Yes
Vanadium	7.33E+00	8.64E+00	4.00E+02	1.75E+04	1.60E+03	2.20E+01	Yes
Yttrium	6.22E+00	9.45E+00	--	--	--	--	Yes
Zinc	1.81E+02	1.98E+02	2.40E+04	1.05E+06	5.97E+03	3.26E+04	Yes
Zirconium	1.19E+02	1.80E+02	--	--	--	--	Yes
1, 2, 4-Trichlorobenzene*	1.95E-03	2.40E-03	3.45E+01	4.53E+03	5.63E-02	--	Yes

[a] Mean Concentrations taken from Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] 95% Upper Confidence Level Concentration = Mean Concentration + (1.96 × Mean Concentration × Relative Standard Deviation). Mean Concentrations and Relative Standard Deviation provided in Table A-1 in Appendix A of RPP-RPT-58514.

[c] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

[d] DOE/RL-92-24, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, Rev. 4, Volume 1.

[e] DOE/RL-96-12, Hanford Site Background: Part 2, Soil Background for Radionuclides.

[f] ECF-HANFORD-11-0038, "Soil Background for Interim Use at the Hanford Site."

* Dangerous waste constituent per WAC 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III), insoluble salts.

-- = Value is not available

Table 5-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Average Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
1, 2, 4-Trichlorobenzene*	1.95E-03	5.66E-05	4.31E-07	3.47E-02	Yes	--
Aluminum	2.71E+05	3.39E+00	7.74E-02	5.65E-01	Yes	Yes
Arsenic*	6.19E+00	9.29E+00	7.07E-02	1.82E+02	Yes	Yes
Barium*	4.09E+00	--	--	--	Yes	--
Benzene*	1.59E-03	8.75E-05	6.66E-07	3.55E-01	Yes	--
Bismuth	3.39E+03	--	--	--	Yes	--
Boron	1.59E+01	9.94E-04	2.27E-05	7.76E-02	Yes	Yes
Butylbenzylphthalate*	5.30E-01	1.01E-03	7.67E-06	4.11E-02	Yes	--
Cadmium*	3.74E+00	4.68E-02	1.07E-03	5.42E+00	Yes	Yes
Calcium	3.54E+02	--	--	--	Yes	Yes
Chromium, Total*	1.01E+02	8.42E-04	1.92E-05	5.05E-02	Yes	No
Cobalt	1.28E+00	5.33E-02	1.22E-03	2.95E-01	Yes	Yes
Copper	1.07E+02	3.34E-02	7.64E-04	3.77E-01	Yes	Yes
Cyanide*	6.02E+00	1.25E-01	2.87E-03	6.21E+00	Yes	--
Dichloromethane (methylene chloride)*	1.29E-02	2.69E-05	6.14E-07	5.92E-01	Yes	--
Fluoride	1.00E+03	2.08E-01	4.76E-03	3.47E-01	Yes	No
Hydroxide OH	3.86E+01	--	--	--	Yes	--
Iron	9.48E+03	1.69E-01	3.87E-03	1.68E+00	Yes	Yes
Lanthanum	4.88E+00	--	--	--	Yes	--
Lead*	8.27E+02	--	8.27E-01	2.76E-01	Yes	Yes

Table 5-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Average Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
Lithium	2.43E+00	1.52E-02	3.47E-04	1.26E-02	Yes	Yes
Magnesium	1.42E+02	--	--	--	Yes	Yes
Manganese	1.56E+02	1.39E-02	3.18E-04	3.12E-01	Yes	No
Mercury*	1.93E+01	8.04E-01	1.84E-02	9.24E+00	Yes	Yes
Molybdenum	5.91E+00	1.48E-02	3.38E-04	1.83E-01	Yes	Yes
Neodymium	2.53E+01	--	--	--	Yes	--
Nickel*	4.95E+00	--	--	--	Yes	--
Nitrate	1.02E+03	1.80E-03	4.10E-05	5.67E+00	Yes	Yes
Nitrite	6.90E+02	2.88E-02	6.57E-04	5.23E+01	Yes	--
Oxalate	5.60E+01	--	--	--	Yes	--
Phosphate	1.53E+04	--	--	--	Yes	Yes
Potassium	2.86E+01	--	--	--	Yes	Yes
Ruthenium	2.02E+01	--	--	--	Yes	--
Samarium	2.39E+01	--	--	--	Yes	--
Silicon	4.37E+03	--	--	--	Yes	--
Silver*	9.15E+02	2.29E+00	5.23E-02	6.73E+01	Yes	Yes
Sodium	2.21E+04	--	--	--	Yes	Yes
Strontium	7.15E+01	1.49E-03	3.40E-05	1.06E-02	Yes	--
Sulfate	3.81E+02	--	--	3.81E-01	Yes	Yes
Tellurium	9.14E+00	--	--	--	Yes	--

Table 5-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Average Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
Thorium	1.09E+01	--	--	--	Yes	--
Tin	1.79E+01	3.73E-04	8.52E-06	3.73E-04	Yes	--
Titanium	2.74E+01	--	--	--	Yes	--
Toluene*	4.39E-03	6.86E-07	1.57E-08	9.43E-04	Yes	--
Tungsten	1.90E+01	--	--	--	Yes	--
Uranium	6.56E+03	2.73E+01	6.25E-01	2.43E+01	Yes	Yes
Vanadium	7.33E+00	1.83E-02	4.19E-04	4.58E-03	Yes	No
Yttrium	6.22E+00	--	--	--	Yes	--
Zinc	1.81E+02	7.54E-03	1.72E-04	3.03E-02	Yes	No
Zirconium	1.19E+02	--	--	--	Yes	--

[a] Mean Concentrations taken from Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

* Dangerous waste constituent per WAC 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium (III), insoluble salts.

-- = Value is not available

Table 5-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
1, 2, 4-Trichlorobenzene*	2.40E-03	6.95E-05	5.30E-07	4.26E-02	Yes	--
Aluminum	2.89E+05	3.61E+00	8.26E-02	6.02E-01	Yes	Yes
Arsenic*	7.66E+00	1.15E+01	8.75E-02	2.25E+02	Yes	Yes
Barium*	5.55E+00	--	--	--	Yes	--
Benzene*	2.08E-03	1.14E-04	8.71E-07	4.64E-01	Yes	--
Bismuth	4.81E+03	--	--	--	Yes	--
Boron	3.12E+01	1.95E-03	4.46E-05	1.53E-01	Yes	Yes
Butylbenzylphthalate*	1.00E+00	1.91E-03	1.45E-05	7.78E-02	Yes	--
Cadmium*	4.43E+00	5.54E-02	1.27E-03	6.43E+00	Yes	Yes
Calcium	4.51E+02	--	--	--	Yes	Yes
Chromium, Total*	1.34E+02	1.12E-03	2.55E-05	6.69E-02	Yes	No
Cobalt	1.62E+00	6.74E-02	1.54E-03	3.73E-01	Yes	Yes
Copper	1.18E+02	3.69E-02	8.44E-04	4.16E-01	Yes	Yes
Cyanide*	7.73E+00	1.61E-01	3.68E-03	7.97E+00	Yes	--
Dichloromethane (methylene chloride)*	1.37E-02	2.86E-05	6.54E-07	6.31E-01	Yes	--
Fluoride	1.30E+03	2.70E-01	6.17E-03	4.49E-01	Yes	No
Hydroxide OH	7.71E+01	--	--	--	Yes	--
Iron	1.31E+04	2.33E-01	5.33E-03	2.31E+00	Yes	Yes
Lanthanum	6.45E+00	--	--	--	Yes	--

Table 5-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
Lead*	9.54E+02	--	9.54E-01	3.18E-01	Yes	Yes
Lithium	2.59E+00	1.62E-02	3.71E-04	1.35E-02	Yes	Yes
Magnesium	1.69E+02	--	--	--	Yes	Yes
Manganese	2.41E+02	2.15E-02	4.92E-04	4.81E-01	Yes	No
Mercury*	2.37E+01	9.85E-01	2.25E-02	1.13E+01	Yes	Yes
Molybdenum	9.78E+00	2.44E-02	5.59E-04	3.03E-01	Yes	Yes
Neodymium	3.11E+01	--	--	--	Yes	--
Nickel*	6.19E+00	--	--	--	Yes	--
Nitrate	1.43E+03	2.52E-03	5.75E-05	7.94E+00	Yes	Yes
Nitrite	9.54E+02	3.97E-02	9.08E-04	7.23E+01	Yes	--
Oxalate	6.34E+01	--	--	--	Yes	--
Phosphate	2.55E+04	--	--	--	Yes	Yes
Potassium	3.71E+01	--	--	--	Yes	Yes
Ruthenium	3.61E+01	--	--	--	Yes	--
Samarium	2.87E+01	--	--	--	Yes	--
Silicon	5.71E+03	--	--	--	Yes	--
Silver*	1.30E+03	3.25E+00	7.43E-02	9.56E+01	Yes	Yes
Sodium	3.10E+04	--	--	--	Yes	Yes
Strontium	9.45E+01	1.97E-03	4.50E-05	1.40E-02	Yes	--

Table 5-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Constituents above Detection in 241-C-107 Tank Residual Wastes. (3 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Residual Wastes to Soil Cleanup Standards				
		Soil Direct Contact (Method B)	Soil Direct Contact (Method C)	Soil Concentrations Protective of Groundwater	Above Detection Limits	Above 90 Percentile Background
Sulfate	4.58E+02	--	--	4.58E-01	Yes	Yes
Tellurium	1.03E+01	--	--	--	Yes	--
Thorium	1.55E+01	--	--	--	Yes	--
Tin	2.72E+01	5.67E-04	1.30E-05	5.67E-04	Yes	--
Titanium	2.92E+01	--	--	--	Yes	--
Toluene*	5.04E-03	7.88E-07	1.80E-08	1.08E-03	Yes	--
Tungsten	2.22E+01	--	--	--	Yes	--
Uranium	8.45E+03	3.52E+01	8.05E-01	3.13E+01	Yes	Yes
Vanadium	8.64E+00	2.16E-02	4.94E-04	5.40E-03	Yes	No
Yttrium	9.45E+00	--	--	--	Yes	--
Zinc	1.98E+02	8.27E-03	1.89E-04	3.32E-02	Yes	No
Zirconium	1.80E+02	--	--	--	Yes	--

[a] 95% Upper Confidence Level Concentration = Mean Concentration + (1.96 × Mean Concentration × Relative Standard Deviation). Mean Concentrations and Relative Standard Deviation provided in Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

* Dangerous waste constituent per WAC 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III), insoluble salts.

-- = Value is not available

The results for waste residual concentrations estimated in the 95% UCL residual waste inventory are briefly summarized below.

- For direct contact under an unrestricted land use scenario, aluminum, arsenic, silver, and uranium are above the cleanup levels, with arsenic having a concentration more than 10 times the cleanup level. Arsenic is listed as a dangerous constituent per WAC 173-303-9905.

- For direct contact under an industrial land use scenario, all constituents are reported at concentrations less than the soil cleanup level.

- For soil concentrations protective of groundwater, arsenic, cadmium, cyanide, iron, mercury, nitrate, nitrite, silver, and uranium are all above the concentration predicted by the MTCA fixed parameter three-phase model, with arsenic being greater than 200 times above the concentration protective of groundwater. Arsenic, cadmium, cyanide, mercury, and silver are listed as dangerous constituents per WAC 173-303-9905.

5.5.2 WAC 173-340 Ecological Risk

WAC 173-340-900, "Tables" includes the following tables:

- Table 749-2, Priority Contaminants of Ecological Concern for Sites that Qualify for the Simplified Terrestrial Ecological Evaluation Procedure

- Table 749-3, Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals.

Each of these tables contains a footnote stating that it is not intended for the purpose of evaluating sludges or waste, as follows (key statement bolded for this report).

- Table 749-2, footnote a: "Caution on misusing these chemical concentration numbers. These values have been developed for use at sites where a site-specific terrestrial ecological evaluation is not required. They are not intended to be protective of terrestrial ecological receptors at every site. Exceedances of the values in this table do not necessarily trigger requirements for cleanup action under this chapter. **The table is not intended for purposes such as evaluating sludges or wastes.**
  This list does not imply that sampling must be conducted for each of these chemicals at every site. Sampling should be conducted for those chemicals that might be present based on available information, such as current and past uses of chemicals at the site."

- Table 749-3, footnote a: "Caution on misusing ecological indicator concentrations. Exceedances of the values in this table do not necessarily trigger requirements for cleanup action under this chapter. Natural background concentrations may be substituted for ecological indicator concentrations provided in this table. **The table is not intended for purposes such as evaluating sludges or wastes.**
  This list does not imply that sampling must be conducted for each of these chemicals at

every site. Sampling should be conducted for those chemicals that might be present based on available information, such as current and past uses of chemicals at the site."

Because of the limitations stated above, comparisons between the concentrations of waste constituents remaining in tank C-107 have not been made against Table 749-2 [under WAC 173-340-7492, "Simplified Terrestrial Ecological Evaluation Procedures," subsection (1) "Purpose"] or Table 749-3 [under WAC 173-340-7493, "Site-Specific Terrestrial Ecological Evaluation Procedures," subsection (2) "Problem formulation step," (i) "The chemicals of ecological concern"].

5.6 RISK ASSESSMENT SUMMARY

Cumulative analysis results of the risk assessment performed to examine impacts from post-retrieval inventories for SST C-107 are summarized as follows.

- The impacts estimated for residual waste left in SST C-107, using either the average or the 95% UCL inventory, are orders of magnitude below the various performance objectives identified for the groundwater pathway.
- Total ILCRs estimated for all radionuclides are one to two orders of magnitude below the upper end of the performance objective range 1.0E-06 to 1.0E-04 ILCR.
- Total ILCRs estimated for all detectable non-radionuclides are six to seven orders of magnitude below the performance objective of 1.0E-05 ILCR.
- Total hazard indices estimated for all detectable analytes are three to four orders of magnitude below the performance objective of 1.0.
- Estimated doses for all detectable radionuclides are between:
    - Four to five orders of magnitude below the performance objective for the all-pathways dose of 25 mrem/yr
    - Three to four orders of magnitude below the performance objective for drinking water dose of 4 mrem/yr.

Following are conclusions about the impacts from key analytes identified in the residual wastes within SST C-107 for each of the performance metrics evaluated.

- **Total ILCR for Radionuclides:** For both the average and 95% UCL inventory, ^{99}Tc and ^{14}C are the primary contributors to the total ILCR for all radionuclides with the industrial land use and residential land use scenarios. The contribution from all other detectable radionuclides, including ^{129}I and the uranium isotopes, was not detectable in residual waste samples, arrived at the WMA C fenceline within the 10,000-year period of interest

below concentrations of 1.0E-03 pCi/L, or did not arrive at the WMA C fenceline within the 10,000-year period of interest.

- **Total ILCR for Nonradionuclides:** For both the average and 95% UCL inventory, the contribution from non-radioactive analytes detectable in residual waste samples arrived at the WMA C fenceline within the 10,000-year period of interest below concentrations of 1.0E-03 µg/L, or did not arrive at the WMA C fenceline within the 10,000-year period of interest.

- **Hazard Indices:** For both the average and 95% UCL inventory, fluoride, nitrate, and nitrite are the primary contributors to the hazard indices. The contribution from non-radioactive analytes detectable in residual waste samples arrived at the WMA C fenceline within the 10,000-year period of interest below concentrations of 1.0E-03 mg/L, did not arrive at the WMA C fenceline within the 10,000-year period of interest, or did not have available toxicological information.

- **All-Pathways Dose:** ^{99}Tc, with a maximum dose rate of 1.0E-04 mrem/yr, and ^{14}C with a maximum dose of 6.2E-04 mrem/yr contributed the majority of the radiological dose for the all pathways farmer scenario (25 mrem/yr). The contribution from all other radionuclides, including ^{129}I and the uranium isotopes, was not detectable in residual waste samples, arrived at the WMA C fenceline below concentrations of 1.0E-03 pCi/L, or did not arrive at the WMA C fenceline within the 10,000-year period of interest.

- **Drinking Water Dose (Target Organ):** ^{99}Tc, with a maximum dose rate of 7.9E-04 mrem/yr, contributed the majority of the radiological dose for beta/photon emitters (4 mrem/yr target organ dose). The contribution to dose from all other radionuclides, including ^{14}C, ^{129}I, and the uranium isotopes, was not detectable in residual waste samples, arrived at the WMA C fenceline below concentrations of 1.0E-03 pCi/L, or did not arrive at the WMA C fenceline within the 10,000-year period of interest.

- **Intruder Dose:** Doses calculated from inadvertent intrusion are primarily attributable to doses from ^{90}Sr, ^{137}Cs, ^{239}Pu, and ^{241}Am. The relative contribution and timing of doses from these radionuclides to the total doses estimated during the 1,000-year period of analysis depends on the scenario considered. In general, dose contributions from ^{90}Sr and ^{137}Cs typically account for the majority of the dose during the first 100 to 350 years. Doses from ^{239}Pu and ^{241}Am contribute the majority of the dose realized after 150 to 350 years. For both average and 95% UCL inventories estimated for SST C-107, none of the inadvertent intruder evaluations produce results that exceed the performance objectives for either acute exposure or chronic exposure after ~200 years following closure.

As additional risk management information, concentrations of constituents remaining in waste residuals within tank C-107 are compared against the MTCA cleanup standards. For MTCA Method B and Method C soil cleanup levels based on human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the pathway, the point of compliance shall be established in the soils throughout the site from the ground surface to

15 ft below the ground surface. Under a closure configuration, waste residuals left in tank C-107 and other SSTs in WMA C would be expected to be below 15 ft below ground surface.

For MTCA soil cleanup levels protective of groundwater, the assumption is that constituents of interest are found in soils and are immediately available to be leached by infiltrating precipitation. Under a closure configuration, constituents associated with waste residuals left in tank C-107 and other SSTs in WMA C would be contained within a grout-filled tank, a steel tank liner, and an underlying concrete pad below the liner and would not be immediately available for leaching by infiltrating water.

Following are conclusions about the comparison of tank C-107 water residual concentrations against MTCA cleanup levels.

- **MTCA Method B Unrestricted Land Use:** For both the average and 95% UCL inventory, aluminum, arsenic, silver, and uranium are above the cleanup levels. Arsenic is listed as a dangerous constituent per WAC 173-303-9905.

- **MTCA Method C Industrial Land Use:** For both the average and 95% UCL inventory, all constituents are reported at concentrations less than the soil cleanup level.

- **MTCA Soil Concentrations Protective of Groundwater:** For both the average and 95% UCL inventory, arsenic, cadmium, cyanide, fluoride, iron, mercury, nitrate, nitrite, silver, and uranium are greater than the soil cleanup level. For the 95% UCL, mercury and silver are also above the soil cleanup level. Arsenic, cadmium, cyanide, mercury, and silver are listed as dangerous constituents per WAC 173-303-9905.

Table 5-12 provides a comparison of the inventory used in DOE/ORP-2005-01 against the inventory for detected analytes calculated using post-retrieval samples for the average inventory and the 95% UCL inventories. For the purpose of this comparison, Table 5-12 includes inventories calculated from the laboratory's minimum detection limit for an analyte. Inventories calculated from one half of the laboratory's minimum detection limit are included in the risk assessment analysis. The following observations are made from the comparison of the Hanford Tank Waste Operations Simulator (HTWOS) and post-retrieval inventories.

- Comparison of the HTWOS estimated inventories and post-retrieval inventories for analytes important for assessment of groundwater impacts are as follows:

    - Post-retrieval inventories for ^{99}Tc are ~2 times less than the HTWOS estimate for ^{99}Tc

    - Post-retrieval inventories for chromium are ~1.1 to 1.5 times greater than the HTWOS estimate for chromium

    - Post-retrieval inventories for nitrate are ~3 to 5 times less than the HTWOS estimates for nitrate

- Post-retrieval inventories for nitrite are ~2 to 3 times less than the HTWOS estimates for nitrite
- Post-retrieval inventories for fluoride are ~3 to 4 times greater than the HTWOS estimate for fluoride.

- Comparison of the HTWOS estimated inventories and post-retrieval inventories for analytes important to assessing inadvertent intruder impacts are as follows:
  - Post-retrieval inventories for ^{90}Sr are ~1.1 and 1.6 times less than HTWOS estimates for ^{90}Sr
  - Post-retrieval inventories for ^{137}Cs are 1.4 times (nominal inventory) less than and similar to (95% UCL inventory) the HTWOS inventory estimates for ^{137}Cs
  - Post-retrieval inventories for ^{232}Th are ~4 to 7 times less than the HTWOS estimates for ^{232}Th
  - Post-retrieval inventories for the plutonium isotopes are 1.2 less than and 1.2 times greater than those in the HTWOS estimate
  - Post-retrieval inventories for ^{241}Am are ~3 to 4 times less than those in the HTWOS estimate
  - Post-retrieval inventories for the uranium isotopes range from 2 times greater than to one order of magnitude greater than estimated in the HTWOS inventory.

Table 5-12. Comparison of Hanford Tank Waste Operations Simulator Predicted Inventory Used in DOE/ORP-2005-01 with the Average and 95% Upper Confidence Level Post-Retrieval Inventories.

	Analyte	Units	DOE/ORP-2005-01[a] (HTWOS Predicted)	Average Post-Retrieval Inventory[b]	95% UCL Inventory[b]	Detected in Residual Wastes	Ratio Average/ HTWOS	Ratio Bounding/ HTWOS
Analytes Important for Groundwater Impacts	^{14}C	Ci	3.46E-03	2.79E-02	8.37E-02	No	N/A	N/A
	^{99}Tc	Ci	2.13E-01	8.83E-02	1.15E-01	Yes	4.15E-01	5.40E-01
	Chromium, Total	Kg	6.25E+00	6.65E+00	9.08E+00	Yes	1.06E+00	1.45E+00
	Fluoride	Kg	2.44E+01	6.60E+01	8.86E+01	Yes	2.70E+00	3.63E+00
	Nitrate	Kg	3.34E+02	6.74E+01	9.69E+01	Yes	2.02E-01	2.90E-01
	Nitrite	Kg	1.34E+02	4.55E+01	6.46E+01	Yes	3.40E-01	4.82E-01
Analytes Important for Inadvertent Intruder	^{90}Sr	Ci	1.77E+04	1.12E+04	1.58E+04	Yes	6.35E-01	8.95E-01
	^{137}Cs	Ci	3.98E+02	2.86E+02	4.00E+02	Yes	7.18E-01	1.00E+00
	^{232}Th	Ci	5.34E-04	7.87E-05	1.33E-04	Yes	1.47E-01	2.49E-01
	^{233}U	Ci	3.48E-02	6.37E-02	1.91E-01	No	N/A	N/A
	^{234}U	Ci	2.30E-02	2.51E-01	3.12E-01	Yes	1.09E+01	1.36E+01
	^{235}U	Ci	9.91E-04	6.08E-03	8.40E-03	Yes	6.14E+00	8.48E+00
	^{236}U	Ci	3.76E-04	3.96E-03	5.92E-03	Yes	1.05E+01	1.57E+01
	^{238}U	Ci	2.27E-02	1.44E-01	1.92E-01	Yes	6.34E+00	8.46E+00
	^{237}Np	Ci	3.89E-04	2.40E-02	3.63E-02	Yes	6.16E+01	9.32E+01
	^{238}Pu	Ci	3.74E-01	1.92E+00	2.66E+00	Yes	5.13E+00	7.11E+00
	^{239}Pu	Ci	1.85E+01	1.60E+01	2.18E+01	Yes	8.67E-01	1.18E+00
	^{240}Pu	Ci	3.00E+00	1.74E+00	2.37E+00	Yes	5.81E-01	7.91E-01
	^{241}Pu	Ci	1.51E+01	1.76E+01	2.50E+01	Yes	1.17E+00	1.66E+00
	^{241}Am	Ci	5.68E+01	1.33E+01	1.86E+01	Yes	2.34E-01	3.27E-01
	^{242}Cm	Ci	2.22E-02	7.10E-02	1.24E-01	Yes	3.21E+00	5.60E+00
	^{243}Cm	Ci	1.31E-03	9.95E-02	1.60E-01	Yes	7.59E+01	1.22E+02
	^{244}Cm	Ci	3.05E-02	2.11E+00	3.40E+00	Yes	6.91E+01	1.11E+02

[a] Inventories for contaminants having the greatest impact for groundwater or inadvertent intruder pathway.

[b] Includes inventories in sludge calculated from one half of the laboratory's minimum detection limit for an analyte.

Reference: DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site.

HTWOS = Hanford Tank Waste Operations Simulator

N/A = Not applicable

UCL = upper confidence level

6.0 OPPORTUNITIES AND ACTIONS BEING TAKEN TO REFINE OR DEVELOP TANK WASTE RETRIEVAL TECHNOLOGIES, BASED ON LESSONS LEARNED

This section discusses aspects of the tank C-107 waste retrieval operations, provides recommendations for further actions, and addresses opportunities to refine waste retrieval technologies based on lessons learned from the tank C-107 retrieval operation. The format of this section is to provide brief discussions of the major Lessons-Learned topic areas; some of those areas are taken from other tank waste retrieval activities.

