

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635438

Proj.
ECN

2. ECN Category (mark one) Supplemental <input type="checkbox"/> Direct Revision <input checked="" type="checkbox"/> Change ECN <input type="checkbox"/> Temporary <input type="checkbox"/> Standby <input type="checkbox"/> Supersedure <input type="checkbox"/> Cancel/Void <input type="checkbox"/>	3. Originator's Name, Organization, MSIN, and Telephone No. Cheryl J. Benar, Data Assessment and Interpretation, R2-12, 372-1256	4. USQ Required? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	5. Date 02/20/97
	6. Project Title/No./Work Order No. Tank 241-B-111	7. Bldg./Sys./Fac. No. 241-B-111	8. Approval Designator N/A
9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-549, Rev. 0		10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work <input type="checkbox"/> Yes (fill out Blk. 12b) <input checked="" type="checkbox"/> No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. N/A	12c. Modification Work Complete N/A Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) N/A Design Authority/Cog. Engineer Signature & Date
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13a. Description of Change
 This ECN was generated in order to revise the document to the new format per Department of Energy performance agreements.

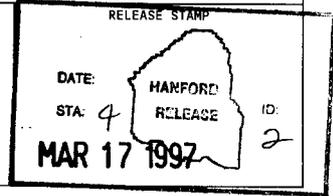
13b. Design Baseline Document? Yes No

14a. Justification (mark one)

Criteria Change <input type="checkbox"/>	Design Improvement <input type="checkbox"/>	Environmental <input type="checkbox"/>	Facility Deactivation <input type="checkbox"/>
As-Found <input checked="" type="checkbox"/>	Facilitate Const <input type="checkbox"/>	Const. Error/Omission <input type="checkbox"/>	Design Error/Omission <input type="checkbox"/>

14b. Justification Details
 This document was revised per Department of Energy performance agreements and direction from the Washington State Department of Ecology to revise 23 tank characterization reports (letter dated 7/6/95).

15. Distribution (include name, MSIN, and no. of copies)
 See attached distribution.



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1. ECN (use no. from pg. 1)

ECN-635438

16. Design Verification Required <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	17. Cost Impact <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 50%; text-align: center;">ENGINEERING</th> <th style="width: 50%; text-align: center;">CONSTRUCTION</th> </tr> <tr> <td>Additional <input type="checkbox"/> \$</td> <td>Additional <input type="checkbox"/> \$</td> </tr> <tr> <td>Savings <input type="checkbox"/> \$</td> <td>Savings <input type="checkbox"/> \$</td> </tr> </table>	ENGINEERING	CONSTRUCTION	Additional <input type="checkbox"/> \$	Additional <input type="checkbox"/> \$	Savings <input type="checkbox"/> \$	Savings <input type="checkbox"/> \$	18. Schedule Impact (days) Improvement <input type="checkbox"/> Delay <input type="checkbox"/>
ENGINEERING	CONSTRUCTION							
Additional <input type="checkbox"/> \$	Additional <input type="checkbox"/> \$							
Savings <input type="checkbox"/> \$	Savings <input type="checkbox"/> \$							

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number/Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. C.J. Benar	<i>Cheryl L. Benar</i>	<u>3/13/97</u>	PE		_____
Cog. Mgr. K.M. Halperin	<i>K.M. Halperin</i>	<u>3/13/97</u>	QA		_____
QA			Safety		_____
Safety			Design		_____
Environ.			Environ.		_____
Other R.J. Cash	<i>R.J. Cash</i>	<u>3/14/97</u>	Other		_____

N.W. Kirch	<i>N.W. Kirch</i>	<u>3-13-97</u>			_____

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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Tank Characterization Report for Single-Shell Tank 241-B-111

Cheryl J. Benar

Lockheed Martin Hanford Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: ECN-635438 UC: 2070
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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-B-111, Tank B-111, B-111, B Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

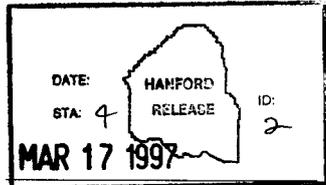
Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-B-111. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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Tank Characterization Report for Single-Shell Tank 241-B-111

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Date Published
March 1997

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

Project Hanford Management Contractor for the
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LIST OF TERMS

2C	second-cycle decontamination waste
2C2	second-cycle decontamination waste (1945 to 1953)
AEA	alpha energy analysis
ANOVA	analysis of variance
ASTM	American Society for Testing and Materials
BY saltcake	Saltcake waste generated from in-tank solidification units 1 and 2 between 1965 and 1974
Btu/hr	British thermal units per hour
Ci	curies
Ci/L	curies per liter
cm	centimeter
CSR	Waste sent to B-Plant for cesium
CVAA	cold vapor atomic absorption
DL	detection limit
DQO	data quality objective
DSC	differential scanning calorimetry
DW	decontamination waste
dynes/cm ²	dynes per square centimeter
EB	evaporator bottoms
ECN	Engineering Change Notice
FIC	Food Instrument Corporation
ft	feet
FP	fission products waste
g	gram
g/L	grams per liter
g/mL	grams per milliliter
GC/MS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
GFAA	graphite furnace atomic absorption
HAS	Hanford Analytical Services
HDW	Hanford defined waste
HHF	hydrostatic head fluid
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
ISE	ion selective electrode
IX	ion exchange
J/g	joules per gram
kg	kilogram
kgal	kilogallons
kL	kiloliters

LIST OF TERMS (Continued)

LFL	lower flammability limit
m	meter
M	moles per liter
mL	milliliters
n/d	not determined
NPH	normal paraffin hydrocarbon
n/r	not reported
P2	PUREX high-level waste (1964 to 1967)
PHMC	Project Hanford Management Contract
PUREX	plutonium-uranium extraction
ppm	parts per million
QA	quality assurance
QC	quality control
RCRA	<i>Resource Conservation and Recovery Act</i>
RPD	relative percent difference
RSD	relative standard deviation
SORWT	Sort on Radioactive Waste Type
SVOA	semivolatile organic analysis
TC	total carbon
TCLP	toxicity characteristic leaching procedure
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
VOA	volatile organic analysis
W	watts
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
μmol/g	micromoles per gram

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1.0 INTRODUCTION

One major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of the waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for single-shell tank 241-B-111. The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-B-111 waste, and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 provides the best-basis inventory estimate, and Section 4.0 provides recommendations about safety status and additional sampling needs. The appendixes contain supporting data and information. This report also supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996), Milestone M-44-05.

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. The most recent sampling of tank 241-B-111 (September and October 1991) predated the application of data quality objectives (DQOs) to core sampling. An evaluation of the technical issues from the current safety screening DQO (Dukelow et al. 1995) has been performed using the data from the 1991 sampling event. Historical information in Appendix A includes surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

Appendix B summarizes the most recent sampling event (see Table 1-1) and the sampling results. There are no pre-1989 sampling events for this tank. The sampling and analysis of the 1991 core samples were performed in accordance with the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991), the results were reported in a laboratory data package (Giamberardini 1993) and summarized in Benar (1996) and Remund et al. (1994). Appendix C reports on the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation used to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is a bibliography resulting from an in-depth literature search of all known information sources applicable to tank 241-B-111 and its respective waste types. The reports listed in Appendix E can be found in the Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/Date	Phase	Location	Segmentation	Recovery	Mass (g)
Core 29 (September 1991)	Solid	Riser 3	No segmentation	Full recovery of four segments.	944
Core 30 (October 1991)	Solid	Riser 5	No segmentation	Full recovery for two segments and partial recovery for two segments.	614

1.2 TANK BACKGROUND

Tank 241-B-111 is located in the 200 East Area B Tank Farm on the Hanford Site. It is the second tank in a three-tank cascade series. The tank was constructed in 1943 and 1944 and went into service in 1945. From 1945 to 1953, the tank received second-cycle decontamination waste (2C2) from the bismuth phosphate process cascaded from tank 241-B-110. From 1953 to 1959, the tank received waste from various tanks and flush water. From 1961 to 1962 the tank received B Plant decontamination waste. Between 1963 and 1967, PUREX high-level waste, waste from tank 241-B-112, and flush water was transferred to the tank. Between 1969 and 1972, the tank received cesium recovery waste, waste from various tanks, and flush water. The tank was removed from service in 1976, declared an assumed leaker in 1978, and salt well pumped in 1983.

Table 1-2 summarizes a description of tank 241-B-111. The tank has an operating capacity of 2,010 kL (530 kgal) and presently contains an estimated 897 kL (237 kgal) of noncomplexed waste (Hanlon 1996). The tank is not on a Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-B-111.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1943 to 1944
In service	1945
Diameter	22.9 m (75.0 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Noncomplexed
Total waste volume ¹	897 kL (237 kgal)
Supernatant volume	4 kL (1 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	893 kL (236 kgal)
Drainable interstitial liquid volume	80 kL (21 kgal)
Waste surface level (October 2, 1996, manual Food Instrument Corporation [FIC] gauge)	2.12 m (83.3 in.)
Temperature (April 9, 1975 to July 1, 1996)	12.2 °C (54 °F) to 36.6 °C (98 °F)
Integrity	Assumed leaker
Watch List	None
SAMPLING DATE	
Core samples	September and October 1991
Tank headspace gas samples	March 1996
SERVICE STATUS	
Removed from service	April 1976
Interim stabilization	June 1985
Intrusion prevention	October 1985

Note:

¹The waste volume is estimated from surface-level measurements.

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2.0 RESPONSE TO TECHNICAL ISSUES

One technical issue has been identified for tank 241-B-111. It is:

- **Safety screening:** Does the waste pose or contribute to any recognized potential safety problems?

The 1991 sampling and 1993 analysis of cores 29 and 30 predates the safety screening DQO (Dukelow et al 1995). However, the analytical results from this sampling event and the tank headspace flammability measurements obtained in 1996 can provide useful information in response to this issue (see Appendix B).

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-B-111 is documented in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). Potential safety problems include exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each condition is addressed separately. Because the core sampling and analysis predate the DQO, this evaluation is provided for information only.

2.1.1 Exothermic Conditions (Energetics)

The first requirement in Dukelow et al. (1995) is to ensure exothermic constituents (organic or ferrocyanide) in tank 241-B-111 do not cause a safety hazard. The safety screening DQO requires that waste sample profiles be tested for energetics every 24 cm (half segment) to determine whether the energetics exceed the safety threshold limit. The threshold limit for energetics is -480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated no exotherms were observed in any segment of either core.

Based on historical process transfer records, some waste in tank 241-B-111 is expected to contain some exothermic agents. However, historical modeling estimates (Agnew et al. 1996a) and analytical data place organic levels at well below the action limit.

2.1.2 Flammable Gas

The tank headspace was sampled and analyzed for the presence of flammable gases in March 1996. Results indicated no flammable gas was detected (0 percent of the lower flammability limit [LFL]). Appendix B provides measurement data.

2.1.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all total alpha activity is from ^{239}Pu and using the highest measured density of 1.3 g/mL 1 g/L of ^{239}Pu is equivalent to 46.9 $\mu\text{Ci/g}$ of alpha activity. By using the highest density result, the lowest threshold limit was obtained in $\mu\text{Ci/g}$. Concentrations for both analytes in all samples were approximately 0.1 $\mu\text{Ci/g}$, well below the limit. Additionally, as required by the DQO, the upper limit (UL) of the one-sided 95 percent confidence interval for these results were all less than 1 g/L; therefore, criticality is not an issue for this tank. Appendix C contains the method used to calculate the confidence limits and values obtained.

2.2 OTHER TECHNICAL ISSUES

Heat generation and waste temperature are factors in assessing tank safety. Because the waste in tank 241-B-111 is radioactive, it generates heat through radioactive decay. Based on results from the 1991 sampling event, the most significant radioactive contributors in the waste are ^{90}Sr and ^{137}Cs , contributing 264,000 and 168,000 curies, respectively. Table 2-1 summarizes the power produced by the radionuclides in the waste. The heat load calculations indicate that 2,570 W (8,771 Btu/hr) of heat are produced in the tank. The heat load estimate based on tank process history was 9,330 W (31,900 Btu/hr) (Agnew et al. 1996a), and the estimate based on the tank headspace temperature was 3,220 W (11,000 Btu/hr) (Kummerer 1995). All three estimates are below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat load tanks (Smith 1986).

Table 2-1. Radionuclide Inventory and Projected Heat Load.

Analyte	Total CI	Watts/CI	Watts
²⁴¹ Am	90.1	0.0328	2.96
¹³⁷ Cs ²	1.68E+05	0.00472	796
⁶⁰ Co	4.12	0.0154	0.0635
²⁴² Cm	0.0979	0.0362	0.0035
^{243/244} Cm	0.501	0.0344	0.0172
¹⁵⁴ Eu	181	0.00898	1.63
¹⁵⁵ Eu	213	7.23E-04	0.155
²³⁷ Np	0.0761	0.0288	0.00181
²³⁸ Pu	3.25	0.0326	0.108
^{239/240} Pu	104	0.0306	3.18
⁹⁰ Sr ³	2.64E+05	0.00669	1,760
⁹⁹ Tc	121	5.01E-04	0.0606
²³² Th	0.0324	0.0238	7.72E-04
Tritium	2.93	0.261	0.763
Total			2,570

Notes:

¹Kirkpatrick and Brown (1984)²Includes ¹³⁷Cs and ¹³⁷Ba³Includes ⁹⁰Sr and ⁹⁰Y**2.3 SUMMARY**

Not all 1991 core sampling and 1993 analyses were performed to the requirements of Dukelow et al. (1995) because they predate the document. Energetic analyses were not conducted at the half-segment level. As a result, the current safety screening DQOs were not met. However no primary analyte exceeded safety decision threshold limits (see Table 2-2).

Table 2-2. Summary of Safety Screening Evaluation Results.

Issue	Sub-Issue	Result
Safety screening	Energetics	No exotherms observed in any sample.
	Flammable gas	Combustible gas meter reported 0 percent of the LFL.
	Criticality	All analyses well below 46.9 $\mu\text{Ci/g}$ total alpha (within 95 percent confidence limit on each sample).

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used when performing safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses, and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by the Los Alamos National Laboratory (Agnew et al. 1996). Not surprisingly, information derived from these two approaches is often inconsistent. An effort is underway to provide waste inventory estimates that will serve as standard characterization information for waste management activities (Hodgson and LeClair 1996).

A best-basis inventory estimate for chemical and radionuclide components in tank 241-B-111 follows (see Appendix D). The results from this evaluation are based on sampling data for tank 241-B-111 for the following reasons:

- Analytical results from two widely spaced core samples were used to estimate the component inventories. There is no reason to dispute the analytical results.
- There was no horizontal stratification of the tank.
- Analytical results for the core samples are consistent with the receipt of second cycle decontamination (2C) waste.

These results are subject to future review because of the lack of agreement with the flowsheet projected inventory. Tables 3-1 and 3-2 show the best-basis inventory estimates for tank 241-B-111.

Table 3-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-111 (September 30, 1996).

Analyte	Total Inventory (kg)	Basis (S, M, or E) ¹	Comment RSD Percent ²
Al	958	S	7
Bi	21,500	S	1
Ca	734	S	23
Cl	1,090	S	2
TIC as CO ₃	23,800	S	11
Cr	1,180	S	5
F	1,660	S	2
Fe	18,900	S	5
Hg	9.93	S	50
K	718	S	18
La	12	S	27
Mn	84.1	S	6
Na	102,000	S	2
Ni	22.1	S	7
NO ₂	47,900	S	9
NO ₃	87,400	S	8
Pb	1,670	S	7
P as PO ₄	51,800	S	8
Si	11,100	S	8
S as SO ₄	12,400	S	1
Sr	232	S	2
TOC	932	S	12
U _{TOTAL}	210	S	4
Zr	15.3	S	29

Notes:

TIC = total inorganic carbon

TOC = total organic carbon

¹S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based²The uncertainties associated with each mass total are expressed as RSD percent.

Table 3-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996).

Analyte	Total Inventory (Ci)	Basis (S, M, or E) ¹	Comment RSD Percent ²
¹⁴ C	1.7	S	36
⁶⁰ Co	< 4.12	S	
⁹⁰ Sr	264,000	S	22
⁹⁹ Tc	121	S	10
¹³⁷ Cs	168,000	S	9
¹⁵⁴ Eu	181	S	26
²³⁷ Np	0.0761	S	22
^{239/240} Pu	104	S	5
²⁴¹ Am	90.1	S	25
^{243/244} Cm	0.501	S	57

Note:

¹S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based
²The uncertainties associated with each mass total are expressed as RSD percent.

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4.0 RECOMMENDATIONS

The sampling and analysis of cores 29 and 30 predated the application of DQOs. However, these results were evaluated against the requirements of the safety screening DQO (Dukelow et al. 1995). All analytical results were well within the safety notification limits. The tank can be classified as "safe." A characterization best-basis inventory was developed for tank contents.

Table 4-1 summarizes the status of Project Hanford Management Contract (PHMC) TWRS Program Office review and acceptance of the sampling and analysis results reported in this TCR. Table 4-1 lists the DQO issues addressed by the sampling and analysis. Column 2 indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered "yes" or "no." The third column indicates the concurrence and acceptance by the program in TWRS responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in column 3 indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results and information have not been reviewed, "N/R" is shown; if the results and /information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown.

Table 4-1. Acceptance of Tank 241-B-111 Sampling and Analysis.

Issue	Evaluation Performed	TWRS ¹ Program Acceptance
Safety screening DQO	Yes	Yes

Note:

¹PHMC TWRS Program Office

Table 4-2 summarizes the status of TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations in this report include the best-basis inventory evaluation and the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column 1 lists the evaluations performed in this report. Columns 2 or 3 are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-B-111.

Issue	Evaluation Performed	TWRS ¹ Program Acceptance
Safety categorization	Yes	Yes

Note:

¹PHMC TWRS Program Office

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-B-111 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary to provide a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1:** Current status of tank 241-B-111, including current waste levels and the stabilization and isolation status.
- **Section A2:** Information about the tank design.
- **Section A3:** Process knowledge of the tank, that is, the waste transfer history and the estimated contents of the tank based on modeling data.
- **Section A4:** Surveillance data, including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5:** References for Appendix A.

A1.0 CURRENT TANK STATUS

As of September 30, 1996, tank 241-B-111 contained an estimated 897 kL (237 kgal) of noncomplexed waste (Hanlon 1996). The waste volume was estimated using an FIC surface-level gauge. Table A1-1 shows the volume estimates of the waste phases found in the tank.

Tank 241-B-111 was removed from service in 1976 and was declared an assumed leaker in 1978. It was interim stabilized in June 1985; intrusion prevention (interim isolation) was completed in October 1985 (Brevick et al. 1994). The tank is passively ventilated, and it is not on the Watch List (Public Law 101-510).

Table A1-1. Tank Contents Summary.¹

Waste Type	Volume	
	kiloliters	kilogallons
Total waste	897	237
Supernate	4	1
Sludge	893	236
Saltcake	0	0
Drainable interstitial liquid	79	21
Drainable liquid remaining	83	22
Pumpable liquid remaining	61	16

Note:

¹For definitions and calculation methods refer to Appendix C of Hanlon (1996).

A2.0 TANK DESIGN AND BACKGROUND

Tank 241-B-111 was constructed during 1943 and 1944. It is one of twelve 2,010 kL (530 kgal) tanks in the B Tank Farm. The tanks were designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Leach and Stahl 1996). Tank 241-B-111 has 11 risers ranging in size from 10 cm (4 in.) to 1.1 m (42 in.) in diameter that provide surface-level access to the underground tank (Alstad 1993). There is one riser through the center of the tank dome and five each on opposite sides of the dome.

Tank 241-B-111 entered service in 1945 as the middle tank in a three-tank cascade that included tanks 241-B-110 and 241-B-112. Many tanks in the Hanford Site tank farms are connected in cascades (groups of tanks that have overflow lines from one to another). Cascaded tanks required fewer connections to be made during waste disposal; consequently, all three tanks were usable without having to connect the active waste transfer line directly to each individual tank. In a cascade arrangement, most solids in the waste slurries routed to the tanks settled in the first tank, and the clarified liquids cascaded to other tanks in the series. Supernate from the final tank in the cascade series was sometimes routed to a disposal trench.

Tank 241-B-111 is constructed of 30-cm (1-ft)-thick reinforced concrete with a 6.4 mm (0.25 in.) mild carbon steel liner (ASTM A283 Grade C) on the bottom and sides and a 38-cm (1.25-ft)-thick domed concrete top. It has a dished bottom with a 1.2-m (4-ft) radius

knuckle and a 5.2-m (17-ft) operating depth. The tank sits on a reinforced concrete foundation (Leach and Stahl 1996). Each tank in the B Tank Farm was covered with at least 1.5 m (5 ft) of overburden.

Figure A2-1 shows a tank cross section with the approximate waste levels and a schematic of the tank equipment, and Figure A2-2 shows the riser locations. The surface level is monitored through riser 1 with an FIC gauge. Riser 8 contains a thermocouple tree. Risers 3, 4, 5, and 7 are tentatively available for sampling (Lipnicki 1996). Tank 241-B-111 has four process inlet nozzles and one cascade overflow inlet located about 4.8 m (15.7 ft) from the tank bottom (as measured at the tank wall). Table A2-1 lists tank 241-B-111 risers and nozzles, their sizes, and general use.

Figure A2-1. Tank 241-B-111 Cross Section and Schematic.

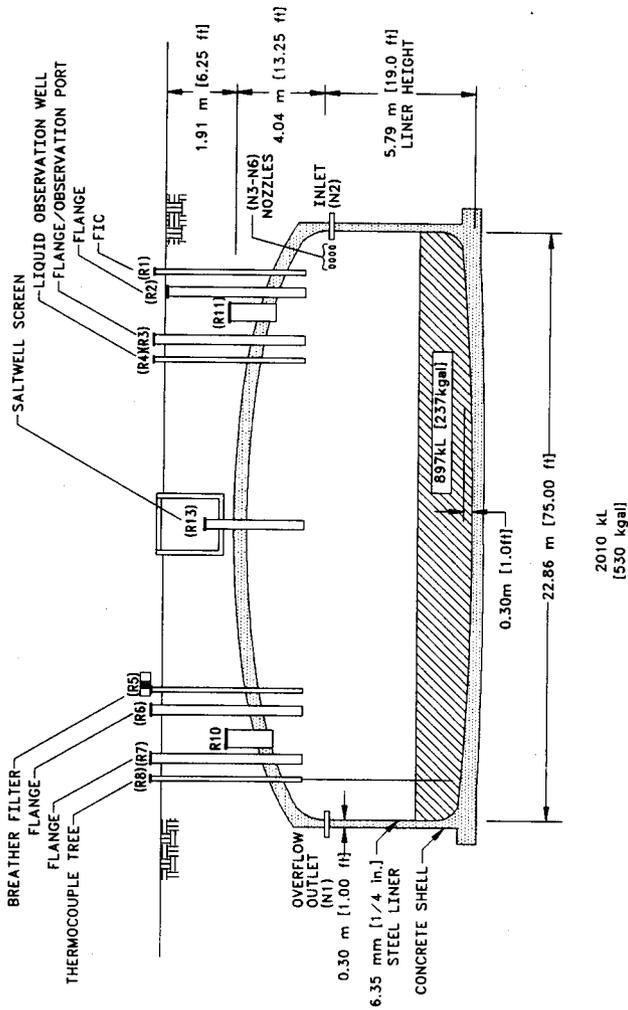


Figure A2-2. Riser Configuration for Tank 241-B-111.