There are opportunities to improve future waste retrieval operations by looking at the ways to modify equipment, make operational changes (e.g., operating sequencing and conditions), plan work, and enhance the design and fabrication of equipment. All RDRs have a Lessons Learned section and it must be recognized that several of the previously identified lessons learned have been incorporated in the formulation and operation of subsequent tank waste retrieval operations, and in the tank C-107 retrieval operation.

Improvements implemented during the retrieval of tank C-107 are as follows.

- The MARS arm software was changed to allow for a greater angle washing action of the wastes on the walls and stiffener rings. Previous interlocks had inhibited operation with the arm higher than about 8° below the horizontal plane.

- Uniformity in the pump design and procurement aided more rapid deployment following the loss of the tank AN-106 electric supernate pump and its spare. The supernate pump was replaced with a pump procured for slurry operations and then replaced shortly thereafter following failure in September 2012. The same pump design was employed to replace the slurry pump in tank C-107 upon its failure in July 2013.

- Inadvertent disengagement of remote operation of a flow control valve during maintenance within the Portable Instrument and Valve Box POR240, and failure of the remote operation of another flow control valve (fan nozzle supply) within POR240 demonstrated that the control assembly of the flow control valves should be established outside of the shielded valve boxes. This design improvement has been applied in the MARS Vacuum process.

- Removal of the chemical precipitation agglomeration was demonstrated by the third technology retrieval activities. Hot water rinses and hot water recirculating flushes were employed to remobilize waste solids agglomerated by precipitation of saturated natrophosphate that was in the tank AN-106 supernate. The water rinses and flushes were further used to dilute the tank AN-106 supernate in order to inhibit further natrophosphate precipitation.

- Final tank waste water rinses were configured, through procedural and MARS arm use, to conduct continuous dilution rinsing of residual waste rather than batched dilution. This configuration reduced the expected rinsing operating time from three days to one shift and waste generation and transfer to tank AN-106 from ~78,000 gal to 14,000 gal. These

work and waste generation reduction techniques will be applied, as available, in future retrievals.

6.1 MOBILE ARM RETRIEVAL SYSTEM POTENTIAL ENHANCEMENTS

Dropping the full length of umbilical to the floor as required by the current winch design resulted in the cord forming dams, impacting slurry drainage and flow of solids to the pump; more drag on the cord may also have led to earlier wear of the cord and hydraulic leaks at the connection with the Mobile Retrieval Tool (MRT). Therefore, more MRT movement and maneuvering was required to get around the cord and push the waste toward the pump. A modification to the winch design is needed to optimize the length of the MRT umbilical cord placed on the tank floor.

The cause(s) of the hydraulic leak near the MRT during right track reverse movement and later during left track movement needs to be evaluated, and changes implemented as needed, to minimize or prevent hydraulic leaks from the MRT.

The MRT umbilical cord was bent at the Cold Test Facility and needed to be straightened before installation. Care should be taken to avoid excessive bends/looping in the umbilical cord prior to installation.

Mechanical problems with the control pressure on the high-pressure water skid (e.g., Pulsation dampener and failed pressure switch) could possibly have been identified and fixed sooner. The design may be more complicated than needed and a better way to control the pressure should be identified.

The following additional MRT design changes were identified:

- A heavy duty pig-tail type of spring and/or angled fittings should be incorporated to protect hydraulic hoses at FoldTrack® Vehicle/Umbilical connection point to reduce hose stress and increase bend radius
- Hydraulic rams for the blade "UP" and "DOWN" functions should be modified to "push" to raise the blade and "pull" to lower the blade
- All parts should be constructed to be compliant with American Standards (e.g., fittings, fasteners, hoses, seals)
- Blade should be modified to be able to lower several degrees beyond horizontal to allow for more effective "back-blading/dragging"
- All bearings should be fully sealed to protect against corrosive liquid
- Incorporation of hydraulic line air bleed valves on the umbilical interface (highest elevation point in lines) would be beneficial.

6.2 SLUICING EQUIPMENT AND OPERATION

At times, the sluicer pushed waste from one side of the tank to the other, but did not always move waste to the pump effectively. Improved directions and changing of sluicers used may have enhanced sluicing effectiveness.

6.3 OTHER POTENTIAL ENHANCEMENTS

Volume balance results need to be more consistent and complete. A Honeywell Enraf® measurement in August 2012 suggested that initial BBI inventory for tank C-107 wastes were larger than actual inventory. The volume balance estimates had to be revised as described in Revision 2 of RPP-CALC-52903 and resulted in a correction of the initial waste estimate of the tank by 32,898 gal, from 252,940 gal to 220,042 gal; this was due to a finding during retrieval operations that an Enraf® measurement of waste solids level suggested a significant difference in waste solids residue relative to material transfer. The key reasons identified were inaccurate low flow meter measurements and neglecting evaporation.

a. Before retrieval starts, need to ensure meters are calibrated for accurate low flow meter measurements and use meters capable of providing accurate low flow.

b. When using hot water, evaporation during retrieval is high and must be considered in volume balance estimates.

The hot water skid was designed for high flow. A better low flow design (e.g., Flow meters) should be considered for future retrievals.

A volumetric displacement for the measurement of tank waste residuals was conducted and found the Enraf® measurement of the elevation of the steel tank floor was in error by 1.67 inches. The correction of this calibration error has been applied back to volumetric corrections (above). The displacement activity is fully described and documented within RPP-CALC-52903, detailing an estimate of wastes upon the tank floor of 8,748 gal of wetted waste solids. RPP-CALC-52903 further assesses waste crusted in a ring on the tank wall as 3,286 gal, and residual rinse waters as 2,020 gal.

A final water rinse of the tank was conducted on August 9, 2014. The objective of the rinse was to remove soluble supernate-based contaminants from the SST. In this operation, the design of the MARS allowed a continuous rinse and dilution rather than batched dilutions. This concept of final waste rinse needs to be applied wherever practicable.

This page intentionally left blank.

7.0 LEAK DETECTION, MONITORING, AND MITIGATION

The LDMM program was implemented to protect the workers, public, and environment from leaks of radioactive liquid waste. The LDMM program included technologies and methods used prior to, during, and after waste retrieval to detect leaks, reduce the potential for a leak to occur, or minimize leak volumes.

The operational history and decades of waste and liquid level monitoring indicate that tank C-107 had not leaked and was sound before starting retrieval (HNF-EP-0182, "Waste Tank Summary Report for Month Ending March 31, 2015," Rev. 327). Additionally, there was no evidence of a leak during retrieval of waste from tank C-107.

The following sections describe the LDMM requirements, leak detection monitoring implementation, mitigative approach, chronology, and results. The major results for the LDMM program during tank C-107 waste retrieval were as follows.

a. Drywell moisture and gamma logging showed no evidence of leaks during the tank C-107 waste retrieval.

b. Modified static level monitoring demonstrated no evidence of leakage during retrieval.

c. Material balance calculations showed no evidence of leaks during the tank C-107 waste retrieval.

d. A high-resolution resistivity (HRR) system was deployed with drywells and the tank thermocouple as electrodes to detect changes in baseline soil moisture levels. The HRR system showed no evidence of a leak during retrieval.

e. Transfer line and access pit leak detection showed no evidence of leaks during the tank C-107 waste retrieval.

Retrieval of tank C-107 was begun and the majority of the waste in the tank was removed under work plan RPP-22393, Revision 5. Work plan RPP-22393, Revision 6 (and any additional revisions to this work plan) was applicable to the remaining tank C-107 waste retrieval operations.

7.1 REQUIREMENTS

Details of the LDMM program are presented in RPP-22393. The leak detection and monitoring (LDM) system requirements are contained in the safety basis controls given in HNF-SD-WM-TSR-006, "Tank Farms Technical Safety Requirements," specifically Technical Safety Requirement (TSR) Limiting Condition for Operation Section 3.1.1, "Transfer Leak Detection Systems." Material balances during transfers are required by the TSR Administrative Control Section 5.11, "Transfer Control," and RPP-12711, "Temporary Waste Transfer Line Management Program Plan." The primary procedures governing notification and reporting of leaks are TFC-OPS-OPER-C-24, "Occurrence Reporting and Processing of Operations

Information," and TFC-ESHQ-ENV_FS-C-01, "Environmental Notification." Table 7-1 presents the tank C-107 LDM functions and requirements.

Table 7-1. Tank 241-C-107 Leak Detection and Monitoring Functions and Requirements.

Function	Requirement	Basis	Key Elements
Detect leaks during waste removal from SST	The leak detection and monitoring (LDM) system shall be capable of detecting liquid waste releases during all waste removal operations.	Washington Administrative Code (WAC) 173-303	Utilize LDM technologies to detect loss of liquid from a tank; see Section 7.2.
Monitor leaks from SST during waste removal	The waste retrieval system (WRS) shall be capable of providing data to support quantifying leak volumes from the tanks in the event a release is detected during waste retrieval operations.	WAC 173-303	Utilize both ex-tank LDM technologies and process data that will allow estimate of leak volume and migration rate to be developed to the extent practical in the event of a leak.
Mitigate leaks during SST waste retrieval	The integrated retrieval and LDM system shall be designed and operated to mitigate leaks as the primary means of minimizing environmental impacts from leaks during waste retrieval if they occur.	WAC 173-303	Leak mitigation strategy described in Section 7.3.
WRS secondary containment and leak detection RP103DT.	For ex-tank equipment and piping, the WRS shall incorporate secondary containment and leak-detection design features in accordance with 40 CFR 265.193 and DOE O 435.1.	40 CFR 265 WAC 173-303 DOE O 435.1 RPP-13033 HNF-SD-WM-TSR-006	Provide for safe and compliant transfer of waste to the receiver double-shell tank.

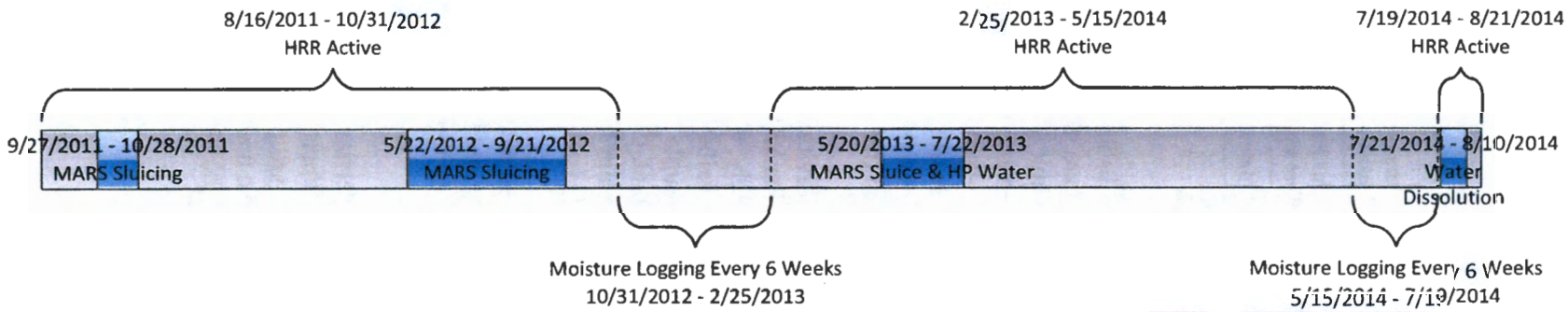
CFR = Code of Federal Regulations DOE = U.S. Department of Energy SST = single-shell tank

References:
40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J—Tank Systems, §265.193 Containment and detection of releases.
DOE O 435.1, Radioactive Waste Management.
HNF-SD-WM-TSR-006, "Tank Farms Technical Safety Requirements."
RPP-13033, "Tank Farms Documented Safety Analysis."
WAC 173-303, "Dangerous Waste Regulations."

7.2 LEAK DETECTION AND TANK MONITORING

During the sluicing retrieval of tank C-107, HRR was used as the primary leak detection method with drywell moisture logging as a backup. Between sluicing and hard heel retrieval, Enraf® level measurements and drywell moisture loggings were used for leak detection. When hard heel retrieval operations started, HRR was again used as the primary leak detection method. Figure 7-1 is a timeline of retrieval operations and the leak detection methods used. Leak detection and monitoring was accomplished by the use of HRR, drywell monitoring, visual inspection, leak detectors, Enraf® gauges in tank AN-106, radiological monitoring, and material balances as shown in Table 7-2 and discussed in Sections 7.2.1 through 7.2.3.

Figure 7-1. Tank 241-C-107 Leak Detection Monitoring Timeline.



HP = high-pressure
HRR = high-resolution resistivity
MARS = Mobile Arm Retrieval System

Table 7-2. Leak Detection and Monitoring Methods for Each Waste Retrieval System Component.

Component	Leak Detection and Monitoring Method
Single-shell tank 241-C-107	Drywells, liquid level indicators, visual inspection, material balance and high-resolution resistivity
Double-shell tank 241-AN-106	Liquid level indicators, annulus leak detectors, radiation monitoring for annulus exhaust air
Ancillary equipment (hose-in-hose transfer line)	Secondary containment, leak detectors, radiation monitoring

7.2.1 Drywell Logging and High-Resolution Resistivity

The basic resistivity measurement concept utilizes the existing drywells and a tank electrode (normally the tank thermocouple) as measurement electrodes. There are reference transmitters and receiver electrodes located a nominal 1,500 ft or more from the tank farm. Power is applied to a drywell-reference transmitter electrode pair and an amperage measurement obtained. Concurrently, a voltage measurement is obtained at another electrode-reference receiver electrode pair. Soil resistivity is calculated by dividing the voltage measured across the receiver electrode pair by the current measured across the transmitter pair. These measurements are repeated and the subsequent resistivity data analyzed for changes with time.

Ideally, drywell-to-tank (WTT) and drywell-to-drywell (WTW) resistivity measurements are available to review and are in agreement. Throughout the retrieval, the WTW measurements were less variable and caused several anomaly evaluations. Fortunately, the more reliable WTT measurements that are less susceptible to interference were usually available to make a leak determination. When the waste level in the tank is low, the thermocouple (tank electrode) may not be in contact with the waste; however, the thermocouple tree in tank C-107 remained in contact with the waste and WTT resistivity measurements were the main focus for leak determinations.

During the first phase of retrieval when sluicing was the main retrieval technology, several anomalous results were evaluated. Table 7-3 identifies the anomalies and provides a description of the anomaly and the resolution during tank C-107 retrieval. None of the anomalous data indicated a leak of the tank.

Subsequent to tank C-107 retrieval, additional drywell logging was performed by a subcontractor [RPP-RPT-58648, "241-C-107 Tank Waste Retrieval Project Final Report of Drywell Monitoring Data (HGLP-MBL-015, Rev. 0)"]. None of the drywells around tank C-107 show evidence of significant changes in either gamma activity or subsurface moisture. Available data from these drywells provide no evidence of any leak or contaminant movement associated with tank retrieval operations.

Table 7-3. High-Resolution Resistivity Anomaly Evaluation During and After Sluicing.

Number	Date	Anomaly Description	Resolution/Comments
2011-06	10/10/11	High WTW readings.	Plots were made and no WTT trends showed a leak pattern. Precipitation and a power outage might have contributed to the noise in the WTW readings. The WTW noise was present before retrieval started and persisted through several years of monitoring. It is suspected that there was a localized ground fault that caused the noise. Stepwise shifts and fluctuations were frequently evident and did not correspond to operational activities.
2012-01	3/10/12	Step change in all HRR data.	A power outage caused a hardware problem. No leak indicated. No active retrieval.
2012-02	6/7/12	Step change in a WTW plot.	Plots were made and no trends showed a leak pattern. The WTT leak potential values and plots did not indicate a leak. The WTW noise was present before retrieval started and persisted through several years of monitoring. It is suspected that there was a localized ground fault that caused the noise. Stepwise shifts and fluctuations were frequently evident and did not correspond to operational activities.
2012-03	7/15/12	High WTT readings.	Lightning activity was in the area and all of the HRR systems on line showed spikes. Plots showed not trend before or after the spike indicative of a leak.
2014-01	8/8/14	Step change in WTW readings.	An investigation was made to try and determine the source of the step changes. As noted in previous anomaly evaluations, step changes and noise were present in the WTW readings throughout C-107 monitoring. These steps changes could not be correlated to retrieval equipment or retrieval operations. The WTT readings were normal and no leaks were indicated.

HRR = high-resolution resistivity WTT = drywell-to-tank WTW = drywell-to-drywell

7.2.2 Single-Shell Tank 241-C-107

7.2.2.1 Liquid Level Monitoring. The overall waste retrieval operating strategy for tank C-107 was to reduce the tank liquid inventory and minimize liquid additions during waste retrieval operations. Liquid levels were monitored to evaluate liquid inventories and indicate potential leaks in the system to implement this strategy.

No active retrieval occurred during the following stagnant periods:

a. September 28, 2011 through May 23, 2012
b. September 21, 2012 through May 20, 2013
c. July 15, 2013 through January 29, 2014
d. March 28, 2014 through July 21, 2014.

During these stagnant periods, liquid levels in tanks C-107 and AN-106 did not decrease, indicating that no leaks occurred.

7.2.2.2 Visual Inspection. Before initiating waste retrieval operations, a visual assessment and documentation of in-tank conditions in tank C-107 were performed using an in-tank video camera. Throughout waste retrieval, the closed-circuit television system was used to identify the waste surface condition, qualitatively assess the amount of liquid in the tank, observe any significant changes, and implement the mitigation strategy of minimizing liquid pools.

Observations of the waste surface in tank C-107 indicated that the surface level decrease corresponded with waste retrieval activities.

7.2.2.3 Material Balance. Process control measurements were used periodically to perform a material balance and determine the change in tank C-107 waste inventory. Once determined, the change in waste inventory was compared to the anticipated change (gallons of slurry produced and/or released per gallon of water added, adjusted for changes in the central pool and interstitial liquid volumes).

During retrieval operations, material balances were performed during transfers by Operations for tank leak detection and mitigation for the portion of the system between the portable valve pit and tank AN-106, inclusive. Radiation surveys were required for the portion of the transfer line where volume material balance could not be performed. The frequency of material balance measurements and radiation surveys met the requirements of HNF-IP-1266, "Tank Farms Operations Administrative Controls." During the May 20 to 21, 2013 volume displacement assessment it was determined that a mass balance discrepancy had occurred that was above the allowable limits (Revision 3 of RPP-CALC-52903). The investigation found that there was no spill but a discrepancy in the tank AN-106 Enraf® readings due to a waste "berg", biasing the reading. The waste berg moved away from the Enraf® location when supernate was pumped to tank C-107, enabling the Enraf® plummet to properly contact the waste surface. The result was that it appeared as though the level change was more than had been pumped through the totalizer.

7.2.3 Double-Shell Tank 241-AN-106

7.2.3.1 Liquid Level Monitoring. The waste level in the DST was monitored using an Enraf®, and annulus leak detector probes were used to provide indication of leaks, as described in Section 4.0 of OSD-T-151-00031, "Operating Specifications for Tank Farm Leak Detection and Single-Shell Tank Intrusion Detection."

Daily liquid level measurements were recorded for the receiving DST. The Enraf® gauge was capable of measuring liquid level changes to a precision of 0.1 inch.

During waste retrieval there was no evidence of a release from tank AN-106 based on results of liquid level monitoring. The tank AN-106 liquid level increase corresponded with the material balance results for tank C-107.

7.2.3.2 Leak Detection. Tank AN-106 was monitored for leaks in the inner shell by a conductivity probe leak detection system installed in the tank annulus during tank construction. Slots cut in the concrete that support the tank at the bottom were designed to drain any leakage to

the annulus floor. Enraf® assemblies in the annulus would have activated an audible alarm and an annunciator panel light in the event of liquid leaking to the annulus so that mitigation could have begun. Throughout the tank C-107 waste retrieval campaign, no leaks were detected by any of the leak detectors in tank AN-106.

7.2.3.3 Radiation Monitoring. A continuous air monitor operated to detect airborne radionuclides entrained in the ventilation exhaust stream of the annulus of tank AN-106. Detection of radiation exceeding a set limit in the annulus of the DST would have activated an audible alarm and an annunciator panel light, initiating mitigative action.

The continuous air monitor for the tank AN-106 annulus detected no radiation levels above background during retrieval that could have been attributed to leak-induced airborne radionuclides.

7.2.4 Ancillary Equipment

Leak detectors were installed in the valve pits to detect the presence of liquid through conductivity, which would have activated alarms and shut down the WRS.

In accordance with RPP-12711, the hose-in-hose transfer line system underwent radiation monitoring and was equipped with leak detectors as part of the leak detection program.

7.3 MITIGATION

Leak mitigation was accomplished through design features and the operational strategy developed for the retrieval system. Mitigation included actions that reduced the chance of a leak and the environmental impact of a leak should one have occurred. Potential leaks were proactively prevented and minimized throughout the waste retrieval operations.

The leak mitigation strategy (i.e., reduction of leak loss potential) was to minimize the liquid volume within the tank during waste retrieval operations. Conditions to control leak potential involved the following:

a. In-tank liquid levels during retrieval were lower than liquid levels present before interim stabilization

b. Tank C-107 was retrieved from the center out

c. Liquid was removed between waste retrieval campaigns

d. Leak assessment protocols were in accordance with procedures

e. Drywell surveys were conducted.

Conditions to control leak minimization included the following.

a. Liquid additions were minimized and liquid pools were removed as practical.

b. Tank C-107 was retrieved from the center out.

c. Equipment handling controls were imposed to minimize the potential for dropping equipment that could have penetrated the tank bottom.

d. A benchmark waste level was maintained to ensure a low head of introduced liquid. The waste level did not exceed this benchmark.

7.3.1 Single-Shell Tank 241-C-107

A summary of the tank C-107 mitigation actions to minimize or prevent a leak were as follows.

a. The addition of water to the retrieval tank was minimized to the extent practical.

b. Waste was retrieved to the extent practical by working from the center of the tank outwards. In the center-out waste retrieval strategy, mobilized waste and interstitial liquids drain quickly into a central pool and could have been rapidly pumped from the tank had a leak been detected.

c. Waste sluicing activities were performed only while a video camera was in place to observe the sluicing operation and the waste surface.

d. Equipment handling controls were used to minimize the potential for dropping equipment into the tank, which could have penetrated the tank bottom during installation.

e. A benchmark level was maintained to ensure a low head of introduced liquid. The waste level did not exceed this benchmark.

The mitigative approach was implemented to ensure that potential leakage from tank C-107 was monitored at all times. Key mitigative actions which would have been taken in the event of a leak are described in the Tank Waste Retrieval Work Plan (RPP-22393), Sections 4.6.1 and 4.6.2.

7.3.2 Double-Shell Tank 241-AN-106

Mitigating actions for a leak from AN-106 primary tank piping into the secondary DST containment system during a waste transfer from tank C-107 would have included (1) stopping the flow of waste into the tank system (stopping the transfer), (2) pumping waste in the primary tank to another DST until the liquid level in the secondary containment was no longer increasing, and (3) removing the waste from the secondary containment system as soon as practicable. Leaks at or near the AN-106 tank bottom might have required saltwell jet pumping to remove

trapped liquids from between solid layers in the tank. Transfer line leakage would have drained to a common point for collection, detection, and removal.

7.4 CONCLUSION

Based on the available data (presented in Sections 7.2 and 7.3), no evidence of a tank leak occurred during tank C-107 waste retrieval operations. The tank C-107 LDMM program focused on a mitigation strategy to successfully control potential leaks. This strategy included the following.

a. Minimize residual tank waste.

b. Minimize in-tank water use.

c. Minimize standing liquid pools in the tank.

d. Control and monitor additions of water.

e. Visually monitor tank conditions and retrieval operations.

f. Retrieve from the center of the tank out to minimize water accumulation around the tank knuckle.

The goal of the LDMM program for tank C-107 as set forth in RPP-22393 was achieved.

This page intentionally left blank.

8.0 REFERENCES

14-TF-0114, 2014, "The U.S. Department of Energy, Office of River Protection Submits the Retrieval Completion Certification and Report for Tank 241-C-107" (letter from K. W. Smith to J. A. Hedges, Nuclear Waste Program, Washington State Department of Ecology, September 30), U.S. Department of Energy, Office of River Protection, Richland, Washington.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J—Tank Systems, §265.193 Containment and detection of releases, Code of Federal Regulations, as amended.

65 FR 76708, 2000, "National Primary Drinking Water Regulations; Radionuclides; Final Rule," Federal Register, Vol. 65, pp. 76708–76753 (December 7).

ATL-MP-1011, 2012, "ATL Quality Assurance Project Plan for 222-S Laboratory," Rev. 11-A, Advanced Technologies and Laboratories International, Inc., Richland, Washington.

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

BPF-73550, 1944, "Specifications For Construction of Composite Storage Tanks Bldg. No. 241 Hanford Engineer Works Project 9536," Drawing D-3, Rev. 2, Richland, Washington.

Change Notice 2014-02, 2014, "RPP-22393, Rev. 7, 241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan," Tank Waste Retrieval Work Plan/Functions and Requirements Change Notice, Washington River Protection Solutions, LLC, Office of River Protection, State of Washington Department of Ecology, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Public Law 96-510, 94 Stat. 2767, 42 USC 9601 et seq.

Consent Decree, State of Washington v. Department of Energy, Case No. CV-08-5085-FVS, United States District Court, Eastern District of Washington (October 25, 2010).

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

DOE/ORP-2005-01, 2006, Initial Single-Shell Tank System Performance Assessment for the Hanford Site, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/RL-92-24, 2001, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-12, 1996, Hanford Site Background: Part 2, Soil Background for Radionuclides, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

ECF-HANFORD-11-0038, 2012, "Soil Background for Interim Use at the Hanford Site," Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology, EPA, and DOE, 1989, Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA/540/1-89/002, 1989, "Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final," U.S. Environmental Protection Agency, Washington, D.C.

EPA 540/R/99/006, 1999, "Radiation Risk Assessment at CERCLA Sites: Q & A," Directive 9200.4-31P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA Method 300.7, 1986, "Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Federal Water Pollution Control Act (33 USC § 1251 et seq.), as amended (Clean Water Act).

H-14-109854, 2014, "CCMS Residual Waste Surface Volume Tank 241-C-107," Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

HNF-EP-0182, 2015, "Waste Tank Summary Report for Month Ending March 31, 2015," Rev. 327, Washington River Protection Solutions, LLC, Richland, Washington.

HNF-IP-1266, 2013, "Tank Farms Operations Administrative Controls," as amended, Washington River Protection Solutions, LLC, Richland, Washington.

HNF-SD-WM-TI-707, 2007, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments," Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 2015, "Tank Farms Technical Safety Requirements," Rev. 7-W, Washington River Protection Solutions, LLC, Richland, Washington.

OSD-T-151-00031, 2014, "Operating Specifications for Tank Farm Leak Detection and Single-Shell Tank Intrusion Detection," Rev. 5, Washington River Protection Solutions, LLC, Richland, Washington.

PNNL-13895, 2003, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

RCW 70.105, "Hazardous Waste Management," Revised Code of Washington, as amended.

RCW 70.105D, "Hazardous Waste Cleanup — Model Toxics Control Act," Revised Code of Washington, as amended.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

RPP-5945, 2000, "Best-Basis Inventory Maintenance Tool (BBIM): Database Description and User Guide," Rev. 0, CH2M HILL Hanford Group Inc., Richland, Washington.

RPP-6924, 2010, "Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories," Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-7625, 2013, "Guidelines for Updating Best-Basis Inventory," Rev. 11, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-8847, 2007, "Best-Basis Inventory Template Compositions of Common Tank Waste Layers," Rev. 1B, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-12711, 2013, "Temporary Waste Transfer Line Management Program Plan," Rev. 7, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-13033, 2015, "Tank Farms Documented Safety Analysis," Rev. 5-I, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-22393, 2010, "241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan," Rev. 5, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-22393, 2011, "241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan," Rev. 6, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-22393, 2013, "241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan," Rev. 7, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-23403, 2013, "Single-Shell Tank Component Closure Data Quality Objectives," Rev. 5, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-52784, 2012, "Video Camera/CAD Modeling System for Retrieval: HISI #3254 Software Management Plan," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-52903, 2012, "Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-52903, 2014, "Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System," Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-52903, 2014, "Retrieval Performance of Tank 241-C-107 Using the Bulk Mobile Arm Retrieval System," Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-59985, 2014, "Post-Retrieval Camera/CAD Modeling System Waste Volume Estimate for Tank 241-C-107," Rev. 0, Washington River Protection Solutions, LLC/ Weirich Consulting Services Inc., Richland, Washington.

RPP-PLAN-23827, 2013, "Sampling and Analysis Plan for Single-Shell Tanks Component Closure," Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-40145, 2014, "Single-Shell Tank Waste Retrieval Plan," Rev. 4, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-52884, 2014, "Sampling and Analysis Plan for Post-Retrieval Waste Solids in Tank 241-C-107," Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-57604, 2014, "Single-Shell Tank 241-C-107 Retrieval Third Technology Selection," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-23412, 2005, "Hanford Tank Waste Operations Simulator Model Data Package for the Development Run for the Refined Target Case," Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-48745, 2015, "Derivation of Best-Basis Inventory for Tank 241-C-107 as of March 1, 2015," Rev. 8, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-54959, 2014, "Single-Shell Tank 241-C-107 Hard Heel and Third Technology Retrieval Completion Report," Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-58150, 2014, "Retrieval Completion Certification Report for Tank 241-C-107," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-58494, 2015, "Final Report for Tank 241-C-107 Post-Retrieval Waste Solid Samples in Support of Tank Closure," Rev. 1, Advanced Technologies and Laboratories International, Inc./Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-58514, 2015, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment," Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-58648, 2015, "241-C-107 Tank Waste Retrieval Project Final Report of Drywell Monitoring Data (HGLP-MBL-015, Rev. 0)," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

Safe Drinking Water Act of 1974, 42 USC 300, et seq.

Searle, S. R., Casella, G., and McCulloch, C. E., 1992, Variance Components, John Wiley and Sons, Inc., New York, New York.

SW-846, 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Third Edition as amended, http://www.epa.gov/epaoswer/hazwaste/test/main.htm, U.S. Environmental Protection Agency, Washington, D.C.

TFC-ESHQ-ENV_FS-C-01, "Environmental Notification," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-FACSUP-CD-22, "Post-Retrieval Tank Waste Volume Determination," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-OPS-OPER-C-24, "Occurrence Reporting and Processing of Operations Information," Washington River Protection Solutions, LLC, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," Washington Administrative Code, as amended.

WAC 173-303-9905, "Dangerous Waste Constituents List," Washington Administrative Code, as amended.

WAC 173-340, "Model Toxics Control Act – Cleanup," Washington Administrative Code, as amended.

WAC 173-340-705, "Use of Method B," Washington Administrative Code, as amended.

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," Washington Administrative Code, as amended.

WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection," Washington Administrative Code, as amended.

WAC 173-340-7492, "Simplified Terrestrial Ecological Evaluation Procedures," Washington Administrative Code, as amended.

WAC 173-340-7493, "Site-Specific Terrestrial Ecological Evaluation Procedures," Washington Administrative Code, as amended.

WAC 173-340-900, "Tables," Washington Administrative Code, as amended.

This page intentionally left blank.

APPENDIX A

SINGLE-SHELL TANK 241-C-107 INVENTORY PRE- AND POST-SLUICING TECHNOLOGY RETRIEVAL

This page intentionally left blank.

APPENDIX A

SINGLE-SHELL TANK 241-C-107 INVENTORY PRE- AND POST-SLUICING TECHNOLOGY RETRIEVAL

Table A-1. Single-Shell Tank 241-C-107 Best-Basis Inventory Pre-Retrieval Inventory and Post-Sluicing Operations. (2 sheets)

Constituent Name	BBI July 2004[a]	BBI March 2015[b]			Constituent Name	BBI July 2004[a]	BBI March 2015[b]	
Volume (Kgal)	247	10						
Analyte	Inventory	Inventory	Unit		Analyte	Inventory	Inventory	Unit
Al	5.83E+04	1.79E+04	Kg		^{99}Tc	3.77E+01	8.83E-02	Ci
Bi	1.03E+04	2.24E+02	Kg		^{106}Ru	1.38E-04	4.49E-13	Ci
Ca	1.24E+03	2.33E+01	Kg		^{113m}Cd	3.09E+00	6.56E-03	Ci
Cl	8.65E+02	2.54E+00	Kg		^{125}Sb	4.79E+01	3.90E-05	Ci
CN	6.08E+00	3.96E-01	Kg		^{126}Sn	2.40E-01	7.21E-04	Ci
Cr	9.26E+02	6.65E+00	Kg		^{129}I	7.15E-01	2.98E-03	Ci
F	6.34E+03	6.60E+01	Kg		^{134}Cs	4.24E-02	2.12E-08	Ci
Fe	1.02E+05	6.25E+02	Kg		^{137}Cs	5.38E+04	2.86E+02	Ci
Hg	6.66E-01	1.28E+00	Kg		^{137m}Ba	5.07E+02	2.70E+02	Ci
K	4.27E+02	1.88E+00	Kg		^{151}Sm	6.12E+05	1.66E+04	Ci
La	2.69E+00	3.22E-01	Kg		^{152}Eu	1.11E+02	3.65E-04	Ci
Mn	5.01E+03	1.03E+01	Kg		^{154}Eu	9.08E+02	2.19E-02	Ci
Na	9.47E+04	1.46E+03	Kg		^{155}Eu	3.62E+02	7.27E-03	Ci
Ni	3.08E+03	7.94E+01	Kg		^{226}Ra	8.63E-06	8.72E-07	Ci
NO_2	3.51E+04	4.55E+01	Kg		^{227}Ac	2.58E-03	1.32E-05	Ci
NO_3	4.75E+04	6.74E+01	Kg		^{228}Ra	7.24E-02	7.87E-05	Ci
Oxalate	4.04E+02	3.69E+00	Kg		^{229}Th	1.45E-02	2.76E-09	Ci
Pb	1.01E+04	5.45E+01	Kg		^{231}Pa	5.32E-04	5.58E-05	Ci
PO_4	5.84E+04	1.01E+03	Kg		^{232}Th	7.24E-02	7.87E-05	Ci
Si	1.86E+03	2.88E+02	Kg		^{232}U	7.31E-02	1.69E-06	Ci
SO_4	8.38E+03	2.51E+01	Kg		^{233}U	4.72E+00	1.47E-07	Ci
Sr	2.56E+02	4.71E+00	Kg		^{234}U	3.12E-00	1.42E-01	Ci
TIC as CO_3	1.14E+04	9.41E+02	Kg		^{235}U	1.34E-01	6.33E-03	Ci
TOC	7.32E+02	6.07E+01	Kg		^{236}U	5.11E-02	1.58E-03	Ci

Table A-1. Single-Shell Tank 241-C-107 Best-Basis Inventory Pre-Retrieval Inventory and Post-Sluicing Operations. (2 sheets)

Constituent Name	BBI July 2004[a]	BBI March 2015[b]			Constituent Name	BBI July 2004[a]	BBI March 2015[b]	
Volume (Kgal)	247	10						
Analyte	Inventory	Inventory	Unit		Analyte	Inventory	Inventory	Unit
U_{TOTAL}	9.23E+03	4.33E+02	Kg		^{237}Np	5.28E-02	2.40E-02	Ci
Zr	7.37E+01	7.83E+00	Kg		^{238}Pu	4.29E+01	1.09E-01	Ci
^{3}H	2.51E+00	2.77E-02	Ci		^{238}U	3.08E+00	1.44E-01	Ci
^{14}C	5.56E-01	3.16E-02	Ci		^{239}Pu	2.18E+03	1.77E+01	Ci
^{59}Ni	2.81E+00	1.72E-03	Ci		^{240}Pu	3.54E+02	1.60E+01	Ci
^{60}Co	9.90E+01	6.46E-03	Ci		^{241}Am	6.66E+03	1.74E+00	Ci
^{63}Ni	2.54E+02	3.26E+02	Ci		^{241}Pu	1.47E+03	1.35E+01	Ci
^{79}Se	1.16E-01	3.94E-04	Ci		^{242}Cm	2.57E+00	2.41E+00	Ci
^{90}Sr	1.89E+06	1.12E+04	Ci		^{242}Pu	1.63E-02	2.26E-03	Ci
^{90}Y	1.89E+06	1.12E+04	Ci		^{243}Am	1.88E+00	2.42E-05	Ci
^{93m}Nb	3.85E+00	2.07E-01	Ci		^{243}Cm	1.41E-01	1.35E-03	Ci
^{93}Zr	4.50E+00	2.25E-01	Ci		^{244}Cm	3.25E-02	2.34E-05	Ci

BBI = Best-Basis Inventory TIC = total inorganic carbon TOC = total organic carbon

[a] RPP-RPT-43034, 2009, "2009 Auto-TCR for Tank 241-C-107," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

[b] RPP-RPT-48745, 2015, "Derivation of Best-Basis Inventory for Tank 241-C-107 as of March 1, 2015," Rev. 8, Washington River Protection Solutions, LLC, Richland, Washington.

APPENDIX B

MEAN CONCENTRATIONS AND RELATIVE STANDARD DEVIATIONS FOR TANK 241-C-107 RESIDUAL SOLIDS

This page intentionally left blank.

APPENDIX B

MEAN CONCENTRATIONS AND RELATIVE STANDARD DEVIATIONS FOR TANK 241-C-107 RESIDUAL SOLIDS

A summary of concentrations estimated for selected radioactive and non-radioactive analytes in residual waste solids left in single-shell tank 241-C-107 following final retrieval is provided in this appendix.

Waste concentrations provided in this appendix in Table B-1 were taken from Table A.1 in RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment." These calculated concentrations were developed from sampling of waste solids in single-shell tank 241-C-107. The mean concentrations for each sample set were estimated as follows.

Equations from Variance Components (Searle et al. 1992) were used in the automated Best-Basis Inventory Maintenance (BBIM) tool [RPP-5945, "Best-Basis Inventory Maintenance Tool (BBIM): Database Description and User Guide"] to estimate the mean concentration and density and the associated standard deviation for all constituents that had 50% or more of their reported values greater than the detection limit. These equations compute means by weighting results based on the variance components. Some constituents had concentrations that were below the detection limits. In these cases, the detection limits were used for calculating the mean concentrations. For a constituent with a majority of results below the detection limit, a simple average of the detection limits was calculated. Note that in accordance with Best-Basis Inventory protocol, the relative standard deviations for non-detected constituents were assumed to be "1" (RPP-6924, "Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories").

To calculate the average analyte inventories provided in Table B-1, the BBIM tool automatically used the mean concentrations from the samples taken after heel retrieval when available. Otherwise, the adjusted mean concentrations of analytes from the samples taken after modified sluicing were used.

Table B-1. Mean Concentrations[1] and Relative Standard Deviations for Selected Constituents in Tank 241-C-107 Residual Solids. (4 Sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
1,2,4-Trichlorobenzene	120-82-1		1.29E-04	1.65E-04	kg
^{125}Sb	14234-35-6	<	9.69E+01	2.91E+02	Ci
^{126}Sn	15832-50-5	<	3.03E-01	9.09E-01	Ci
^{129}I	15046-84-1		2.98E-03	4.89E-03	Ci
^{137}Cs	10045-97-3		2.86E+02	3.99E+02	Ci
^{137m}Ba	N/A		2.70E+02	3.77E+02	Ci
^{14}C	14762-75-5	<	2.79E-02	8.37E-02	Ci
^{152}Eu	14683-23-9	<	2.65E+01	7.95E+01	Ci
^{154}Eu	15585-10-1	<	2.96E+01	8.88E+01	Ci
^{155}Eu	14391-16-3	<	4.73E+01	1.42E+02	Ci
^{228}Th	14274-82-9		1.23E-02	3.18E-02	Ci
^{230}Th	14269-63-7	<	4.37E+00	1.31E+01	Ci
^{231}Pa	14331-85-2	<	1.00E+01	3.00E+01	Ci
^{232}Th	N/A		7.87E-05	1.33E-04	Ci
^{233}U	13968-55-3	<	6.37E-02	1.91E-01	Ci
^{234}U	13966-29-5		2.51E-01	3.12E-01	Ci
^{235}U	15117-96-1		6.08E-03	8.40E-03	Ci
^{236}U	13982-70-2		3.96E-03	5.92E-03	Ci
^{237}Np	13994-20-2		2.40E-02	3.63E-02	Ci
^{238}Pu	13981-16-3		1.92E+00	2.66E+00	Ci
^{238}U	N/A		1.44E-01	1.92E-01	Ci
^{239}Pu	15117-48-3		1.60E+01	2.18E+01	Ci
^{240}Pu	14119-33-6		1.74E+00	2.37E+00	Ci
^{241}Am	14596-10-2		1.33E+01	1.86E+01	Ci
^{241}Pu	14119-32-5		1.76E+01	2.50E+01	Ci
^{242}Cm	15510-73-3		7.10E-02	1.24E-01	Ci
^{242}Pu	13982-10-0	<	6.77E-02	2.03E-01	Ci
^{243}Cm	15757-87-6		9.95E-02	1.60E-01	Ci
^{244}Cm	13981-15-2		2.11E+00	3.40E+00	Ci
2-Butanone	78-93-3	<	1.11E-03	3.33E-03	kg

Table B-1. Mean Concentrations[1] and Relative Standard Deviations for Selected Constituents in Tank 241-C-107 Residual Solids. (4 Sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
^{3}H	15086-10-9	<	2.77E-02	8.31E-02	Ci
^{60}Co	10198-40-0	<	1.43E+01	4.29E+01	Ci
^{63}Ni	13981-37-8		3.26E+02	4.24E+02	Ci
^{79}Se	15758-45-9	<	3.89E-03	1.17E-02	Ci
^{90}Sr	10098-97-2		1.12E+04	1.58E+04	Ci
^{90}Y	10098-91-6		1.12E+04	1.58E+04	Ci
^{99}Tc	14133-76-7		8.83E-02	1.15E-01	Ci
Acetate	10098-91-6	<	3.74E+00	1.12E+01	kg
Acetone	67-64-1	<	1.24E-03	3.72E-03	kg
Ag	7440-22-4		6.03E+01	8.79E+01	kg
Al	7429-90-5		1.79E+04	2.10E+04	kg
Aroclors (Total PCB)	1336-36-3	<	1.98E-03	5.95E-03	kg
As	7440-38-2		4.08E-01	5.26E-01	kg
B	7440-42-8		1.05E+00	2.10E+00	kg
Ba	7440-39-3		1.68E+00	2.58E+00	kg
Be	7440-41-7	<	6.61E-02	1.98E-01	kg
Benzene	71-43-2		1.05E-04	1.42E-04	kg
Bi	7440-69-9		2.24E+02	3.26E+02	kg
Br	24959-67-9	<	2.01E+00	6.03E+00	kg
Butylbenzylphthalate	85-68-7		3.49E-02	6.72E-02	kg
Ca	7440-70-2		2.33E+01	3.08E+01	kg
Cd	7440-43-9		2.46E-01	3.07E-01	kg
Ce	7440-45-1	<	1.65E+00	4.95E+00	kg
Cl	16887-00-6	<	2.54E+00	7.62E+00	kg
CN	57-12-5		3.96E-01	5.27E-01	kg
Co	7440-48-4		8.45E-02	1.11E-01	kg
Cr	7440-47-3		6.65E+00	9.08E+00	kg
Cu	7440-50-8		7.03E+00	8.36E+00	kg
Di-n-octylphthalate	117-84-0	<	3.12E-02	9.36E-02	kg
Eu	7440-53-1	<	6.61E-02	1.98E-01	kg

Table B-1. Mean Concentrations[1] and Relative Standard Deviations for Selected Constituents in Tank 241-C-107 Residual Solids. (4 Sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
F	16984-48-8		6.60E+01	8.86E+01	kg
Fe	7439-89-6		6.25E+02	8.86E+02	kg
Formate	12311-97-6	<	5.61E+00	1.68E+01	kg
Free OH	N/A		2.54E+00	5.16E+00	kg
Glycolate	666-14-8	<	2.14E+00	6.42E+00	kg
Hg	7439-97-6		1.28E+00	1.64E+00	kg
K	7440-09-7		1.88E+00	2.52E+00	kg
La	7439-91-0		3.22E-01	4.39E-01	kg
Li	7439-93-2		1.60E-01	1.87E-01	kg
Methylenechloride	75-09-2		8.51E-04	9.96E-04	kg
Mg	7439-95-4		9.34E+00	1.17E+01	kg
Mn	7439-96-5		1.03E+01	1.63E+01	kg
Mo	7439-98-7		3.90E-01	6.58E-01	kg
Na	7440-23-5		1.46E+03	2.10E+03	kg
Nb	7440-03-1	<	3.97E-01	1.19E+00	kg
Nd	7440-00-8		1.67E+00	2.14E+00	kg
NH_3	7664-41-7	<	5.01E-02	1.50E-01	kg
Ni	7440-02-0		7.94E+01	9.27E+01	kg
NO_2	14797-65-0		4.55E+01	6.46E+01	kg
NO_3	14797-55-8		6.74E+01	9.69E+01	kg
Oxalate	338-70-5		3.69E+00	4.45E+00	kg
Pb	7439-92-1		5.45E+01	6.66E+01	kg
Pd	7440-05-3	<	7.93E-01	2.38E+00	kg
PO_4	14265-44-2		1.01E+03	1.72E+03	kg
Pr	7440-10-0	<	1.72E+00	5.16E+00	kg
Rb	7440-17-7	<	3.77E+00	1.13E+01	kg
Rh	7440-16-6	<	5.95E-01	1.79E+00	kg
Ru	7440-18-8		1.33E+00	2.42E+00	kg
Sb	7440-36-0	<	7.98E-02	2.39E-01	kg
Se	7782-49-2		9.90E-01	1.52E+00	kg

Table B-1. Mean Concentrations[1] and Relative Standard Deviations for Selected Constituents in Tank 241-C-107 Residual Solids. (4 Sheets)

Constituent	Chemical Abstract Services Number	< Detection Limit	Average Inventory	Upper-Bounding Inventory	Inventory Units[1]
Si	7440-21-3		2.88E+02	3.89E+02	kg
Sm	7440-19-9		1.57E+00	1.98E+00	kg
Sn	7440-31-5		1.18E+00	1.84E+00	kg
SO_4	14808-79-8		2.51E+01	3.16E+01	kg
Sr	7440-24-6		4.71E+00	6.42E+00	kg
Ta	7440-25-7	<	3.31E-01	9.93E-01	kg
Te	13494-80-9		6.02E-01	7.24E-01	kg
Th	7440-29-1		7.16E-01	1.05E+00	kg
Ti	7440-32-6		1.81E+00	2.12E+00	kg
Tl	7440-28-0	<	2.64E-01	7.92E-01	kg
Toluene	108-88-3		2.89E-04	3.53E-04	kg
Tributyl phosphate	126-73-8	<	4.42E-02	1.33E-01	kg
Trichloroethene	79-01-6	<	6.83E-05	2.05E-04	kg
U	7440-61-1		4.33E+02	5.78E+02	kg
V	7440-62-2		4.83E-01	5.99E-01	kg
W	7440-33-7		1.25E+00	1.54E+00	kg
Xylene (m & p)	108-28-3M	<	9.46E-05	2.84E-04	kg
Xylene (o)	95-47-6	<	5.20E-05	1.56E-04	kg
Xylenes (total)	1330-20-7	<	1.15E-04	3.45E-04	kg
Y	7440-65-5		4.10E-01	6.37E-01	kg
Zn	7440-66-6		1.19E+01	1.41E+01	kg
Zr	7440-67-7		7.83E+00	1.21E+01	Kg

Ci = curie kg = kilogram N/A = not applicable

[1] Radionuclide concentrations are decay corrected to January 1, 2008.

REFERENCES

RPP-5945, 2000, "Best-Basis Inventory Maintenance Tool (BBIM): Database Description and User Guide," Rev. 0, CH2M HILL Hanford Group Inc., Richland, Washington.

RPP-6924, 2010, "Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories," Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-58514, 2015, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment," Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

Searle, S. R., Casella, G., and McCulloch, C. E., 1992, Variance Components, John Wiley and Sons, Inc., New York, New York.

APPENDIX C

COMPARISON OF SINGLE-SHELL TANK 241-C-107 FINAL INVENTORY TO SINGLE-SHELL TANK 241-C-107 INVENTORY USED IN DOE/ORP-2005-01, *INITIAL SINGLE-SHELL TANK SYSTEM PERFORMANCE ASSESSMENT FOR THE HANFORD SITE*

This page intentionally left blank.

APPENDIX C

COMPARISON OF SINGLE-SHELL TANK 241-C-107 FINAL INVENTORY TO SINGLE-SHELL TANK 241-C-107 INVENTORY USED IN DOE/ORP-2005-01, *INITIAL SINGLE-SHELL TANK SYSTEM PERFORMANCE ASSESSMENT FOR THE HANFORD SITE*

Table C-1. Comparison of Single-Shell Tank 241-C-107 Final Inventory to Single-Shell Tank 241-C-107 Inventory Used in DOE/ORP-2005-01.

Analyte	Units	DOE/ORP-2005-01, Rev. 0	RPP-RPT-58514, Rev. 1 Average Inventory	RPP-RPT-58514, Rev. 1 Upper Bounding Inventory
Tritium	Ci	1.19E-02	2.77E-02	8.31E-02
C-14	Ci	3.46E-03	2.79E-02	8.37E-02
I-129	Ci	2.72E-03	2.98E-03	4.89E-03
Tc-99	Ci	2.13E-01	8.83E-02	1.15E-01
Cr	kg	6.25E+00	6.65E+00	9.08E+00
F	kg	2.44E+01	6.60E+01	8.86E+01
NO_2	kg	1.34E+02	4.55E+01	6.46E+01
NO_3	kg	3.34E+02	6.74E+01	9.69E+01
U	kg	6.80E+01	4.33E+02	5.78E+02

REFERENCES

DOE/ORP-2005-01, 2006, Initial Single-Shell Tank System Performance Assessment for the Hanford Site, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

RPP-RPT-58514, 2015, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment," Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

This page intentionally left blank.