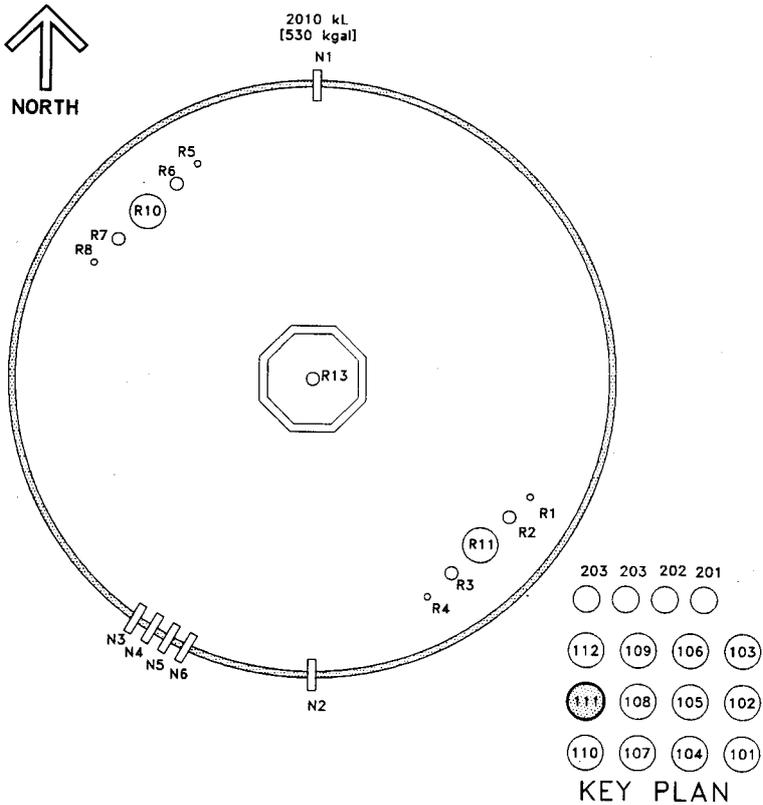


Table A2-1. Tank 241-B-111 Risers and Nozzles.¹

Number	Diameter (In.)	Sampling ²	Description and Comments
1	4		FIC surface-level gauge (benchmark)
2	12		Dip tubes (cut off/blind flanged)
3	12	X	B-222 observation port
4	4	X	Steel liquid observation well ECN-614182 September 27, 1994
5	4	X	Breather filter (G1 housing)
6	12		Flange with lead, spare
7	12	X	Blind flange
8	4		Temperature probe (bench mark)
10	42		Manhole (below grade)
11	42		Manhole (below grade)
13	12		Salt well screen (weather covered)
N1	3		Cascade overflow
N2	3		Cascade inlet
N3	3		Spare
N4	3		Line V-260
N5	3		Spare
N6	3		Spare

Notes:

ECN = Engineering Change Notice

¹Alstad (1993) and Vitro Engineering Corporation (1986)²Risers tentatively available for sampling (Lipnicki 1996)

A3.0 PROCESS KNOWLEDGE

The following sections 1) provide information about the transfer history of tank 241-B-111, 2) describe the process wastes that made up the transfers, and 3) give an estimate of the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-B-111. The tank initially received 2C waste in December 1945 through the cascade from tank 241-B-110 (Agnew et al. 1996b). This waste originated from the bismuth phosphate process used at B Plant. Tank 241-B-111 was filled in April 1946, then waste cascaded to tank 241-B-112. Tank 241-B-111 continued to receive 2C waste through the first quarter of 1953. Anderson (1990) indicates most liquid waste was pumped from tank 241-B-111 to a crib during the second quarter of 1950.

During the second quarter of 1954, tank 241-B-111 received evaporator bottoms from tank 241-B-105. During the same period, waste cascaded from tank 241-B-111 to tank 241-C-112. Supernate waste from tank 241-B-111 was transferred to tank 241-B-108 during the third quarter of 1955.

From the second quarter of 1957 to the second quarter of 1962, tank 241-B-111 received flush water and decontamination waste (DW) from B Plant. From the second quarter of 1963 to the second quarter of 1969, waste was transferred from tank 241-B-111 to tank 241-B-112. During the same period, tank 241-B-111 continued to receive PUREX high-level waste and flush water.

From the third quarter of 1969 to the second quarter of 1970, tank 241-B-111 received a large amount of waste from cesium recovery operations at B Plant, from tank 241-BY-112, and flush water. During this period, waste was sent from tank 241-B-111 to tanks 241-B-112, 241-B-108, 241-B-109, and 241-B-103. During the first quarter of 1972, waste was sent from tank 241-B-111 to tanks 241-B-103 and 241-BY-112.

Tank 241-B-111 was removed from service in 1976. About 45 kL (12 kgal) of liquid was transferred from tank 241-B-111 and sent to tank 241-AN-103 for interim stabilization during salt well pumping in 1983.

Table A3-1. Tank 241-B-111 Major Transfers.^{1,2}

Transfer Source	Transfer Destination	Waste Type	Period	Estimated Waste Volume ³	
				kL	kgal
241-B-110		2C2	1945 to 1953	20,450	5,402
	241-B-112	Supernate	1945 to 1953	-18,440	-4,872
241-B-105		Evaporator bottoms	1954	1,060	281
	241-B-112	Supernate	1954	-1,060	-281
	241-B-108	Supernate	1955	-1,060	-281
B Plant		Flush water	1957 to 1959	314	83
B Plant		DW	1961 to 1962	818	216
	241-B-112	Supernate	1963	-836	-221
PUREX		PUREX high-level waste	1964 to 1967	2,530	699
	241-B-112	Supernate	1965 to 1967	-2,270	-600
Misc. sources		Flush water	1966	72	19
241-B-112		Supernate	1967	367	97
	241-B-112	Supernate	1969	-2,700	-714
B Plant		Cesium recovery	1969 to 1970	7,093	1,874
	241-B-108 and 241-B-109	Supernate	1969	-3,009	-795
241-BY-112		Evaporator bottoms	1969 to 1970	348	92
	241-B-103	Supernate	1970 to 1972	-2,750	-726
	241-BY-112	Supernate	1972	-79	-21
	241-AN-103	Salt well liquid	1983	-45	-12

Notes:

¹Agnew et al. (1996b)²Because only major transfers are listed, the sum of these transfers will not equal the current tank waste volume.³Positive transfer volumes are amounts transferred to tank 241-B-111; negative transfer volumes are amounts transferred from tank 241-B-111.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The following is an estimate of the contents of tank 241-B-111 based on historical data. The historical data used for the estimate are from the *Waste Status and Transaction Record Summary for the Northeast Quadrant (WSTRS)* (Agnew et al. (1996b)), the *Hanford Tank Chemical and Radionuclide Inventories: HDW Model, Rev. 3* (this document contains the Hanford Defined Waste [HDW] list, the Supernatant Mixing Model [SMM], the Tank Layer Model [TLM]) (Agnew et al. 1996a), and the *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Areas (HTCE)* (Brevick et al. 1996a). The WSTRS is a balanced tank-by-tank, quarterly summary spreadsheet of waste transactions. In most cases, the available data are incomplete reducing the reliability of the transfer data and the derived modeling results. Using these records, the TLM defines the sludge and saltcake layers within each tank. The SMM uses information from both the WSTRS and TLM to describe the supernates and concentrates within each tank. Together, the WSTRS, TLM, and SMM are used to determine each tank's inventory estimate. Thus, these model predictions are considered estimates only that require further evaluation using analytical data.

Based on Agnew et al. (1996a), tank 241-B-111 contains 4 kL (1 kgal) of supernate, 98 kL (26 kgal) of P2 waste, 4 kL (1 kgal) of DW, and 791 kL (209 kgal) of 2C2 waste. Figure A3-1 is a graphical representation of the estimated waste type and volume for the waste layers. The constituents estimated to be above 1 wt% in 2C2 waste are sodium, iron, nitrate, phosphate, and hydroxide. The constituents estimated to be above 1 wt% of DW are hydroxide, sodium, chromium, nickel, calcium, sulfate, and iron. The constituents estimated to be about 1 wt% in P2 waste are sodium, iron, hydroxide, nitrite, nitrate, uranium, and silicate. The most prevalent radionuclide expected in P2 waste is Sr⁹⁰. Table A3-2 shows the HTCE of the expected waste constituents and their concentrations.

Figure A3-1. Hanford Defined Wastes Model.

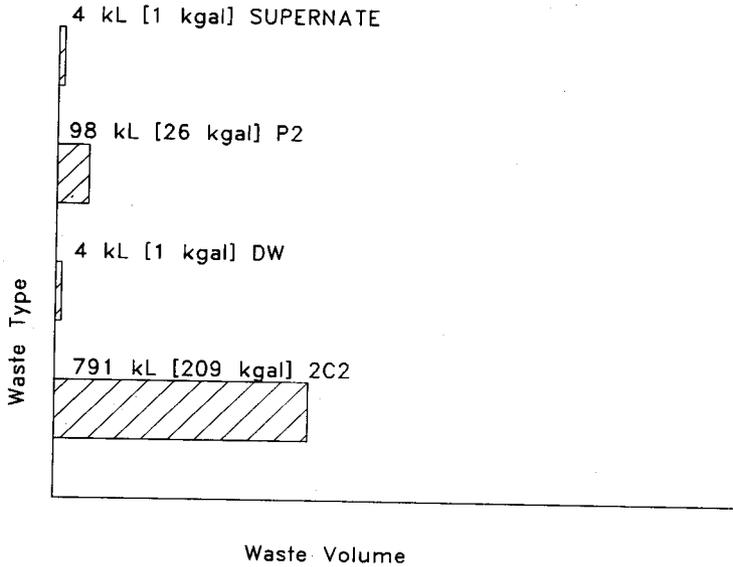


Table A3-2. Tank 241-B-111 Historical Tank Content Estimate.^{1,2} (2 sheets)

Total Inventory Estimate ³			
Physical Properties			
Total waste	1.04E+06 kg (237 kgal)		
Heat load	9,330 W (31,900 Btu/hr)		
Bulk density ⁴	1.16 (g/mL)		
Water wt% ⁴	78.2		
TOC wt% C (wet) ⁴	0.00278		
Chemical Constituents	M	ppm	kg
Na ⁺	1.54	3.05E+04	3.18E+04
Al ³⁺	0.00684	159	166
Fe ³⁺ (total Fe)	1.03	4.98E+04	5.18E+04
Cr ³⁺	0.00875	392	408
Bi ³⁺	0.0362	6,530	6,790
La ³⁺	1.77E-08	0.00212	0.00221
Hg ²⁺	4.28E-08	0.0074	0.0077
Zr (as ZrO(OH) ₂)	1.63E-06	0.128	0.133
Pb ²⁺	6.85E-06	1.22	1.27
Ni ²⁺	0.00941	477	496
Sr ²⁺	5.90E-09	4.46E-04	4.64E-04
Mn ⁴⁺	1.78E-05	0.846	0.88
Ca ²⁺	0.274	9,480	9,860
K ⁺	0.00379	128	133
OH ⁻	3.34	4.89E+04	5.09E+04
NO ₃ ⁻	0.589	3.15E+04	3.27E+04
NO ₂ ⁻	0.0754	2,990	3,110

Table A3-2. Tank 241-B-111 Historical Tank Content Estimate.^{1,2} (2 sheets)

Total Inventory Estimate ³			
Chemical Constituents	M	ppm	kg
CO ₃ ²⁻	0.276	1.43E+04	1.48E+04
PO ₄ ³⁻	0.124	1.02E+04	1.06E+04
SO ₄ ²⁻	0.0394	3,270	3,400
Si (as SiO ₃ ²⁻)	0.184	4,450	4,620
F ⁻	0.0968	1,590	1,650
Cl ⁻	0.0172	525	546
C ₆ H ₅ O ₇ ³⁻	1.32E-04	21.5	22.3
EDTA ⁴⁻	2.95E-05	7.34	7.64
HEDTA ³⁻	3.99E-06	0.943	0.981
Glycolate ⁻	9.27E-05	6.00	6.24
Acetate ⁻	1.76E-04	8.95	9.31
Oxalate ²⁻	1.51E-08	0.00115	0.0012
DBP	1.40E-04	32.1	33.4
Butanol	1.40E-04	8.94	9.30
NH ₃	0.0266	390	406
Fe(CN) ₆ ⁴⁻	0	0	0
Radiological Constituents	Ci/L	μCi/g	Ci
Pu	---	0.148	2.56 (kg)
U	0.0193 (M)	3,960 (μg/g)	4,120 (kg)
Cs	0.0625	53.9	5.61E+04
Sr	1.50	1,290	1.35E+06

Notes:

¹Agnew et al. (1996a)²These estimates have not been validated and should be used with caution.³Unknowns in tank solids inventory are assigned by the TLM.⁴Volume average for density, mass average water wt% and TOC wt% carbon.

A4.0 SURVEILLANCE DATA

Tank 241-B-111 surveillance consists of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well (dry well) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate whether the tank has a major leak. Solid surface-level measurements indicate physical changes in and consistency of the solid layers. Dry wells located around the tank perimeter may show increased radioactivity because of leaks.

A4.1 SURFACE-LEVEL READINGS

An FIC gauge is used to monitor the surface level through riser 1. An automatic FIC had been used in the past, but readings are not available after April 1990. A manual FIC reading of 2.12 m (83.3 in.), a neutron interstitial liquid-level gauge reading of 2.29 m (90.24 in.) and an FIC in intrusion mode reading of 2.14 m (84.4 in.) were measured on October 2, 1996. Figure A4-1 shows the supernate and solid waste levels within tank 241-B-111 from 1945 to 1996. Supernate and sludge levels were taken on a quarterly basis as part of the overall surveillance effort in the tank farms. For surface-level reading in this tank farm, zero on the vertical scale is at the knuckle bottom of the tank. The bottom center of the dish bottom is 30.5 cm (12 in.) below the knuckle bottom.

A4.2 INTERNAL TANK TEMPERATURES

Tank 241-B-111 has a single thermocouple tree with 11 thermocouples used to monitor waste temperature semiannually through riser 8. Thermocouple elevations were not available (Tran 1993). Thermocouples 2 through 11 are in service. On July 1, 1996, the high temperature in the tank was 21.1 °C (70 °F) at thermocouple 10; the low temperature was 18.7 °C (65.7 °F) at thermocouple 11. These temperature readings were obtained from the Surveillance Analysis Computer System (WHC 1996).

There is a gap in the data from early 1983 to mid 1989 and from late 1989 to mid 1993. The maximum temperature was 36.6 °C (98 °F) recorded at thermocouples 1 and 2 on April 8, 1979. The minimum temperature was 12.2 °C (54 °F) at thermocouple 10 on January 5, 1990. The average temperature for all the readings is 25.6 °C (78.1 °F).

A4.3 IN-TANK PHOTOGRAPHS

The clearest and most recent set of interior tank photographs was taken on June 26, 1985. A photographic montage is in the *Supporting Document for the Historical Tank Content Estimate for the B-Tank Farm* (Brevick et al. 1994). The montage shows a dark brown sludge surface with pockets of supernate. An unusable recirculating dip tube, salt well screen, temperature probe, and some debris are visible. At the time the photographs were taken, the tank contained approximately 897 kL (237 kgal) of waste. Because the tank has been inactive since the 1970s, the photographic montage should accurately represent the tank interior.

Figure A4-1. Tank 241-B-111 Level History.

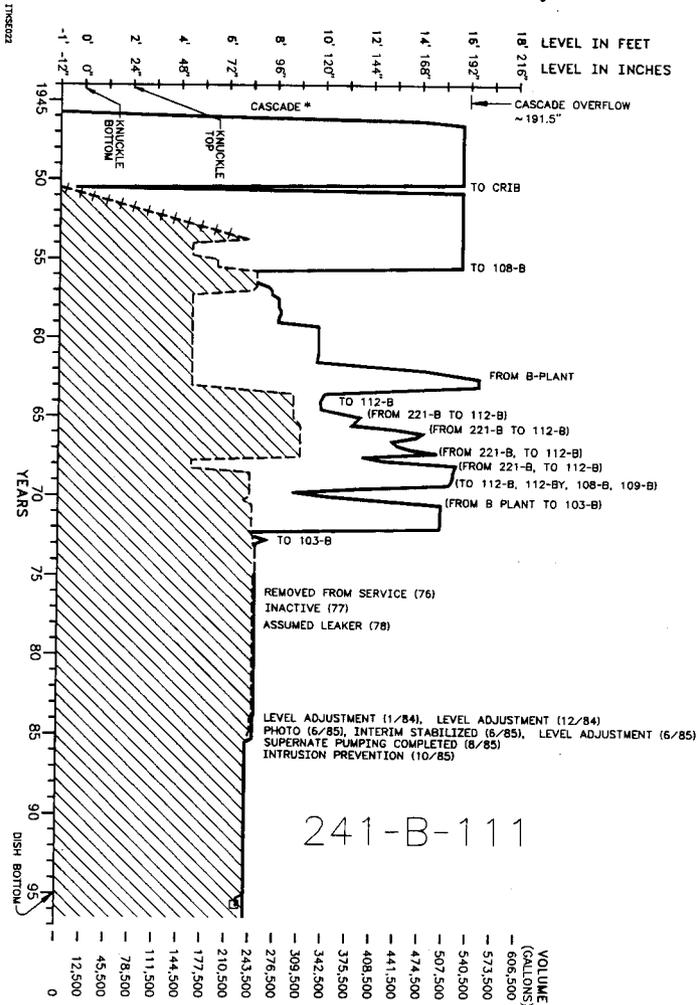
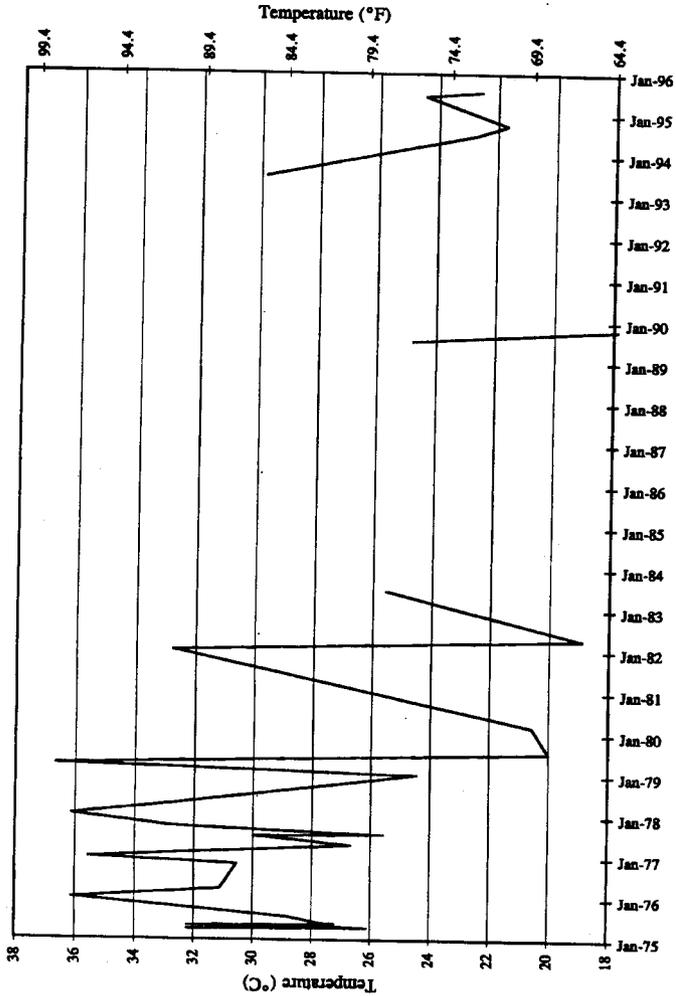


Figure A4-2. Tank 241-B-111 Temperature Plot.



A5.0 APPENDIX A REFERENCES

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APPENDIX B

SAMPLING OF TANK 241-B-111

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APPENDIX B

SAMPLING OF TANK 241-B-111

Appendix B provides sampling and analysis information for each known sampling event for tank 241-B-111 and assesses the core sampling results. It includes the following:

- **Section B1:** Tank Sampling Overview
- **Section B2:** Analytical Results
- **Section B3:** Assessment of Characterization Results
- **Section B4:** References for Appendix B.

Future sampling of tank 241-B-111 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the 1991 sampling and the 1993 analysis for tank 241-B-111. The characterization information supported the design of pretreatment and final waste disposal systems and was used to make risk assessment-based decisions.

The sampling and analysis were performed in accordance with the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991). The sampling event predated DQOs, however, this report evaluates analytical results against the current safety screening DQO (Dukelow et al. 1995). The tank headspace was sampled and analyzed for the presence of flammable gases in March 1996 to satisfy this safety screening DQO requirement. For further discussions of the sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994). There are no historical sampling events recorded for this tank.

B1.1 DESCRIPTION OF SAMPLING EVENT

Two push-mode core samples were taken from tank 241-B-111. Core 29, consisting of four segments, was collected from riser 3 from September 24 to 30, 1991; core 30, also four segments, was collected from riser 5 on the opposite side of the tank on October 2 and 4, 1991. Each segment was delivered to the Pacific Northwest National Laboratory 325 Analytical Chemistry Laboratory. Normal paraffin hydrocarbons (NPH) were used as a hydrostatic head fluid (HHF) during core sampling.

Four complete segments and one partial segment were expected to be recovered from each tank 241-B-111 core (Hill et al. 1991). Segment 1 was not recovered for cores 29 or 30. Segments 2 through 5 were completely recovered for core 29. Segments 3 and 4 were completely recovered for core 30; segments 2 and 5 were partially recovered. After extrusion from the sampler, the core material was placed in glass bottles, sealed, and stored in the high-level radioactive facility. Laboratory analysis and characterization activities were delayed until February 1993 because of waste disposal, funding, and priority issues (Giamberardini 1993).

Although DQOs were not applicable to this sampling event, this report evaluates analytical results against the current safety screening DQO (Dukelow et al. 1995). Two vertical waste profiles were required. Although the riser locations, from which the core samples were taken, met the safety screening requirement of being separated radially to the maximum extent possible, the sample recovery did not fully meet the requirement of two complete vertical profiles. The safety screening DQO requirement that analyses be performed at the half segment level was also not met. The safety screening DQO also requires the determination of the flammability of tank headspace gases. Tank headspace gas sampling was performed on tank 241-B-111 in March 1996. Results indicated no flammable gas was detected (0 percent of the lower flammability limit [LFL]).

B1.2 SAMPLE HANDLING

The two cores recovered from tank 241-B-111 were similar except that only core 30 contained drainable liquid. Both cores were sludges that held their shape upon extrusion. The flow behavior and bulk density of the solids in segment 5, core 30 indicated some mixing of solid material and drainable liquid. The sample color in both cores varied from dark brown to tan (Giamberardini 1993).