APPENDIX D

RISK ASSESSMENT INFORMATION FOR RESIDUAL WASTES REMAINING IN SINGLE-SHELL TANK 241-C-107

This page intentionally left blank.

APPENDIX D

RISK ASSESSMENT INFORMATION FOR RESIDUAL WASTES REMAINING IN SINGLE-SHELL TANK 241-C-107

This appendix provides risk assessment information related to post-retrieval inventories estimated to remain in single-shell tank (SST) 241-C-107 (C-107). The potential risk impacts to human health posed by the residual waste in SST C-107 were evaluated using the methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site. The process used for the SST C-107 risk assessment, and this methodology, is described in detail in Chapter 3 of DOE/ORP-2005-01. The SST performance assessment methodology represents the current approach being used to support the assessment of long-term impacts to human health from tank residuals left in individual SSTs in retrieval data reports. Decisions on final closure of tank C-107, all other SSTs, and ancillary facilities and equipment within Waste Management Area C will be supported by a site-specific performance assessment as outlined in Appendix I of the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989).

The risk assessment-related information for post-retrieval inventories estimated to remain in SST C-107 and contained in this appendix are as follows:

- Summary of incremental lifetime cancer risk, radiological dose, and drinking water dose for radionuclide contaminants of potential concern estimated in the average post-retrieval inventory for SST C-107 (see Table D-1)

- Summary of maximum value for incremental lifetime cancer risk and hazard index for non-radionuclide contaminants of potential concern estimated in the average post-retrieval inventory for SST C-107 (see Table D-2)

- Summary of incremental lifetime cancer risk, radiological dose, and drinking water dose for radionuclide contaminants of potential concern estimated in the 95% upper confidence level (UCL) post-retrieval inventory for SST C-107 (see Table D-3)

- Summary of maximum value for incremental lifetime cancer risk and hazard index for non-radionuclide contaminants of potential concern estimated in the 95% UCL post-retrieval inventory for SST C-107 (see Table D-4)

- Tables and plots of doses from a well driller scenario for radioactive contaminants of concern found within the average and 95% UCL inventory estimated for SST C-107 (see Table D-5 and Figure D-1)

- Tables and plots of doses from a rural pasture scenario for radioactive contaminants of concern found within the average and 95% UCL inventories estimated for SST C-107 (see Table D-6 and Figure D-2)

- Tables and plots of doses from a suburban garden scenario for radioactive contaminants of concern found within the average and 95% UCL inventories estimated for SST C-107 (see Table D-7 and Figure D-3)

- Tables and plots of doses from a commercial farm scenario for radioactive contaminants of concern found within the average and 95% UCL inventories estimated for SST C-107 (see Table D-8 and Figure D-4).

Table D-9 provides a comparison of the average and 95% UCL concentrations for waste residuals within tank C-107 against Washington Administrative Code 173-340, "Model Toxics Control Act – Cleanup" cleanup levels for soil direct contact unrestricted land use (Method B), industrial land use (Method C), and soil concentrations protective of groundwater.

Tables D-10 and D-11 provide additional risk management information related to (average and 95% UCL) concentrations of constituents remaining in waste residuals within tank C-107 compared against the Washington Administrative Code 173-340 cleanup standards. See Section 5.5 for additional discussion.

Table D-12 provides information on background concentration levels at the Hanford Site that have been developed for selected constituents. This is provided to bring additional perspective in the concentration levels of constituents remaining in residual wastes within tank C-107.

Table D-1. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose per Radionuclide Contaminant of Potential Concern for the Average Inventory for Single-Shell Tank 241-C-107. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Americium-241	Yes	1.33E+01	0.00E+00	DNA	3.00E+00	4.33E+02	NE	NE	NE	NE
Antimony-125	No	4.85E+01	0.00E+00	DNA	1.00E+00	2.73E+00	NE	NE	NE	NE
Barium-137m	Yes	2.70E+02	0.00E+00	DNA	0.00E+00	4.86E-06	NE	NE	NE	NE
Carbon-14	No	1.40E-02	2.15E-02	9.78E+03	0.00E+00	5.73E+03	1.67E-10	1.21E-09	1.04E-04	2.33E-06
Cesium-137 + Daughters	Yes	2.86E+02	0.00E+00	DNA	2.50E+01	3.00E+01	NE	NE	NE	NE
Cobalt-60	No	7.15E+00	0.00E+00	DNA	1.00E-01	5.27E+00	NE	NE	NE	NE
Curium-242	Yes	7.10E-02	0.00E+00	DNA	3.00E+00	4.46E-01	NE	NE	NE	NE
Curium-243	Yes	9.95E-02	0.00E+00	DNA	3.00E+00	2.85E+01	NE	NE	NE	NE
Curium-244	Yes	2.11E+00	0.00E+00	DNA	3.00E+00	1.81E+01	NE	NE	NE	NE
Europium-152	No	1.33E+01	0.00E+00	DNA	1.00E+00	1.33E+01	NE	NE	NE	NE
Europium-154	No	1.48E+01	0.00E+00	DNA	1.00E+00	8.59E+00	NE	NE	NE	NE
Europium-155	No	2.37E+01	0.00E+00	DNA	1.00E+00	4.68E+00	NE	NE	NE	NE
Iodine-129	Yes	2.98E-03	<1.00E-03	1.20E+04	2.00E-01	1.57E+07	NE	NE	NE	NE
Neptunium-237 + D	Yes	2.40E-02	0.00E+00	DNA	2.00E+00	2.14E+06	NE	NE	NE	NE
Nickel-63	Yes	3.26E+02	0.00E+00	DNA	4.80E+01	1.00E+02	NE	NE	NE	NE
Plutonium-238	Yes	1.92E+00	0.00E+00	DNA	3.00E+00	8.77E+01	NE	NE	NE	NE
Plutonium-239	Yes	1.60E+01	0.00E+00	DNA	3.00E+00	2.41E+04	NE	NE	NE	NE

Table D-1. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose per Radionuclide Contaminant of Potential Concern for the Average Inventory for Single-Shell Tank 241-C-107. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Plutonium-240	Yes	1.74E+00	0.00E+00	DNA	3.00E+00	6.56E+03	NE	NE	NE	NE
Plutonium-241 + D	Yes	1.76E+01	0.00E+00	DNA	3.00E+00	1.44E+01	NE	NE	NE	NE
Plutonium-242	No	3.39E-02	0.00E+00	DNA	3.00E+00	3.74E+05	NE	NE	NE	NE
Protactinium-231	No	5.00E+00	0.00E+00	DNA	5.50E+02	3.28E+04	NE	NE	NE	NE
Selenium-79	No	1.95E-03	0.00E+00	DNA	3.10E+00	8.05E+05	NE	NE	NE	NE
Strontium-90 + D	Yes	1.12E+04	0.00E+00	DNA	1.61E+01	2.81E+01	NE	NE	NE	NE
Technetium-99	Yes	8.83E-02	3.53E-01	1.05E+04	0.00E+00	2.11E+05	4.86E-09	1.18E-07	6.18E-04	7.91E-04
Thorium-228 + D	Yes	1.23E-02	0.00E+00	DNA	3.00E+00	1.91E+00	NE	NE	NE	NE
Thorium-230	No	2.19E+00	0.00E+00	DNA	3.00E+00	7.54E+04	NE	NE	NE	NE
Thorium-232	Yes	7.87E-05	0.00E+00	DNA	3.00E+00	1.41E+10	NE	NE	NE	NE
Tin-126	No	1.52E-01	0.00E+00	DNA	1.00E+00	2.46E+05	NE	NE	NE	NE
Tritium	No	1.39E-02	0.00E+00	DNA	0.00E+00	1.23E+01	NE	NE	NE	NE
Uranium-233	No	3.19E-02	0.00E+00	DNA	6.00E-01	1.59E+05	NE	NE	NE	NE
Uranium-234	Yes	2.51E-01	0.00E+00	DNA	6.00E-01	2.46E+05	NE	NE	NE	NE
Uranium-235 + D	Yes	6.08E-03	0.00E+00	DNA	6.00E-01	7.04E+08	NE	NE	NE	NE
Uranium-236	Yes	3.96E-03	0.00E+00	DNA	6.00E-01	2.34E+07	NE	NE	NE	NE
Uranium-238 + D	Yes	1.44E-01	0.00E+00	DNA	6.00E-01	4.47E+09	NE	NE	NE	NE

Table D-1. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose per Radionuclide Contaminant of Potential Concern for the Average Inventory for Single-Shell Tank 241-C-107. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Yttrium-90	Yes	1.12E+04	0.00E+00	DNA	0.00E+00	7.31E-03	NE	NE	NE	NE
Performance Objectives[c]							**1-0E-6 to 1.0E-4[d]**	**1-0E-6 to 1.0E-4[d]**	**25[e]**	**4[f]**

[a] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, and Section 4.3 of PNNL-14702, "Vadose Zone Hydrogeology Data Package for Hanford Assessments" for the basis for the K_d values listed for the radionuclides.

[b] All exposure scenarios are described in HNF-SD-WM-TI-707, Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments.

[c] Performance objectives apply to the cumulative (i.e., all contaminants) for the entire waste management area.

[d] EPA 540/R/99/006, "Radiation Risk Assessment At CERCLA Sites: Q & A," Directive 9200.4-31P.

[e] DOE O 435.1, Radioactive Waste Management.

[f] 65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule."

DNA = Did not arrive at fenceline within the 10,000-year modeling period.
N/A = Radionuclide is not a beta/photon emitter.
NE = Incremental cancer risk for industrial and residential scenarios or radiological dose evaluated for the all-pathways farmer and drinking water only scenarios not evaluated because radiological constituent had no estimated initial inventory or did not arrive in concentrations greater than at the fenceline within the 10,000-year modeling period. In the Decision Management Tool (DMT) that is used to implement the calculational methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site for this Retrieval Data Report, calculated concentrations less than 1.00E-21 pCi/L are considered to be effectively zero. This risk metric may have also not been calculated because the radioactive analyte was predicted to have a concentration less than 0.001 pCi/L, which is well below the ability of standard laboratory analytical methods to detect it.

Table D-2. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index per Nonradionuclide Contaminant of Potential Concern Using Average Post-Retrieval Inventory for Single-Shell Tank 241-C-107. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Aluminum	Yes	1.79E+04	0.00E+00	DNA	1.00E+00	NE	NE
Ammonia -- (a)	No	2.51E-02	<1.00E-03	1.05E+04	9.30E-04	NE	NE
Antimony	No	3.99E-02	0.00E+00	DNA	1.00E+00	NE	NE
Arsenic	Yes	4.08E-01	0.00E+00	DNA	3.90E+01	NE	NE
Barium	Yes	1.68E+00	0.00E+00	DNA	6.00E+01	NE	NE
Beryllium	No	3.31E-02	0.00E+00	DNA	7.00E+01	NE	NE
Bismuth	Yes	2.24E+02	9.20E-01	1.05E+04	0.00E+00	No CPF	No Rfd
Boron	Yes	1.05E+00	0.00E+00	DNA	3.00E+00	NE	NE
Bromide	No	1.01E+00	4.13E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Cadmium	Yes	2.46E-01	0.00E+00	DNA	1.26E+00	NE	NE
Calcium	Yes	2.33E+01	0.00E+00	DNA	4.00E+00	NE	NE
Cerium	No	8.25E-01	3.39E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Chloride	No	1.27E+00	5.21E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Chromium, Total	Yes	6.65E+00	2.73E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Cobalt	Yes	8.45E-02	<1.00E-03	1.20E+04	1.00E-01	NE	NE
Copper	Yes	7.03E+00	0.00E+00	DNA	3.50E+01	NE	NE
Cyanide	Yes	3.96E-01	0.00E+00	DNA	9.90E+00	NE	NE
Europium	No	3.31E-02	0.00E+00	DNA	5.00E+01	NE	NE
Fluoride	Yes	6.60E+01	2.71E-01	1.05E+04	0.00E+00	No CPF	2.82E-04
Formate+A2	No	2.81E+00	1.15E-02	1.05E+04	0.00E+00	No CPF	No Rfd

Table D-2. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index per Nonradionuclide Contaminant of Potential Concern Using Average Post-Retrieval Inventory for Single-Shell Tank 241-C-107. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Iron	Yes	6.25E+02	0.00E+00	DNA	2.50E+01	NE	NE
Hydroxide OH	Yes	2.54E+00	1.04E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Lanthanum	Yes	3.22E-01	1.32E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Lead	Yes	5.45E+01	0.00E+00	DNA	5.20E+00	NE	NE
Lithium	Yes	1.60E-01	0.00E+00	DNA	3.00E+02	NE	NE
Magnesium	Yes	9.34E+00	0.00E+00	DNA	4.50E+00	NE	NE
Manganese	Yes	1.03E+01	0.00E+00	DNA	1.00E+00	NE	NE
Mercury	Yes	1.28E+00	0.00E+00	DNA	5.20E+00	NE	NE
Molybdenum	Yes	3.90E-01	0.00E+00	DNA	4.00E+00	NE	NE
Neodymium	Yes	1.67E+00	6.86E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Nickel	Yes	7.94E+01	0.00E+00	DNA	4.80E+01	NE	NE
Niobium	No	1.99E-01	0.00E+00	DNA	1.00E+02	NE	NE
Nitrate	Yes	6.74E+01	2.77E-01	1.05E+04	0.00E+00	No CPF	1.08E-05
Nitrite	Yes	4.55E+01	1.87E-01	1.05E+04	0.00E+00	No CPF	1.17E-04
Oxalate	Yes	3.69E+00	1.51E-02	1.05E+04	0.00E+00	No CPF	No Rfd
o-Xylene	No	2.60E-05	<1.00E-03	1.20E+04	7.23E-02	NE	NE
Palladium	No	3.97E-01	0.00E+00	DNA	5.00E+01	NE	NE
Phosphate	Yes	1.01E+03	4.15E+00	1.05E+04	0.00E+00	No CPF	No Rfd
Potassium	Yes	1.88E+00	7.72E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Praseodymium	No	8.60E-01	3.53E-03	1.05E+04	0.00E+00	No CPF	No Rfd

Table D-2. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index per Nonradionuclide Contaminant of Potential Concern Using Average Post-Retrieval Inventory for Single-Shell Tank 241-C-107. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Rhodium	No	2.98E-01	1.22E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Rubidium	No	1.89E+00	7.74E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Ruthenium	Yes	1.33E+00	0.00E+00	DNA	1.00E+00	NE	NE
Samarium	Yes	1.57E+00	0.00E+00	DNA	1.00E+00	NE	NE
Selenium	Yes	9.90E-01	0.00E+00	DNA	5.00E+00	NE	NE
Silicon	Yes	2.88E+02	0.00E+00	DNA	3.00E+01	NE	NE
Silver	Yes	6.03E+01	0.00E+00	DNA	2.70E+00	NE	NE
Sodium	Yes	1.46E+03	5.99E+00	1.05E+04	0.00E+00	No CPF	No Rfd
Strontium	Yes	4.71E+00	0.00E+00	DNA	1.61E+01	NE	NE
Sulfate	Yes	2.51E+01	1.03E-01	1.05E+04	0.00E+00	No CPF	No Rfd
Tantalum	No	1.66E-01	<1.00E-03	1.05E+04	0.00E+00	NE	NE
Tellurium	Yes	6.02E-01	2.47E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Thallium	No	1.32E-01	0.00E+00	DNA	7.10E+01	NE	NE
Thorium	Yes	7.16E-01	0.00E+00	DNA	1.00E+00	NE	NE
Tin	Yes	1.18E+00	0.00E+00	DNA	2.50E+02	NE	NE
Titanium	Yes	1.81E+00	0.00E+00	DNA	1.00E+03	NE	NE
Tungsten	Yes	1.25E+00	5.13E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Uranium	Yes	4.33E+02	0.00E+00	DNA	6.00E-01	NE	NE
Vanadium	Yes	4.83E-01	0.00E+00	DNA	5.00E+01	NE	NE
Yttrium	Yes	4.10E-01	1.68E-03	1.05E+04	0.00E+00	No CPF	No Rfd

Table D-2. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index per Nonradionuclide Contaminant of Potential Concern Using Average Post-Retrieval Inventory for Single-Shell Tank 241-C-107. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Zinc	Yes	1.19E+01	0.00E+00	DNA	6.20E+01	NE	NE
Zirconium	Yes	7.83E+00	0.00E+00	DNA	5.00E+02	NE	NE
1, 1, 2-Trichloroethylene	No	3.42E-05	<1.00E-03	1.20E+04	2.82E-02	NE	NE
1, 2, 4-Trichlorobenzene	Yes	1.29E-04	<1.00E-03	1.20E+04	4.98E-01	NE	NE
2-Butanone(MEK)	No	5.55E-04	<1.00E-03	1.05E+04	1.35E-03	NE	NE
2-Propanone (Acetone)	No	6.20E-04	<1.00E-03	1.05E+04	1.73E-04	NE	NE
4-Methyl-2-pentanone (MIBK)	Yes	0.00E+00	<1.00E-03	DNA	4.02E-02	NE	NE
Acetate C2H3O2-	No	1.87E+00	7.68E-03	1.05E+04	3.00E-04	No CPF	No Rfd
Benzene	Yes	1.05E-04	<1.00E-03	1.05E+04	1.86E-02	NE	NE
Butylbenzylphthalate	Yes	3.49E-02	0.00E+00	DNA	4.14E+00	NE	NE
Dichloromethane (methylene chloride)	Yes	8.51E-04	<1.00E-03	1.05E+04	3.00E-03	NE	NE
Di-n-octylphthalate	No	1.56E-02	0.00E+00	DNA	2.49E+04	NE	NE
Glycolate C2H3O3	No	1.07E+00	4.39E-03	1.05E+04	0.00E+00	No CPF	No Rfd
m-Xylene	No	4.73E-05	<1.00E-03	1.20E+04	5.88E-02	NE	NE
Polychlorinated Biphenyls (high risk)	No	9.90E-04	0.00E+00	DNA	9.27E+01	NE	NE
Toluene	Yes	2.89E-04	<1.00E-03	1.20E+04	4.20E-02	NE	NE
Tributyl phosphate	No	2.21E-02	<1.00E-03	1.20E+04	5.67E-01	NE	NE
Xylenes	No	5.75E-05	<1.00E-03	1.20E+04	5.88E-02	NE	NE
Performance Objective[d]						**1.0E-06[e]**	**1.0[f]**

Table D-2. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index per Nonradionuclide Contaminant of Potential Concern Using Average Post-Retrieval Inventory for Single-Shell Tank 241-C-107. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	

[a] Dangerous waste constituent per Washington Administrative Code (WAC) 173-303-9905, "Dangerous Waste Constituents List."

[b] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, for the basis for the K_d values listed for chromium and nitrate. The K_d values listed for the organic chemical compounds are determined from the chemicals' organic carbon/water partitioning coefficient and an estimate of 0.03% for the Hanford Site sediments fraction of organic content (PNNL-13895, Rev. 1, page 11, paragraph 3).

[c] All exposure scenarios are described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

[d] Single Analyte Performance objectives apply to entire waste management area, not just a single component of the waste management area.

[e] WAC 173-340-705, "Use of Method B," subpart (2)(c)(ii).

[f] WAC 173-340-705 (2)(c)(i).

DNA = Did not arrive at fenceline within the 10,000-year modeling period.

NE = Incremental cancer risk or hazard quotient calculated under WAC 173-340, "Model Toxics Control Act – Cleanup," Method B not evaluated because hazardous chemical constituent had no estimated initial inventory or did not arrive in concentrations greater than zero at the fenceline within the 10,000-year modeling period. In the Decision Management Tool (DMT) that is used to implement the calculational methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site for this Retrieval Data Report, calculated concentrations less than 1.00E-21 µg/L are considered to be effectively zero. The risk metric may have also not been calculated because the chemical analyte was predicted to have a concentration less than 0.001 µg/L, which is well below the ability of standard laboratory analytical methods to detect it.

No CPF = No cancer potency factor available.

No Rfd = No reference dose available.

Table D-3. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose for Single-Shell Tank 241-C-107 per Radionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Americium-241	Yes	1.86E+01	0.00E+00	DNA	3.00E+00	4.33E+02	NE	NE	NE	NE
Antimony-125	No	1.46E+02	0.00E+00	DNA	1.00E+00	2.73E+00	NE	NE	NE	NE
Barium-137m	Yes	3.77E+02	0.00E+00	DNA	0.00E+00	4.86E-06	NE	NE	NE	NE
Carbon-14	No	4.19E-02	6.45E-02	9.78E+03	0.00E+00	5.73E+03	5.01E-10	3.62E-09	3.12E-04	1.29E-04
Cesium-137 + Daughters	Yes	3.99E+02	0.00E+00	DNA	2.50E+01	3.00E+01	NE	NE	NE	NE
Cobalt-60	No	2.15E+01	0.00E+00	DNA	1.00E-01	5.27E+00	NE	NE	NE	NE
Curium-242	Yes	1.24E-01	0.00E+00	DNA	3.00E+00	4.46E-01	NE	NE	NE	NE
Curium-243	Yes	1.60E-01	0.00E+00	DNA	3.00E+00	2.85E+01	NE	NE	NE	NE
Curium-244	Yes	3.40E+00	0.00E+00	DNA	3.00E+00	1.81E+01	NE	NE	NE	NE
Europium-152	No	3.98E+01	0.00E+00	DNA	1.00E+00	1.33E+01	NE	NE	NE	NE
Europium-154	No	4.44E+01	0.00E+00	DNA	1.00E+00	8.59E+00	NE	NE	NE	NE
Europium-155	No	7.10E+01	0.00E+00	DNA	1.00E+00	4.68E+00	NE	NE	NE	NE
Iodine-129	Yes	4.89E-03	<1.00E-03	1.20E+04	2.00E-01	1.57E+07	NE	NE	NE	NE
Neptunium-237 + D	Yes	3.63E-02	0.00E+00	DNA	2.00E+00	2.14E+06	NE	NE	NE	NE
Nickel-63	Yes	4.24E+02	0.00E+00	DNA	4.80E+01	1.00E+02	NE	NE	NE	NE
Plutonium-238	Yes	2.66E+00	0.00E+00	DNA	3.00E+00	8.77E+01	NE	NE	NE	NE

Table D-3. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose for Single-Shell Tank 241-C-107 per Radionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Plutonium-239	Yes	2.18E+01	0.00E+00	DNA	3.00E+00	2.41E+04	NE	NE	NE	NE
Plutonium-240	Yes	2.37E+00	0.00E+00	DNA	3.00E+00	6.56E+03	NE	NE	NE	NE
Plutonium-241 + D	Yes	2.50E+01	0.00E+00	DNA	3.00E+00	1.44E+01	NE	NE	NE	NE
Plutonium-242	No	1.02E-01	0.00E+00	DNA	3.00E+00	3.74E+05	NE	NE	NE	NE
Protactinium-231	No	1.50E+01	0.00E+00	DNA	5.50E+02	3.28E+04	NE	NE	NE	NE
Selenium-79	No	5.85E-03	0.00E+00	DNA	3.10E+00	8.05E+05	NE	NE	NE	NE
Strontium-90 + D	Yes	1.58E+04	0.00E+00	DNA	1.61E+01	2.81E+01	NE	NE	NE	NE
Technetium-99	Yes	1.15E-01	4.59E-01	1.05E+04	0.00E+00	2.11E+05	6.33E-09	1.54E-07	8.04E-04	2.04E-03
Thorium-228 + D	Yes	3.18E-02	0.00E+00	DNA	3.00E+00	1.91E+00	NE	NE	NE	NE
Thorium-230	No	6.55E+00	0.00E+00	DNA	3.00E+00	7.54E+04	NE	NE	NE	NE
Thorium-232	Yes	1.33E-04	0.00E+00	DNA	3.00E+00	1.41E+10	NE	NE	NE	NE
Tin-126	No	4.55E-01	0.00E+00	DNA	1.00E+00	2.46E+05	NE	NE	NE	NE
Tritium	No	4.16E-02	0.00E+00	DNA	0.00E+00	1.23E+01	NE	NE	NE	NE
Uranium-233	No	9.55E-02	0.00E+00	DNA	6.00E-01	1.59E+05	NE	NE	NE	N/A
Uranium-234	Yes	3.12E-01	0.00E+00	DNA	6.00E-01	2.46E+05	NE	NE	NE	N/A
Uranium-235 + D	Yes	8.40E-03	0.00E+00	DNA	6.00E-01	7.04E+08	NE	NE	NE	N/A
Uranium-236	Yes	5.92E-03	0.00E+00	DNA	6.00E-01	2.34E+07	NE	NE	NE	N/A

Table D-3. Incremental Lifetime Cancer Risk, Radiological Dose, and Drinking Water Dose for Single-Shell Tank 241-C-107 per Radionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (3 sheets)

Analyte Name	Above Detection Limits in Residual Wastes	Inventory (Ci)	Waste Management Area C Fenceline Concentration	Peak Year	K_d (mL/g)[a]	Half-Life (yr)	Incremental Cancer Risk (Groundwater)[b]		Radiological Dose (mrem/yr) All-Pathway Farmer Scenario[b]	Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
							Industrial	Residential		
Uranium-238 + D	Yes	1.92E-01	0.00E+00	DNA	6.00E-01	4.47E+09	NE	NE	NE	N/A
Yttrium-90	Yes	1.58E+04	0.00E+00	DNA	0.00E+00	7.31E-03	NE	NE	NE	NE
Performance Objectives[c]							**1-0E-6 to 1.0E-4[d]**	**1-0E-6 to 1.0E-4[d]**	**25[e]**	**4[f]**

[a] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, and Section 4.3 of PNNL-14702, "Vadose Zone Hydrogeology Data Package for Hanford Assessments" for the basis for the K_d values listed for the radionuclides.

[b] All exposure scenarios are described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

[c] Performance objectives apply to the cumulative (i.e., all contaminants) for the entire waste management area.

[d] EPA 540/R/99/006, "Radiation Risk Assessment At CERCLA Sites: Q & A," Directive 9200.4-31P.

[e] DOE O 435.1, Radioactive Waste Management.

[f] 65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule."

DNA = Did not arrive at fenceline within the 10,000-year modeling period.
N/A = Radionuclide is not a beta/photon emitter.
NE = Incremental cancer risk for industrial and residential scenarios or radiological dose evaluated for the all-pathways farmer and drinking water only scenarios not evaluated because radiological constituent had no estimated initial inventory or did not arrive in concentrations greater than at the fenceline within the 10,000-year modeling period. In the Decision Management Tool (DMT) that is used to implement the calculational methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site for this Retrieval Data Report, calculated concentrations less than 1.00E-21 pCi/L are considered to be effectively zero. This risk metric may have also not been calculated because the radioactive analyte was predicted to have a concentration less than 0.001 pCi/L, which is well below the ability of standard laboratory analytical methods to detect it.

Table D-4. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index for Single-Shell Tank 241-C-107 per Nonradionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Aluminum	Yes	2.10E+04	0.00E+00	DNA	1.00E+00	NE	NE
Ammonia -- (a)	No	7.50E-02	<1.00E-03	1.05E+04	9.30E-04	NE	NE
Antimony	No	1.20E-01	0.00E+00	DNA	1.00E+00	NE	NE
Arsenic	Yes	5.26E-01	0.00E+00	DNA	3.90E+01	NE	NE
Barium	Yes	2.58E+00	0.00E+00	DNA	6.00E+01	NE	NE
Beryllium	No	9.90E-02	0.00E+00	DNA	7.00E+01	NE	NE
Bismuth	Yes	3.26E+02	1.34E+00	1.05E+04	0.00E+00	No CPF	No Rfd
Boron	Yes	2.10E+00	0.00E+00	DNA	3.00E+00	NE	NE
Bromide	No	3.02E+00	1.24E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Cadmium	Yes	3.07E-01	0.00E+00	DNA	1.26E+00	NE	NE
Calcium	Yes	3.08E+01	0.00E+00	DNA	4.00E+00	NE	NE
Cerium	No	2.48E+00	1.02E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Chloride	No	3.81E+00	1.56E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Chromium, Total	Yes	9.08E+00	3.73E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Cobalt	Yes	1.11E-01	<1.00E-03	1.20E+04	1.00E-01	NE	NE
Copper	Yes	8.36E+00	0.00E+00	DNA	3.50E+01	NE	NE
Cyanide	Yes	5.27E-01	0.00E+00	DNA	9.90E+00	NE	NE
Europium	No	9.90E-02	0.00E+00	DNA	5.00E+01	NE	NE
Fluoride	Yes	8.86E+01	3.64E-01	1.05E+04	0.00E+00	No CPF	3.79E-04

Table D-4. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index for Single-Shell Tank 241-C-107 per Nonradionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Formate+A2	No	8.40E+00	3.45E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Iron	Yes	8.86E+02	0.00E+00	DNA	2.50E+01	NE	NE
Hydroxide OH	Yes	5.16E+00	2.12E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Lanthanum	Yes	4.39E-01	1.80E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Lead	Yes	6.66E+01	0.00E+00	DNA	5.20E+00	NE	NE
Lithium	Yes	1.87E-01	0.00E+00	DNA	3.00E+02	NE	NE
Magnesium	Yes	1.17E+01	0.00E+00	DNA	4.50E+00	NE	NE
Manganese	Yes	1.63E+01	0.00E+00	DNA	1.00E+00	NE	NE
Mercury	Yes	1.64E+00	0.00E+00	DNA	5.20E+00	NE	NE
Molybdenum	Yes	6.58E-01	0.00E+00	DNA	4.00E+00	NE	NE
Neodymium	Yes	2.14E+00	8.79E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Nickel	Yes	9.28E+01	0.00E+00	DNA	4.80E+01	NE	NE
Niobium	No	5.95E-01	0.00E+00	DNA	1.00E+02	NE	NE
Nitrate	Yes	9.69E+01	3.98E-01	1.05E+04	0.00E+00	No CPF	1.55E-05
Nitrite	Yes	6.46E+01	2.65E-01	1.05E+04	0.00E+00	No CPF	1.66E-04
Oxalate	Yes	4.45E+00	1.83E-02	1.05E+04	0.00E+00	No CPF	No Rfd
o-Xylene	No	7.80E-05	<1.00E-03	1.20E+04	7.23E-02	NE	NE
Palladium	No	1.19E+00	0.00E+00	DNA	5.00E+01	NE	NE
Phosphate	Yes	1.72E+03	7.06E+00	1.05E+04	0.00E+00	No CPF	No Rfd

Table D-4. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index for Single-Shell Tank 241-C-107 per Nonradionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Potassium	Yes	2.52E+00	1.03E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Praseodymium	No	2.58E+00	1.06E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Rhodium	No	8.95E-01	3.67E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Rubidium	No	5.65E+00	2.32E-02	1.05E+04	0.00E+00	No CPF	No Rfd
Ruthenium	Yes	2.42E+00	0.00E+00	DNA	1.00E+00	NE	NE
Samarium	Yes	1.98E+00	0.00E+00	DNA	1.00E+00	NE	NE
Selenium	Yes	1.52E+00	0.00E+00	DNA	5.00E+00	NE	NE
Silicon	Yes	3.89E+02	0.00E+00	DNA	3.00E+01	NE	NE
Silver	Yes	8.79E+01	0.00E+00	DNA	2.70E+00	NE	NE
Sodium	Yes	2.10E+03	8.62E+00	1.05E+04	0.00E+00	No CPF	No Rfd
Strontium	Yes	6.42E+00	0.00E+00	DNA	1.61E+01	NE	NE
Sulfate	Yes	3.16E+01	1.30E-01	1.05E+04	0.00E+00	No CPF	No Rfd
Tantalum	No	4.97E-01	2.04E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Tellurium	Yes	7.24E-01	2.97E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Thallium	No	3.96E-01	0.00E+00	DNA	7.10E+01	NE	NE
Thorium	Yes	1.05E+00	0.00E+00	DNA	1.00E+00	NE	NE
Tin	Yes	1.84E+00	0.00E+00	DNA	2.50E+02	NE	NE
Titanium	Yes	2.12E+00	0.00E+00	DNA	1.00E+03	NE	NE
Tungsten	Yes	1.54E+00	6.32E-03	1.05E+04	0.00E+00	No CPF	No Rfd

Table D-4. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index for Single-Shell Tank 241-C-107 per Nonradionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Uranium	Yes	5.78E+02	0.00E+00	DNA	6.00E-01	NE	NE
Vanadium	Yes	5.99E-01	0.00E+00	DNA	5.00E+01	NE	NE
Yttrium	Yes	6.37E-01	2.62E-03	1.05E+04	0.00E+00	No CPF	No Rfd
Zinc	Yes	1.41E+01	0.00E+00	DNA	6.20E+01	NE	NE
Zirconium	Yes	1.21E+01	0.00E+00	DNA	5.00E+02	NE	NE
1, 1, 2-Trichloroethylene	No	1.03E-04	<1.00E-03	1.20E+04	2.82E-02	NE	NE
1, 2, 4-Trichlorobenzene	Yes	1.65E-04	<1.00E-03	1.20E+04	4.98E-01	NE	NE
2-Butanone(MEK)	No	1.67E-03	<1.00E-03	1.05E+04	1.35E-03	NE	NE
2-Propanone (Acetone)	No	1.86E-03	<1.00E-03	1.05E+04	1.73E-04	NE	NE
4-Methyl-2-pentanone (MIBK)	Yes	0.00E+00	<1.00E-03	DNA	4.02E-02	NE	NE
Acetate C2H3O2-	No	5.60E+00	2.30E-02	1.05E+04	3.00E-04	No CPF	No Rfd
Benzene	Yes	1.42E-04	<1.00E-03	1.05E+04	1.86E-02	NE	NE
Butylbenzylphthalate	Yes	6.72E-02	0.00E+00	DNA	4.14E+00	NE	NE
Dichloromethane (methylene chloride)	Yes	9.96E-04	<1.00E-03	1.05E+04	3.00E-03	NE	NE
Di-n-octylphthalate	No	4.68E-02	0.00E+00	DNA	2.49E+04	NE	NE
Glycolate C2H3O3	No	3.21E+00	1.32E-02	1.05E+04	0.00E+00	No CPF	No Rfd
m-Xylene	No	1.42E-04	<1.00E-03	1.20E+04	5.88E-02	NE	NE
Polychlorinated Biphenyls (high risk)	No	2.98E-03	0.00E+00	DNA	9.27E+01	NE	NE
Toluene	Yes	3.53E-04	<1.00E-03	1.20E+04	4.20E-02	NE	NE

Table D-4. Maximum Value for Incremental Lifetime Cancer Risk and Hazard Index for Single-Shell Tank 241-C-107 per Nonradionuclide Contaminants of Potential Concern Using the 95% Upper Confidence Level Concentration Based Inventory. (5 sheets)

Analyte	Above Detection Limits in Residual Waste	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)	Peak Year	K_d (mL/g)[b]	Incremental Lifetime Cancer Risk (Groundwater)[c]	Hazard Quotient (Groundwater)[c]
						WAC 173-340 Method B	
Tributyl phosphate	No	6.65E-02	<1.00E-03	1.20E+04	5.67E-01	NE	NE
Xylenes	No	1.73E-04	<1.00E-03	1.20E+04	5.88E-02	NE	NE
Performance Objective[d]						**1.0E-06[e]**	**1.0[f]**

[a] Dangerous waste constituent per Washington Administrative Code (WAC) 173-303-9905, "Dangerous Waste Constituents List."

[b] See PNNL-13895, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, for the basis for the K_d values listed for chromium and nitrate. The K_d values listed for the organic chemical compounds are determined from the chemicals' organic carbon/water partitioning coefficient and an estimate of 0.03% for the Hanford Site sediments fraction of organic content (PNNL-13895, Rev. 1, page 11, paragraph 3).

[c] All exposure scenarios are described in HNF-SD-WM-TI-707, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments."

[d] Single Analyte Performance objectives apply to entire waste management area, not just a single component of the waste management area.

[e] WAC 173-340-705, "Use of Method B," subpart (2)(c)(ii).

[f] WAC 173-340-705 (2)(c)(i).

DNA = Did not arrive at fenceline within the 10,000-year modeling period.

NE = Incremental cancer risk or hazard quotient calculated under WAC 173-340, "Model Toxics Control Act – Cleanup," Method B not evaluated because hazardous chemical constituent had no estimated initial inventory or did not arrive in concentrations greater than zero at the fenceline within the 10,000-year modeling period. In the Decision Management Tool (DMT) that is used to implement the calculational methodology documented in DOE/ORP-2005-01, Initial Single-Shell Tank System Performance Assessment for the Hanford Site for this Retrieval Data Report, calculated concentrations less than 1.00E-21 µg/L are considered to be effectively zero. The risk metric may have also not been calculated because the chemical analyte was predicted to have a concentration less than 0.001 µg/L, which is well below the ability of standard laboratory analytical methods to detect it.

No CPF = No cancer potency factor available.

No Rfd = No reference dose available.

Table D-5. Well Driller Scenario Doses (mrem) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	7.87E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	7.05E-02	7.05E-02	7.04E-02	7.04E-02	7.04E-02	7.04E-02	7.04E-02	7.03E-02	7.03E-02	7.03E-02
Iodine-129	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06
Cesium-137 + Daughters	2.11E+00	2.10E-01	2.08E-02	2.06E-03	2.05E-04	2.03E-05	2.01E-06	2.00E-07	1.98E-08	1.97E-09
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	2.30E-07	2.28E-07	2.25E-07	2.22E-07	2.20E-07	2.17E-07	2.14E-07	2.12E-07	2.09E-07	2.07E-07
Europium-152	5.20E-03	2.87E-05	1.58E-07	8.73E-10	4.83E-12	3.52E-14	8.79E-15	8.65E-15	8.65E-15	8.65E-15
Europium-154	1.75E-04	5.50E-08	1.73E-11	5.41E-15	1.70E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	2.20E-09	8.14E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	1.03E-01	1.45E-01	1.84E-01	2.22E-01	2.58E-01	2.93E-01	3.26E-01	3.57E-01	3.88E-01	4.17E-01
Protactinium-231	2.51E+00	2.53E+00	2.53E+00	2.52E+00	2.52E+00	2.51E+00	2.51E+00	2.50E+00	2.50E+00	2.49E+00
Thorium-232	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05	5.64E-05
Uranium-233	1.75E-04	2.41E-04	3.07E-04	3.73E-04	4.38E-04	5.02E-04	5.66E-04	6.29E-04	6.91E-04	7.53E-04
Uranium-234	6.95E-04	7.08E-04	7.25E-04	7.47E-04	7.72E-04	8.01E-04	8.33E-04	8.69E-04	9.08E-04	9.50E-04
Uranium-235 + D	2.42E-04	2.48E-04	2.55E-04	2.61E-04	2.68E-04	2.74E-04	2.81E-04	2.87E-04	2.94E-04	3.00E-04
Uranium-236	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05
Neptunium-237 + D	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03	2.93E-03

Table D-5. Well Driller Scenario Doses (mrem) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	3.77E-02	1.71E-02	7.76E-03	3.52E-03	1.60E-03	7.26E-04	3.31E-04	1.51E-04	7.00E-05	3.31E-05
Uranium-238 + D	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03	1.15E-03
Plutonium-239	9.24E-01	9.22E-01	9.19E-01	9.16E-01	9.14E-01	9.11E-01	9.09E-01	9.06E-01	9.03E-01	9.01E-01
Plutonium-240	9.96E-02	9.85E-02	9.75E-02	9.65E-02	9.54E-02	9.44E-02	9.34E-02	9.25E-02	9.15E-02	9.05E-02
Americium-241	6.82E-01	5.81E-01	4.95E-01	4.22E-01	3.59E-01	3.06E-01	2.61E-01	2.22E-01	1.89E-01	1.61E-01
Plutonium-241 + D	3.09E-02	2.64E-02	2.25E-02	1.91E-02	1.63E-02	1.39E-02	1.18E-02	1.01E-02	8.60E-03	7.33E-03
Curium-242	7.13E-06	3.23E-06	1.47E-06	6.66E-07	3.02E-07	1.37E-07	6.25E-08	2.85E-08	1.31E-08	6.15E-09
Plutonium-242	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03	1.87E-03
Curium-243	3.34E-04	3.56E-05	9.37E-06	7.04E-06	6.82E-06	6.78E-06	6.76E-06	6.74E-06	6.72E-06	6.70E-06
Curium-244	9.17E-04	3.43E-04	3.27E-04	3.23E-04	3.20E-04	3.17E-04	3.13E-04	3.10E-04	3.07E-04	3.04E-04
Tritium	6.01E-12	2.18E-14	7.88E-17	2.85E-19	1.03E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	2.97E-07	5.79E-13	1.13E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	6.19E-04	3.10E-04	1.55E-04	7.76E-05	3.88E-05	1.94E-05	9.72E-06	4.86E-06	2.43E-06	1.22E-06
Selenium-79	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.31E-07
Strontium-90 + D	1.17E+00	1.00E-01	8.53E-03	7.27E-04	6.20E-05	5.28E-06	4.50E-07	3.84E-08	3.27E-09	2.79E-10
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	1.68E-06	1.68E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06
Total Dose	**7.76E+00**	**4.71E+00**	**4.36E+00**	**4.28E+00**	**4.24E+00**	**4.21E+00**	**4.19E+00**	**4.17E+00**	**4.15E+00**	**4.15E+00**

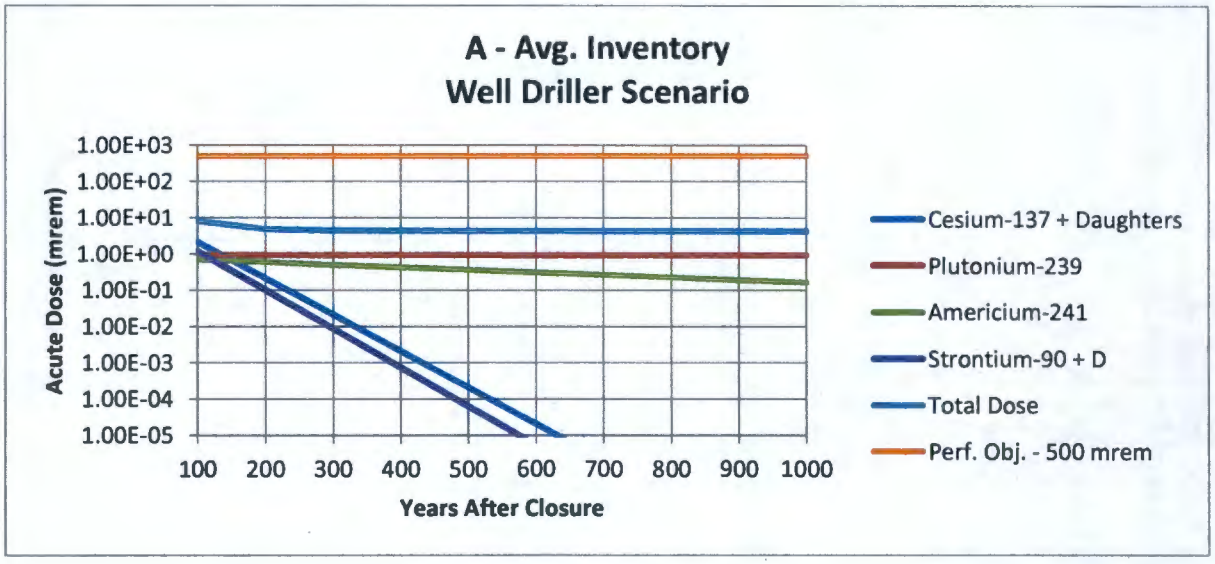
Table D-5. Well Driller Scenario Doses (mrem) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

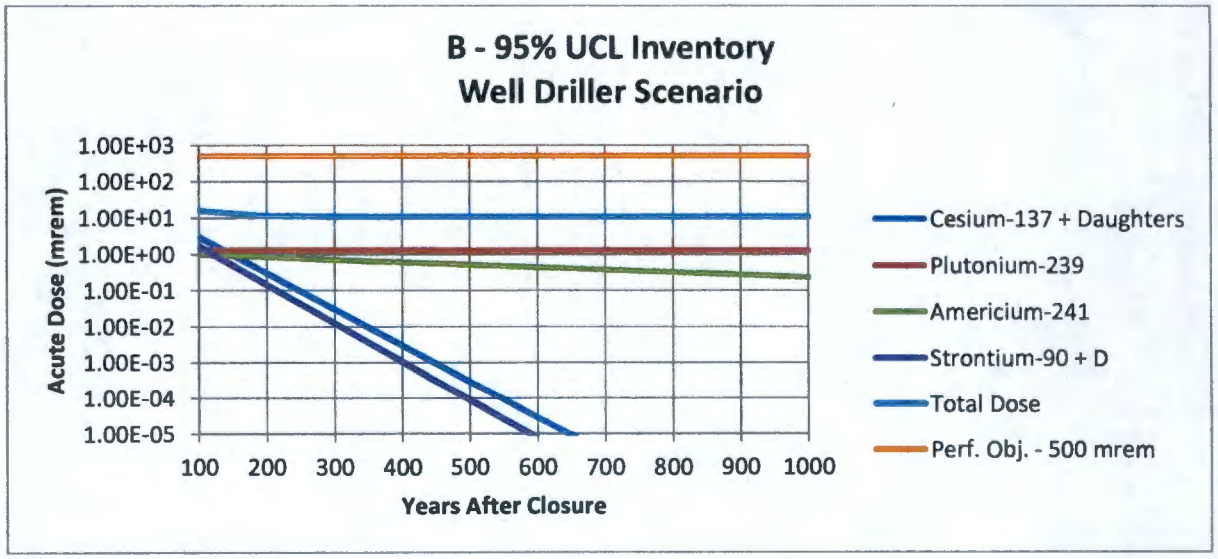
B – 95% Upper Confidence Level Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	2.36E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01	2.11E-01
Iodine-129	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05	1.46E-05
Cesium-137 + Daughters	2.95E+00	2.92E-01	2.90E-02	2.88E-03	2.86E-04	2.83E-05	2.81E-06	2.79E-07	2.77E-08	2.74E-09
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	6.91E-07	6.83E-07	6.75E-07	6.67E-07	6.59E-07	6.51E-07	6.43E-07	6.35E-07	6.28E-07	6.20E-07
Europium-152	1.56E-02	8.60E-05	4.75E-07	2.62E-09	1.45E-11	1.06E-13	2.64E-14	2.59E-14	2.59E-14	2.59E-14
Europium-154	5.26E-04	1.65E-07	5.18E-11	1.62E-14	5.09E-18	1.60E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	6.61E-09	2.44E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	3.10E-01	4.34E-01	5.52E-01	6.66E-01	7.74E-01	8.78E-01	9.77E-01	1.07E+00	1.16E+00	1.25E+00
Protactinium-231	7.52E+00	7.59E+00	7.58E+00	7.57E+00	7.55E+00	7.53E+00	7.52E+00	7.50E+00	7.49E+00	7.47E+00
Thorium-232	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05	9.53E-05
Uranium-233	5.23E-04	7.24E-04	9.22E-04	1.12E-03	1.31E-03	1.51E-03	1.70E-03	1.88E-03	2.07E-03	2.26E-03
Uranium-234	8.64E-04	8.80E-04	9.02E-04	9.28E-04	9.59E-04	9.95E-04	1.04E-03	1.08E-03	1.13E-03	1.18E-03
Uranium-235 + D	3.34E-04	3.43E-04	3.52E-04	3.61E-04	3.70E-04	3.79E-04	3.88E-04	3.97E-04	4.06E-04	4.14E-04
Uranium-236	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05	1.53E-05
Neptunium-237 + D	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03	4.44E-03

Table D-5. Well Driller Scenario Doses (mrem) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

B – 95% Upper Confidence Level Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	5.22E-02	2.37E-02	1.07E-02	4.88E-03	2.21E-03	1.01E-03	4.58E-04	2.10E-04	9.69E-05	4.59E-05
Uranium-238 + D	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03	1.53E-03
Plutonium-239	1.26E+00	1.26E+00	1.25E+00	1.25E+00	1.25E+00	1.24E+00	1.24E+00	1.23E+00	1.23E+00	1.23E+00
Plutonium-240	1.36E-01	1.34E-01	1.33E-01	1.31E-01	1.30E-01	1.29E-01	1.27E-01	1.26E-01	1.25E-01	1.23E-01
Americium-241	9.53E-01	8.12E-01	6.92E-01	5.90E-01	5.03E-01	4.28E-01	3.65E-01	3.11E-01	2.65E-01	2.26E-01
Plutonium-241 + D	4.39E-02	3.75E-02	3.19E-02	2.72E-02	2.32E-02	1.97E-02	1.68E-02	1.43E-02	1.22E-02	1.04E-02
Curium-242	1.24E-05	5.65E-06	2.56E-06	1.16E-06	5.28E-07	2.40E-07	1.09E-07	4.98E-08	2.29E-08	1.07E-08
Plutonium-242	5.61E-03	5.61E-03	5.61E-03	5.61E-03	5.61E-03	5.61E-03	5.61E-03	5.60E-03	5.60E-03	5.60E-03
Curium-243	5.37E-04	5.72E-05	1.51E-05	1.13E-05	1.10E-05	1.09E-05	1.09E-05	1.08E-05	1.08E-05	1.08E-05
Curium-244	1.48E-03	5.53E-04	5.27E-04	5.21E-04	5.16E-04	5.10E-04	5.05E-04	5.00E-04	4.94E-04	4.89E-04
Tritium	1.80E-11	6.53E-14	2.36E-16	8.55E-19	3.09E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	8.92E-07	1.74E-12	3.38E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	8.06E-04	4.03E-04	2.02E-04	1.01E-04	5.05E-05	2.53E-05	1.26E-05	6.33E-06	3.16E-06	1.58E-06
Selenium-79	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07	3.93E-07
Strontium-90 + D	1.66E+00	1.41E-01	1.20E-02	1.03E-03	8.74E-05	7.45E-06	6.35E-07	5.41E-08	4.61E-09	3.93E-10
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06	2.18E-06
Total Dose	**1.51E+01**	**1.10E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**	**1.05E+01**

Figure D-1. Comparison of Well Driller Scenario Doses (mrem) with Performance Objective for Acute Exposure for Key Analytes – A) Average Inventory and B) 95% Upper Confidence Level Inventory in Residual Wastes within Single-Shell Tank 241-C-107.