The drainable liquid contained in segments 2 and 5 of core 30 was determined to be HHF. This drainable liquid had a density of 0.80 g/mL and appeared to be organic. Although the density and appearance of the liquid was consistent with the properties of HHF, it was not analyzed.

As shown in Table B1-1, four segments of core 29 were fully recovered. Two segments of core 30 were fully recovered, and two were partially recovered. There was no mention of mechanical failure to account for the partial recoveries of these samples.

The 8 segments from cores 29 and 30 were individually homogenized. Segment 4 of core 29 and segments 3 and 5 of core 30 were subsampled so that analytical tests could be performed to evaluate sample homogenization. After being prepared for analysis by caustic fusion, these subsamples were submitted to the laboratory for gamma energy analysis (GEA), inductively coupled plasma analysis (ICP), and total alpha analysis. Section B3.2 discusses the results.

Table B1-1. Tank 241-B-111 Sample Description.¹

Segment	Sample ID	Mass (g)	Volume (mL)	Percent Recovery	Sample Characteristics
Core 29 - Riser 3					
1	---	0	0	0	Sampler empty.
2	91-081	230	187	100	Sticky sludges that held shape upon extrusion; soft and creamy texture, but extruded in chunks. The top portion of segment 2 was dark brown, but remaining segments were tan with the exception of streaks of brown in top section of segment 3.
3	91-082	232	187	100	
4	91-083	243	187	100	
5	91-084	239	187	100	
Core 30 - Riser 5					
1	---	0	0	0	Sampler empty.
2	91-086	38 ²	30 ²	16 ²	Solids of segments 2 through 5 similar to solids in core 29. Drainable liquid caused solids in segments 2 and 5 to flow indicating mixing of solids and liquid.
3	91-087	244	187	100	
4	91-088	245	187	100	
5	91-089	87 ²	70 ²	35 ²	

Notes:

¹Giamberardini (1993)²Does not include drainable liquid that was determined to be HHF.

Two core composites were built for each core using homogenized aliquots from each segment. The core 29 composite samples were prepared using equal portions from each segment. The core 30 composite samples were prepared using amounts proportional to the solids recovered from each segment (Giamberardini 1993). The composite samples were prepared in duplicate.

The tank headspace gas monitoring was performed using a combustible gas meter, and the flammability was measured as a percent of the lower flammability LFL.

B1.3 SAMPLE ANALYSIS

An extensive set of analyses were required by Hill et al. (1991) including tests for chemical, physical, and thermodynamic properties. Table B1-2 lists the methods used to assay tank 241-B-111 samples for the suite of requested analyses.

Table B1-2. Sample Preparation and Analytical Methods
for Tank 241-B-111 Samples. (2 sheets)

Analyte	Sample Prep.	Method	Analyte	Sample Prep.	Method
Aluminum	A, F, W	ICP:A	Antimony	A, F, W	ICP:A
Arsenic	A, F, W	ICP:A	Barium	A, F, W	ICP:A
Bismuth	A, F, W	ICP:F	Beryllium	A, F, W	ICP:A
Boron	A, F, W	ICP:A	Cadmium	A, F, W	ICP:A
Calcium	A, F, W	ICP:A	Cerium	A, F, W	ICP:A
Chromium	A, F, W	ICP:A	Cobalt	A, F, W	ICP:A
Copper	A, F, W	ICP:A	Dysprosium	A, F, W	ICP:A
Europium	A, F, W	ICP:A	Gadolinium	A, F, W	ICP:A
Iron	A, F, W	ICP:F	Lanthanum	A, F, W	ICP:A
Lead	A, F, W	ICP:A	Lithium	A, F, W	ICP:A
Magnesium	A, F, W	ICP:A	Manganese	A, F, W	ICP:A
Molybdenum	A, F, W	ICP:A	Neodymium	A, F, W	ICP:A
Nickel	A, F, W	ICP:A	Palladium	A, F, W	ICP:A
Phosphorus	A, F, W	ICP:F	Potassium	A, F, W	ICP:A
Rhodium	A, F, W	ICP:A	Ruthenium	A, F, W	ICP:A
Selenium	A, F, W	ICP:A	Silicon	A, F, W	ICP:F
Silver	A, F, W	ICP:A	Sodium	A, F, W	ICP:F
Strontium	A, F, W	ICP:A	Tellurium	A, F, W	ICP:A
Thallium	A, F, W	ICP:A	Thorium	A, F, W	ICP:A
Tin	A, F, W	ICP:A	Titanium	A, F, W	ICP:A
Tungsten	A, F, W	ICP:A	Vanadium	A, F, W	ICP:A
Yttrium	A, F, W	ICP:A	Zinc	A, F, W	ICP:A
Zirconium	A, F, W	ICP:A	Chloride	W	IC:W
Cyanide	W	IC:W	Fluoride	W	IC:W
Nitrate	W	IC:W	Nitrite	W	IC:W
Phosphate	W	IC:W	Sulfate	W	IC:W
Ammonia	W	ISE:W	Mercury	A	CVAA:A
^{243/244} Cm	F	Alpha radchem:F	Gross alpha	F	Alpha radchem:F
²³⁷ Np	F	Alpha radchem:F	²³⁸ Pu	F	Alpha radchem:F

Table B1-2. Sample Preparation and Analytical Methods
for Tank 241-B-111 Samples. (2 sheets)

Analyte	Sample Prep.	Method	Analyte	Sample Prep.	Method
^{239/240} Pu	F	Alpha radchem:F	Total alpha	F, W	Alpha radchem:F
Gross beta	F, W	Beta radchem:F	⁹⁰ Sr	F	Beta radchem:F
⁹⁹ Tc	F	Beta radchem:F	²⁴¹ Am	A, F, W	GEA:F
¹⁴⁴ Ce	A, F, W	GEA:F	¹³⁴ Cs	A, F, W	GEA:F
¹³⁷ Cs	A, F, W	GEA:F	⁶⁰ Co	A, F, W	GEA:F
¹⁵⁴ Eu	A, F, W	GEA:F	¹⁵⁵ Eu	A, F, W	GEA:F
⁴⁰ K	A, F, W	GEA:F	Uranium	F	Laser fluorimetry:F
²³⁹ Pu	F	Mass spectrometry:F	²⁴⁰ Pu	F	Mass spectrometry:F
²⁴¹ Pu	F	Mass spectrometry:F	²⁴² Pu	F	Mass spectrometry:F
²³⁴ U	F	Mass spectrometry:F	²³⁵ U	F	Mass spectrometry:F
²³⁶ U	F	Mass spectrometry:F	²³⁸ U	F	Mass spectrometry:F
Tritium	W	Liquid scintillation:W	¹⁴ C	W	Liquid scintillation:W
⁵⁹ Ni	A	Liquid scintillation:A	⁶³ Ni	A	Beta radchem:A
TOC	D, W	Persulfate oxidation:W	Hexavalent Chromium	W	Colorimetric:W
Total carbon	D, W	Persulfate oxidation:W	TIC	D, W	Persulfate oxidation:W
SVOA	---	GC/MS	VOA	---	GC/MS

Notes:

A = acid
D = direct
GC/MS = gas chromatography/mass spectrometry
ICP = inductively coupled plasma
W = water

CVAA = cold vapor atomic absorption
F = fusion
IC = ion chromatography
ISE = ion selective electrode

Analyses have limits imposed between the time a sample is recovered and the analysis (hold time limits). No attempt was made to meet holding time limits for these samples because of waste disposal issues and program priorities. The samples were received on October 8, 1991, and analysis began in February 1993.

A total of 4,625 analytical measurements were made on the tank 241-B-111 samples. Table B1-3 shows a list of sample numbers and applicable analyses. Table B1-4 contains a summary of the analytical result counts. The most complete segment-level analyses were performed on physical properties. All segment-level chemical analyses were homogenization tests. Almost one-third of all analytical results in the data set were quality assurance data (that is, matrix spikes, method blanks, etc.).

The core composite data were used to determine mean concentrations and their associated uncertainties. These values were used to estimate the inventories of the tank 241-B-111 waste constituents. The available segment-level data were used to conduct the sample homogenization tests and to determine the physical properties of tank 241-B-111 waste.

B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

There are no historical sampling events for this tank.

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

Segment	Sample Portion	Sample Number	Analyses
2	Whole	93-04312-K1	Weight percent solids
		91-081	Bulk density
		91-10545	DSC/TGA Particle size distribution
3	Whole	93-04312-K2	Weight percent solids
		91-082	Bulk density, centrifuged solids density, centrifuged supernate density, shear strength
		91-10549	DSC/TGA Particle size distribution
4	Upper 1/2	91-10553H-1T	ICP (fusion digest)
		91-10553-H1T	GEA, alpha (fusion digest)
	Lower 1/2	91-10553H-1B	ICP (fusion digest)
		91-10553-H1B	GEA, alpha (fusion digest)
	Whole	93-04313-K1	Weight percent solids
		91-083	Bulk density DSC/TGA
5	Whole	91-10553	Particle size distribution
		93-04313-K2	Weight percent solids
		91-084	Bulk density, centrifuged solids density, centrifuged supernate density, shear strength DSC/TGA
		91-10557	Particle size distribution

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

Segment	Sample Portion	Sample Number	Core 25	Analyses
Composite	Whole	93-04312		pH
		93-04313		pH
		93-04312-A,B		GFAA (acid digest)
		93-04313-A,B		GFAA (acid digest)
		93-04312-C		cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest)
		93-04313-C		cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest)
		93-04312-D		CVAA
		93-04313-D		CVAA
		93-04312a1		ICP (acid digest)
		93-04313a1		ICP (acid digest)
		93-4312h1,c1		ICP (fusion digest, water digest)
		93-4313h1,c1		ICP (fusion digest, water digest)
		93-04312-C-1		liquid scintillation counting (water digest)
		93-04313-C-1		liquid scintillation counting (water digest)
		93-04312-H-1		laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest)
		93-04313-H-1		laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest)
		93-04312-J-1		SVOA
		93-04313-J-1		SVOA
		93-04312-E1		liquid scintillation counting
		93-04313-E1		liquid scintillation counting
93-04312-F1		ETOX		
93-04313-F1		ETOX		
93-04312-J		TC, TOC, TIC, liquid scintillation counting		
93-04313-J		TC, TOC, TIC, liquid scintillation counting		
93-04313-K1		weight percent solids		
93-04312-K1		weight percent solids		
93-04312-L1		CVAA for TCLP, ICP for TCLP		
93-04313-L1		CVAA for TCLP, ICP for TCLP		

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

Segment	Sample Portion	Sample Number	Analyses
2	whole	91-086	Bulk density
		92-04050	DSC/TGA Particle size distribution
3	Upper	92-04054H-1T	ICP (fusion digest)
		92-04054-H1T	GEA, alpha (fusion digest)
	Lower	92-04054H-1B	ICP (fusion digest)
		92-04054-H1B	GEA, alpha (fusion digest)
4	Whole	93-04316-K1	Weight percent solids
		91-087	Bulk density DSC/TGA
		92-04054	Particle size distribution
		93-04316-K2	Weight percent solids
5	Upper half	91-088	Bulk density
		92-04058	DSC/TGA Particle size distribution
	Lower half	92-04062H-1T	ICP (fusion digest)
		92-04062-H1T	GEA, alpha (fusion digest)
Whole	92-04062H-1B	ICP (fusion digest)	
	92-04062-H1B	GEA, alpha (fusion digest)	
	Whole	93-04319-K1	Weight percent solids
		91-089	Bulk density DSC/TGA
		92-04062	Particle size distribution

Table BI-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

Segment	Sample Portion	Sample Number	Analyses
Composite	Whole	93-04316	pH
		93-04317	pH
		93-04316-A,B	GFAA (acid digest)
		93-04317-A,B	GFAA (acid digest)
		93-04316-C	cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest)
		93-04317-C	cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest)
		93-04316-D	CVAA
		93-04317-D	CVAA
		93-04316a1	ICP (acid digest)
		93-04317a1	ICP (acid digest)
		93-4316h1,c1	ICP (fusion digest, water digest)
		93-4317h1,c1	ICP (fusion digest, water digest)
		93-04316-C-1	liquid scintillation counting (water digest)
		93-04317-C-1	liquid scintillation counting (water digest)
		93-04316-H-1	laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest)
		93-04317-H-1	laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest)
		93-04316-J-1	liquid scintillation counting
		93-04317-J-1	liquid scintillation counting
		93-04312-E1	liquid scintillation counting
		93-04313-E1	SVOA
		93-04312-F1	ETOX
		93-04313-F1	ETOX
		93-04312-J	TC, TOC, TIC
93-04313-J	TC, TOC, TIC		
93-04313-K1	weight percent solids		
93-04312-K1	weight percent solids		
93-04317-L1	ICP for TCLP, CVAA for TCLP		

Note:

TGA = thermogravimetric analysis
 *Giamberardini (1993)

Table B1-4. Summary of Tank 241-B-111 Analytical Result Counts.

Analyses		Segment					Composite	Totals
		1	2	3	4	5		
Physical properties	Core 29	0	42	47	50	55	6	200
	Core 30	0	48	50	46	49	6	199
Chemical analyses	Core 29	0	0	0	196	0	1,096	1,292
	Core 30	0	0	196	0	196	1,063	1,455
Quality assurance (QA) data		0	0	0	49	49	1,381	1,479
Totals		0	90	293	341	349	3,552	4,625

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the sampling and analytical results associated with the 1991 sampling and the 1993 analysis of tank 241-B-111, and the tank headspace gas monitoring performed in March 1996. Table B2-1 describes the chemical, physical, and thermodynamic results in this document. Results were taken from Giamberardini (1993).

Table B2-1. Analytical Presentation Tables.

Analysis	Table Number
Metals by graphite furnace atomic absorption	B2-2 through B2-4
Mercury by cold vapor atomic absorption	B2-5
Metals by inductively coupled plasma spectroscopy	B2-6 through B2-40
Hexavalent chromium by colorimetry	B2-41
Uranium by laser fluorimetry	B2-42
Anions by ion chromatography	B2-43 through B2-49
Ammonia by ion selective electrode	B2-50
Extractable organic halides	B2-51
Semivolatile organic analysis	B2-52 through B2-61
Analyses for total carbon/total organic carbon/total inorganic carbon	B2-62 through B2-67
Radionuclides by gamma energy analysis	B2-68 through B2-72
Radionuclides by mass spectrometry	B2-73 through B2-76
Radionuclides by alpha proportional counting and alpha energy analysis	B2-77 through B2-84
Radionuclides by beta proportional counting	B2-85 through B2-87
Radionuclides by liquid scintillation	B2-88 through B2-91
Analyses for physical and rheological properties	B2-92 through B2-98
Analyses for thermodynamic properties	B2-99 through B2-100
Analyses for headspace flammability	B2-101

Data was validated in accordance with Hill et al. (1991). Quality control (QC) and quality assurance (QA) parameters included standard recoveries, spike recoveries, duplicate analyses, and blanks. Section B3.3 summarizes data validation findings.

The following sections discuss the methods used in analyzing the core samples.

B2.2 INORGANIC ANALYSES

B2.2.1 Graphite Furnace Atomic Absorption

Graphite furnace atomic absorption (GFAA) analyses for arsenic, selenium, and antimony were performed on the core composite samples (Giamberardini 1993). The samples were analyzed using procedures PNL-ALO-214, PNL-ALO-215, and PNL-ALO-219 for arsenic, selenium, and antimony respectively. Arsenic and selenium were analyzed from HNO_3 digestions, and antimony was analyzed from HNO_3/HCl digestions. All results were below the detection limit (Giamberardini 1993).

B2.2.2 Cold Vapor Atomic Absorption

A mercury analysis was performed on the core composites by CVAA using a modification of procedure PNL-ALO-213 (Giamberardini 1993). The modification changed the sample size, digestion volume, and heating method. The results ranged from 4 to 16 $\mu\text{g/g}$.

B2.2.3 Toxicity Characteristic Leaching Procedure

A TCLP was performed on the core composites. Both composites were leached using procedure PNL-ALO-110 (Giamberardini 1993). The leachate was then digested using acid to determine the concentrations of arsenic, barium, cadmium, chromium, lead, selenium, and silver using ICP. Mercury was analyzed in the leachate using CVAA.

The only analytes at or above the regulatory level were mercury and chromium. Mercury levels ranged from 0.21 to 0.39 $\mu\text{g/g}$, and chromium levels ranged from 12.2 to 14.8 $\mu\text{g/g}$. All other analytes, including silver which showed poor spike/control recovery, are well below the regulatory level. When compared to the water leach ICP results, all the water soluble chromium appears to be extracted by the TCLP. For further detail regarding the TCLP results, refer to Giamberardini (1993).

B2.2.4 Inductively Coupled Plasma

Analyses for the waste's metallic constituents were performed by ICP (Giamberardini 1993). The ICP analyses were run after fusion, acid, and water digestions for most but not all analytes. Fusions were prepared from core 29 samples (two composites and segment 4) and core 30 samples (segments 3 and 5) using procedure PNL-ALO-102. Acid digestions were prepared from core 29 and 30 composites using procedure PNL-ALO-101. Water leaches were prepared from core 29 and 30 composites using procedure PNL-ALO-103. The fusions, digestions, and leachates were analyzed following procedure PNL-ALO-211 on a Jarrell-Ash ICP system.

Analytes present in large amounts included sodium, bismuth, iron, and phosphorus. Results ranged from 16,000 to 20,000 $\mu\text{g/g}$. Sodium levels were as high as 99,398 $\mu\text{g/g}$. Aluminum, calcium, chromium, lead, potassium, and silicon results ranged from 700 to 18,000 $\mu\text{g/g}$. Copper, magnesium, manganese, strontium, and zinc results ranged from 36 to 409 $\mu\text{g/g}$. Analytes present in smaller amounts included antimony, barium, boron, cadmium, cobalt, molybdenum, nickel, selenium, silver, tellurium, vanadium, total uranium, and zirconium. Lathanam, palladium, and yttrium were not detected.

Interelement corrections for spectral interferences were performed online, and the reported instrument detection limits were determined in accordance with the statement of work and technical project plan requirements.

B2.2.5 Colorimetry

Analyses for chromium (VI) were performed by colorimetry on core composite samples that had been water leached (Giamberardini 1993). The samples were analyzed using procedure PNL-ALO-227. Results ranged from 142 to 185 $\mu\text{g/g}$.

B2.2.6 Laser Fluorimetry

Total uranium concentrations were measured on the KOH fusion preparations of core 29 and 30 composite samples using laser fluorimetry. No procedure number was provided in Giamberardini (1993). Results ranged from 186 to 206 $\mu\text{g/g}$.

B2.2.7 Ion Chromatography

Ion chromatography analyses were performed on water leachates prepared from core 29 and core 30 composite samples (Giamberardini 1993). They were analyzed for the anions fluoride, chloride, nitrite, nitrate, phosphate, and sulfate using procedure PNL-ALO-212. Nitrate and nitrite were present in amounts ranging from 75,000 to 89,000 $\mu\text{g/g}$, and 40,500 to 49,500 $\mu\text{g/g}$ respectively. Phosphate and sulfate were present in smaller amounts with

results ranging 23,100 to 25,300 $\mu\text{g/g}$ and 11,300 to 11,950 $\mu\text{g/g}$, respectively. Fluoride and chloride had results ranging from 1,000 to 1,500 $\mu\text{g/g}$. Samples were also analyzed for free cyanide using procedure PNL-ALO-271. Results ranged from less than the detection limit to 2.9 $\mu\text{g/g}$. The lowest calibration standard for each analyte is defined as the method detection limit.

B2.2.8 Ion Selective Electrode

Analyses for ammonia were performed on water-leached core composite samples using procedure PNL-ALO-226. No distillation procedure was performed on the samples because the ISE analysis is performed directly on the leachates (Giamberardini 1993). Results ranged from 22 to 66 $\mu\text{g/g}$.

B2.3 ORGANIC ANALYSES

B2.3.1 Extractable Organic Halides

Core 29 and 30 composite samples were analyzed for the presence of extractable organic halides using method PNL-ALO-320. All results were less than the detection limit (Giamberardini 1993).

B2.3.2 Semivolatiles

Semivolatile organic compounds were analyzed on core 29 and 30 composites by GC/MS. The samples were extracted using procedure PNL-ALO-120 and analyzed using procedure PNL-ALO-345 (Giamberardini 1993). Results of specific compounds include tridecane ranging from 740 to 3,050 $\mu\text{g/g}$, tetradecane and dodecane ranging from 230 to 1,800 $\mu\text{g/g}$, and pentadecane ranging from 21 to 99 $\mu\text{g/g}$. Compounds present in smaller amounts included dioctyl adipate, undecane, and dodecane,4,6-dimethyl.

B2.4 CARBON ANALYSES

Results for TOC, TIC, and total carbon (TC) are obtained during the same analysis; therefore, the discussion of the analytical method for the three analytes has been combined.

The TOC/TIC/TC analyses were performed direct and on water leachates prepared from core 29 and 30 composites (Giamberardini 1993). Water leachates were analyzed using procedure PNL-7-40.7. Direct analyses were performed using procedure PNL-ALO-381.

Results from the TC analyses range from 4,00 to 5,765 $\mu\text{g/g}$. The TOC and TIC results range from 615 to 1,605 $\mu\text{g/g}$ and 3,960 to 5,110 $\mu\text{g/g}$, respectively.

The TOC results for water leach analysis are similar to those obtained from the direct hot persulfate analysis suggesting that most, if not all, of the organic carbon is soluble. The soluble TOC may contribute slightly to the interferences observed in the fluoride and chloride IC analyses (Giamberardini 1993).

B2.5 RADIONUCLIDE ANALYSES

A full suite of radiochemical analyses were performed on water and the KOH fusion preparations of core 29 and 30 composite samples. Some analyses (GEA and total alpha analysis [AEA]) were performed on the homogenization test samples (that is, core 29, segment 4; and core 30, segments 3 and 5). Results are based on the wet weight of the sample. Procedure numbers for most preparations and analyses were not given in Giamberardini (1993).

B2.5.1 Gamma Energy Analysis

A GEA was performed on core composite samples and homogenization test segment samples prepared by caustic fusion (Giamberardini 1993). Results of specific radionuclides include ^{137}Cs , ranging from 144 to 177 $\mu\text{g/g}$; and ^{241}Am , ^{154}Eu , ^{155}Eu , and ^{60}Co , ranging from below detection limits to 0.27 $\mu\text{Ci/g}$. The emphasis in the homogenization tests was on the detection of ^{137}Cs . Results were decay corrected to January 1, 1993.

B2.5.2 Mass Spectrometry

Thermal ionization mass spectrometry was used to determine the presence of all isotopes of U (Giamberardini 1993). Because the Pu content of these samples was low, isotopic composition by mass spectrometry was not possible. However, isotopic information is available from the AEA of the separated plutonium.

B2.5.3 Total Alpha Activity, Pu, Am/Cm, and Np Analysis

Total alpha activity, Pu, Am/Cm, and Np analyses were performed on KOH fusions of the core composite samples (Giamberardini 1993). Total alpha was also measured on the homogenization samples. The total activity was determined by drying a small aliquot on a counting plate and counting the plate. The Pu, Am/Cm, and Np fractions were separated by ion exchange and/or solvent extraction procedures, then counted. The Pu analyses were reported as total alpha Pu because the Pu concentration of the samples was too low for isotopic determination by mass spectrometry. Plutonium-239/240 and ^{238}Pu from the AEA of

the separated Pu were also reported. Separation of Am and Pu was not complete; therefore, a correction based on the AEA of the Pu and Am was required, and an additional 10 percent was added to the estimated error of the measurement. Total alpha results ranged from $1.61\text{E-}1$ to $1.95\text{E-}1$ $\mu\text{Ci/g}$. Results of specific radionuclides include ^{241}Am ranging from $5.56\text{E-}2$ to $8.87\text{E-}2$ $\mu\text{Ci/g}$, $^{239/240}\text{Pu}$ ranging from $8.18\text{E-}2$ to $1.06\text{E-}1$ $\mu\text{Ci/g}$, $^{243/244}\text{Cm}$ ranging from $1.35\text{E-}4$ to $1.27\text{E-}3$ $\mu\text{Ci/g}$, and ^{237}Np ranging from $5.20\text{E-}5$ to $1.10\text{E-}4$ $\mu\text{Ci/g}$. Total alpha Pu results ranged from $8.52\text{E-}2$ to $1.10\text{E-}1$ $\mu\text{Ci/g}$.

B2.5.4 Total Beta, ^{90}Sr , and ^{99}Tc

Total beta, ^{90}Sr , and ^{99}Tc analyses were performed on the KOH fusions of the composites from both cores (Giamberardini 1993). Total beta values were determined by drying a small aliquot of each solution and counting in a beta proportional counter. Technetium-99 and ^{90}Sr were also measured by beta counting after separating each fraction by ion exchange and/or solvent extraction. Total beta results ranged from 524 to 734 $\mu\text{Ci/g}$. Results of ^{90}Sr and ^{99}Tc measurements ranged from 172 to 308 $\mu\text{Ci/g}$ and from $9.93\text{E-}2$ to $1.27\text{E-}1$ $\mu\text{Ci/g}$, respectively.

B2.5.5 Liquid Scintillation Counting

Carbon-14 was determined by the hot persulfate oxidation/liquid scintillation counting method (PNL-ALO-482). Carbon-14 analyses were performed direct and on water leachates from core composite samples. For water leach samples, a process dilution factor of about 100 times is used causing most results to be below method detection limits (Giamberardini 1993).

Selenium-79 was detectable at very low activity levels in all samples except the preparation blanks.

The analysis of tritium blanks showed possible gross contamination of the core composite samples during preparation in the hot cell. This was attributed to a recurring problem of high residual tritium levels in the Shielded Analytical Laboratory.

B2.6 PHYSICAL ANALYSES

Measurements of physical characteristics such as weight percent solids, penetration resistance, shear strength, particle size, and settling behavior were taken. General physical assays were performed on samples from core 29. Particle size assays were performed on duplicate samples taken from unhomogenized segments from both core 29 and 30. Shear strength was run on unhomogenized segments from core 29. Because holding time was exceeded, shear strength is a qualified estimate.

B2.6.1 Penetration Resistance

The penetration resistance was measured according to procedure PNL-ALO-506, Rev. 0, on each extruded segment except for core 30, segment 2 (Giamberardini 1993). The volume of solids in this segment was too small to measure. The penetration measurement was made on unhomogenized segment material before further subsampling. These measurements were made after the sample had been sealed in a bottle for approximately one year. The penetration resistance for all segments was below the detection limit of the penetrometer (less than 1 pound per square inch); therefore, the sludge is cohesive.

B2.6.2 Weight Percent Solids

The weight percent total solids analyses were performed on samples from the core composites and duplicate samples according to technical procedure PNL-ALO-504 (Giamberardini 1993). This analysis is a gravimetric determination of the weight percent solids as measured by the loss of mass in the sample after drying in an oven at 105 °C (221 °F) for 24 hours. The segment data was obtained on unhomogenized material in the PNNL 325 High level Radiochemistry Facility, and the reported core composite data was obtained in the Shielded Analytical Laboratory on homogenized core composite material. The weight percent total solids ranged from 36.3 to 37.9 on the composite samples.

B2.6.3 Density

Bulk density was determined for samples from segments 2, 3, 4, and 5 of cores 29 and 30. Results ranged from 0.9 to 1.3 g/mL, with an overall tank density of 1.19 g/mL. Density of centrifuged solids and of centrifuged supernate was determined for samples from segments 3 and 5 of core 29. The centrifuged solids density results were 1.38 and 1.45 g/mL and the centrifuged supernate density results were 1.15 and 1.17 g/mL (Giamberardini 1993).

B2.6.4 Shear Strength

The shear strength of the waste was measured on unhomogenized segment samples from segments 3 and 5 of core 29. The shear strength measurements were made at ambient temperature using a shear vane connected to a viscometer and rotated at 0.3 revolutions per minute according to procedure PNL-ALO-501. Shear strength is a semiquantitative measurement of the force required to displace the sample. Because shear strength is affected by sample handling, the measurement was taken without sample homogenization (Giamberardini 1993). The shear stress of the material exceeded the baseline value for the measurement system (300 dynes/cm²) in only one of two cases. Because of the long lag time between sampling and analysis, these should be considered estimates.

B2.6.5 Particle Size Analysis

Particle size distribution was measured on unhomogenized samples from each segment (Giamberardini 1993). A particle size analyzer was used according to procedure PNL-ALO-530, Rev. 0, to determine particle size in the range of 0.5 to 150 microns. Most particles in these samples were less than 20 microns in diameter. The volume density data indicate there is a small percent of particles of much larger size, but it appears only a few particles exceed 100 microns in diameter.

B2.6.6 pH Measurement

The pH of the water leachates of both core composite materials was measured according to procedure PNL-ALO-225 (Giamberardini 1993). Measurement ranged from 8.74 to 8.98.

B2.7 THERMODYNAMIC ANALYSES

Thermogravimetric analysis (TGA) and DSC are techniques used to determine the thermal stability or reactivity of a material. Differential scanning calorimetry measures heat released or absorbed while the temperature of the sample is increased at a constant rate. It is often used to measure thermal decomposition temperatures, heats of reaction, reaction temperatures, melting points, and solid-solid transition temperatures. Thermogravimetric analysis measures the mass of a sample while the temperature is increased at a constant rate. It is used to measure thermal decomposition temperatures, water contents, and reaction temperatures. Both methods can be modified to measure isothermal change in the material and provide complimentary information.

B2.7.1 Thermogravimetric Analysis

Thermogravimetric analysis was performed on unhomogenized material from each segment of cores 29 and 30 (Giamberardini 1993). The balance of the thermogravimetric analyzer was checked with a 100 milligrams standard weight, and the temperature calibration of the analyzer was checked with alumel and perkalloy curie point magnetic transition standards.

B2.7.2 Differential Scanning Calorimetry

Differential scanning calorimetry was performed on aliquots from each unhomogenized segment from cores 29 and 30 (Giamberardini 1993). An indium standard was run on the differential scanning calorimeter to check the temperature and enthalpy calibrations.

No exothermic transitions were observed and because thermal measurements were made on aliquots from all segments of both cores, it is relatively certain that no exothermic layer

exists in this waste (Benar 1996). However, the thermal analysis did identify four endotherms in the waste, which absorbed approximately 300 calories per gram in total. These endotherms occurred at approximately 94, 176, 219, and 310 °C, (201.2, 348.8, 426.2, and 590 °F) with 95 percent of the endothermic behavior occurring between ambient and 140 °C (284 °F). The other endotherms are much smaller and may represent fluctuations associated with the baseline or stages in a series of endothermic events. Because of the relatively close proximity of transitions 2 and 3 in temperature, their relatively small size, the qualitative nature of the assay, and the fact that no corresponding mass loss was observed during the TGA, these endotherms are not considered fully credible. However, the endotherm observed with transition 4 had a more substantial signal in the DSC. Therefore, this endotherm is considered credible and potentially represents a physiochemical process occurring in the waste in that temperature range (277 to 500 °C) (530.6 to 932 °F). Because no exotherms were observed in the analyses of tank 241-B-111 waste, DSC data tables are not provided in this document. For additional data, refer to Giamberardini (1993).

B2.8 VAPOR PHASE MEASUREMENT

The vapor phase flammability measurements were taken from the tank 241-B-111 headspace on March 19, 1996. These measurements support the safety screening DQO (Dukelow et al. 1995).

B2.9 ANALYTICAL DATA TABLES

Table B2-2. Tank 241-B-111 Analytical Results: Antimony (AA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#/#	#/#	#/#
93-04312-A	Core 29 composite	Whole	< 1.9	< 1.8	< 1.9
93-04313-A		Whole	< 1.8	< 1.7	< 1.8
93-04316-A	Core 30 composite	Whole	< 1.9	< 1.9	< 1.9
93-04317-A		Whole	< 1.8	< 1.8	< 1.8

Table B2-3. Tank 241-B-111 Analytical Results: Arsenic (AA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312-B	Core 29 composite	Whole	< 3.0	< 2.9	< 3.0
93-04313-B		Whole	< 2.9	< 2.9	< 2.9
93-04316-B	Core 30 composite	Whole	< 2.9	< 2.9	< 2.9
93-04317-B		Whole	< 2.9	< 2.9	< 2.9

Table B2-4. Tank 241-B-111 Analytical Results: Selenium (AA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312-B	Core 29 composite	Whole	< 15	< 15	< 15 ^{QC:c}
93-04313-B		Whole	< 14	< 15	< 15
93-04316-B	Core 30 composite	Whole	< 15	< 14	< 15 ^{QC:c}
93-04317-B		Whole	< 15	< 14	< 15

Table B2-5. Tank 241-B-111 Analytical Results: Mercury (CVAA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids:			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-D	Core 29 composite	Whole	4.6	3.9	4.3
93-04313-D		Whole	5.1	5.0	5.1
93-04316-D	Core 30 composite	Whole	13	11	12
93-04317-D		Whole	19	13	16
Solids: TCLP			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
93-04312-L1	Core 29 composite	Whole	0.22	0.20	0.21
93-04313-L1		Whole	0.21	0.22	0.22
93-04317-L1	Core 30 composite	Whole	0.39	n/d ¹	0.39

Note:

¹n/d = not determined

Table B2-6. Tank 241-B-111 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312a1	Core 29 composite	Whole	893	n/d	893
93-04312a1		Whole	852	834	843
93-04313a1		Whole	788	823	806
93-04316a1	Core 30 composite	Whole	946	968	957
93-04317a1		Whole	986	n/d	986
93-04317a1		Whole	961	966	963.5
Solids: Fusion digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
91-10553H-1B	29: 4	Lower half	212	256	234
91-10553H-1T		Upper half	211	249	230
92-04054H-1B	30: 3	Lower half	1,680	1,440	1,560
92-04054H-1T		Upper half	1,320	1,340	1,330
92-04062H-1B	30: 5	Lower half	1,750	1,880	1,810

Table B2-6. Tank 241-B-111 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: Fusion digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
92-04062H-1T		Upper half	1,660	1,780	1,720
93-4312h1	Core 29 composite	Whole	1,150	1,110	1,130
93-4313h1		Whole	1,130	1,190	1,160
93-4316h1	Core 30 composite	Whole	1,610	1,630	1,620
93-4317h1		Whole	1,570	1,510	1,540
Solids: Water digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-4312c1	Core 29 composite	Whole	< 11	< 11	< 11
93-4313c1		Whole	< 12	< 9.2	< 10
93-4316c1	Core 30 composite	Whole	< 11	< 8.9	< 9.8
93-4317c1		Whole	< 11	15	< 13

Table B2-7. Tank 241-B-111 Analytical Results: Antimony (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312a1	Core 29 composite	Whole	< 10	< 9.5	< 9.7
93-04313a1		Whole	10	10	10
93-04316a1	Core 30 composite	Whole	12	15	14
93-04317a1		Whole	< 9.5	< 9.8	< 9.8

Table B2-8. Tank 241-B-111 Analytical Results: Arsenic (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: TCLP			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
93-04312-L1	Core 29 composite	Whole	0.20	0.30	0.25
93-04313-L1		Whole	0.30	0.30	0.30

Table B2-9. Tank 241-B-111 Analytical Results: Barium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	34	n/d	34
93-04312a1		Whole	32	31	32
93-04313a1		Whole	29	31	30
93-04316a1	Core 30 composite	Whole	25	25	25
93-04317a1		Whole	25	n/d	26
93-04317a1		Whole	25	25	25
Solids: TCLP			µg/mL	µg/mL	µg/mL
93-04312-L1	Core 29 composite	Whole	0.02	n/d	0.02
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	56	36	46
92-04054H-1T		Upper half	38	33	36
92-04062H-1B	30: 5	Lower half	43	44	44
92-04062H-1T		Upper half	52	42	47
93-4312h1	Core 29 composite	Whole	43	45	44
93-4313h1		Whole	44	48	46
93-4316h1	Core 30 composite	Whole	37	53	45
93-4317h1		Whole	33	35	34

Table B2-10. Tank 241-B-111 Analytical Results: Bismuth (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	19,100	n/d	19,100
93-04312a1		Whole	19,900	19,500	19,700
93-04313a1		Whole	18,200	19,200	18,700
93-04316a1	Core 30 composite	Whole	20,000	20,000	20,000
93-04317a1		Whole	16,700	n/d	16,700
93-04317a1		Whole	19,800	20,200	20,000
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	15,642	18,857	17,249.5
91-10553H-1T		Upper half	18,819	18,082	18,450.5
92-04054H-1B	30: 3	Lower half	23,940	20,052	21,996
92-04054H-1T		Upper half	19,304	19,272	19,288
92-04062H-1B	30: 5	Lower half	12,616	12,920	12,768
92-04062H-1T		Upper half	13,394	13,210	13,302
93-4312h1	Core 29 composite	Whole	20,580	20,001	20,290.5
93-4313h1		Whole	19,968	20,189	20,078.5
93-4316h1	Core 30 composite	Whole	20,366	20,436	20,401
93-4317h1		Whole	19,297	20,688	19,992.5
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	49	62	55.5
93-4313c1		Whole	76	54	65
93-4316c1	Core 30 composite	Whole	76	54	65
93-4317c1		Whole	68	68	68

Table B2-11. Tank 241-B-111 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	59	n/d	59
93-04312a1		Whole	54	59	56.5
93-04313a1		Whole	41	48	44.5
93-04316a1	Core 30 composite	Whole	47	71	59
93-04317a1		Whole	40	n/d	40
93-04317a1		Whole	42	53	47.5
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 53	136	< 94
91-10553H-1T		Upper half	82	107	94.5
92-04054H-1B	30: 3	Lower half	248	126	187
92-04054H-1T		Upper half	133	82	107.5
92-04062H-1B	30: 5	Lower half	165	137	151
92-04062H-1T		Upper half	212	128	170
93-4312h1	Core 29 composite	Whole	65	82	73.5
93-4313h1		Whole	46	44	45
93-4316h1	Core 30 composite	Whole	66	186	126
93-4317h1		Whole	< 42	58	< 50
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	21	12	16.5
93-4312c1		Whole	< 18	n/d	< 18
93-4313c1		Whole	17	10	13.5
93-4316c1	Core 30 composite	Whole	15	14	14.5
93-4317c1		Whole	17	13	15

Table B2-12. Tank 241-B-111 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	2	2	2
93-04313a1		Whole	3	3	3
93-04316a1	Core 30 composite	Whole	3	3	3
93-04317a1		Whole	1	1	1
Solids: TCLP			µg/mL	µg/mL	µg/mL
93-04312-L1	Core 29 composite	Whole	0.22	0.09	0.155
93-04313-L1		Whole	0.07	0.07	0.07
93-04317-L1	Core 30 composite	Whole	0.03	n/d	0.03
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	30	29	29.5
91-10553H-1T		Upper half	28	34	31
92-04054H-1B	30: 3	Lower half	20	18	19
92-04054H-1T		Upper half	26	22	24
92-04062H-1B	30: 5	Lower half	19	18	18.5
92-04062H-1T		Upper half	21	16	18.5
93-4312h1	Core 29 composite	Whole	41	30	35.5
93-4313h1		Whole	27	23	25
93-4316h1	Core 30 composite	Whole	14	14	14
93-4317h1		Whole	< 10	11	< 11
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 0.9	< 0.9	< 0.9
93-4313c1		Whole	< 1	< 0.8	< 0.9
93-4316c1	Core 30 composite	Whole	< 0.9	< 0.7	< 0.8
93-4317c1		Whole	< 0.9	< 1	< 1

Table B2-13. Tank 241-B-111 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	572	n/d	572
93-04312a1		Whole	544	527	535.5
93-04313a1		Whole	492	525	508.5
93-04316a1	Core 30 composite	Whole	847	828	837.5
93-04317a1		Whole	876	n/d	876
93-04317a1		Whole	842	857	849.5
Solids: fusion digest			#B/E	#B/E	#B/E
91-10553H-1B	29: 4	Lower half	307	410	358.5
91-10553H-1T		Upper half	382	436	409
92-04054H-1B	30: 3	Lower half	1,109	988	1,048.5
92-04054H-1T		Upper half	824	805	814.5
92-04062H-1B	30: 5	Lower half	988	1,033	1,010.5
92-04062H-1T		Upper half	1,060	1,035	1,047.5
93-4312h1	Core 29 composite	Whole	808	735	771.5
93-4313h1		Whole	708	734	721
93-4316h1	Core 30 composite	Whole	1,033	1,049	1,041
93-4317h1		Whole	1,038	1,054	1,046
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	20	14	17
93-4313c1		Whole	13	10	11.5
93-4316c1	Core 30 composite	Whole	< 9	7	< 8
93-4317c1		Whole	9	10	< 10

Table B2-14. Tank 241-B-111 Analytical Results: Cerium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#2/E	#2/E	#2/E
93-04312a1	Core 29 composite	Whole	21	20	20.5
93-04313a1		Whole	22	23	22.5
93-04316a1	Core 30 composite	Whole	22	27	24.5
93-04317a1		Whole	< 15	< 16	< 15
Solids: fusion digest			#2/E	#2/E	#2/E
91-10553H-1B	29: 4	Lower half	< 212	< 217	< 215
91-10553H-1T		Upper half	< 192	< 220	< 206
92-04054H-1B	30: 3	Lower half	< 210	< 191	< 201
92-04054H-1T		Upper half	< 204	< 217	< 210
92-04062H-1B	30: 5	Lower half	< 214	< 216	< 215
92-04062H-1T		Upper half	< 213	< 214	< 214
93-4312h1	Core 29 composite	Whole	< 158	< 150	< 154
93-4313h1		Whole	< 147	< 149	< 148
93-4316h1	Core 30 composite	Whole	< 166	< 162	< 164
93-4317h1		Whole	< 167	< 160	< 163
Solids: water digest			#2/E	#2/E	#2/E
93-4312c1	Core 29 composite	Whole	< 15	< 15	< 15
93-4313c1		Whole	< 15	< 12	< 14
93-4316c1	Core 30 composite	Whole	< 14	< 12	< 13
93-4317c1		Whole	< 15	< 16	< 15

Table B2-15. Tank 241-B-111 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	1,119	n/d	1,119
93-04312a1		Whole	1,089	1,062	1,075.5
93-04313a1		Whole	991	1,051	1,021
93-04316a1	Core 30 composite	Whole	1,150	1,153	1,151.5
93-04317a1		Whole	1,187	n/d	1,187
93-04317a1		Whole	1,146	1,170	1,158
Solids: TCLP			µg/mL	µg/mL	µg/mL
93-04312-L1	Core 29 composite	Whole	15.2	14.3	14.75
93-04313-L1		Whole	14.5	14.9	14.7
93-04317-L1	Core 30 composite	Whole	12.2	n/a	12.2
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	923	1,105	1,014
91-10553H-1T		Upper half	1,101	1,056	1,078.5
92-04054H-1B	30: 3	Lower half	1,360	1,172	1,266
92-04054H-1T		Upper half	1,036	1,029	1,032.5
92-04062H-1B	30: 5	Lower half	898	912	905
92-04062H-1T		Upper half	924	930	927
93-4312h1	Core 29 composite	Whole	1,119	1,156	1,137.5
93-4313h1		Whole	1,096	1,111	1,103.5
93-4316h1	Core 30 composite	Whole	1,178	1,183	1,180.5
93-4317h1		Whole	1,130	1,193	1,161.5
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	298	301	299.5
93-4312c1		Whole	305	n/d	305
93-4313c1		Whole	303	298	300.5
93-4316c1	Core 30 composite	Whole	234	230	232
93-4317c1		Whole	232	235	233.5

Table B2-16. Tank 241-B-111 Analytical Results: Cobalt (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#g/g	#g/g	#g/g
93-04312a1	Core 29 composite	Whole	3	3	3
93-04313a1		Whole	3	4	3.5
93-04316a1	Core 30 composite	Whole	4	4	4
93-04317a1		Whole	< 2	< 2	< 2
Solids: fusion digest			#g/g	#g/g	#g/g
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	< 26	< 24	< 25
92-04054H-1T		Upper half	< 25	< 27	< 26
92-04062H-1B	30: 5	Lower half	< 27	< 27	< 27
92-04062H-1T		Upper half	< 27	< 27	< 27
93-4312h1	Core 29 composite	Whole	22	21	21.5
93-4313h1		Whole	20	23	21.5
93-4316h1	Core 30 composite	Whole	< 21	21	< 21 ^{QC:f}
93-4317h1		Whole	21	< 20	< 21 ^{QC:f}
Solids: water digest			#g/g	#g/g	#g/g
93-4312c1	Core 29 composite	Whole	< 2	< 2	< 2
93-4313c1		Whole	< 2	2	< 2
93-4316c1	Core 30 composite	Whole	< 2	< 1	< 2
93-4317c1		Whole	< 2	2	< 2

Table B2-17. Tank 241-B-111 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	15	n/d	15 ^{QC:f}
93-04312a1		Whole	11	10	11 ^{QC:f}
93-04313a1		Whole	10	11	11 ^{QC:f}
93-04316a1	Core 30 composite	Whole	381	378	379.5
93-04317a1		Whole	410	n/d	410
93-04317a1		Whole	393	400	396.5
Solids: fusion digest			#B/E	#B/E	#B/E
91-10553H-1B	29: 4	Lower half	< 13	< 14	< 13
91-10553H-1T		Upper half	< 12	17	< 15
92-04054H-1B	30: 3	Lower half	449	362	405.5
92-04054H-1T		Upper half	284	297	290.5
92-04062H-1B	30: 5	Lower half	764	699	731.5
92-04062H-1T		Upper half	558	567	562.5
93-4312h1	Core 29 composite	Whole	37	34	35.5
93-4313h1		Whole	35	40	37.5
93-4316h1	Core 30 composite	Whole	402	403	402.5
93-4317h1		Whole	399	418	408.5
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	< 0.9	< 0.9	< 0.9
93-4313c1		Whole	< 1	1	< 1
93-4316c1	Core 30 composite	Whole	9	8	8.5
93-4317c1		Whole	10	10	10