UCL = upper confidence level

Table D-6. Rural Pasture Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	8.24E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	7.99E-03	7.99E-03	7.99E-03	7.99E-03	7.98E-03	7.98E-03	7.98E-03	7.98E-03	7.97E-03	7.97E-03
Iodine-129	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05	9.03E-05
Cesium-137 + Daughters	5.68E-01	5.64E-02	5.59E-03	5.55E-04	5.50E-05	5.46E-06	5.42E-07	5.37E-08	5.33E-09	5.29E-10
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	2.54E-05	2.51E-05	2.48E-05	2.45E-05	2.42E-05	2.39E-05	2.36E-05	2.33E-05	2.31E-05	2.28E-05
Europium-152	5.88E-04	3.24E-06	1.79E-08	9.88E-11	5.47E-13	5.45E-15	2.46E-15	2.44E-15	2.44E-15	2.44E-15
Europium-154	1.98E-05	6.22E-09	1.95E-12	6.11E-16	1.92E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	1.89E-10	6.99E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	2.51E-02	3.39E-02	4.23E-02	5.04E-02	5.82E-02	6.56E-02	7.26E-02	7.94E-02	8.59E-02	9.21E-02
Protactinium-231	6.40E-01	6.46E-01	6.45E-01	6.43E-01	6.42E-01	6.41E-01	6.39E-01	6.38E-01	6.36E-01	6.35E-01
Thorium-232	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05
Uranium-233	7.10E-05	8.62E-05	1.01E-04	1.16E-04	1.31E-04	1.46E-04	1.60E-04	1.75E-04	1.89E-04	2.03E-04
Uranium-234	4.00E-04	4.03E-04	4.06E-04	4.11E-04	4.17E-04	4.23E-04	4.30E-04	4.38E-04	4.47E-04	4.56E-04
Uranium-235 + D	3.28E-05	3.44E-05	3.61E-05	3.77E-05	3.94E-05	4.10E-05	4.27E-05	4.43E-05	4.60E-05	4.76E-05
Uranium-236	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06	5.95E-06
Neptunium-237 + D	6.23E-04	6.23E-04	6.23E-04	6.23E-04	6.23E-04	6.23E-04	6.23E-04	6.24E-04	6.24E-04	6.24E-04
Plutonium-238	1.07E-02	4.85E-03	2.20E-03	1.00E-03	4.54E-04	2.07E-04	9.44E-05	4.35E-05	2.04E-05	9.92E-06

Table D-6. Rural Pasture Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Uranium-238 + D	2.96E-04	2.96E-04	2.96E-04	2.96E-04	2.96E-04	2.96E-04	2.96E-04	2.96E-04	2.97E-04	2.97E-04
Plutonium-239	2.63E-01	2.62E-01	2.62E-01	2.61E-01	2.60E-01	2.59E-01	2.59E-01	2.58E-01	2.57E-01	2.56E-01
Plutonium-240	2.83E-02	2.80E-02	2.78E-02	2.75E-02	2.72E-02	2.69E-02	2.66E-02	2.63E-02	2.60E-02	2.58E-02
Americium-241	1.88E-01	1.60E-01	1.36E-01	1.16E-01	9.90E-02	8.43E-02	7.19E-02	6.12E-02	5.22E-02	4.45E-02
Plutonium-241 + D	8.51E-03	7.26E-03	6.19E-03	5.27E-03	4.49E-03	3.83E-03	3.26E-03	2.78E-03	2.37E-03	2.02E-03
Curium-242	2.02E-06	9.18E-07	4.16E-07	1.89E-07	8.59E-08	3.91E-08	1.78E-08	8.20E-09	3.83E-09	1.85E-09
Plutonium-242	5.33E-04	5.33E-04	5.33E-04	5.33E-04	5.32E-04	5.32E-04	5.32E-04	5.32E-04	5.32E-04	5.32E-04
Curium-243	7.20E-05	8.10E-06	2.48E-06	1.98E-06	1.93E-06	1.92E-06	1.92E-06	1.91E-06	1.91E-06	1.90E-06
Curium-244	2.63E-04	9.77E-05	9.31E-05	9.21E-05	9.11E-05	9.02E-05	8.92E-05	8.83E-05	8.74E-05	8.64E-05
Tritium	2.23E-10	8.08E-13	2.92E-15	1.06E-17	3.83E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	3.40E-08	6.61E-14	1.29E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	1.65E-02	8.25E-03	4.13E-03	2.07E-03	1.03E-03	5.17E-04	2.59E-04	1.29E-04	6.48E-05	3.24E-05
Selenium-79	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07	6.24E-07
Strontium-90 + D	6.78E+01	5.78E+00	4.93E-01	4.20E-02	3.58E-03	3.05E-04	2.60E-05	2.21E-06	1.89E-07	1.61E-08
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	3.06E-04	3.06E-04	3.05E-04	3.05E-04	3.05E-04	3.05E-04	3.05E-04	3.05E-04	3.05E-04	3.05E-04
Total Dose	**6.96E+01**	**7.00E+00**	**1.63E+00**	**1.16E+00**	**1.11E+00**	**1.09E+00**	**1.08E+00**	**1.08E+00**	**1.07E+00**	**1.07E+00**

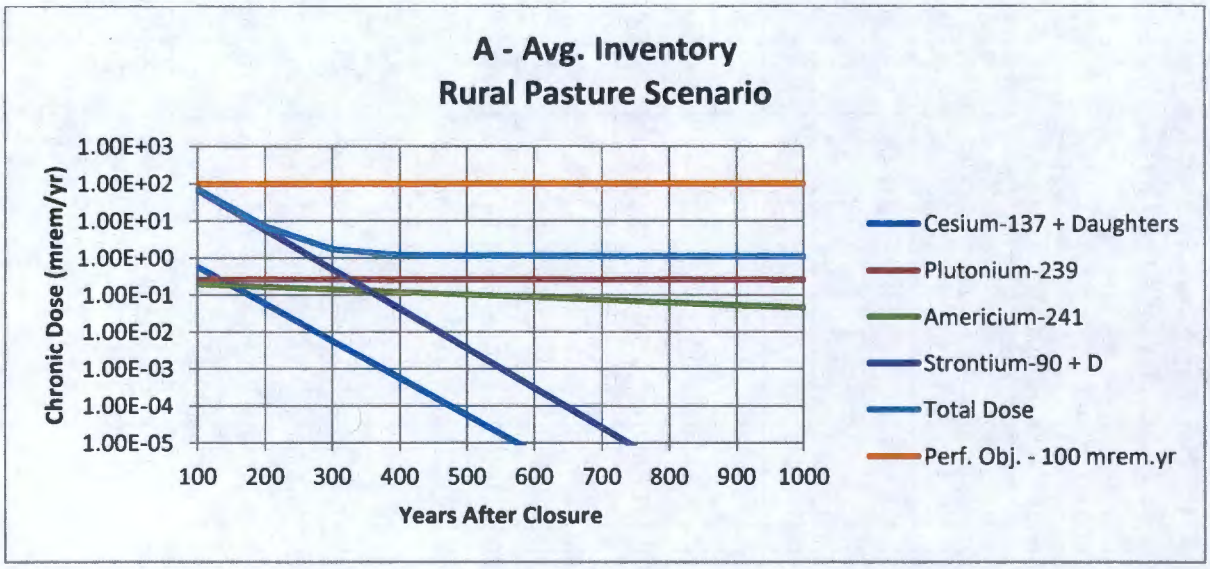
Table D-6. Rural Pasture Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

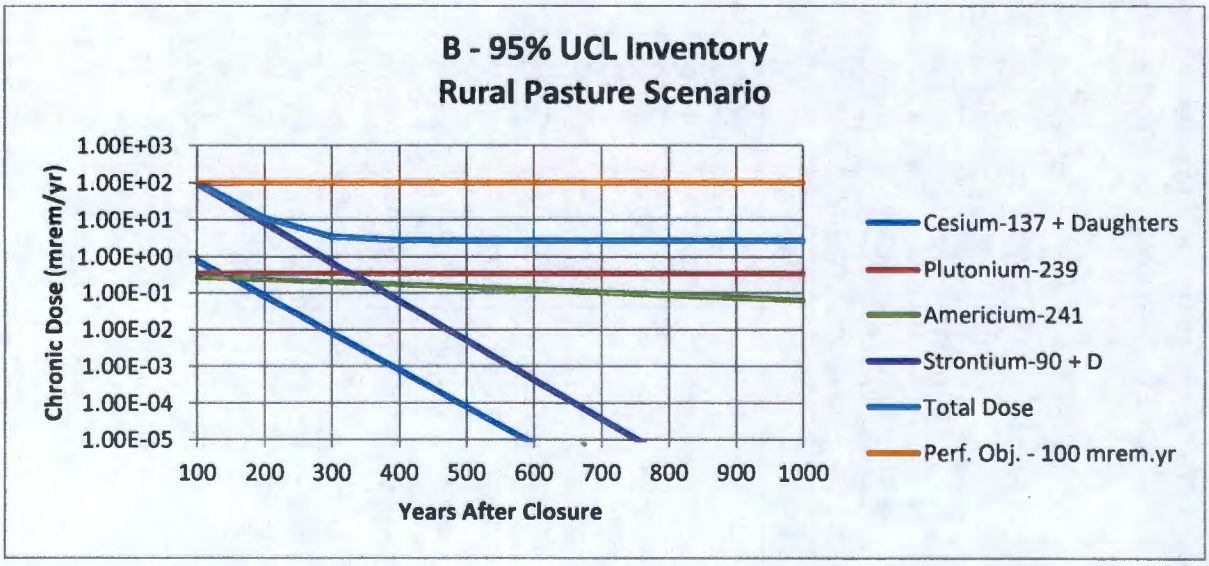
B – 95% Upper Confidence Level Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	2.47E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	2.40E-02	2.40E-02	2.40E-02	2.40E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02	2.39E-02
Iodine-129	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04	1.48E-04
Cesium-137 + Daughters	7.93E-01	7.87E-02	7.80E-03	7.74E-04	7.68E-05	7.62E-06	7.56E-07	7.50E-08	7.44E-09	7.38E-10
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	7.62E-05	7.53E-05	7.44E-05	7.35E-05	7.26E-05	7.17E-05	7.09E-05	7.00E-05	6.92E-05	6.83E-05
Europium-152	1.76E-03	9.73E-06	5.37E-08	2.96E-10	1.64E-12	1.63E-14	7.37E-15	7.32E-15	7.32E-15	7.32E-15
Europium-154	5.95E-05	1.87E-08	5.85E-12	1.83E-15	5.75E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	5.67E-10	2.10E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.52E-02	1.02E-01	1.27E-01	1.51E-01	1.74E-01	1.97E-01	2.18E-01	2.38E-01	2.57E-01	2.76E-01
Protactinium-231	1.92E+00	1.94E+00	1.93E+00	1.93E+00	1.93E+00	1.92E+00	1.92E+00	1.91E+00	1.91E+00	1.91E+00
Thorium-232	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05	1.73E-05
Uranium-233	2.13E-04	2.59E-04	3.04E-04	3.49E-04	3.93E-04	4.37E-04	4.81E-04	5.24E-04	5.67E-04	6.09E-04
Uranium-234	4.97E-04	5.00E-04	5.05E-04	5.11E-04	5.18E-04	5.26E-04	5.35E-04	5.45E-04	5.56E-04	5.67E-04
Uranium-235 + D	4.53E-05	4.76E-05	4.99E-05	5.21E-05	5.44E-05	5.67E-05	5.90E-05	6.12E-05	6.35E-05	6.58E-05
Uranium-236	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06	8.89E-06
Neptunium-237 + D	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04	9.43E-04
Plutonium-238	1.48E-02	6.72E-03	3.05E-03	1.39E-03	6.29E-04	2.86E-04	1.31E-04	6.02E-05	2.82E-05	1.37E-05

Table D-6. Rural Pasture Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

B – 95% Upper Confidence Level Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Uranium-238 + D	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04
Plutonium-239	3.59E-01	3.58E-01	3.57E-01	3.55E-01	3.54E-01	3.53E-01	3.52E-01	3.51E-01	3.50E-01	3.49E-01
Plutonium-240	3.86E-02	3.82E-02	3.78E-02	3.74E-02	3.70E-02	3.66E-02	3.62E-02	3.59E-02	3.55E-02	3.51E-02
Americium-241	2.63E-01	2.24E-01	1.91E-01	1.62E-01	1.38E-01	1.18E-01	1.00E-01	8.56E-02	7.30E-02	6.22E-02
Plutonium-241 + D	1.21E-02	1.03E-02	8.79E-03	7.49E-03	6.38E-03	5.44E-03	4.63E-03	3.95E-03	3.36E-03	2.87E-03
Curium-242	3.53E-06	1.60E-06	7.27E-07	3.30E-07	1.50E-07	6.82E-08	3.11E-08	1.43E-08	6.69E-09	3.23E-09
Plutonium-242	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03
Curium-243	1.16E-04	1.30E-05	3.99E-06	3.19E-06	3.11E-06	3.09E-06	3.08E-06	3.07E-06	3.07E-06	3.06E-06
Curium-244	4.24E-04	1.57E-04	1.50E-04	1.48E-04	1.47E-04	1.45E-04	1.44E-04	1.42E-04	1.41E-04	1.39E-04
Tritium	6.70E-10	2.42E-12	8.77E-15	3.17E-17	1.15E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	1.02E-07	1.98E-13	3.86E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	2.14E-02	1.07E-02	5.37E-03	2.69E-03	1.34E-03	6.72E-04	3.36E-04	1.68E-04	8.42E-05	4.21E-05
Selenium-79	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06	1.88E-06
Strontium-90 + D	9.56E+01	8.15E+00	6.95E-01	5.92E-02	5.05E-03	4.30E-04	3.67E-05	3.12E-06	2.66E-07	2.27E-08
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	3.98E-04	3.98E-04	3.98E-04	3.98E-04	3.98E-04	3.97E-04	3.97E-04	3.97E-04	3.97E-04	3.97E-04
Total Dose	**9.92E+01**	**1.09E+01**	**3.40E+00**	**2.74E+00**	**2.67E+00**	**2.66E+00**	**2.66E+00**	**2.66E+00**	**2.66E+00**	**2.66E+00**

Figure D-2. Comparison of Rural Pasture Scenario Doses with Performance Objective for Chronic Exposure for Key Analytes within A) Average Inventory and B) 95% Upper Confidence Level Inventory Estimated for Residual Wastes in Single-Shell Tank 241-C-107.





UCL = upper confidence level

Table D-7. Suburban Garden Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2007) and Pathways. (4 sheets)

A – Average Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	8.00E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	7.69E-02	7.69E-02	7.69E-02	7.69E-02	7.68E-02	7.68E-02	7.68E-02	7.68E-02	7.68E-02	7.67E-02
Iodine-129	4.49E-04	4.49E-04	4.49E-04	4.48E-04	4.48E-04	4.48E-04	4.48E-04	4.48E-04	4.48E-04	4.48E-04
Cesium-137 + Daughters	5.51E+00	5.46E-01	5.42E-02	5.38E-03	5.34E-04	5.29E-05	5.25E-06	5.21E-07	5.17E-08	5.13E-09
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	4.46E-04	4.40E-04	4.35E-04	4.30E-04	4.25E-04	4.19E-04	4.14E-04	4.09E-04	4.04E-04	4.00E-04
Europium-152	5.65E-03	3.12E-05	1.72E-07	9.49E-10	5.27E-12	6.35E-14	3.47E-14	3.46E-14	3.46E-14	3.46E-14
Europium-154	1.91E-04	5.98E-08	1.88E-11	5.88E-15	1.84E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	1.86E-09	6.86E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	4.29E-01	6.32E-01	8.28E-01	1.02E+00	1.20E+00	1.37E+00	1.53E+00	1.69E+00	1.84E+00	1.98E+00
Protactinium-231	1.36E+01	1.37E+01	1.37E+01	1.36E+01	1.36E+01	1.36E+01	1.35E+01	1.35E+01	1.35E+01	1.35E+01
Thorium-232	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04	1.18E-04
Uranium-233	2.72E-03	2.94E-03	3.15E-03	3.36E-03	3.57E-03	3.77E-03	3.98E-03	4.18E-03	4.38E-03	4.58E-03
Uranium-234	1.89E-02	1.90E-02	1.91E-02	1.92E-02	1.93E-02	1.94E-02	1.95E-02	1.97E-02	1.99E-02	2.01E-02
Uranium-235 + D	6.80E-04	7.15E-04	7.50E-04	7.85E-04	8.20E-04	8.55E-04	8.90E-04	9.25E-04	9.60E-04	9.94E-04
Uranium-236	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04	2.84E-04
Neptunium-237 + D	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02	4.31E-02

Table D-7. Suburban Garden Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2007) and Pathways. (4 sheets)

A – Average Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	2.37E-01	1.07E-01	4.87E-02	2.21E-02	1.01E-02	4.60E-03	2.12E-03	9.89E-04	4.78E-04	2.47E-04
Uranium-238 + D	1.10E-02	1.10E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02
Plutonium-239	5.84E+00	5.82E+00	5.80E+00	5.79E+00	5.77E+00	5.75E+00	5.74E+00	5.72E+00	5.71E+00	5.69E+00
Plutonium-240	6.29E-01	6.22E-01	6.16E-01	6.09E-01	6.03E-01	5.96E-01	5.90E-01	5.84E-01	5.78E-01	5.72E-01
Americium-241	4.11E+00	3.50E+00	2.99E+00	2.54E+00	2.17E+00	1.85E+00	1.58E+00	1.34E+00	1.15E+00	9.76E-01
Plutonium-241 + D	1.86E-01	1.59E-01	1.36E-01	1.16E-01	9.84E-02	8.39E-02	7.15E-02	6.10E-02	5.20E-02	4.43E-02
Curium-242	4.47E-05	2.03E-05	9.22E-06	4.19E-06	1.90E-06	8.69E-07	4.00E-07	1.87E-07	9.00E-08	4.61E-08
Plutonium-242	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02	1.18E-02
Curium-243	1.38E-03	1.60E-04	5.33E-05	4.38E-05	4.28E-05	4.26E-05	4.25E-05	4.24E-05	4.22E-05	4.21E-05
Curium-244	5.68E-03	2.16E-03	2.07E-03	2.04E-03	2.02E-03	2.00E-03	1.98E-03	1.96E-03	1.94E-03	1.92E-03
Tritium	1.95E-09	7.06E-12	2.55E-14	9.25E-17	3.35E-19	1.21E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	3.40E-07	6.61E-13	1.29E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	1.12E-01	5.60E-02	2.80E-02	1.40E-02	7.01E-03	3.51E-03	1.75E-03	8.78E-04	4.39E-04	2.20E-04
Selenium-79	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
Strontium-90 + D	9.62E+02	8.20E+01	6.99E+00	5.95E-01	5.07E-02	4.32E-03	3.69E-04	3.14E-05	2.68E-06	2.28E-07
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	2.33E-02	2.33E-02	2.33E-02	2.33E-02	2.33E-02	2.32E-02	2.32E-02	2.32E-02	2.32E-02	2.32E-02
Total Dose	**9.93E+02**	**1.07E+02**	**3.13E+01**	**2.45E+01**	**2.37E+01**	**2.34E+01**	**2.32E+01**	**2.31E+01**	**2.30E+01**	**2.29E+01**

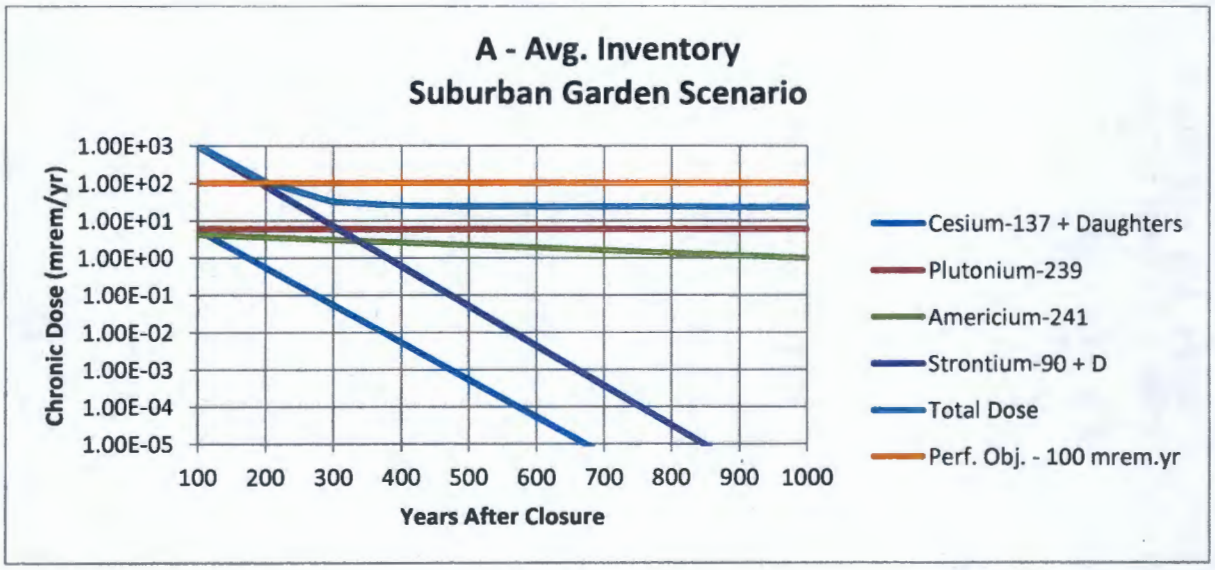
Table D-7. Suburban Garden Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2007) and Pathways. (4 sheets)

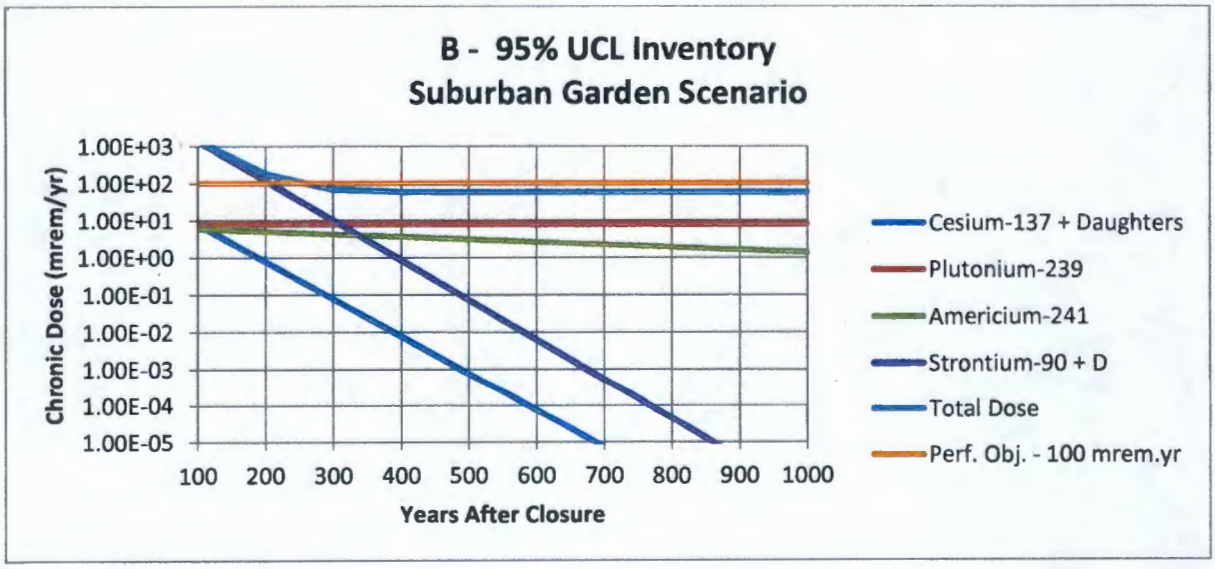
B – 95% Upper Confidence Level Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	2.40E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	2.31E-01	2.31E-01	2.31E-01	2.31E-01	2.31E-01	2.30E-01	2.30E-01	2.30E-01	2.30E-01	2.30E-01
Iodine-129	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04	7.36E-04
Cesium-137 + Daughters	7.68E+00	7.62E-01	7.56E-02	7.50E-03	7.44E-04	7.38E-05	7.33E-06	7.27E-07	7.21E-08	7.15E-09
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	1.34E-03	1.32E-03	1.30E-03	1.29E-03	1.27E-03	1.26E-03	1.24E-03	1.23E-03	1.21E-03	1.20E-03
Europium-152	1.70E-02	9.36E-05	5.16E-07	2.85E-09	1.58E-11	1.90E-13	1.04E-13	1.04E-13	1.04E-13	1.04E-13
Europium-154	5.72E-04	1.79E-07	5.63E-11	1.76E-14	5.53E-18	1.74E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	5.57E-09	2.06E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	1.28E+00	1.90E+00	2.48E+00	3.05E+00	3.58E+00	4.10E+00	4.59E+00	5.06E+00	5.51E+00	5.94E+00
Protactinium-231	4.07E+01	4.10E+01	4.10E+01	4.09E+01	4.08E+01	4.07E+01	4.06E+01	4.05E+01	4.04E+01	4.04E+01
Thorium-232	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04
Uranium-233	8.17E-03	8.81E-03	9.45E-03	1.01E-02	1.07E-02	1.13E-02	1.19E-02	1.25E-02	1.31E-02	1.37E-02
Uranium-234	2.35E-02	2.36E-02	2.37E-02	2.38E-02	2.40E-02	2.41E-02	2.43E-02	2.45E-02	2.47E-02	2.50E-02
Uranium-235 + D	9.39E-04	9.88E-04	1.04E-03	1.08E-03	1.13E-03	1.18E-03	1.23E-03	1.28E-03	1.33E-03	1.37E-03
Uranium-236	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04	4.24E-04
Neptunium-237 + D	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02	6.51E-02