Table B2-18. Tank 241-B-111 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#E/g	#E/g	#E/g
93-04312a1	Core 29 composite	Whole	16,446	n/d	16,446
93-04312a1		Whole	15,922	15,581	15,751.5
93-04313a1		Whole	14,561	15,309	14,935
93-04316a1	Core 30 composite	Whole	17,136	17,138	17,137
93-04317a1		Whole	18,001	n/d	18,001
93-04317a1		Whole	17,232	17,442	17,337
Solids: fusion digest			#E/g	#E/g	#E/g
91-10553H-1B	29: 4	Lower half	12,213	14,760	13,486.5
91-10553H-1T		Upper half	14,567	14,063	14,315
92-04054H-1B	30: 3	Lower half	20,501	17,682	19,091.5
92-04054H-1T		Upper half	16,054	16,054	16,054
92-04062H-1B	30: 5	Lower half	12,525	12,867	12,696
92-04062H-1T		Upper half	12,996	13,199	13,097.5
93-4312h1	Core 29 composite	Whole	16,891	16,848	16,869.5
93-4313h1		Whole	16,660	17,136	16,898
93-4316h1	Core 30 composite	Whole	18,828	18,753	18,790.5
93-4317h1		Whole	17,952	18,683	18,317.5
Solids: water digest			#E/g	#E/g	#E/g
93-4312c1	Core 29 composite	Whole	70	91	80.5
93-4312c1		Whole	67	n/d	67
93-4313c1		Whole	99	65	82
93-4316c1	Core 30 composite	Whole	87	73	80
93-4317c1		Whole	82	86	84

Table B2-19. Tank 241-B-111 Analytical Results: Lanthanum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#E/E	#E/E	#E/E
93-04312a1	Core 29 composite	Whole	7	7	7
93-04313a1		Whole	7	8	7.5
93-04316a1	Core 30 composite	Whole	6	8	7
93-04317a1		Whole	< 6	< 6	< 6
Solids: fusion digest			#E/E	#E/E	#E/E
91-10553H-1B	29: 4	Lower half	< 79	< 82	< 80
91-10553H-1T		Upper half	< 72	< 82	< 77
92-04054H-1B	30: 3	Lower half	< 79	< 72	< 75
92-04054H-1T		Upper half	< 76	< 81	< 89
92-04062H-1B	30: 5	Lower half	< 80	< 81	< 81
92-04062H-1T		Upper half	< 80	< 80	< 80
93-4312h1	Core 29 composite	Whole	< 59	< 56	< 58
93-4313h1		Whole	< 55	< 56	< 56
93-4316h1	Core 30 composite	Whole	< 62	< 61	< 61
93-4317h1		Whole	< 63	< 60	< 61
Solids: water digest			#E/E	#E/E	#E/E
93-4312c1	Core 29 composite	Whole	< 5.5	< 5.7	< 5.6
93-4313c1		Whole	< 5.8	< 4.6	< 5.2
93-4316c1	Core 30 composite	Whole	< 5.4	< 4.4	< 4.9
93-4317c1		Whole	< 5.7	< 5.8	< 5.8

Table B2-20. Tank 241-B-111 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	1,569	n/d	1,569
93-04312a1		Whole	1,477	1,436	1,456.5
93-04313a1		Whole	1,371	1,453	1,412
93-04316a1	Core 30 composite	Whole	1,665	1,678	1,671.5
93-04317a1		Whole	1,726	n/d	1,726
93-04317a1		Whole	1,666	1,688	1,677
Solids: TCLP			µg/mL	µg/mL	µg/mL
93-04312-L1	Core 29 composite	Whole	0.54	0.65	0.595
93-04313-L1		Whole	0.3	0.3	0.3
Solids: fusion digest			#B/E	#B/E	#B/E
91-10553H-1B	29: 4	Lower half	215	224	219.5
91-10553H-1T		Upper half	192	302	247
92-04054H-1B	30: 3	Lower half	1,868	1,563	1,715.5
92-04054H-1T		Upper half	1,277	1,262	1,269.5
92-04062H-1B	30: 5	Lower half	2,242	2,319	2,280.5
92-04062H-1T		Upper half	2,318	2,307	2,312.5
93-4312h1	Core 29 composite	Whole	1,899	1,804	1,851.5
93-4313h1		Whole	1,740	1,791	1,765.5
93-4316h1	Core 30 composite	Whole	1,875	1,915	1,895
93-4317h1		Whole	1,821	1,927	1,874
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	< 11	< 11	< 11
93-4313c1		Whole	< 12	10	< 11
93-4316c1	Core 30 composite	Whole	11	< 9	< 10
93-4317c1		Whole	< 11	12	< 12

Table B2-21. Tank 241-B-111 Analytical Results: Magnesium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	219	n/d	219
93-04312a1		Whole	196	194	195
93-04313a1		Whole	180	192	186
93-04316a1	Core 30 composite	Whole	201	199	200
93-04317a1		Whole	196	n/d	196
93-04317a1		Whole	188	191	189.5
Solids: fusion digest			#B/E	#B/E	#B/E
92-04054H-1B	30: 3	Lower half	288	284	286
92-04054H-1T		Upper half	210	230	220
92-04062H-1B	30: 5	Lower half	324	388	356
92-04062H-1T		Upper half	294	353	323.5
93-4312h1	Core 29 composite	Whole	307	304	305.5
93-4313h1		Whole	297	315	306
93-4316h1	Core 30 composite	Whole	360	371	365.5
93-4317h1		Whole	354	364	359
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	< 14	< 15	< 15
93-4313c1		Whole	< 15	< 12	< 14
93-4316c1	Core 30 composite	Whole	< 14	< 12	< 13
93-4317c1		Whole	< 15	20	< 18

Table B2-22. Tank 241-B-111 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	88	n/d	88
93-04312a1		Whole	86	84	85
93-04313a1		Whole	79	83	81
93-04316a1	Core 30 composite	Whole	74	73	73.5
93-04317a1		Whole	76	n/d	76
93-04317a1		Whole	74	75	74.5
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	47	55	51
91-10553H-1T		Upper half	54	55	54.5
92-04054H-1B	30: 3	Lower half	104	93	98.5
92-04054H-1T		Upper half	81	81	81
92-04062H-1B	30: 5	Lower half	94	92	93
92-04062H-1T		Upper half	83	86	84.5
93-4312h1	Core 29 composite	Whole	107	121	114
93-4313h1		Whole	105	112	108.5
93-4316h1	Core 30 composite	Whole	111	109	110
93-4317h1		Whole	118	103	110.5
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 0.9	< 0.9	< 0.9
93-4313c1		Whole	< 1	< 0.8	< 0.9
93-4316c1	Core 30 composite	Whole	< 0.9	< 0.7	< 0.8
93-4317c1		Whole	< 0.9	< 1	< 1

Table B2-23. Tank 241-B-111 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µB/g	µB/g	µB/g
93-04312a1	Core 29 composite	Whole	51	n/d	51
93-04312a1		Whole	46	45	45.5
93-04313a1		Whole	42	45	43.5
93-04316a1	Core 30 composite	Whole	39	40	39.5
93-04317a1		Whole	35	n/d	35
93-04317a1		Whole	37	37	37
Solids: fusion digest			µB/g	µB/g	µB/g
91-10553H-1B	29: 4	Lower half	< 53	< 54	< 54
91-10553H-1T		Upper half	< 48	< 55	< 51
92-04054H-1B	30: 3	Lower half	< 53	< 48	< 50
92-04054H-1T		Upper half	< 51	< 54	< 53
92-04062H-1B	30: 5	Lower half	< 53	< 54	< 54
92-04062H-1T		Upper half	< 53	< 54	< 53
93-4312h1	Core 29 composite	Whole	58	58	58
93-4313h1		Whole	57	56	56.5
93-4316h1	Core 30 composite	Whole	50	53	51.5
93-4317h1		Whole	53	49	51
Solids: water digest			µB/g	µB/g	µB/g
93-4312c1	Core 29 composite	Whole	40	40	40
93-4312c1		Whole	41	n/d	41
93-4313c1		Whole	40	40	40
93-4316c1	Core 30 composite	Whole	33	32	32.5
93-4317c1		Whole	33	35	34

Table B2-24. Tank 241-B-111 Analytical Results: Neodymium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/g	#B/g	#B/g
93-04312a1	Core 29 composite	Whole	54	n/d	54
93-04312a1		Whole	18	18	18
93-04313a1		Whole	22	24	23
93-04316a1	Core 30 composite	Whole	18	24	21
93-04317a1		Whole	7	8	7.5
Solids: fusion digest			#B/g	#B/g	#B/g
91-10553H-1B	29: 4	Lower half	< 79	< 82	< 80
91-10553H-1T		Upper half	< 72	< 82	< 77
92-04054H-1B	30: 3	Lower half	< 79	< 72	< 75
92-04054H-1T		Upper half	< 76	< 81	< 79
92-04062H-1B	30: 5	Lower half	< 80	< 81	< 81
92-04062H-1T		Upper half	< 80	< 80	< 80
93-4312h1	Core 29 composite	Whole	105	90	97.5
93-4313h1		Whole	88	112	100
93-4316h1	Core 30 composite	Whole	75	93	84
93-4317h1		Whole	100	91	95.5
Solids: water digest			#B/g	#B/g	#B/g
93-4312c1	Core 29 composite	Whole	< 6	< 6	< 6
93-4313c1		Whole	< 6	7	< 6
93-4316c1	Core 30 composite	Whole	5	< 4	< 5
93-4317c1		Whole	6	7	6.5

Table B2-25. Tank 241-B-111 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	19	19	19
93-04313a1		Whole	18	20	19
93-04316a1	Core 30 composite	Whole	19	20	19.5
93-04317a1		Whole	17	17	17
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 6	< 6	< 6
93-4313c1		Whole	< 6	< 5	< 6
93-4316c1	Core 30 composite	Whole	< 5	< 4	< 5
93-4317c1		Whole	< 6	7	< 6

Table B2-26. Tank 241-B-111 Analytical Results: Palladium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	< 30	< 28	< 29
93-04313a1		Whole	< 28	< 27	< 28
93-04316a1	Core 30 composite	Whole	< 30	32	< 31
93-04317a1		Whole	< 28	< 29	< 29
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 370	< 408	< 402
91-10553H-1T		Upper half	< 360	< 412	< 386
92-04054H-1B	30: 3	Lower half	< 395	< 358	< 377
92-04054H-1T		Upper half	< 382	< 408	< 394
92-04062H-1B	30: 5	Lower half	< 401	< 404	< 403
92-04062H-1T		Upper half	< 400	< 402	< 401
93-4312h1	Core 29 composite	Whole	< 297	< 282	< 289
93-4313h1		Whole	< 276	306	< 291
93-4316h1	Core 30 composite	Whole	< 310	< 304	< 307
93-4317h1		Whole	< 313	< 300	< 307

Table B2-27. Tank 241-B-111 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	14,314	n/d	14,314
93-04312a1		Whole	13,999	14,043	14,021
93-04313a1		Whole	12,959	13,765	13,362
93-04316a1	Core 30 composite	Whole	16,898	16,737	16,817.5
93-04317a1		Whole	17,042	n/d	17,042
93-04317a1		Whole	16,430	16,710	16,570
Solids: fusion digest			#B/E	#B/E	#B/E
91-10553H-1B	29: 4	Lower half	13,673	16,433	15,053
91-10553H-1T		Upper half	16,154	15,527	15,840.5
92-04054H-1B	30: 3	Lower half	20,935	18,141	19,538
92-04054H-1T		Upper half	15,901	15,875	15,888
92-04062H-1B	30: 5	Lower half	13,578	13,867	13,722.5
92-04062H-1T		Upper half	14,271	14,417	14,344
93-4312h1	Core 29 composite	Whole	14,855	14,589	14,722
93-4313h1		Whole	14,534	14,520	14,527
93-4316h1	Core 30 composite	Whole	17,380	17,432	17,406
93-4317h1		Whole	16,589	17,547	17,068
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	7,102	7,165	7,133.5
93-4312c1		Whole	7,099	n/d	7,099
93-4313c1		Whole	7,355	7,230	7,292.5
93-4316c1	Core 30 composite	Whole	7,818	7,633	7,725.5
93-4317c1		Whole	7,933	7,918	7,925.5

Table B2-28. Tank 241-B-111 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312a1	Core 29 composite	Whole	1,578	n/d	1,578
93-04312a1		Whole	499	493	496
93-04313a1		Whole	590	663	626.5
93-04316a1	Core 30 composite	Whole	602	773	687.5
93-04317a1		Whole	289	304	296.5
Solids: water digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-4312c1	Core 29 composite	Whole	586	623	604.5
93-4313c1		Whole	600	698	649
93-4316c1	Core 30 composite	Whole	564	477	520.5
93-4317c1		Whole	566	592	579

Table B2-29. Tank 241-B-111 Analytical Results: Selenium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312a1	Core 29 composite	Whole	20	19	19.5
93-04313a1		Whole	25	25	25
93-04316a1	Core 30 composite	Whole	27	32	29.5
93-04317a1		Whole	< 14	< 15	< 14
Solids: TCLP			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
93-04312-L1	Core 29 composite	Whole	0.2	0.2	0.2
93-04313-L1		Whole	n/a	0.2	0.2

Table B2-29. Tank 241-B-111 Analytical Results: Selenium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 198	< 204	< 201
91-10553H-1T		Upper half	< 180	< 206	< 193
92-04054H-1B	30: 3	Lower half	< 197	< 179	< 188
92-04054H-1T		Upper half	< 191	< 203	< 197
92-04062H-1B	30: 5	Lower half	< 201	< 202	< 201
92-04062H-1T		Upper half	< 200	< 201	< 200
93-4312h1	Core 29 composite	Whole	< 148	< 141	< 145
93-4313h1		Whole	< 138	< 140	< 139
93-4316h1	Core 30 composite	Whole	< 155	< 152	< 154
93-4317h1		Whole	< 156	< 150	< 153
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 14	< 14	< 14
93-4313c1		Whole	< 14	< 11	< 13
93-4316c1	Core 30 composite	Whole	< 13	< 11	< 12
93-4317c1		Whole	< 14	< 15	< 14

Table B2-30. Tank 241-B-111 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312a1	Core 29 composite	Whole	617	n/d	617
93-04312a1		Whole	589	559	574
93-04313a1		Whole	605	607	606
93-04316a1	Core 30 composite	Whole	417	351	384 ^{QC:c}
93-04317a1		Whole	399	n/d	399
93-04317a1		Whole	397	370	383.5
Solids: fusion digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
91-10553H-1B	29: 4	Lower half	2,874	3,684	3,279
91-10553H-1T		Upper half	3,383	3,407	3,395
92-04054H-1B	30: 3	Lower half	5,945	5,113	5,529
92-04054H-1T		Upper half	5,795	5,490	5,642.5
92-04062H-1B	30: 5	Lower half	6,785	6,893	6,839
92-04062H-1T		Upper half	4,791	5,242	5,016.5
93-4312h1	Core 29 composite	Whole	9,497	9,452	9,474.5
93-4313h1		Whole	9,365	9,612	9,488.5
93-4316h1	Core 30 composite	Whole	11,183	11,341	11,262
93-4317h1		Whole	10,987	11,420	11,203.5
Solids: water digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-4312c1	Core 29 composite	Whole	632	644	638
93-4312c1		Whole	631	n/d	631
93-4313c1		Whole	699	642	670.5
93-4316c1	Core 30 composite	Whole	636	598	617
93-4317c1		Whole	705	677	691

Table B2-31. Tank 241-B-111 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	2	2	2
93-04313a1		Whole	4	4	4
93-04316a1	Core 30 composite	Whole	9	9	9
93-04317a1		Whole	5	5	5
Solids: TCLP			µg/mL	µg/mL	µg/mL
93-04312-L1	Core 29 composite	Whole	0.03	0.03	0.03 ^{QC:c}
93-04313-L1		Whole	0.04	0.04	0.04
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	32	34	33
92-04054H-1T		Upper half	< 25	28	< 27
92-04062H-1B	30: 5	Lower half	42	40	41
92-04062H-1T		Upper half	36	50	43
93-4312h1	Core 29 composite	Whole	145	129	137
93-4313h1		Whole	116	125	120.5
93-4316h1	Core 30 composite	Whole	76	72	74
93-4317h1		Whole	60	56	58
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 2	< 2	< 2
93-4313c1		Whole	< 2	2	< 2
93-4316c1	Core 30 composite	Whole	< 2	< 1	< 2
93-4317c1		Whole	< 2	< 2	< 2

Table B2-32. Tank 241-B-111 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/g	#B/g	#B/g
93-04312a1	Core 29 composite	Whole	90,178	n/d	90,178
93-04312a1		Whole	88,236	87,315	87,775.5
93-04313a1		Whole	80,354	85,503	82,928.5
93-04316a1	Core 30 composite	Whole	89,897	88,672	89,284.5
93-04317a1		Whole	91,987	n/d	91,987
93-04317a1		Whole	88,940	90,710	89,825
Solids: fusion digest			#B/g	#B/g	#B/g
91-10553H-1B	29: 4	Lower half	78,224	94,786	86,505
91-10553H-1T		Upper half	94,023	90,289	92,156
92-04054H-1B	30: 3	Lower half	1.168E+05	1.007E+05	1.087E+05
92-04054H-1T		Upper half	84,791	84,540	84,665.5
92-04062H-1B	30: 5	Lower half	79,505	79,011	79,258
92-04062H-1T		Upper half	83,626	82,005	82,815.5
93-4312h1	Core 29 composite	Whole	1.010E+05	97,753	99,397.5
93-4313h1		Whole	96,341	94,872	95,606.5
93-4316h1	Core 30 composite	Whole	94,845	94,963	94,904
93-4317h1		Whole	90,676	95,236	92,956
Solids: water digest			#B/g	#B/g	#B/g
93-4312c1	Core 29 composite	Whole	80,647	80,435	80,541
93-4312c1		Whole	81,389	n/d	81,389
93-4313c1		Whole	80,864	79,476	80,170
93-4316c1	Core 30 composite	Whole	80,248	79,111	79,679.5
93-4317c1		Whole	80,706	81,656	81,181

Table B2-33. Tank 241-B-111 Analytical Results: Strontium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	226	n/d	226
93-04312a1		Whole	223	218	220.5
93-04313a1		Whole	203	215	209
93-04316a1	Core 30 composite	Whole	217	215	216
93-04317a1		Whole	227	n/d	227
93-04317a1		Whole	220	225	222.5
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	162	197	179.5
91-10553H-1T		Upper half	194	188	191
92-04054H-1B	30: 3	Lower half	256	227	241.5
92-04054H-1T		Upper half	203	203	203
92-04062H-1B	30: 5	Lower half	151	153	152
92-04062H-1T		Upper half	157	156	156.5
93-4312h1	Core 29 composite	Whole	228	223	225.5
93-4313h1		Whole	223	226	224.5
93-4316h1	Core 30 composite	Whole	219	219	219
93-4317h1		Whole	209	222	215.5
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	1	1	1
93-4313c1		Whole	1	1	1
93-4316c1	Core 30 composite	Whole	1	1	1
93-4317c1		Whole	< 1	< 1	< 1

Table B2-34. Tank 241-B-111 Analytical Results: Tellurium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#1/g	#2/g	#3/g
93-04312a1	Core 29 composite	Whole	< 20	< 19	< 19
93-04313a1		Whole	19	21	20
93-04316a1	Core 30 composite	Whole	23	25	24
93-04317a1		Whole	< 19	< 20	< 19
Solids: fusion digest			#1/g	#2/g	#3/g
91-10553H-1B	29: 4	Lower half	< 265	< 272	< 269
91-10553H-1T		Upper half	< 240	< 275	< 258
92-04054H-1B	30: 3	Lower half	< 263	< 239	< 251
92-04054H-1T		Upper half	< 255	< 271	< 263
92-04062H-1B	30: 5	Lower half	< 267	< 270	< 269
92-04062H-1T		Upper half	< 267	< 268	< 268
93-4312h1	Core 29 composite	Whole	< 198	< 189	< 194
93-4313h1		Whole	< 184	< 186	< 185
93-4316h1	Core 30 composite	Whole	< 207	< 203	< 205
93-4317h1		Whole	< 209	< 200	< 205
Solids: water digest			#1/g	#2/g	#3/g
93-4312c1	Core 29 composite	Whole	1	1	1
93-4313c1		Whole	1	1	1
93-4316c1	Core 30 composite	Whole	1	1	1
93-4317c1		Whole	< 1	< 1	< 1

Table B2-35. Tank 241-B-111 Analytical Results: Titanium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#2/2	#2/2	#2/2
93-04312a1	Core 29 composite	Whole	10	n/d	10
93-04312a1		Whole	8	9	8.5
93-04313a1		Whole	9	9	9
93-04316a1	Core 30 composite	Whole	7	7	7
93-04317a1		Whole	8	n/d	8
93-04317a1		Whole	6	6	6
Solids: fusion digest			#2/2	#2/2	#2/2
91-10553H-1B	29: 4	Lower half	< 13	< 14	< 13
91-10553H-1T		Upper half	< 12	< 14	< 13
92-04054H-1B	30: 3	Lower half	23	20	21.5
92-04054H-1T		Upper half	19	17	18
92-04062H-1B	30: 5	Lower half	29	33	31
92-04062H-1T		Upper half	31	36	33.5
93-4312h1	Core 29 composite	Whole	29	28	28.5
93-4313h1		Whole	25	28	26.5
93-4316h1	Core 30 composite	Whole	31	29	30
93-4317h1		Whole	30	29	29.5

Table B2-36. Tank 241-B-111 Analytical Results: Total Uranium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#B/E	#B/E	#B/E
93-04312a1	Core 29 composite	Whole	229	221	225
93-04313a1		Whole	301	323	312
93-04316a1	Core 30 composite	Whole	317	408	362.5
93-04317a1		Whole	< 190	< 196	< 193
Solids: fusion digest			#B/E	#B/E	#B/E
91-10553H-1B	29: 4	Lower half	< 2,600	< 2,700	< 2,700
91-10553H-1T		Upper half	< 2,400	< 2,700	< 2,600
92-04054H-1B	30: 3	Lower half	< 2,600	< 2,400	< 2,500
92-04054H-1T		Upper half	< 2,500	< 2,700	< 2,600
92-04062H-1B	30: 5	Lower half	< 2,700	< 2,700	< 2,700
92-04062H-1T		Upper half	< 2,700	< 2,700	< 2,700
93-4312h1	Core 29 composite	Whole	< 2,000	< 1,900	< 1,900
93-4313h1		Whole	< 1,800	< 1,900	< 1,900
93-4316h1	Core 30 composite	Whole	< 2,100	< 2,000	< 2,000
93-4317h1		Whole	< 2,100	< 2,000	< 2,000
Solids: water digest			#B/E	#B/E	#B/E
93-4312c1	Core 29 composite	Whole	< 183	196	< 190
93-4313c1		Whole	< 192	226	< 209
93-4316c1	Core 30 composite	Whole	187	164	175.5
93-4317c1		Whole	< 189	200	< 195

Table B2-37. Tank 241-B-111 Analytical Results: Vanadium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#E/E	#E/E	#E/E
93-04312a1	Core 29 composite	Whole	2	2	2
93-04313a1		Whole	3	3	3
93-04316a1	Core 30 composite	Whole	3	3	3
93-04317a1		Whole	< 2	< 2	< 2
Solids: fusion digest			#E/E	#E/E	#E/E
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	< 26	< 24	< 25
92-04054H-1T		Upper half	< 25	< 27	< 26
92-04062H-1B	30: 5	Lower half	< 27	< 27	< 27
92-04062H-1T		Upper half	< 27	< 27	< 27
93-4312h1	Core 29 composite	Whole	< 20	< 19	< 19
93-4313h1		Whole	< 18	< 19	< 19
93-4316h1	Core 30 composite	Whole	< 21	< 20	< 20
93-4317h1		Whole	< 21	< 20	< 20
Solids: water digest			#E/E	#E/E	#E/E
93-4312c1	Core 29 composite	Whole	< 2	< 2	< 2
93-4313c1		Whole	< 2	< 2	< 2
93-4316c1	Core 30 composite	Whole	< 2	< 2	< 2
93-4317c1		Whole	< 2	< 2	< 2

Table B2-38. Tank 241-B-111 Analytical Results: Yttrium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	3	3	3
93-04313a1		Whole	3	3	3
93-04316a1	Core 30 composite	Whole	< 2	2	< 2
93-04317a1		Whole	< 2	< 2	< 2
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	< 26	< 24	< 25
92-04054H-1T		Upper half	< 25	< 27	< 26
92-04062H-1B	30: 5	Lower half	< 27	< 27	< 27
92-04062H-1T		Upper half	< 27	< 27	< 27
93-4312h1	Core 29 composite	Whole	< 20	< 19	< 19
93-4313h1		Whole	< 18	< 19	< 19
93-4316h1	Core 30 composite	Whole	< 21	< 20	< 20
93-4317h1		Whole	< 21	< 20	< 20
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 2	< 2	< 2
93-4313c1		Whole	< 2	< 2	< 2
93-4316c1	Core 30 composite	Whole	< 2	< 2	< 2
93-4317c1		Whole	< 2	< 2	< 2

Table B2-39. Tank 241-B-111 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-04312a1	Core 29 composite	Whole	58	n/d	58
93-04312a1		Whole	57	56	56.5
93-04313a1		Whole	52	55	53.5
93-04316a1	Core 30 composite	Whole	163	162	162.5
93-04317a1		Whole	174	n/d	174
93-04317a1		Whole	164	169	166.5
Solids: fusion digest			µg/g	µg/g	µg/g
91-10553H-1B	29: 4	Lower half	< 53	< 54	< 54
91-10553H-1T		Upper half	< 48	< 55	< 51
92-04054H-1B	30: 3	Lower half	166	141	153.5
92-04054H-1T		Upper half	92	97	94.5
92-04062H-1B	30: 5	Lower half	291	298	294.5
92-04062H-1T		Upper half	295	300	297.5
93-4312h1	Core 29 composite	Whole	151	129	140
93-4313h1		Whole	124	127	125.5
93-4316h1	Core 30 composite	Whole	215	215	215
93-4317h1		Whole	211	212	211.5
Solids: water digest			µg/g	µg/g	µg/g
93-4312c1	Core 29 composite	Whole	< 4	< 4	< 4
93-4313c1		Whole	< 4	< 4	< 4
93-4316c1	Core 30 composite	Whole	< 4	< 4	< 4
93-4317c1		Whole	< 4	< 4	< 4

Table B2-40. Tank 241-B-111 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			#E/E	#E/E	#E/E
93-04312a1	Core 29 composite	Whole	22	n/d	22
93-04312a1		Whole	18	18	18
93-04313a1		Whole	17	18	17.5
93-04316a1	Core 30 composite	Whole	10	11	10.5
93-04317a1		Whole	11	n/d	11
93-04317a1		Whole	9	10	9.5
Solids: fusion digest			#E/E	#E/E	#E/E
91-10553H-1B	29: 4	Lower half	< 26	< 27	< 27
91-10553H-1T		Upper half	< 24	< 27	< 26
92-04054H-1B	30: 3	Lower half	< 26	< 24	< 25
92-04054H-1T		Upper half	< 25	< 27	< 26
92-04062H-1B	30: 5	Lower half	< 27	< 27	< 27
92-04062H-1T		Upper half	< 27	< 27	< 27
93-4312h1	Core 29 composite	Whole	22	19	21
93-4313h1		Whole	19	22	21
93-4316h1	Core 30 composite	Whole	< 21	< 20	< 20
93-4317h1		Whole	< 21	< 20	< 20
Solids: water digest			#E/E	#E/E	#E/E
93-4312c1	Core 29 composite	Whole	< 2	< 2	< 2
93-4313c1		Whole	< 2	< 2	< 2
93-4316c1	Core 30 composite	Whole	< 2	< 2	< 2
93-4317c1		Whole	< 2	< 2	< 2

Table B2-41. Tank 241-B-111 Analytical Results: Hexavalent Chromium (Colorimetric).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	187	182	184.5
93-04313-C		Whole	162	152	157
93-04316-C	Core 30 composite	Whole	140	143	141.5
93-04317-C		Whole	165	158	161.5

Table B2-42. Tank 241-B-111 Analytical Results: Total Uranium (LF).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µg/g	µg/g	µg/g
93-04312-H-1	Core 29 composite	Whole	207	204	205.5
93-04313-H-1		Whole	204	208	206
93-04316-H-1	Core 30 composite	Whole	188	184	186
93-04317-H-1		Whole	189	195	192

Table B2-43. Tank 241-B-111 Analytical Results: Cyanide (CN).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	2.7	3.1	2.9
93-04313-C		Whole	2.6	< 0.4	< 1.5 ^{QCd}
93-04316-C	Core 30 composite	Whole	1.6	2.0	1.8
93-04317-C		Whole	1.3	1.3	1.3

Table B2-44. Tank 241-B-111 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	1,000	1,000	1,000
93-04313-C		Whole	1,100	1,000	1,050
93-04316-C	Core 30 composite	Whole	1,000	1,000	1,000 ^{QCc}
93-04317-C		Whole	1,000	1,100	1,050

Table B2-45. Tank 241-B-111 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	1,500	1,500	1,500
93-04313-C		Whole	1,600	1,500	1,550
93-04316-C	Core 30 composite	Whole	1,600	1,600	1,600 ^{QCd}
93-04317-C		Whole	1,600	1,600	1,600

Table B2-46. Tank 241-B-111 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	75,000	75,000	75,000
93-04313-C		Whole	75,000	77,000	76,000
93-04316-C	Core 30 composite	Whole	88,000	87,000	87,500
93-04317-C		Whole	89,000	90,000	89,500

Table B2-47. Tank 241-B-111 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	49,000	49,000	49,000
93-04313-C		Whole	49,000	50,000	49,500
93-04316-C	Core 30 composite	Whole	40,000	41,000	40,500
93-04317-C		Whole	41,000	41,000	41,000

Table B2-48. Tank 241-B-111 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	23,100	23,300	23,200
93-04313-C		Whole	23,800	22,400	23,100
93-04316-C	Core 30 composite	Whole	24,900	23,300	24,100
93-04317-C		Whole	25,400	25,200	25,300

Table B2-49. Tank 241-B-111 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	11,800	11,800	11,800
93-04313-C		Whole	11,800	12,100	11,950
93-04316-C	Core 30 composite	Whole	11,300	11,300	11,300
93-04317-C		Whole	11,300	11,300	11,300

Table B2-50. Tank 241-B-111 Analytical Results: Ammonium (ISE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-C	Core 29 composite	Whole	16	28	22
93-04313-C		Whole	31	38	34.5
93-04316-C	Core 30 composite	Whole	72	59	65.5
93-04317-C		Whole	60	62	61

Table B2-51. Tank 241-B-111 Analytical Results: ETOX (Extractable Organic Halides).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-F1	Core 29 composite	Whole	< 10	< 10	< 10
93-04313-F1		Whole	< 10	< 10	< 10
93-04316-F1	Core 30 composite	Whole	< 10	< 10	< 10
93-04317-F1		Whole	< 10	< 10	< 10

Table B2-52. Tank 241-B-111 Analytical Results: Bis(2-ethylhexyl) phthalate (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-E1	Core 29 composite	Whole	2.9	3.1	3
93-04313-E1		Whole	3	2.8	2.9
93-04316-E1	Core 30 composite	Whole	1.7	2.9	2.3
93-04317-E1		Whole	2.8	2.6	2.7

Table B2-53. Tank 241-B-111 Analytical Results: Decane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			#/g	#/g	#/g
93-04316-E1	Core 30 composite	Whole	10	18	14
93-04317-E1		Whole	20	19	20

Table B2-54. Tank 241-B-111 Analytical Results: Dioctyl adipate (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			#/g	#/g	#/g
93-04312-E1	Core 29 composite	Whole	8.9	11	9.95
93-04313-E1		Whole	10	10	10
93-04316-E1	Core 30 composite	Whole	9.3	16	12.65
93-04317-E1		Whole	16	15	15.5

Table B2-55. Tank 241-B-111 Analytical Results: Dodecane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			#/g	#/g	#/g
93-04312-E1	Core 29 composite	Whole	210	250	230
93-04313-E1		Whole	290	270	280
93-04316-E1	Core 30 composite	Whole	950	1,400	1,175
93-04317-E1		Whole	1,500	1,500	1,500

Table B2-56. Tank 241-B-111 Analytical Results: Dodecane,4,6-dimethyl (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04316-E1	Core 30 composite	Whole	n/d	11	11
93-04317-E1		Whole	11	11	11

Table B2-57. Tank 241-B-111 Analytical Results: Pentadecane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-E1	Core 29 composite	Whole	19	23	21
93-04313-E1		Whole	24	22	23
93-04316-E1	Core 30 composite	Whole	62	93	77.5
93-04317-E1		Whole	97	100	98.5

Table B2-58. Tank 241-B-111 Analytical Results: TBP (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04316-E1	Core 30 composite	Whole	14	24	19
93-04317-E1		Whole	25	25	25

Table B2-59. Tank 241-B-111 Analytical Results: Tetradecane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
93-04312-E1	Core 29 composite	Whole	520	600	560
93-04313-E1		Whole	620	590	605
93-04316-E1	Core 30 composite	Whole	1,400	1,800	1,600
93-04317-E1		Whole	1,800	1,800	1,800

Table B2-60. Tank 241-B-111 Analytical Results: Tridecane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
93-04312-E1	Core 29 composite	Whole	680	800	740
93-04313-E1		Whole	860	820	840
93-04316-E1	Core 30 composite	Whole	2,200	2,400	2,300
93-04317-E1		Whole	3,100	3,000	3,050

Table B2-61. Tank 241-B-111 Analytical Results: Undecane (SVOA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
93-04316-E1	Core 30 composite	Whole	22	38	30
93-04317-E1		Whole	42	40	41

Table B2-62. Tank 241-B-111 Analytical Results: Total Carbon (Persulfate Oxidation [TC]).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-J	Core 29 composite	Whole	4,650	5,030	4,840
93-04313-J		Whole	4,900	4,690	4,795
93-04316-J	Core 30 composite	Whole	4,960	4,980	4,970
93-04317-J		Whole	4,680	4,550	4,615

Table B2-63. Tank 241-B-111 Analytical Results: Total Carbon (TC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-C	Core 29 composite	Whole	5,770	5,760	5,765
93-04313-C		Whole	5,770	5,590	5,680
93-04316-C	Core 30 composite	Whole	5,250	4,770	5,010
93-04317-C		Whole	4,900	4,900	4,900

Table B2-64. Tank 241-B-111 Analytical Results: Total Organic Carbon (Persulfate Oxidation [TOC]).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{g/g}$	$\mu\text{g/g}$	$\mu\text{g/g}$
93-04312-J	Core 29 composite	Whole	680	820	750
93-04313-J		Whole	670	560	615
93-04316-J	Core 30 composite	Whole	1,620	1,590	1,605
93-04317-J		Whole	1,320	1,340	1,330

Table B2-65. Tank 241-B-111 Analytical Results: Total Organic Carbon (TOC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	780	530	655
93-04313-C		Whole	1,090	750	920
93-04316-C	Core 30 composite	Whole	720	1,250	985
93-04317-C		Whole	550	1,330	940

Table B2-66. Tank 241-B-111 Analytical Results: Total Inorganic Carbon (Persulfate Oxidation [TIC]).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
93-04312-J	Core 29 composite	Whole	3,970	4,210	4,090
93-04313-J		Whole	4,240	4,130	4,185
93-04316-J	Core 30 composite	Whole	3,340	3,390	3,365
93-04317-J		Whole	3,360	3,210	3,285

Table B2-67. Tank 241-B-111 Analytical Results: Total Inorganic Carbon (TIC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-04312-C	Core 29 composite	Whole	4,990	5,230	5,110
93-04313-C		Whole	4,680	4,840	4,760
93-04316-C	Core 30 composite	Whole	4,530	3,520	4,025
93-04317-C		Whole	4,350	3,570	3,960

Table B2-68. Tank 241-B-111 Analytical Results: Americium-241 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	< 0.049	< 0.05	< 0.0495
91-10553-H1T		Upper half	< 0.047	< 0.05	< 0.0485
92-04054-H1B	30: 3	Lower half	< 0.055	0.0677	< 0.06135
92-04054-H1T		Upper half	< 0.053	< 0.054	< 0.0535
92-04062-H1B	30: 5	Lower half	0.134	0.111	0.1225
92-04062-H1T		Upper half	0.124	0.118	0.121
93-04312-H-1	Core 29 composite	Whole	0.064	0.088	0.076
93-04313-H-1		Whole	0.14	0.13	0.135
93-04316-H-1	Core 30 composite	Whole	0.084	0.069	0.0765
93-04317-H-1		Whole	0.034	0.068	0.051

Table B2-69. Tank 241-B-111 Analytical Results: Cesium-137 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	162	163	162.5
91-10553-H1T		Upper half	160	161	160.5
92-04054-H1B	30: 3	Lower half	145	142	143.5
92-04054-H1T		Upper half	138	139	138.5
92-04062-H1B	30: 5	Lower half	126	125	125.5
92-04062-H1T		Upper half	125	127	126
93-04312-H-1	Core 29 composite	Whole	173	162	167.5
93-04313-H-1		Whole	190	164	177
93-04316-H-1	Core 30 composite	Whole	143	144	143.5
93-04317-H-1		Whole	142	148	145

Table B2-70. Tank 241-B-111 Analytical Results: Cobalt-60 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	< 0.005	< 0.005	< 0.005
93-04313-H-1		Whole	< 0.005	< 0.005	< 0.005
93-04316-H-1	Core 30 composite	Whole	< 0.003	< 0.002	< 0.0025
93-04317-H-1		Whole	< 0.003	< 0.003	< 0.003

Table B2-71. Tank 241-B-111 Analytical Results: Europium-154 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	< 0.014	< 0.011	< 0.0125
91-10553-H1T		Upper half	< 0.014	< 0.015	< 0.0145
92-04054-H1B	30: 3	Lower half	0.104	0.109	0.1065
92-04054-H1T		Upper half	0.0887	0.108	0.09835
92-04062-H1B	30: 5	Lower half	0.179	0.167	0.173
92-04062-H1T		Upper half	0.172	0.183	0.1775
93-04312-H-1	Core 29 composite	Whole	0.22	0.177	0.1985
93-04313-H-1		Whole	0.234	0.227	0.2305
93-04316-H-1	Core 30 composite	Whole	0.12	0.133	0.1265
93-04317-H-1		Whole	0.124	0.127	0.1255

Table B2-72. Tank 241-B-111 Analytical Results: Europium-155 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	< 0.091	< 0.093	< 0.092
91-10553-H1T		Upper half	< 0.087	< 0.092	< 0.0895
92-04054-H1B	30: 3	Lower half	0.141	0.152	0.1465
92-04054-H1T		Upper half	0.1	0.11	0.105
92-04062-H1B	30: 5	Lower half	0.203	0.206	0.2045
92-04062-H1T		Upper half	0.18	0.201	0.1905
93-04312-H-1	Core 29 composite	Whole	0.259	0.223	0.241
93-04313-H-1		Whole	0.292	0.265	0.2785
93-04316-H-1	Core 30 composite	Whole	0.126	0.141	0.1335
93-04317-H-1		Whole	0.168	0.126	0.147

Table B2-73. Tank 241-B-111 Analytical Results: U234 to U ratio (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			%	%	%
93-04312-H-1	Core 29 composite	Whole	0.0057	0.003	0.00435
93-04313-H-1		Whole	0.0055	0.0054	0.00545
93-04316-H-1	Core 30 composite	Whole	0.0056	0.0057	0.00565
93-04317-H-1		Whole	0.0057	0.0056	0.00565

Table B2-74. Tank 241-B-111 Analytical Results: U235 to U ratio (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			%	%	%
93-04312-H-1	Core 29 composite	Whole	0.6582	0.6595	0.65885
93-04313-H-1		Whole	0.6661	0.6611	0.6636
93-04316-H-1	Core 30 composite	Whole	0.6637	0.6613	0.6625
93-04317-H-1		Whole	0.6589	0.6645	0.6617

Table B2-75. Tank 241-B-111 Analytical Results: U236 to U ratio (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			%	%	%
93-04312-H-1	Core 29 composite	Whole	0.0099	0.0061	0.008
93-04313-H-1		Whole	0.0104	0.0099	0.01015
93-04316-H-1	Core 30 composite	Whole	0.0097	0.0097	0.0097
93-04317-H-1		Whole	0.0097	0.0094	0.00955

Table B2-76. Tank 241-B-111 Analytical Results: U238 to U ratio (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			%	%	%
93-04312-H-1	Core 29 composite	Whole	99.3261	99.3313	99.3287
93-04313-H-1		Whole	99.3179	99.3235	99.3207
93-04316-H-1	Core 30 composite	Whole	99.321	99.3233	99.3221
93-04317-H-1		Whole	99.3257	99.3205	99.3231

Table B2-77. Tank 241-B-111 Analytical Results: Americium-241 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	0.0931	0.0843	0.0887
93-04313-H-1		Whole	0.0767	0.078	0.07735
93-04316-H-1	Core 30 composite	Whole	0.0558	0.0554	0.0556
93-04317-H-1		Whole	0.0536	0.0585	0.05605

Table B2-78. Tank 241-B-111 Analytical Results: Cm-243/244 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	3.800E-04	2.500E-04	3.150E-04
93-04313-H-1		Whole	1.700E-04	1.600E-04	1.650E-04
93-04316-H-1	Core 30 composite	Whole	5.300E-04	0.002	0.001265
93-04317-H-1		Whole	1.300E-04	1.400E-04	1.350E-04

Table B2-79. Tank 241-B-111 Analytical Results: Curium-242 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	1.300E-04	1.100E-04	1.200E-04
93-04313-H-1		Whole	1.200E-04	1.100E-04	1.150E-04
93-04317-H-1	Core 30 composite	Whole	5.400E-05	7.600E-05	6.500E-05

Table B2-80. Tank 241-B-111 Analytical Results: Neptunium-237 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	1.100E-04	1.100E-04	1.100E-04
93-04313-H-1		Whole	8.200E-05	4.700E-05	6.450E-05
93-04316-H-1	Core 30 composite	Whole	6.600E-05	5.200E-05	5.900E-05
93-04317-H-1		Whole	5.300E-05	5.100E-05	5.200E-05

Table B2-81. Tank 241-B-111 Analytical Results: Plutonium-238 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	0.00308	0.00377	0.003425
93-04313-H-1		Whole	0.00327	0.00336	0.003315
93-04316-H-1	Core 30 composite	Whole	0.00298	0.00366	0.00332
93-04317-H-1		Whole	0.00236	0.00194	0.00215

Table B2-82. Tank 241-B-111 Analytical Results: Plutonium-239/40 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	0.0733	0.0902	0.08175
93-04313-H-1		Whole	0.104	0.107	0.1055
93-04316-H-1	Core 30 composite	Whole	0.0951	0.105	0.10005
93-04317-H-1		Whole	0.109	0.0944	0.1017

Table B2-83. Tank 241-B-111 Analytical Results: Total alpha Pu (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	0.0764	0.0939	0.08515
93-04313-H-1		Whole	0.108	0.111	0.1095
93-04316-H-1	Core 30 composite	Whole	0.0981	0.109	0.10355
93-04317-H-1		Whole	0.111	0.0964	0.1037

Table B2-84. Tank 241-B-111 Analytical Results: Total Alpha (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	0.0757	0.089	0.08235
91-10553-H1T		Upper half	0.078	0.0713	0.07465
92-04054-H1B	30: 3	Lower half	0.125	0.103	0.114
92-04054-H1T		Upper half	0.127	0.149	0.138
92-04062-H1B	30: 5	Lower half	0.122	0.141	0.1315
92-04062-H1T		Upper half	0.133	0.147	0.14
93-04312-H-1	Core 29 composite	Whole	0.177	0.178	0.1775
93-04313-H-1		Whole	0.186	0.204	0.195
93-04316-H-1	Core 30 composite	Whole	0.177	0.165	0.171
93-04317-H-1		Whole	0.15	0.172	0.161

Table B2-85. Tank 241-B-111 Analytical Results: Strontium-90 (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	337	279	308
93-04313-H-1		Whole	294	304	299
93-04316-H-1	Core 30 composite	Whole	169	175	172
93-04317-H-1		Whole	207	219	213

Table B2-86. Tank 241-B-111 Analytical Results: Technetium-99 (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	0.13	0.124	0.127
93-04313-H-1		Whole	0.12	0.127	0.1235
93-04316-H-1	Core 30 composite	Whole	0.104	0.107	0.1055
93-04317-H-1		Whole	0.0985	0.1	0.09925

Table B2-87. Tank 241-B-111 Analytical Results: Total Beta (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	736	731	733.5
93-04313-H-1		Whole	708	724	716
93-04316-H-1	Core 30 composite	Whole	520	527	523.5
93-04317-H-1		Whole	523	552	537.5

Table B2-88. Tank 241-B-111 Analytical Results: Carbon-14 (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-J-1	Core 29 composite	Whole	0.002	0.0014	0.0017
93-04313-J-1		Whole	8.100E-04	5.200E-04	6.650E-04
93-04316-J-1	Core 30 composite	Whole	0.0053	0.0011	0.0032
93-04317-J-1		Whole	8.600E-04	8.300E-04	8.450E-04

Table B2-89. Tank 241-B-111 Analytical Results: Carbon-14 (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-C-1	Core 29 composite	Whole	< 0.0037	< 0.0038	< 0.00375
93-04313-C-1		Whole	0.0181	< 0.0031	< 0.0106
93-04316-C-1	Core 30 composite	Whole	< 0.0036	< 0.003	< 0.0033
93-04317-C-1		Whole	0.028	< 0.0029	< 0.01545

Table B2-90. Tank 241-B-111 Analytical Results: Selenium-79 (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-H-1	Core 29 composite	Whole	9.800E-05	8.600E-05	9.200E-05
93-04313-H-1		Whole	1.100E-04	9.300E-05	1.015E-04
93-04316-H-1	Core 30 composite	Whole	5.900E-05	5.500E-05	5.700E-05
93-04317-H-1		Whole	4.100E-05	4.600E-05	4.350E-05

Table B2-91. Tank 241-B-111 Analytical Results: Tritium (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
93-04312-C-1	Core 29 composite	Whole	0.00254	0.00192	0.00223
93-04313-C-1		Whole	0.00224	0.00267	0.002455
93-04316-C-1	Core 30 composite	Whole	0.00332	0.00337	0.003345
93-04317-C-1		Whole	0.00354	0.00238	0.00296

Table B2-92. Tank 241-B-111 Analytical Results: Weight Percent Solids (Percent Solids).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
93-04312-K1	29: 2	Whole	31.5	32.3	31.9
93-04312-K2	29: 3	Whole	31.8	31.9	31.85
93-04313-K1	29: 4	Whole	35.5	34.9	35.2
93-04313-K2	29: 5	Whole	36.1	36.4	36.25
93-04316-K1	30: 3	Whole	33	32.9	32.95
93-04316-K2	30: 4	Whole	35.6	34.5	35.05
93-04319-K1	30: 5	Whole	31.5	n/d	31.5
93-04313-K1	Core 29 composite II	Whole	36.2	36.3	36.25
93-04312-K1	Core 29 composite I	Whole	36.3	36.2	36.3
93-04317-K1	Core 30 composite II	Whole	37.3	37.8	37.9
93-04316-K1	Core 30 composite I	Whole	37.6	37.3	37.5

Table B2-93. Tank 241-B-111 Analytical Results: Bulk Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
91-081	29: 2	Whole	1.2	n/d	1.2
91-082	29: 3	Whole	1.2	n/d	1.2
91-083	29: 4	Whole	1.3	n/d	1.3
91-084	29: 5	Whole	1.3	n/d	1.3
91-086	30: 2	Whole	0.9	n/d	0.9
91-087	30: 3	Whole	1.3	n/d	1.3
91-088	30: 4	Whole	1.3	n/d	1.3
91-089	30: 5	Whole	1	n/d	1

Table B2-94. Tank 241-B-111 Analytical Results: Centrifuged Solids Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
91-082	29: 3	Whole	1.38	n/d	1.38
91-084	29: 5	Whole	1.45	n/d	1.45

Table B2-95. Tank 241-B-111 Analytical Results: Centrifuged Supernate Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			g/mL	g/mL	g/mL
91-082	29: 3	Whole	1.15	n/d	1.15
91-084	29: 5	Whole	1.17	n/d	1.17

Table B2-96. Tank 241-B-111 Analytical Results: Shear Strength (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			dynes/cm ²	dynes/cm ²	dynes/cm ²
91-082	29: 3	Whole	< 300	n/d	< 300
91-084	29: 5	Whole	900	n/d	900

Table B2-97. Particle Size Distribution for Cores 29 and 30.