Table D-7. Suburban Garden Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2007) and Pathways. (4 sheets)

B – 95% Upper Confidence Level Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	3.28E-01	1.49E-01	6.75E-02	3.07E-02	1.40E-02	6.37E-03	2.93E-03	1.37E-03	6.63E-04	3.42E-04
Uranium-238 + D	1.47E-02	1.47E-02	1.47E-02	1.47E-02	1.47E-02	1.47E-02	1.48E-02	1.48E-02	1.48E-02	1.48E-02
Plutonium-239	7.95E+00	7.93E+00	7.91E+00	7.89E+00	7.86E+00	7.84E+00	7.82E+00	7.80E+00	7.77E+00	7.75E+00
Plutonium-240	8.56E-01	8.47E-01	8.39E-01	8.30E-01	8.21E-01	8.12E-01	8.04E-01	7.95E-01	7.87E-01	7.79E-01
Americium-241	5.75E+00	4.90E+00	4.18E+00	3.56E+00	3.03E+00	2.59E+00	2.20E+00	1.88E+00	1.60E+00	1.37E+00
Plutonium-241 + D	2.65E-01	2.26E-01	1.93E-01	1.64E-01	1.40E-01	1.19E-01	1.02E-01	8.66E-02	7.38E-02	6.29E-02
Curium-242	7.81E-05	3.55E-05	1.61E-05	7.31E-06	3.33E-06	1.52E-06	6.98E-07	3.26E-07	1.57E-07	8.05E-08
Plutonium-242	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02
Curium-243	2.22E-03	2.58E-04	8.57E-05	7.04E-05	6.89E-05	6.85E-05	6.83E-05	6.81E-05	6.79E-05	6.77E-05
Curium-244	9.15E-03	3.49E-03	3.33E-03	3.29E-03	3.26E-03	3.22E-03	3.19E-03	3.16E-03	3.12E-03	3.09E-03
Tritium	5.85E-09	2.12E-11	7.66E-14	2.77E-16	1.00E-18	3.63E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	1.02E-06	1.98E-12	3.86E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	1.45E-01	7.28E-02	3.64E-02	1.82E-02	9.12E-03	4.56E-03	2.28E-03	1.14E-03	5.71E-04	2.86E-04
Selenium-79	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05	3.05E-05
Strontium-90 + D	1.36E+03	1.16E+02	9.86E+00	8.40E-01	7.16E-02	6.10E-03	5.20E-04	4.43E-05	3.78E-06	3.22E-07
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.02E-02	3.02E-02
Total Dose	**1.42E+03**	**1.74E+02**	**6.70E+01**	**5.77E+01**	**5.68E+01**	**5.66E+01**	**5.66E+01**	**5.66E+01**	**5.66E+01**	**5.67E+01**

Figure D-3. Comparison of Doses from Suburban Garden Scenario with Performance Objective for Chronic Exposure for Key Analytes within A) Average Inventory and B) 95% Upper Confidence Level Inventory Estimated for Residual Wastes in Single-Shell Tank 241-C-107.





UCL = upper confidence level

Table D-8. Commercial Farm Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	3.14E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	3.04E-04	3.04E-04	3.04E-04	3.03E-04	3.03E-04	3.03E-04	3.03E-04	3.03E-04	3.03E-04	3.03E-04
Iodine-129	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08	4.16E-08
Cesium-137 + Daughters	9.09E-03	9.02E-04	8.95E-05	8.88E-06	8.81E-07	8.74E-08	8.67E-09	8.60E-10	8.53E-11	8.46E-12
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	1.23E-09	1.22E-09	1.20E-09	1.19E-09	1.17E-09	1.16E-09	1.14E-09	1.13E-09	1.12E-09	1.10E-09
Europium-152	2.24E-05	1.24E-07	6.83E-10	3.77E-12	2.09E-14	2.00E-16	8.59E-17	8.53E-17	8.53E-17	8.53E-17
Europium-154	7.56E-07	2.37E-10	7.44E-14	2.33E-17	7.31E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	7.20E-12	2.66E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.15E-04	9.05E-04	1.09E-03	1.26E-03	1.43E-03	1.59E-03	1.74E-03	1.88E-03	2.02E-03	2.16E-03
Protactinium-231	1.82E-02	1.83E-02	1.83E-02	1.83E-02	1.82E-02	1.82E-02	1.82E-02	1.81E-02	1.81E-02	1.80E-02
Thorium-232	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
Uranium-233	1.22E-06	1.73E-06	2.24E-06	2.74E-06	3.24E-06	3.73E-06	4.22E-06	4.70E-06	5.18E-06	5.66E-06
Uranium-234	4.43E-06	4.52E-06	4.62E-06	4.75E-06	4.89E-06	5.04E-06	5.22E-06	5.41E-06	5.61E-06	5.83E-06
Uranium-235 + D	9.86E-07	1.03E-06	1.08E-06	1.13E-06	1.17E-06	1.22E-06	1.27E-06	1.32E-06	1.36E-06	1.41E-06
Uranium-236	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08	6.51E-08
Neptunium-237 + D	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05

Table D-8. Commercial Farm Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

A – Average Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	3.02E-04	1.37E-04	6.21E-05	2.82E-05	1.28E-05	5.81E-06	2.64E-06	1.21E-06	5.56E-07	2.61E-07
Uranium-238 + D	5.43E-06	5.43E-06	5.43E-06	5.43E-06	5.43E-06	5.43E-06	5.43E-06	5.43E-06	5.44E-06	5.44E-06
Plutonium-239	7.41E-03	7.39E-03	7.37E-03	7.35E-03	7.33E-03	7.31E-03	7.29E-03	7.27E-03	7.25E-03	7.23E-03
Plutonium-240	7.99E-04	7.90E-04	7.82E-04	7.74E-04	7.66E-04	7.58E-04	7.50E-04	7.42E-04	7.34E-04	7.26E-04
Americium-241	5.32E-03	4.53E-03	3.86E-03	3.29E-03	2.80E-03	2.39E-03	2.03E-03	1.73E-03	1.48E-03	1.26E-03
Plutonium-241 + D	2.41E-04	2.06E-04	1.75E-04	1.49E-04	1.27E-04	1.08E-04	9.23E-05	7.87E-05	6.71E-05	5.71E-05
Curium-242	5.71E-08	2.59E-08	1.17E-08	5.33E-09	2.42E-09	1.10E-09	5.00E-10	2.28E-10	1.05E-10	4.87E-11
Plutonium-242	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05
Curium-243	2.12E-06	2.36E-07	7.07E-08	5.59E-08	5.45E-08	5.42E-08	5.41E-08	5.39E-08	5.38E-08	5.36E-08
Curium-244	7.29E-06	2.75E-06	2.62E-06	2.59E-06	2.57E-06	2.54E-06	2.51E-06	2.49E-06	2.46E-06	2.44E-06
Tritium	7.81E-12	2.83E-14	1.02E-16	3.70E-19	1.34E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	1.29E-09	2.51E-15	4.89E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	3.52E-06	1.76E-06	8.80E-07	4.41E-07	2.20E-07	1.10E-07	5.52E-08	2.76E-08	1.38E-08	6.91E-09
Selenium-79	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10	6.83E-10
Strontium-90 + D	5.59E-03	4.77E-04	4.06E-05	3.46E-06	2.95E-07	2.51E-08	2.14E-09	1.83E-10	1.56E-11	1.33E-12
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	7.58E-09	7.58E-09	7.58E-09	7.57E-09	7.57E-09	7.57E-09	7.57E-09	7.56E-09	7.56E-09	7.56E-09
Total Dose	**4.81E-02**	**3.41E-02**	**3.22E-02**	**3.15E-02**	**3.11E-02**	**3.07E-02**	**3.04E-02**	**3.02E-02**	**3.00E-02**	**2.98E-02**

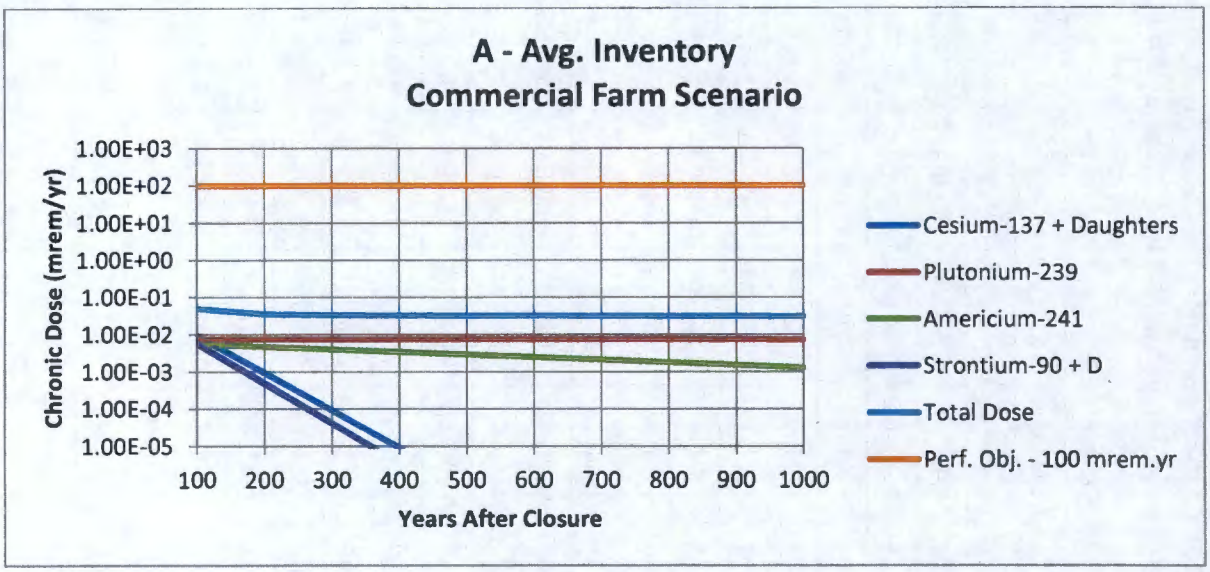
Table D-8. Commercial Farm Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

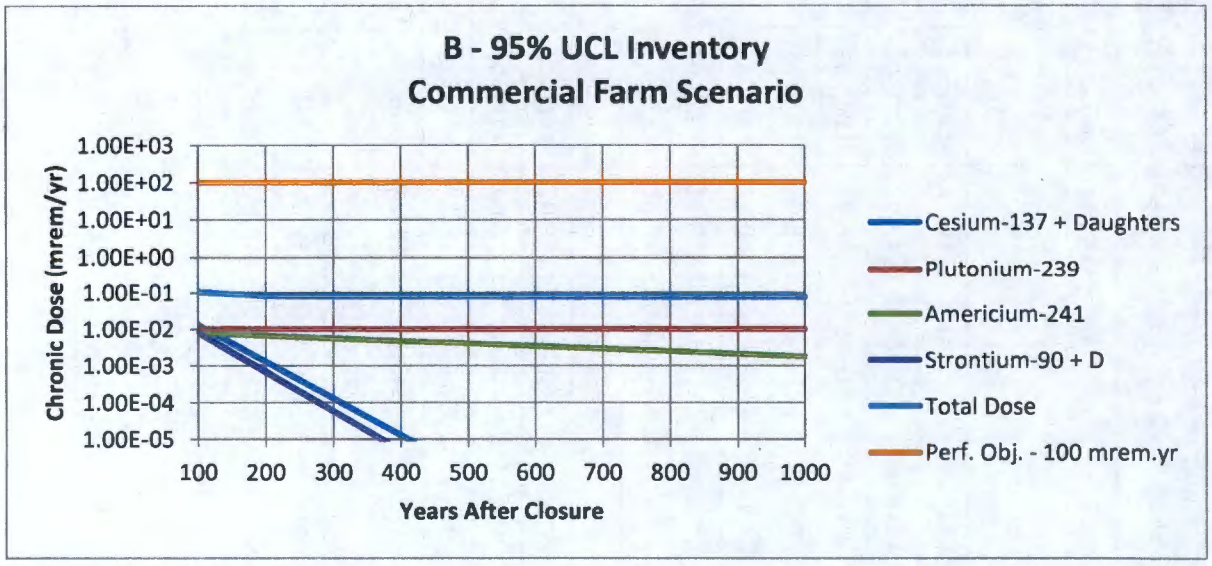
B – 95% Upper Confidence Level Inventory										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Antimony-125	9.43E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin-126	9.11E-04	9.11E-04	9.11E-04	9.10E-04	9.10E-04	9.10E-04	9.10E-04	9.09E-04	9.09E-04	9.09E-04
Iodine-129	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08	6.82E-08
Cesium-137 + Daughters	1.27E-02	1.26E-03	1.25E-04	1.24E-05	1.23E-06	1.22E-07	1.21E-08	1.20E-09	1.19E-10	1.18E-11
Barium-137m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14	3.69E-09	3.65E-09	3.60E-09	3.56E-09	3.52E-09	3.47E-09	3.43E-09	3.39E-09	3.35E-09	3.31E-09
Europium-152	6.73E-05	3.71E-07	2.05E-09	1.13E-11	6.26E-14	6.00E-16	2.58E-16	2.56E-16	2.56E-16	2.56E-16
Europium-154	2.27E-06	7.12E-10	2.23E-13	7.00E-17	2.19E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Europium-155	2.16E-11	7.99E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228 + D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	2.14E-03	2.71E-03	3.26E-03	3.78E-03	4.28E-03	4.75E-03	5.21E-03	5.65E-03	6.06E-03	6.46E-03
Protactinium-231	5.46E-02	5.50E-02	5.49E-02	5.48E-02	5.47E-02	5.46E-02	5.45E-02	5.44E-02	5.43E-02	5.41E-02
Thorium-232	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07	5.14E-07
Uranium-233	3.66E-06	5.19E-06	6.72E-06	8.22E-06	9.72E-06	1.12E-05	1.27E-05	1.41E-05	1.55E-05	1.70E-05
Uranium-234	5.51E-06	5.62E-06	5.75E-06	5.90E-06	6.07E-06	6.27E-06	6.49E-06	6.72E-06	6.98E-06	7.25E-06
Uranium-235 + D	1.36E-06	1.43E-06	1.49E-06	1.56E-06	1.62E-06	1.69E-06	1.75E-06	1.82E-06	1.88E-06	1.95E-06
Uranium-236	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08	9.73E-08
Neptunium-237 + D	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05	2.82E-05
Antimony-125	9.43E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D-8. Commercial Farm Doses (mrem/y) for Single-Shell Tank 241-C-107 Showing Major Constituents for A) Average Inventory and B) 95% Upper Confidence Level Inventory (decayed as of January 2008) and Pathways. (4 sheets)

B – 95% Upper Confidence Level Inventory (continued)										
	Years After Site Closure (January 1, 2032)									
Nuclide	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Plutonium-238	4.18E-04	1.90E-04	8.61E-05	3.91E-05	1.77E-05	8.05E-06	3.66E-06	1.67E-06	7.70E-07	3.61E-07
Uranium-238 + D	7.24E-06	7.24E-06	7.24E-06	7.24E-06	7.24E-06	7.24E-06	7.24E-06	7.25E-06	7.25E-06	7.25E-06
Plutonium-239	1.01E-02	1.01E-02	1.00E-02	1.00E-02	9.99E-03	9.96E-03	9.93E-03	9.90E-03	9.87E-03	9.84E-03
Plutonium-240	1.09E-03	1.08E-03	1.07E-03	1.05E-03	1.04E-03	1.03E-03	1.02E-03	1.01E-03	1.00E-03	9.89E-04
Americium-241	7.43E-03	6.33E-03	5.40E-03	4.60E-03	3.92E-03	3.34E-03	2.85E-03	2.42E-03	2.07E-03	1.76E-03
Plutonium-241 + D	3.42E-04	2.92E-04	2.49E-04	2.12E-04	1.81E-04	1.54E-04	1.31E-04	1.12E-04	9.52E-05	8.12E-05
Curium-242	9.96E-08	4.52E-08	2.05E-08	9.31E-09	4.22E-09	1.92E-09	8.73E-10	3.98E-10	1.83E-10	8.50E-11
Plutonium-242	4.51E-05	4.51E-05	4.51E-05	4.51E-05	4.50E-05	4.50E-05	4.50E-05	4.50E-05	4.50E-05	4.50E-05
Curium-243	3.41E-06	3.80E-07	1.14E-07	9.00E-08	8.77E-08	8.72E-08	8.70E-08	8.67E-08	8.64E-08	8.62E-08
Curium-244	1.17E-05	4.43E-06	4.23E-06	4.18E-06	4.14E-06	4.09E-06	4.05E-06	4.01E-06	3.97E-06	3.92E-06
Tritium	2.34E-11	8.48E-14	3.07E-16	1.11E-18	4.02E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt-60	3.87E-09	7.54E-15	1.47E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel-63	4.57E-06	2.29E-06	1.15E-06	5.73E-07	2.87E-07	1.43E-07	7.18E-08	3.59E-08	1.80E-08	8.99E-09
Selenium-79	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09	2.05E-09
Strontium-90 + D	7.89E-03	6.72E-04	5.73E-05	4.88E-06	4.16E-07	3.55E-08	3.02E-09	2.58E-10	2.20E-11	1.87E-12
Yttrium-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	9.87E-09	9.87E-09	9.87E-09	9.86E-09	9.86E-09	9.86E-09	9.85E-09	9.85E-09	9.85E-09	9.84E-09
Total Dose	**9.78E-02**	**7.87E-02**	**7.63E-02**	**7.56E-02**	**7.52E-02**	**7.49E-02**	**7.46E-02**	**7.45E-02**	**7.44E-02**	**7.43E-02**

Figure D-4. Comparison of Doses from Commercial Farm Scenario with Performance Objective for Chronic Exposure for Key Analytes within A) Average Inventory and B) 95% Upper Confidence Level Inventory Estimated for Residual Wastes in Single-Shell Tank 241-C-107.





UCL = upper confidence level

Table D-9. Average and 95% Upper Confidence Levels for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Above Detection Limits
1, 2, 4-Trichlorobenzene*	1.95E-03	2.40E-03	3.45E+01	4.53E+03	5.63E-02	Yes
Aluminum	2.71E+05	2.89E+05	8.00E+04	3.50E+06	4.80E+05	Yes
Arsenic*	6.19E+00	7.66E+00	6.67E-01	8.75E+01	3.41E-02	Yes
Barium*	4.09E+00	5.55E+00	--	--	--	Yes
Benzene*	1.59E-03	2.08E-03	1.82E+01	2.39E+03	4.48E-03	Yes
Bismuth	3.39E+03	4.81E+03	--	--	--	Yes
Boron	1.59E+01	3.12E+01	1.60E+04	7.00E+05	2.05E+02	Yes
Butylbenzylphthalate*	5.30E-01	1.00E+00	5.26E+02	6.91E+04	1.29E+01	Yes
Cadmium*	3.74E+00	4.43E+00	8.00E+01	3.50E+03	6.90E-01	Yes
Calcium	3.54E+02	4.51E+02	--	--	--	Yes
Chromium, Total*	1.01E+02	1.34E+02	1.20E+05	5.25E+06	2.00E+03	Yes
Cobalt	1.28E+00	1.62E+00	2.40E+01	1.05E+03	4.34E+00	Yes
Copper	1.07E+02	1.18E+02	3.20E+03	1.40E+05	2.84E+02	Yes
Cyanide*	6.02E+00	7.73E+00	4.80E+01	2.10E+03	9.70E-01	Yes
Dichloromethane (methylene chloride)*	1.29E-02	1.37E-02	4.80E+02	2.10E+04	2.18E-02	Yes
Fluoride	1.00E+03	1.30E+03	4.80E+03	2.10E+05	2.88E+03	Yes
Hydroxide OH	3.86E+01	7.71E+01	--	--	--	Yes
Iron	9.48E+03	1.31E+04	5.60E+04	2.45E+06	5.64E+03	Yes
Lanthanum	4.88E+00	6.45E+00	--	--	--	Yes
Lead*	8.27E+02	9.54E+02	--	1.00E+03	3.00E+03	Yes
Lithium	2.43E+00	2.59E+00	1.60E+02	7.00E+03	1.92E+02	Yes
Magnesium	1.42E+02	1.69E+02	--	--	--	Yes
Manganese	1.56E+02	2.41E+02	1.12E+04	4.90E+05	5.01E+02	Yes

Table D-9. Average and 95% Upper Confidence Levels for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Above Detection Limits
Mercury*	1.93E+01	2.37E+01	2.40E+01	1.05E+03	2.09E+00	Yes
Molybdenum	5.91E+00	9.78E+00	4.00E+02	1.75E+04	3.23E+01	Yes
Neodymium	2.53E+01	3.11E+01	--	--	--	Yes
Nickel*	4.95E+00	6.19E+00	--	--	--	Yes
Nitrate	1.02E+03	1.43E+03	5.68E+05	2.49E+07	1.80E+02	Yes
Nitrite	6.90E+02	9.54E+02	2.40E+04	1.05E+06	1.32E+01	Yes
Oxalate	5.60E+01	6.34E+01	--	--	--	Yes
Phosphate	1.53E+04	2.55E+04	--	--	--	Yes
Potassium	2.86E+01	3.71E+01	--	--	--	Yes
Ruthenium	2.02E+01	3.61E+01	--	--	--	Yes
Samarium	2.39E+01	2.87E+01	--	--	--	Yes
Silicon	4.37E+03	5.71E+03	--	--	--	Yes
Silver*	9.15E+02	1.30E+03	4.00E+02	1.75E+04	1.36E+01	Yes
Sodium	2.21E+04	3.10E+04	--	--	--	Yes
Strontium	7.15E+01	9.45E+01	4.80E+04	2.10E+06	6.76E+03	Yes
Sulfate	3.81E+02	4.58E+02	--	--	1.00E+03	Yes
Tellurium	9.14E+00	1.03E+01	--	--	--	Yes
Thorium	1.09E+01	1.55E+01	--	--	--	Yes
Tin	1.79E+01	2.72E+01	4.80E+04	2.10E+06	4.80E+04	Yes
Titanium	2.74E+01	2.92E+01	--	--	--	Yes
Toluene*	4.39E-03	5.04E-03	6.40E+03	2.80E+05	4.65E+00	Yes
Tungsten	1.90E+01	2.22E+01	--	--	--	Yes
Uranium	6.56E+03	8.45E+03	2.40E+02	1.05E+04	2.70E+02	Yes

Table D-9. Average and 95% Upper Confidence Levels for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Above Detection Limits
Vanadium	7.33E+00	8.64E+00	4.00E+02	1.75E+04	1.60E+03	Yes
Yttrium	6.22E+00	9.45E+00	--	--	--	Yes
Zinc	1.81E+02	1.98E+02	2.40E+04	1.05E+06	5.97E+03	Yes
Zirconium	1.19E+02	1.80E+02	--	--	--	Yes
1, 1, 2-Trichloroethylene	1.04E-03	3.08E-03	2.17E+01	1.75E+03	6.29E-03	No
2-Butanone(MEK)	1.68E-02	4.97E-02	4.80E+04	2.10E+06	1.97E+01	No
2-Propanone (Acetone)	1.88E-02	5.56E-02	7.20E+04	3.15E+06	2.89E+01	No
Acetate	5.68E+01	1.68E+02	--	--	--	No
Ammonia	7.60E-01	2.25E+00	--	--	--	No
Antimony*	1.47E+00	4.35E+00	--	--	--	No
Beryllium*	1.00E+00	2.96E+00	1.60E+02	7.00E+03	6.32E+01	No
Bromide	3.04E+01	9.00E+01	--	--	--	No
Cerium	2.51E+01	7.43E+01	--	--	--	No
Chloride	3.86E+01	1.14E+02	--	--	1.00E+03	No
Di-n-octylphthalate*	4.73E-01	1.40E+00	9.60E+02	4.20E+04	3.19E+05	No
Europium	1.00E+00	2.96E+00	--	--	--	No
Formate+A2	8.52E+01	2.52E+02	--	--	--	No
Glycolate C2H3O3	3.25E+01	9.62E+01	--	--	--	No
m-Xylene	1.43E-03	4.23E-03	1.60E+04	7.00E+05	1.35E+01	No
Niobium	6.02E+00	1.78E+01	--	--	--	No
o-Xylene	7.88E-04	2.33E-03	1.60E+04	7.00E+05	1.47E+01	No
Palladium	1.20E+01	3.55E+01	--	--	--	No
Polychlorinated Biphenyls*	3.01E-02	8.91E-02	5.00E-01	6.56E+01	--	No

Table D-9. Average and 95% Upper Confidence Levels for Waste Residuals within Tank 241-C-107, Soil Cleanup Levels for Method B and C Direct Contact Exposure, and Soil Concentrations Protective of Groundwater. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	95% Upper Confidence Level Concentration (mg/kg)[b]	Soil Cleanup Level (mg/kg) – Direct Contact Method B	Soil Cleanup Level (mg/kg) – Direct Contact Method C	Soil Concentrations (mg/kg) – Protective of Groundwater	Above Detection Limits
Praseodymium	2.61E+01	7.73E+01	--	--	--	No
Rhodium	9.03E+00	2.67E+01	--	--	--	No
Rubidium	5.72E+01	1.69E+02	--	--	--	No
Selenium*	5.91E-05	1.75E-04	--	--	--	No
Tantalum	5.01E+00	1.48E+01	--	--	--	No
Thallium*	4.01E+00	1.19E+01	--	--	2.28E-01	No
Tributyl phosphate	6.71E-01	1.99E+00	1.11E+02	1.46E+04	4.96E-01	No
Xylenes	1.74E-03	5.15E-03	1.60E+04	7.00E+05	1.46E+01	No

[a] Mean Concentrations taken from Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] 95% Upper Confidence Level Concentration = Mean Concentration + (1.96 × Mean Concentration × Relative Standard Deviation). Mean Concentrations and Relative Standard Deviation provided in Table A-1 in Appendix A of RPP-RPT-58514.