Segment	Particle Size, Microns (by number)			Particle Size, Microns (by volume)		
	Mean	Standard deviation	Median	Mean	Standard deviation	Median
Core 29						
2	1.23	1.46	8.96	28.74	16.49	30.91
3	1.46	1.55	8.96	13.61	16.88	9.89
4	1.31	1.39	8.91	21.18	28.58	11.58
5	1.53	1.51	1.16	11.12	6.11	10.62
Core 30						
2	21.58	23.37	9.62	21.58	23.37	9.62
3	1.23	1.16	8.89	11.89	9.66	7.67
4	8.94	8.43	8.85	6.62	7.46	2.57
5	1.15	8.95	8.92	22.78	19.36	16.40

Table B2-98. Tank 241-B-111 Analytical Results: pH Measurement (pH).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			unitless	unitless	unitless
93-04312	Core 29 composite I	Whole	8.97	n/d	8.97
93-04313	Core 29 composite II	Whole	8.98	n/d	8.98
93-04316	Core 30 composite I	Whole	8.74	n/d	8.74
93-04317	Core 30 composite II	Whole	8.79	n/d	8.79

Table B2-99. Tank 241-B-111 Analytical Results: Mass Loss - Transition 1 (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
91-10545	29: 2	Whole	60	59	59.5
91-10549	29: 3	Whole	60.7	61	60.85
91-10553	29: 4	Whole	54.2	53.4	53.8
91-10557	29: 5	Whole	53.1	48.6	50.85
92-04050	30: 2	Whole	63.4	63.3	63.35
92-04054	30: 3	Whole	61.3	62.2	61.75
92-04058	30: 4	Whole	55.3	54	54.65
92-04062	30: 5	Whole	59.9	60.2	60.05

Table B2-100. Tank 241-B-111 Analytical Results: Mass Loss - Transition 2 (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
91-10545	29: 2	Whole	2.2	2.4	2.3
91-10549	29: 3	Whole	3.1	3.2	3.15
91-10553	29: 4	Whole	4.8	4.4	4.6
91-10557	29: 5	Whole	5.2	5.8	5.5
92-04050	30: 2	Whole	3.8	3.8	3.8
92-04054	30: 3	Whole	3.9	3.7	3.8
92-04058	30: 4	Whole	5.1	5	5.05
92-04062	30: 5	Whole	5.2	4.8	5

Table B2-101. Tank 241-B-111 Headspace Flammability Results.

Measurement	Result
TOC	0 ppm
LFL	0 %
Oxygen	n/a
Ammonia	25 ppm

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The section discusses the overall quality and consistency of the current sampling results for tank 241-B-111 and provides the results the analytical-based inventory calculation.

This section evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify any limitations in data use.

B3.1 FIELD OBSERVATIONS

Two issues that may impact the representativeness of samples were noted during extrusion at the 325 Laboratory. The first issue is the lack of recovered waste material from segment 1 for both cores. Hill et al. (1991) expected the first segment of both cores to consist of about 25 cm (9.5 in.) of waste. Almost all segments were completely recovered except for segments 2 and 5 of core 30.

The second issue is HHF contamination of segments 2 and 5 of core 30. Both segments contained a large amount of drainable liquid that made the sample material flow upon extrusion. The liquid was determined to be NPH, which was used as HHF during this sampling event (Giamberardini 1993).

B3.2 HOMOGENIZATION TESTS

Homogenization is an important step in making representative core composite samples. There were three homogenization steps for core samples from tank 241-B-111. First, the segments from each core were homogenized. Then, aliquotes were taken from the top and bottom portions of the homogenized core 29, segment 4, and core 30, segments 3 and 5. Finally, homogenized waste from each segment was homogenized into composite samples of each core. The samples were prepared by KOH fusion and chemically analyzed using ICP and GEA to determine whether the sample homogenization was adequate.

The following nested random effects model was fit to the analytical results of the aliquotes taken from the top and bottom portions of the homogenized segment samples:

$$Y_{ijk} = \mu + C_i + S_{ij} + H_{ijk} + E_{ijkm}$$

where:

- Y_{ijk} = the measured value of concentration of a constituent in segment j of core i
- μ = the mean concentration of the constituent
- C_i = the core sampled
- S_{ij} = the segment from the core
- H_{ijk} = the location of the aliquot (homogenization effect)
- E_{ijkm} = the analytical error.

The objective of the homogenization test is to determine whether the variability in results between sampling locations is significantly greater than zero. This objective can be met by using the results from an analysis of variance (ANOVA).

Table B3-1 shows the results from the ANOVA. The homogenization relative standard deviation (RSD) (estimated variability between locations relative to the mean) is given, together with the p-value. Each p-value in the table is the probability of obtaining the tabulated RSD value, given that the homogenization variability (σ_H^2) is equal to zero. If the p-value is less than 0.01, it is concluded that σ_H^2 is greater than 0 (at the 0.01 level of significance). Analytes with more than 75 percent of the analytical results below the detection limits were excluded from this analysis.

Table B3-1. Homogenization Test Results.

Segment Level Homogenization Tests (Acid Digestion ICP and GEA)									
Analyte	Homogenization		<DL	Obs.	Analyte	Homogenization		<DL	Obs.
	RSD (%)	p-value				RSD (%)	p-value		
Aluminum	9	0.141	0	12	Barium	0	0.487	4	12
Bismuth	4	0.334	0	12	Boron	0	0.531	1	12
Cadmium	4	0.354	0	12	Calcium	13	0.019	0	12
Chromium	8	0.097	0	12	Copper	29	0.004	3	12
Iron	7	0.138	0	12	Lead	15	0.021	0	12
Magnesium	9	0.157	4	12	Manganese	9	0.017	0	12
Phosphorus	8	0.085	0	12	Silicon	13	0.016	0	12
Silver	0	0.539	5	12	Sodium	10	0.055	0	12
Strontium	7	0.110	0	12	Titanium	4	0.353	4	12
Zinc	15	0.002	4	12	²⁴¹ Am	0	0.790	7	12
¹³⁷ Cs	1	0.023	0	12	¹⁵⁴ Eu	0	0.673	4	12
¹⁵⁵ Eu	13	0.007	4	12	Gross alpha	6	0.281	0	12

Note:

DL = detection limit

The homogenization tests on the segment data show that for 88 percent of the analytes tested, the variability due to homogenization cannot be distinguished from zero (0.01 significance level). For the other 12 percent of the analytes (zinc, ¹⁵⁵Eu, and copper), the homogenization RSDs are relatively small (that is, 10 percent to 15 percent), except for copper. In general, segment homogenization is considered adequate for tank 241-B-111.

B3.3 QUALITY CONTROL ASSESSMENT

B3.3.1 Evaluation of Spikes and Blanks

Spikes and blanks are regularly run in the laboratory to determine whether the analysis procedures are producing unbiased measurements. If the results for blanks are too high, or if spike recoveries deviate substantially from 100 percent, the associated measurements are rerun or flagged in the database. The control thresholds used in this QA evaluation have been borrowed from the ground water standards contained in the *Resource Conservation and Recovery Act of 1976* (RCRA) and are not necessarily the most relevant standards to apply.

Blank and spike measurements indicate laboratory performance, but no attempt was made to apply the RCRA standards rigorously to this data. For the analysis in other parts of this report, all data, including QA flagged data, has been used. No attempt was made to correct any data for high blanks or low spike recovery.

B3.3.2 Quality Assurance Flags

Hanford Analytical Services (HAS) reviewed all data and assigned QA flags to the results. Of the 4,625 measurements in the data set, HAS classified about 12 percent as unusable or "estimate only" (a QA flag of J or Q). All these measurements were used in the analyses. Approximately 49 percent of the measurements were below the detection limit (that is, the analyte was not found in the samples).

To perform the analysis in this report, all data were used and no HAS-flagged data were deleted. Table B3-2 lists the defined HAS flags, and Table B3-3 summarizes the amount of flagged data in the data set. The tables show that much of the data has been flagged as below detection limit (U and UJ); this is not a QA problem. The "Q" flag in Table B3-3 indicates the result is close to the detection limit (that is, above the detection limit but below the quantification limit) and "NF" indicates no flags.

Table B3-3 shows approximately one-third of all ICP-fusion and ICP-acid measurements above the detection limit have a Q flag. Because ICP is the major measurement method for a substantial number of analytes, a large problem would exist with data interpretation if all Q-flagged measurements were deleted from the ANOVA.

B3.3.3 Blanks

To evaluate blanks, the ratio between the blank and the average result of the sample and its duplicate was computed. Because this ratio would have little meaning when the result is at or below the detection limit, any results at or below detection limits were eliminated. Also, a substantial number of results were eliminated because they did not have an associated sample identification number. Approximately 25 percent of the blanks in the database had no sample identification numbers.

Table B3-2. Quality Assurance Flag Description.

Flag	Meaning
B	Indicates a compound was found in the blank.
C	Does not require data qualification but has a potential impact on data quality.
E	Indicates the measurement was outside of the calibration range.
J	Indicates an estimated value for target and tentatively identified compounds; spectra meet criteria, but response is below Contract Required Quantitation Limit for target compounds.
N	Material was not analyzed, because the sample preparation made the measurement inappropriate (for example, potassium in KOH/Ni: fusion preparation).
O	Measurement was beyond the range of the instrument.
Q	Associated results are qualitative.
R	Data are unusable.
S	Minimum detection limit was substituted for the reported value of the analytical result.
U	Indicates the compound was not detected. The U-flagged concentration is the Contract Required Quantitation Limit.
X	Indicates compound was manually deleted because all requirements were not met.

Table B3-3. Summary of Quality Assurance Flags on Sample and Duplicate Measurements.

Analysis Method	NF	J	Q	U	UJ
AA (As):A	0	0	0	4	4
AA (Sb):A	0	0	0	4	4
AA (Se):A	0	0	0	4	4
CVAA (Hg):A	0	0	0	0	0
ICP:A	186	0	96	178	0
CVAA (Hg):A	4	4	0	0	0
DSC:D	228	0	0	0	0
Extractable Organic Halides	0	0	0	0	8
Extraction Organic (SVOA)	55	9	0	511	0
Alpha Radiochemistry:F	74	0	0	0	0
Beta Radiochemistry:F	24	0	0	0	0
GEA:F	65	0	0	23	0
ICP:F	246	0	134	500	0
Laser Fluorimetry:F	8	0	0	0	0
Liquid Scintillation:F	8	0	0	0	0
Mass Spectroscopy:F	32	0	0	0	0
Liquid Scintillation:W	10	0	0	6	0
Liquid Scintillation:A	8	0	0	0	0
Percent Solids:D	10	11	0	0	0
Persulfate Oxidation (TOC):D	12	12	0	0	0
Physical Properties	19	30	0	1	0
TGA:D	96	0	0	0	0
CN:W	3	4	0	1	0
Calorimetric:W	4	4	0	0	0
ICP:W	70	0	43	301	0
IC:W	24	24	0	0	0
ISE (NH ₃):W	4	4	0	0	0
TIC, TOC, TC:W	12	12	0	0	0
PH:W	4	0	0	0	0
Total Flags	1,206	114	273	1,533	20

Table B3-4 summarizes blank/result rates for each analytical method. The table shows the median and maximum ratios for each analytical method, along with the 75 percent quantile.

Table B3-4. Summary of Blank Analyses for Results Above Detection Limit.

Method	Below DL	Above DL	Median	75-quantile	Maximum
ICP:A	178	282	14	55	200
CVAA (Hg):A	0	8	1	1	1
Extraction Organic (SVOA)	511	64	200	200	200
Alpha Radiochemistry:F	0	74	0	0	51
Beta Radiochemistry:F	0	24	0	1	1
GEA:F	23	65	0	0	1
ICP:F	500	380	36	67	200
Laser Fluorimetry:F	0	8	0	0	0
Liquid Scintillation:F	0	8	37	45	53
Liquid Scintillation:W	6	10	15	16	17
CN-	1	7	45	50	56
Calorimetry:W	0	8	62	67	71
ICP:W	301	113	22	84	115
IC:W	0	48	0	3	4
ISE (NH ₃):W	0	8	15	19	23
TIC, TOC, TC:W	0	24	3	9	12

Some analytical methods show very few blank/result ratios (such as CVAA, radiochemistry, GEA, and laser fluorimetry). The major analytical method, ICP, shows a large number of blanks. These results are not surprising because ICP analytical methods are commonly known to have large blank/result ratios. A common laboratory practice is to use the blanks to correct for background effects, and these measurements show that alterations in laboratory procedure may be appropriate.

B3.3.4 Spikes

Spike recovery percentages are generally between 75 and 125 percent, except for selenium and cyanide measurements. Only six spikes were outside the range. Although most recoveries are within the desired 75 to 125 percent, a question exists about whether this information should be used to correct for biases. For several important measurement methods (that is, fusion GEA, alpha and beta radiochemistry), the results are consistently above or below 100 percent recovery. This consistency in the recoveries indicates that a bias may exist in analytical methods. The variability in the recovery percents is small for several analytical methods.

B3.3.5 Relative Percent Differences

Analytical precision is estimated by the RPD, which is defined as the absolute value of the difference between primary and duplicate sample results, divided by their mean, times 100. One composite sample from core 30 exhibited a high RPD value when analyzed for ^{14}C liquid scintillation. The results were attributed to a nearly dry sample, which may cause inhomogeneity and difficulty in obtaining reliable analyses (Giamberardini 1993).

B3.4 DATA CONSISTENCY CHECKS

Comparing different analytical methods can be useful in assessing data consistency and quality. Several correlations were possible with the data set provided by the two core samples. These included a comparison of phosphorus as analyzed by ICP with phosphate as analyzed by IC, and the comparisons of the gross alpha and gross beta results with the sum of the alpha and beta emitters, respectively. In addition, mass and charge balances were calculated to help assess overall data consistency.

B3.4.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. A close agreement between the two methods strengthens the credibility of both results, whereas a poor agreement brings the reliability of the data into question. All analytical mean results were taken from Table B3-12.

Table B3-5 compares the ICP phosphorus concentration mean to the phosphate concentration mean as determined by IC analysis. The ICP phosphorus result, which represents total phosphorus, was 15,900 $\mu\text{g/g}$. The IC phosphate value of 23,900 $\mu\text{g/g}$, which is a measurement of the water-soluble phosphorus in the form of phosphate, converted to 7,800 $\mu\text{g/g}$ of phosphorus. The ratio between these two phosphate values was 2.04, indicating that approximately half the phosphorus in the tank is water soluble.

Table B3-5. Tank 241-B-111 Comparison of Phosphorus Concentration with the Equivalent Concentration of Phosphate.

Analyte	Overall Mean ($\mu\text{g/g}$)
Measured mean phosphorus concentration by ICP	15,900
Phosphorus concentration from phosphate by IC	7,800
Ratio	2.04

Table B3-6 compares the total alpha activity mean and the sum of the activity means of the individual alpha emitters. The sum of the activities of the individual alpha emitters was 0.185 $\mu\text{Ci/g}$ and was determined by adding the ^{241}Am , ^{238}Pu , and $^{239/240}\text{Pu}$ mean activities, the three major alpha emitters. The total alpha activity was 0.176 $\mu\text{Ci/g}$, yielding a ratio between the two methods of 1.05. This ratio indicates good agreement between the two methods.

Table B3-6. Tank 241-B-111 Comparison of Total Alpha Activity Mean and the Individual Alpha Emitters.

Analyte	Overall Mean ($\mu\text{Ci/g}$)
^{241}Am	0.0846
^{238}Pu	0.00305
$^{239/240}\text{Pu}$	0.09725
Sum of the alpha emitters	0.185
Total alpha activity	0.176
Ratio	1.05

Table B3-7 compares the total beta activity mean and the sum of the activity means of the individual beta emitters. The sum of the activities of the individual beta emitters was determined by adding the ^{137}Cs and $^{89/90}\text{Sr}$ activities. Because $^{89/90}\text{Sr}$ is in equilibrium with its daughter product ^{90}Y , the $^{89/90}\text{Sr}$ must be multiplied by 2 to account for all beta emitters. The total beta activity result was 628 $\mu\text{Ci/g}$, and the sum of the beta emitters was 654 $\mu\text{Ci/g}$. The total values agree as evidenced by the ratio of 1.04.

Table B3-7. Tank 241-B-111 Comparison of Total Beta Activity Mean and the Individual Beta Emitters.

Analyte	Overall Mean ($\mu\text{Ci/g}$)
$^{89/90}\text{Sr}$	$248 * 2 = 496$
^{137}Cs	158
Sum of beta emitters	654
Total beta activity	628
Ratio	1.04

B3.4.2 Mass and Charge Balance

The principle objective in performing mass charge balances is to determine whether the measurements are consistent. The best estimates of tank contents for the metals and anions are summed to postulate the amount of water present in the tank. The postulated water content is compared to the measured water content.

It is assumed that all boron, phosphorus, selenium, silicon, and tellurium measured in the core samples are present in their oxygenated anion forms (see Table 3-8). To estimate complexed hydroxide, a charge balance is calculated, and the appropriate amount of hydroxide is added to balance the charges. Table B3-8 lists the anions with postulated oxy-anions used in the mass and charge balances.

Table B3-9 lists the metals (cations). All the concentrations in the tables are the best estimates of tank contents (Benar 1996). The tables also list the RSD associated with each estimate and its postulated charge. The RSDs are used to calculate the uncertainties associated with the mass totals.

Table B3-10 summarizes the mass and charge balances from Tables B3-8 and B3-9 and the uncertainties associated with each total (expressed as RSD). Total charges are listed in column 4. The excess negative charge is determined from these totals. The excess negative charge is hydroxide, and the charge balance determines the mass of hydroxide. The mass concentration, $\mu\text{g/g}$, or ppm resulting from the cations, anions, and predicted hydroxide is therefore subtracted from 1 million to estimate the water content. The postulated water content in the waste is 63.7 percent, within 1 percent agreement with the measured result. The estimated total mass is 994,000 $\mu\text{g/g}$ which is only -0.6 percent different from the total mass (1,000,000 $\mu\text{g/g}$) of the waste. The mass balance indicates, the assumptions made concerning the hydroxide and oxygen seem to fit the data well.

Table B3-8. Anion Mass and Charge Balance Contribution with Postulated Oxy-Anions.

Anion	Mass		Charge	Postulated Oxygen		
	$\mu\text{g/g}$	RSD %	$\mu\text{mol/g}$	Anion	$\mu\text{g/g}$	RSD %
Boron	51	7	2.38	$\text{B}_4\text{O}_7^{2-}$	133	7
Chloride	1,020	2	28.77	---	---	---
Cyanide	2	19	0.07	---	---	---
Fluoride	1,560	2	82.11	---	---	---
Nitrate	82,000	8	1322.58	---	---	---
Nitrite	45,000	9	987.26	---	---	---
Phosphorus	15,900	8	1540.2	PO_4^{3-}	32,913	8
Selenium	22	15	1.12	SeO_3^{2-}	13	15
Silicon	10,400	8	742.86	SiO_3^{2-}	17,784	8
Sulfate	11,600	1	362.5	---	---	---
Tellurium	21	5	0.32	TeO_3^{2-}	8	6

Table B3-9. Metals (Cations) Mass and Charge Contribution. (2 sheets)

Metal	Mass		Charge	Metal	Mass		Charge
	$\mu\text{g/g}$	RSD %	$\mu\text{mol/g}$		$\mu\text{g/g}$	RSD %	$\mu\text{mol/g}$
Aluminum	899	7	99.96	Antimony	11	9	0.26
Arsenic	28		1.12	Barium	28	11	0.41
Beryllium	2		0.39	Bismuth	20,200	1	289.98
Cadmium	3	15	0.05	Calcium	689	23	34.38
Cerium	21	9	0.44	Chromium	1,110	5	64.04
Cobalt	4	21	0.15	Copper	201	94	6.33
Dysprosium	7		0.13	Europium	3		0.07
Gadolinium	70		1.33	Iron	17,700	5	950.81
Lanthanum	7	6	0.15	Lead	1,570	7	15.16

Table B3-9. Metals (Cations) Mass and Charge Contribution. (2 sheets)

Metal	Mass		Charge	Metal	Mass		Charge
	$\mu\text{g/g}$	RSD %	$\mu\text{mol/g}$		$\mu\text{g/g}$	RSD %	$\mu\text{mol/g}$
Lithium	7		1.00	Magnesium	195	2	16.04
Manganese	79	6	2.87	Molybdenum	42	9	2.61
Neodymium	22	23	0.46	Nickel	19	3	0.63
Palladium	52		0.99	Potassium	674	18	17.24
Rhodium	35		1.02	Ruthenium	17		0.52
Sodium	95,700	2	4162.72	Strontium	218	2	4.98
Thallium	174		0.85	Thorium-232	279		4.81
Tin	279		9.40	Titanium	8	14	0.66
Tungsten	28		0.91	Uranium	197	4	4.97
Vanadium	2	12	0.24	Yttrium	2	21	0.08
Zinc	111	50	3.40	Zirconium	14	29	0.63

Table B3-10. Summary of Mass/Charge Balance.