[c] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

[d] As nitrite, not nitrogen in nitrite; to convert to nitrogen in nitrite divide this number by 3.29.

* Dangerous waste constituent per Washington Administrative Code 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III), insoluble salts.

-- = Value is not available

Table D-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Hazardous Constituents in 241-C-107 Tank Residual Wastes. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Mean Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
1, 2, 4-Trichlorobenzene*	1.95E-03	5.66E-05	4.31E-07	3.47E-02	Yes
Aluminum	2.71E+05	3.39E+00	7.74E-02	5.65E-01	Yes
Arsenic*	6.19E+00	9.29E+00	7.07E-02	1.82E+02	Yes
Barium*	4.09E+00	--	--	--	Yes
Benzene*	1.59E-03	8.75E-05	6.66E-07	3.55E-01	Yes
Bismuth	3.39E+03	--	--	--	Yes
Boron	1.59E+01	9.94E-04	2.27E-05	7.76E-02	Yes
Butylbenzylphthalate*	5.30E-01	1.01E-03	7.67E-06	4.11E-02	Yes
Cadmium*	3.74E+00	4.68E-02	1.07E-03	5.42E+00	Yes
Calcium	3.54E+02	--	--	--	Yes
Chromium, Total*	1.01E+02	8.42E-04	1.92E-05	5.05E-02	Yes
Cobalt	1.28E+00	5.33E-02	1.22E-03	2.95E-01	Yes
Copper	1.07E+02	3.34E-02	7.64E-04	3.77E-01	Yes
Cyanide*	6.02E+00	1.25E-01	2.87E-03	6.21E+00	Yes
Dichloromethane (methylene chloride)*	1.29E-02	2.69E-05	6.14E-07	5.92E-01	Yes
Fluoride	1.00E+03	2.08E-01	4.76E-03	3.47E-01	Yes
Hydroxide OH	3.86E+01	--	--	--	Yes
Iron	9.48E+03	1.69E-01	3.87E-03	1.68E+00	Yes
Lanthanum	4.88E+00	--	--	--	Yes
Lead*	8.27E+02	--	8.27E-01	2.76E-01	Yes
Lithium	2.43E+00	1.52E-02	3.47E-04	1.26E-02	Yes
Magnesium	1.42E+02	--	--	--	Yes

Table D-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Hazardous Constituents in 241-C-107 Tank Residual Wastes. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Mean Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
Manganese	1.56E+02	1.39E-02	3.18E-04	3.12E-01	Yes
Mercury*	1.93E+01	8.04E-01	1.84E-02	9.24E+00	Yes
Molybdenum	5.91E+00	1.48E-02	3.38E-04	1.83E-01	Yes
Neodymium	2.53E+01	--	--	--	Yes
Nickel*	4.95E+00	--	--	--	Yes
Nitrate	1.02E+03	1.80E-03	4.10E-05	5.67E+00	Yes
Nitrite	6.90E+02	2.88E-02	6.57E-04	5.23E+01	Yes
Oxalate	5.60E+01	--	--	--	Yes
Phosphate	1.53E+04	--	--	--	Yes
Potassium	2.86E+01	--	--	--	Yes
Ruthenium	2.02E+01	--	--	--	Yes
Samarium	2.39E+01	--	--	--	Yes
Silicon	4.37E+03	--	--	--	Yes
Silver*	9.15E+02	2.29E+00	5.23E-02	6.73E+01	Yes
Sodium	2.21E+04	--	--	--	Yes
Strontium	7.15E+01	1.49E-03	3.40E-05	1.06E-02	Yes
Sulfate	3.81E+02	--	--	3.81E-01	Yes
Tellurium	9.14E+00	--	--	--	Yes
Thorium	1.09E+01	--	--	--	Yes
Tin	1.79E+01	3.73E-04	8.52E-06	3.73E-04	Yes
Titanium	2.74E+01	--	--	--	Yes
Toluene*	4.39E-03	6.86E-07	1.57E-08	9.43E-04	Yes

Table D-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Hazardous Constituents in 241-C-107 Tank Residual Wastes. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Mean Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
Tungsten	1.90E+01	--	--	--	Yes
Uranium	6.56E+03	2.73E+01	6.25E-01	2.43E+01	Yes
Vanadium	7.33E+00	1.83E-02	4.19E-04	4.58E-03	Yes
Yttrium	6.22E+00	--	--	--	Yes
Zinc	1.81E+02	7.54E-03	1.72E-04	3.03E-02	Yes
Zirconium	1.19E+02	--	--	--	Yes
1, 1, 2-Trichloroethylene	1.04E-03	4.78E-05	5.94E-07	1.65E-01	No
2-Butanone(MEK)	1.68E-02	3.50E-07	8.00E-09	8.55E-04	No
2-Propanone (Acetone)	1.88E-02	2.61E-07	5.97E-09	6.50E-04	No
Acetate	5.68E+01	--	--	--	No
Ammonia	7.60E-01	--	--	--	No
Antimony*	1.47E+00	--	--	--	No
Beryllium*	1.00E+00	6.25E-03	1.43E-04	1.58E-02	No
Bromide	3.04E+01	--	--	--	No
Cerium	2.51E+01	--	--	--	No
Chloride	3.86E+01	--	--	3.86E-02	No
Di-n-octylphthalate*	4.73E-01	4.93E-04	1.13E-05	1.48E-06	No
Europium	1.00E+00	--	--	--	No
Formate+A2	8.52E+01	--	--	--	No
Glycolate C2H3O3	3.25E+01	--	--	--	No
m-Xylene	1.43E-03	8.94E-08	2.04E-09	1.06E-04	No
Niobium	6.02E+00	--	--	--	No

Table D-10. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for Average Concentrations of Selected Hazardous Constituents in 241-C-107 Tank Residual Wastes. (4 sheets)

Analyte	Average Concentration (mg/kg)[a]	Ratio of Mean Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
o-Xylene	7.88E-04	4.93E-08	1.13E-09	5.36E-05	No
Palladium	1.20E+01	--	--	--	No
Polychlorinated Biphenyls*	3.01E-02	6.02E-02	4.59E-04	--	No
Praseodymium	2.61E+01	--	--	--	No
Rhodium	9.03E+00	--	--	--	No
Rubidium	5.72E+01	--	--	--	No
Selenium*	5.91E-05	--	--	--	No
Tantalum	5.01E+00	--	--	--	No
Thallium*	4.01E+00	--	--	1.76E+01	No
Tributyl phosphate	6.71E-01	6.04E-03	4.60E-05	1.35E+00	No
Xylenes	1.74E-03	1.09E-07	2.49E-09	1.19E-04	No

[a] Mean Concentrations taken from Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

[c] As nitrite, not nitrogen in nitrite; to convert to nitrogen in nitrite divide this number by 3.29.

* Dangerous waste constituent per Washington Administrative Code 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III), insoluble salts.

-- = Value is not available

Table D-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Hazardous Constituents above Detection in 241-C-107 Tank Residual Wastes. (5 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
1, 2, 4-Trichlorobenzene*	2.40E-03	6.95E-05	5.30E-07	4.26E-02	Yes
Aluminum	2.89E+05	3.61E+00	8.26E-02	6.02E-01	Yes
Arsenic*	7.66E+00	1.15E+01	8.75E-02	2.25E+02	Yes
Barium*	5.55E+00	--	--	--	Yes
Benzene*	2.08E-03	1.14E-04	8.71E-07	4.64E-01	Yes
Bismuth	4.81E+03	--	--	--	Yes
Boron	3.12E+01	1.95E-03	4.46E-05	1.53E-01	Yes
Butylbenzylphthalate*	1.00E+00	1.91E-03	1.45E-05	7.78E-02	Yes
Cadmium*	4.43E+00	5.54E-02	1.27E-03	6.43E+00	Yes
Calcium	4.51E+02	--	--	--	Yes
Chromium, Total*	1.34E+02	1.12E-03	2.55E-05	6.69E-02	Yes
Cobalt	1.62E+00	6.74E-02	1.54E-03	3.73E-01	Yes
Copper	1.18E+02	3.69E-02	8.44E-04	4.16E-01	Yes
Cyanide*	7.73E+00	1.61E-01	3.68E-03	7.97E+00	Yes
Dichloromethane (methylene chloride)*	1.37E-02	2.86E-05	6.54E-07	6.31E-01	Yes
Fluoride	1.30E+03	2.70E-01	6.17E-03	4.49E-01	Yes
Hydroxide OH	7.71E+01	--	--	--	Yes

Table D-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Hazardous Constituents above Detection in 241-C-107 Tank Residual Wastes. (5 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
Iron	1.31E+04	2.33E-01	5.33E-03	2.31E+00	Yes
Lanthanum	6.45E+00	--	--	--	Yes
Lead*	9.54E+02	--	9.54E-01	3.18E-01	Yes
Lithium	2.59E+00	1.62E-02	3.71E-04	1.35E-02	Yes
Magnesium	1.69E+02	--	--	--	Yes
Manganese	2.41E+02	2.15E-02	4.92E-04	4.81E-01	Yes
Mercury*	2.37E+01	9.85E-01	2.25E-02	1.13E+01	Yes
Molybdenum	9.78E+00	2.44E-02	5.59E-04	3.03E-01	Yes
Neodymium	3.11E+01	--	--	--	Yes
Nickel*	6.19E+00	--	--	--	Yes
Nitrate	1.43E+03	2.52E-03	5.75E-05	7.94E+00	Yes
Nitrite	9.54E+02	3.97E-02	9.08E-04	7.23E+01	Yes
Oxalate	6.34E+01	--	--	--	Yes
Phosphate	2.55E+04	--	--	--	Yes
Potassium	3.71E+01	--	--	--	Yes
Ruthenium	3.61E+01	--	--	--	Yes
Samarium	2.87E+01	--	--	--	Yes

Table D-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Hazardous Constituents above Detection in 241-C-107 Tank Residual Wastes. (5 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
Silicon	5.71E+03	--	--	--	Yes
Silver*	1.30E+03	3.25E+00	7.43E-02	9.56E+01	Yes
Sodium	3.10E+04	--	--	--	Yes
Strontium	9.45E+01	1.97E-03	4.50E-05	1.40E-02	Yes
Sulfate	4.58E+02	--	--	4.58E-01	Yes
Tellurium	1.03E+01	--	--	--	Yes
Thorium	1.55E+01	--	--	--	Yes
Tin	2.72E+01	5.67E-04	1.30E-05	5.67E-04	Yes
Titanium	2.92E+01	--	--	--	Yes
Toluene*	5.04E-03	7.88E-07	1.80E-08	1.08E-03	Yes
Tungsten	2.22E+01	--	--	--	Yes
Uranium	8.45E+03	3.52E+01	8.05E-01	3.13E+01	Yes
Vanadium	8.64E+00	2.16E-02	4.94E-04	5.40E-03	Yes
Yttrium	9.45E+00	--	--	--	Yes
Zinc	1.98E+02	8.27E-03	1.89E-04	3.32E-02	Yes
Zirconium	1.80E+02	--	--	--	Yes
1, 1, 2-Trichloroethylene	3.08E-03	1.42E-04	1.76E-06	4.90E-01	No

Table D-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Hazardous Constituents above Detection in 241-C-107 Tank Residual Wastes. (5 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
2-Butanone(MEK)	4.97E-02	1.04E-06	2.37E-08	2.53E-03	No
2-Propanone (Acetone)	5.56E-02	7.73E-07	1.77E-08	1.93E-03	No
Acetate	1.68E+02	--	--	--	No
Ammonia	2.25E+00	--	--	--	No
Antimony*	4.35E+00	--	--	--	No
Beryllium*	2.96E+00	1.85E-02	4.23E-04	4.68E-02	No
Bromide	9.00E+01	--	--	--	No
Cerium	7.43E+01	--	--	--	No
Chloride	1.14E+02	--	--	1.14E-01	No
Di-n-octylphthalate*	1.40E+00	1.46E-03	3.33E-05	4.38E-06	No
Europium	2.96E+00	--	--	--	No
Formate+A2	2.52E+02	--	--	--	No
Glycolate C2H3O3	9.62E+01	--	--	--	No
m-Xylene	4.23E-03	2.65E-07	6.05E-09	3.13E-04	No
Niobium	1.78E+01	--	--	--	No
o-Xylene	2.33E-03	1.46E-07	3.33E-09	1.59E-04	No
Palladium	3.55E+01	--	--	--	No

Table D-11. Ratios of Concentrations to Cleanup Levels or Soil Concentrations Protective of Groundwater for 95% Upper Confidence Level Concentrations of Selected Hazardous Constituents above Detection in 241-C-107 Tank Residual Wastes. (5 sheets)

Analyte	95% Upper Confidence Level Concentration (mg/kg)[a]	Ratio of 95% Upper Confidence Level Concentrations in Tank 241-C-107 Upper Bound Inventory of Residual Wastes to Soil Cleanup Standards			
		Direct Contact Method B (mg/kg)	Direct Contact Method C (mg/kg)	Soil Concentrations Protective of Groundwater (mg/kg)	Above Detection Limits
Polychlorinated Biphenyls*	8.91E-02	1.78E-01	1.36E-03	--	No
Praseodymium	7.73E+01	--	--	--	No
Rhodium	2.67E+01	--	--	--	No
Rubidium	1.69E+02	--	--	--	No
Selenium*	1.75E-04	--	--	--	No
Tantalum	1.48E+01	--	--	--	No
Thallium*	1.19E+01	--	--	5.21E+01	No
Tributyl phosphate	1.99E+00	1.79E-02	1.36E-04	4.01E+00	No
Xylenes	5.15E-03	3.22E-07	7.36E-09	3.52E-04	No

[a] 95% Upper Confidence Level Concentration = Mean Concentration + (1.96 × Mean Concentration × Relative Standard Deviation). Mean Concentrations and Relative Standard Deviation provided in Table A-1, Appendix A of RPP-RPT-58514, "Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment."

[b] As nitrite, not nitrogen in nitrite; to convert to nitrogen in nitrite divide this number by 3.29.

[c] As nitrate, not nitrogen in nitrate; to convert to nitrogen in nitrate divide this number by 4.43.

* Dangerous waste constituent per Washington Administrative Code 173-303-9905, "Dangerous Waste Constituents List." Total Cr is assumed to be Chromium(III), insoluble salts.

-- = Value is not available

Table D-12. Background Data for Selected Constituents for the Hanford Site. (3 sheets)

Analyte Name	Analyte Symbol	Analyte Class	Units	Lognormal 90th Percentile Background Value	Maximum Background Value	Source of Background Value
Cesium-137	Cs-137	RAD	pCi/g	1.1	1.6	DOE/RL-96-12, Rev. 0
Cobalt-60	Co-60	RAD	pCi/g	0.0084	0.039	DOE/RL-96-12, Rev. 0
Europium-154	Eu-154	RAD	pCi/g	0.033	0.079	DOE/RL-96-12, Rev. 0
Europium-155	Eu-155	RAD	pCi/g	0.054	0.1	DOE/RL-96-12, Rev. 0
Gross Beta	--	RAD	pCi/g	23	25	DOE/RL-96-12, Rev. 0
Plutonium-238	Pu-238	RAD	pCi/g	0.0038	0.019	DOE/RL-96-12, Rev. 0
Plutonium-239/240	Pu-239-240	RAD	pCi/g	0.025	0.033	DOE/RL-96-12, Rev. 0
Potassium-40	K-40	RAD	pCi/g	17	20	DOE/RL-96-12, Rev. 0
Radium-226	Ra-226	RAD	pCi/g	0.82	1.2	DOE/RL-96-12, Rev. 0
Strontium-90	Sr-90	RAD	pCi/g	0.18	0.37	DOE/RL-96-12, Rev. 0
Thorium-232	Th-232	RAD	pCi/g	1.3	1.6	DOE/RL-96-12, Rev. 0
Total beta radiostrontium	--	RAD	pCi/g	0.18	0.37	DOE/RL-96-12, Rev. 0
Uranium-233/234	U-233/234	RAD	pCi/g	1.1	1.5	DOE/RL-96-12, Rev. 0
Uranium-234	U-234	RAD	pCi/g	1.1	1.5	DOE/RL-96-12, Rev. 0
Uranium-235	U-235	RAD	pCi/g	0.11	0.39	DOE/RL-96-12, Rev. 0
Aluminum	Al	Metal	µg/kg	1.18E+07	28,800,000	DOE/RL-92-24, Vol. 1, Rev. 4
Antimony*	An	Metal	µg/kg	130	385	ECF-HANFORD-11-0038
Arsenic*	Ar	Metal	µg/kg	6,470	27,700	DOE/RL-92-24, Vol. 1, Rev. 4
Barium*	Ba	Metal	µg/kg	132,000	480,000	DOE/RL-92-24, Vol. 1, Rev. 4
Beryllium*	Be	Metal	µg/kg	1,510	10,000	DOE/RL-92-24, Vol. 1, Rev. 4
Boron	Bo	Metal	µg/kg	3,890	5,860	ECF-HANFORD-11-0038

Table D-12. Background Data for Selected Constituents for the Hanford Site. (3 sheets)

Analyte Name	Analyte Symbol	Analyte Class	Units	Lognormal 90th Percentile Background Value	Maximum Background Value	Source of Background Value
Cadmium*	Cd	Metal	µg/kg	563	2,900	ECF-HANFORD-11-0038
Calcium	Ca	Metal	µg/kg	1.72E+07	105,000,000	DOE/RL-92-24, Vol. 1, Rev. 4
Chromium	Cr	Metal	µg/kg	18,500	320,000	DOE/RL-92-24, Vol. 1, Rev. 4
Cobalt	Co	Metal	µg/kg	15,700	110,000	DOE/RL-92-24, Vol. 1, Rev. 4
Copper	Cu	Metal	µg/kg	22,000	61,000	DOE/RL-92-24, Vol. 1, Rev. 4
Iron	Fe	Metal	µg/kg	3.26E+07	68,100,000	DOE/RL-92-24, Vol. 1, Rev. 4
Lead*	Pb	Metal	µg/kg	10,200	74,100	DOE/RL-92-24, Vol. 1, Rev. 4
Lithium	Li	Metal	µg/kg	13,300	19,200	ECF-HANFORD-11-0038
Magnesium	Mg	Metal	µg/kg	7.06E+06	32,300,000	DOE/RL-92-24, Vol. 1, Rev. 4
Manganese	Mn	Metal	µg/kg	512,000	1,110,000	DOE/RL-92-24, Vol. 1, Rev. 4
Mercury*	Hg	Metal	µg/kg	13	29	ECF-HANFORD-11-0038
Molybdenum	Mo	Metal	µg/kg	470	3,170	ECF-HANFORD-11-0038
Nickel*	Ni	Metal	µg/kg	19,100	200,000	ECF-HANFORD-11-0038
Potassium	K	Metal	µg/kg	2.15E+06	7,900,000	ECF-HANFORD-11-0038
Selenium*	Se	Metal	µg/kg	780	840	Ecology Publication #94-115
Silver*	Ag	Metal	µg/kg	167	273	ECF-HANFORD-11-0038
Sodium	Na	Metal	µg/kg	690,000	6,060,000	DOE/RL-92-24, V.I, Rev.4
Thallium*	Th	Metal	µg/kg	185	523	ECF-HANFORD-11-0038
Uranium	U	Metal	µg/kg	3,210	4,042	Isotopic Activity Conversion based on DOE/RL-96-12 values
Vanadium	V	Metal	µg/kg	85,100	140,000	DOE/RL-92-24, Vol. 1, Rev. 4

Table D-12. Background Data for Selected Constituents for the Hanford Site. (3 sheets)

Analyte Name	Analyte Symbol	Analyte Class	Units	Lognormal 90th Percentile Background Value	Maximum Background Value	Source of Background Value
Zinc	Zn	Metal	µg/kg	67,800	366,000	DOE/RL-92-24, Vol. 1, Rev. 4
Ammonia	NH_3	Anion	µg/kg	9,230	26,400	DOE/RL-92-24, Vol. 1, Rev. 4
Chloride	Cl	Anion	µg/kg	100,000	1,480,000	DOE/RL-92-24, Vol. 1, Rev. 4
Fluoride	Fl	Anion	µg/kg	2,810	73,300	DOE/RL-92-24, Vol. 1, Rev. 4
Nitrate	NO_3	Anion	µg/kg	52,000	906,000	DOE/RL-92-24, Vol. 1, Rev. 4
Phosphate	PO_4	Anion	µg/kg	785	225,000	DOE/RL-92-24, Vol. 1, Rev. 4
Sulfate	SO_4	Anion	µg/kg	237,000	12,600,000	DOE/RL-92-24, Vol. 1, Rev. 4

* Dangerous waste constituent per Washington Administrative Code 173-303-9905, "Dangerous Waste Constituents List."

References:
DOE/RL-92-24, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analyte, Rev. 4, Volume 1.
DOE/RL-96-12, Hanford Site Background: Part 2, Soil Background for Radionuclides, Rev. 0.
ECF-HANFORD-11-0038, "Soil Background for Interim Use at the Hanford Site."
Ecology Publication #94-115, "Natural Background Soil Metals Concentrations in Washington State."

REFERENCES

65 FR 76708, 2000, "National Primary Drinking Water Regulations; Radionuclides; Final Rule," Federal Register, Vol. 65, pp. 76708–76753 (December 7).

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

DOE/ORP-2005-01, 2006, Initial Single-Shell Tank System Performance Assessment for the Hanford Site, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

DOE/RL-92-24, 2001, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-12, 1996, Hanford Site Background: Part 2, Soil Background for Radionuclides, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

ECF-HANFORD-11-0038, 2012, "Soil Background for Interim Use at the Hanford Site," Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology, EPA, and DOE, 1989, Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA 540/R/99/006, 1999, "Radiation Risk Assessment at CERCLA Sites: Q & A," Directive 9200.4-31P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

HNF-SD-WM-TI-707, 2007, "Exposure Scenarios and Unit Factors for Hanford Tank Waste Performance Assessments," Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

PNNL-13895, 2003, "Hanford Contaminant Distribution Coefficient Database and Users Guide," Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14702, 2006, "Vadose Zone Hydrogeology Data Package for Hanford Assessments," Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

Publication #94-115, 1994, "Natural Background Soil Metals Concentrations in Washington State," Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

RPP-RPT-58514, 2015, *Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

WAC 173-303-9905, "Dangerous Waste Constituents List," Washington Administrative Code, as amended.

WAC 173-340, "Model Toxics Control Act – Cleanup," Washington Administrative Code, as amended.

WAC 173-340-705, "Use of Method B," Washington Administrative Code, as amended.