Source	Mass		Charge
	$\mu\text{g/g}$	RSD	$\mu\text{mol/g}$
Sum of Cations (Metals)	140,708	2	5,702
Sum of Anions	167,576	4	-2,777
Estimated Oxygen	50,851	6	-2,284
Estimated Hydroxide	3,990	0	-641
Subtotal	363,000	n/a	0
Postulated H ₂ O from Mass Balance	637,000	1	
Measured H ₂ O	630,000	2	
Relative Percent Difference (H ₂ O)		1	
Estimated Total (subtotal + H ₂ O)	994,000		
Percent Difference from Total		-0.6	

B3.5 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The core composite data were used to determine mean concentrations and associated uncertainties. These values were used to estimate the waste inventory of tank 241-B-111. The available segment-level data was used to conduct the sample homogenization tests and to determine the physical properties of tank 241-B-111 waste. This section gives a summary of the results from the statistical analysis. The complete results are contained in Benar (1996) and Remund et al. (1994).

B3.5.1 Mean Concentrations

Table B3-11 gives the estimated mean concentration and its associated RSD for each constituent. These results were obtained by fitting a random effects statistical model to the data. The RSD, defined as the square root of the variance estimate divided by the estimated mean of the constituent multiplied by 100, indicates how large the variance estimate is relative to the mean.

If more than 75 percent of the sample results for a given constituent were below the detection limit, the statistical model was not fit to the data. In that case, a mean (including the detection limits) was calculated, and RSDs were not calculated. Some constituents shown were analyzed by more than one method, but only the results from the preferred analytical method are shown. The complete set of constituent results (for all constituents and analytical methods), including the individual variance component estimates, are in Benar (1996) and Remund et al. (1994).

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.¹ (5 sheets)

Analyte	Analytical Method: Sample Preparation	Mean Concentration	
		Composite	RSD (mean)
Anions		($\mu\text{g/g}$)	%
Chloride	IC:W	1,020	2
Cyanide	CN:W	1.88	19
Fluoride	IC:W	1,560	2
Nitrate	IC:W	8.20E+04	8
Nitrite	IC:W	4.50E+04	9
Phosphate	IC:W	2.39E+04	3
Sulfate	IC:W	1.16E+04	1

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.¹ (5 sheets)

Analyte	Analytical Method: Sample Preparation	Mean Concentration	
		Composite	RSD (mean)
Cations		($\mu\text{g/g}$)	%
Aluminum	ICP:A	899	7
Ammonia	ISE:W	45.8	38
Antimony	ICP:A	18.3	28
Arsenic	ICP:A	27.9	n/a
Barium	ICP:A	28.2	11
Bismuth	ICP:F	2.02E+04	1
Boron	ICP:A	51.4	7
Cadmium	ICP:A	2.77	15
Calcium	ICP:A	689	23
Cerium	ICP:A	32.1	24
Chromium	ICP:A	1,110	5
Cobalt	ICP:A	4.43	21
Copper	ICP:A	201	94
Hexavalent chromium	Colorimetric:W	161	6
Iron	ICP:F	1.77E+04	5
Lanthanum	ICP:A	11.3	27
Lead	ICP:A	1,570	7
Magnesium	ICP:A	195	2
Manganese	ICP:A	78.9	6
Mercury	CVAA(Hg):A	9.32	50
Molybdenum	ICP:A	41.7	9
Neodymium	ICP:A	22.1	23
Nickel	ICP:A	20.7	7
Palladium	ICP:A	52.5	n/a
Phosphorus	ICP:F	1.59E+04	8

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.¹ (5 sheets)

Analyte	Analytical Method: Sample Preparation	Mean Concentration	
		Composite	RSD (mean)
Potassium	ICP:A	674	18
Selenium	ICP:A	32.3	22
Silicon	ICP:F	1.04E+04	8
Silver	ICP:A	5.95	26
Sodium	ICP:F	9.57E+04	2
Strontium	ICP:A	218	2
Tellurium	ICP:A	36	28
Titanium	ICP:A	7.90	14
Uranium	Laser Fluorimetry:F	197	4
Vanadium	ICP:A	3.93	25
Yttrium	ICP:A	3.93	25
Zinc	ICP:A	111	50
Zirconium	ICP:A	14.4	29
Organics		(µg/g)	%
Bis(2-ethylhexyl) phthalate	SVOA	2.73	8
Decane	SVOA	16.8	16
Di-n-butylphthalate	SVOA	8.44	n/a
Dioctyl adipate	SVOA	12.0	17
Dodecane	SVOA	796	68
Naphthalene	SVOA	9.61	n/a
Nitrobenzene	SVOA	9.61	n/a
Pentachlorophenol	SVOA	48.1	n/a
Pentadecane	SVOA	55.0	60
Phenanthrene	SVOA	9.61	n/a
Phenol	SVOA	9.61	n/a
Tetradecane	SVOA	1,140	49

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.¹ (5 sheets)

Analyte	Analytical Method: Sample Preparation	Mean Concentration	
		Composite	RSD (mean)
Total carbon	Persulfate Oxidation:W	5,340	7
Total inorganic carbon	Persulfate Oxidation:W	4,460	11
Total organic carbon	Persulfate Oxidation:W	875	12
Tributyl phosphate	SVOA	22.0	14
Tridecane	SVOA	1,730	54
Undecane	SVOA	35.5	15
Physical Properties			
pH Measurement	pH:W	8.87	1
Weight percent solids	Percent Solid:D	36.9%	2
Radionuclides		(μCi/g)	%
Americium-241	GEA:F	0.0846	25
Carbon-14	Liquid Scintillation:W	0.0016	36
Cesium-137	GEA:F	158	9
Cobalt-60	GEA:F	<0.00387	n/a
Curium-242	Alpha Radchem:F	9.16E-05	29
Curium-243/244	Alpha Radchem:F	4.70E-04	57
Europium-154	GEA:F	0.170	26
Europium-155	GEA:F	0.20	30
Gross alpha ²	Alpha Radchem:F	0.176	6
Gross beta	Beta Radchem:F	628	15
Neptunium-237	Alpha Radchem:F	7.14E-05	22
Plutonium-238	Alpha Radchem:F	0.00305	10
Plutonium-239/240	Alpha Radchem:F	0.0973	5
Strontium-90	Beta Radchem:F	248	22
Technetium-99	Beta Radchem:F	0.114	10
Thorium-232	ICP:A	<279	n/a

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.¹ (5 sheets)

Analyte	Analytical Method: Sample Preparation	Mean Concentration	
		Composite	RSD (mean)
Total alpha Pu ²	Alpha Radchem:F	0.10	5
Tritium	Liquid Scintillation:W	0.00275	15
Uranium-234 ³	Mass Spectrometry:F	0.00527%	7
Uranium-235 ³	Mass Spectrometry:F	0.662%	0
Uranium-236 ³	Mass Spectrometry:F	0.00935%	5
Uranium-238 ³	Mass Spectrometry:F	99.3%	0

Notes:

¹Benar (1996)²Total alpha emitted from ²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu.³These are mass percents of total uranium.

B3.5.2 Analysis of Variance Model

As a result of the sampling structure in tank 241-B-111 composite data, the following random effects ANOVA model was fit to the data to estimate the mean concentration and variability of each chemical and radiological constituent:

$$Y_{ijk} = \mu + C_i + S_{ij} + E_{ijk}$$

where:

- Y_{ijk} = the measured value of concentration of a constituent in replicate j of core i
- μ = the mean concentration of the constituent
- C_i = the deviation of concentration in core i from the mean value
- S_{ij} = the deviation of concentration in core replicates from the mean value (two replicates were processed on each composite)
- E_{ijk} = the analytical (lab) error in the measurement.

The random variables C_i , S_{ij} , and E_{ijk} , are assumed to be uncorrelated with zero means and variances σ_C^2 , σ_S^2 , and σ_E^2 , respectively. Each term in the model describes the contribution to the variability of a step in the sampling and measurement process. For each constituent, this model can be used to obtain a mean concentration estimate and its associated uncertainty. This model can also be used to obtain estimates of horizontal variability (σ_C^2), sampling variability (σ_S^2), and analytical variability (σ_E^2) for each constituent.

Statistical difference in the mean values between the two cores were determined using ANOVA. Constituents were excluded from this analysis (that is, no ANOVA was run) if 75 percent or more of the sample and duplicate results were below the detection limit.

B4.0 APPENDIX B REFERENCES

- Benar, C. J., 1996, *Tank Characterization Report for Single-Shell Tank 241-B-111*, WHC-SD-WM-ER-549, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C**C1.0 STATISTICAL ANALYSIS FOR ISSUE RESOLUTION**

Appendix C discusses the statistical analyses required by the safety screening DQO (Dukelow et al. 1995) for tank 241-B-111. The only statistical analyses required were to calculate upper limits to 95 percent confidence intervals on the mean for total alpha activity (criticality). Confidence intervals were not completed using on the DSC data because there were no exothermic reactions. Because the safety screening DQO was not applicable to the 1991 core sampling event, the results of these confidence intervals are provided for informational purposes only.

The safety screening DQO defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals on the mean for each subsample. All data considered in this section were taken from the final laboratory data package (Giamberardini 1993), and were presented in Table B2-84.

The upper limit to a one-sided 95 percent confidence interval for the mean is:

where $\bar{\mu}$ is the mean of the data, n is the number of observations, $\hat{\sigma}^2$ is the estimate of the variance, and $t_{(n-1,0.05)}$ is a quantile from Student's t distribution with $n-1$ degrees of freedom, for a one-sided 95 percent confidence interval. For the tank 241-B-111 data (per sample number), n is two and $t_{(1,0.05)}$ is 6.314.

Table C1-1 lists the upper limit of the 95 percent confidence interval for each sample number based on the total alpha activity data. Each confidence interval can be used to make the following statement. If the upper limit is less than 46.9 $\mu\text{Ci/g}$, reject the null hypothesis that the total alpha was greater than or equal to 46.9 $\mu\text{Ci/g}$ at the 0.05 level of significance. The upper limit of 46.9 $\mu\text{Ci/g}$ was calculated from the 1 g/L plutonium limit assuming a density of 1.31 g/mL (Benar 1996) and assuming that all the plutonium is ^{239}Pu . The table shows all total alpha activity 95 percent confidence interval upper limits were well below the 46.9 $\mu\text{Ci/g}$ threshold.

Table C1-1. 95 Percent Confidence Interval Upper Limits For Total Alpha Activity for Tank 241-B-111.

Sample Number	Sample Location	Sample Portion	Mean	Upper Limit
Solids: fusion digest			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
91-10553-H1B	29: 4	Lower half	0.08235	0.124
91-10553-H1T		Upper half	0.07465	0.0958
92-04054-H1B	30: 3	Lower half	0.114	0.183
92-04054-H1T		Upper half	0.138	0.207
92-04062-H1B	30: 5	Lower half	0.1315	0.191
92-04062-H1T		Upper half	0.14	0.184
93-04312-H-1	Core 29 composite	Whole	0.1775	0.181
93-04313-H-1		Whole	0.195	0.252
93-04316-H-1	Core 30 composite	Whole	0.171	0.209
93-04317-H-1		Whole	0.161	0.23

C2.0 APPENDIX C REFERENCES

- Benar, C. J., 1996, *Tank Characterization Report for Single-Shell Tank 241-B-111*, WHC-SD-WM-ER-549, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Characterization Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
- Giamberardini, K. K., 1993, *PNL 325 Laboratories Single-Shell Tank Waste Characterization, Tank 241-B-111 Cores 29 and 30*, WHC-SD-WM-DP-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

**BEST-BASIS FOR SINGLE-SHELL
TANK 241-B-111**

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APPENDIX D**BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-B-111**

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for waste management activities (Kupfer 1996). As part of this effort, an evaluation of available chemical information for tank 241-B-111 was performed, and a best-basis inventory was established. This work follows the methodology established by the standard inventory task.

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

The TCR for tank 241-B-111 (Giamberardini 1993) provides characterization results from the 1991 sampling event for this tank. Two core samples were obtained and analyzed. A sample-based inventory was prepared based on the core sample analytical results using a waste density of 1.19 g/mL, and a waste volume of 897 kL (237 kgal). This waste volume is the total waste volume which includes 893 kL (236 kgal) of sludge and 4 kL (1kgal) of supernatant. The HDW model (Agnew et al. 1996a) provides tank contents estimates, derived from process flowsheets and waste volume records.

**D2.0 COMPARE COMPONENT INVENTORY VALUES
AND NOTE SIGNIFICANT DIFFERENCES**

Tables D2-1 and D2-2 show the sample-based inventory estimate from the TCR and the inventory estimate from the HDW model (Agnew et al. 1996a) for tank 241-B-111. The waste solids volume used to generate both inventories is 893 kL (236 kgal). The estimates, however, use different waste densities. The sample-based inventory used a bulk density of 1.19 g/mL, which is the overall tank density calculated from the sample data (Giamberardini 1993). The HDW model uses a lower waste density, 1.16 g/mL, which is an estimate derived from process flowsheets and waste volume records. Several significant differences between the sample-based and HDW model inventories are apparent, for example, Al, Bi, Ca, Cl, Cr, Fe, Hg, K, Mn, Na, NH₄, Ni, NO₂, NO₃, Pb, PO₄, Si, S, U, and Zr vary by a factor of two or more.

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-111. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)
Al	958	166	Ni	22.1	496
Ag	6.34	---	NO ₂	47,900	3,110
As	29.7	---	NO ₃	87,400	32,700
B	54.8	---	OH	---	50,900
Ba	30	---	oxalate	---	0.0012
Be	<1.85	---	Pb	1,670	1.27
Bi	21,500	6,790	Pd	55.9	---
Ca	734	9,860	P as PO ₄	51,800	10,600
Ce	34.2	---	Pt	---	---
Cd	2.95	---	Re	---	---
Cl	1,090	546	Rh	<37.2	---
Co	4.72	---	Ru	<18.5	---
Cr	1,180	408	Sb	19.5	---
Cr ⁺³	---	408	Se	34.4	---
Cr ⁺⁶	---	---	Si	11,100	4,620
Cs	---	---	S as SO ₄	12,400	3,400
Cu	214	---	Sn	<297	---
F	1,660	1,650	Sr	232	0.00046
Fe	18,900	51,800	Te	38.4	--
FeCN/CN	2.0	0	TIC as CO ₃	23,600	14,800
Formate	---	---	Th	<2.75E+06	---
Hg	9.93	0.0077	Ti	8.42	--
K	718	133	TOC	932	--
La	12	0.0022	total U	210	4,120
Li	<7.43	---	V	4.19	---
Mg	208	---	W	<29.7	---

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-111. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)
Mn	84.1	0.88	Zn	118	---
Mo	44.4	---	Zr	15.3	1.27
Na	102,000	31,800	H ₂ O(Wt%)	63.1	78.2
Nd	23.5	---	Density (kg/L)	1.19	1.16
NH ₄	48.8	430			

Table D2-2. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-B-111.

Analyte	Sampling inventory estimate (Ci)	HDW model inventory estimate (Ci)	Analyte	Sampling inventory estimate (Ci)	HDW model inventory estimate (Ci)
¹⁴ C	17	n/r	²³⁷ Np	0.0761	n/r
⁹⁰ Sr	264,000	1,350,000	^{239/240} Pu	104	157
⁹⁹ Tc	121	n/r	²⁴¹ Am	90.1	n/r
¹²⁹ I	n/r	n/r	Total α	188	n/r
¹³⁷ Cs	168,000	56,100	Total β	669,000	n/r
¹⁵⁴ Eu	181	n/r			

Note:

n/r = not reported

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents is performed to identify potential errors and/or missing information that could influence the sample-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Tank 241-B-111 was put into service in December 1945 as the second tank in a three-tank cascade that also included tanks 241-B-110 and 241-B-112 cascade. The cascade received 2C waste from B Plant. Waste began overflowing to tank 241-B-112 in April 1946. Tank 241-B-112 was filled in August 1946, and the 2C waste was diverted to a cascade that included tanks 241-B-104, 241-B-105, and 241-B-106 cascade.

After the 241-B-104, 241-B-105 and 241-B-106 cascade was filled, the supernatant from the 241-B-110 cascade was pumped to cribs. The 241-B-110 cascade again received 2C waste from B Plant in July 1950 and continued to do so until B Plant was shut down in June 1952. Tank 241-B-112 began overflowing to a crib in second quarter of 1951 (Anderson 1990).

After B Plant was shut down in June 1952, the 241-B-110 cascade began receiving a concentrated flush waste from B Plant. This concentrate showed up in tank 241-B-111 in the third quarter of 1952. In 1963, tank 241-B-111 began receiving fission product waste from B Plant via tank 241-B-110.

Table D3-1 shows the current waste volumes for the tanks in the 241-B-110 cascade (Hanlon 1996).

Table D3-1. Waste Inventory of 241-B-110, 241-B-111, and 241-B-112 Cascade.

Inventory	Tank 241-B-110 (kL)	Tank 241-B-111 (kL)	Tank 241-B-112 (kL)
Sludge	927	893	114
Saltcake	0	0	0
Supernatant	4	4	11
Drainable liquid	83	79	0

Table D3-2 lists the documented quantities of waste discharged to tank 241-B-111 from the HDW model waste transaction database.

Table D3-2. Waste Transaction Information for Tank 241-B-111.

	Waste Type	Waste Volume (kL)
Waste throughput	2C2	n/r
	DW	818
	P2 (PUREX high-level waste 1964-1967)	2,532
	CSR (Waste sent to B Plant for cesium recovery)	7,093
Total waste throughput		10,443
Current inventory		893

Note:

1 Agnew et al. (1996)

Table D3-3 shows the types of solids accumulated in tank 241-B-111 that were reported by various authors. All sources indicate that second cycle bismuth phosphate waste should be the principal contribution to the waste solids in the tank.

Table D3-3. Expected Solids for Tank 241-B-111.

Reference	Type
Anderson (1990)	2C, 5-6, EB, FP, FP-EB, EB-IX, IX
SORWT model (Hill et al. 1995)	2C, 5-6, FP, IX
WSTRS (Agnew et al. 1996b)	2C2, DW, P2, BY saltcake
HDW model (Agnew et al. 1996a)	2C2, DW, P2, CSR

Notes:

SORWT = sort on radioactive waste type

D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

An estimate of the bismuth phosphate waste discharged to the 241-B-110 cascade can be made from the tank farm process history and the reconstructed fuel processing history in Appendix B of Kupfer (1996). Table D3-4 summarizes this estimate.

Table D3-4. B Plant Fuel Processing and 2C Waste Disposition.

Cascade	Period	Fuel Processed (MTU)
241-B-110/241-B-111/241-B-112	May 1945 to August 1946	631
241-B-104/241-B-105/241-B-106	September 1946 to June 1950	1,312
241-B-110/241-B-111/241-B-112	July 1950 to August 1952	823

An estimate of the amount of 2C waste discharged to each cascade can be made from the fuel process history and the flowsheet information in Appendix C of Kupfer (1996). The technical manual flowsheet is applied to the first time period and the Schneider (1951) flowsheet was applied to the last two time periods. The technical manual, issued in 1944, is considered representative of early B Plant operations, whereas the Schneider (1951) flowsheet is considered more representative of later years. Table D3-5 shows the results of this calculation.

Table D3-5. Disposition of B Plant 2C Waste.

Period ¹	5/45-8/46	9/46-6/50	7/50-8/52	Total
Cascade	241-B-110	241-B-104	241-B-110	B Plant
Fuel processed (MTU)	631	1,312	823	2,766
Waste component (kg)				
Bi	8,990	23,900	15,000	47,900
Cr	421	1,190	748	2,360
F	19,900	54,100	33,900	108,000
Fe	8,610	31,000	19,400	59,000
Na	283,000	675,000	423,000	1,380,000
NO ₃	364,000	1,130,000	708,000	2,200,000
Si	4,970	13,100	8,200	26,300
PO ₄	235,000	423,000	265,000	923,000
SO ₄	29,500	107,000	66,800	203,000

Note:

Dates are provided in the mm/yy format.

Table D3-6 compares the calculated discharge of the 241-B-110 cascade to the sample-based inventory for tanks 241-B-110 and 241-B-111 is shown. Table D3-6 shows nearly equal accumulations of sludge in tanks 241-B-110 and 241-B-111. The waste transaction records state that both inventories are 2C waste. Overall a lack of agreement exists between the sample-based estimate for the tanks 241-B-110 and 241-B-111 versus the B Plant 2C waste projected to be discharged to the 241-B-110 cascade.

Table D3-7 compares the sample-based inventory, the HDW model inventory, and the flowsheet projected inventory. The best agreement for the species most likely to precipitate (Bi, Cr, Fe, and Si) is between the flowsheet based estimate and the sample-based estimate.

The sample-based data for tank 241-B-110 appears to account for the 2C waste discharged to the 241-B-110 cascade. This is the expected result for the first tank in a cascade. This result, however, is at odds with the large inventory of bismuth-bearing sludge found in tank 241-B-111.

Overall reconciliation of the 241-B-110, 241-B-11, and 241-B-112 cascade receipts to the sum of tank 241-B-110 and tank 241-B-111 is poor although the sludge in tanks 241-B-110 and 241-B-111 exhibit the characteristics of 2C waste. The waste is unlikely to be 1C waste because the Zr, Al, and Ce content is too low. The flowsheet evaluation projection accounts for approximately half of the 2C waste found in tanks 241-B-110 and 241-B-111 based on sample analysis. A possible explanation is that the throughput rate was twice the documented rate.

Table D3-6. Comparison of Tank 241-B-110 and Tank 241-B-111 Inventory Estimates to Total Cascade Receipts.

Waste Component (kg)	Tank 241-B-110 Sample-Based Inventory Estimate (kg)	Tank 241-B-111 Sample-Based Inventory Estimate (kg)	Total Calculated Inventory Discharged to B-110, B-111, B-112 Cascade (kg)	HDW B-110, B-111, B-112 Cascade Retained (kg)
Bi	23,200	21,500	24,000	21,000
Cr	1,014	1,180	1,170	792
F	2,370	1,660	53,800	4,400
Fe	22,600	18,900	28,000	89,600
Na	122,000	102,000	706,000	121,000
NO ₃	234,000	87,400	1,070,000	108,000
Si	11,700	11,100	13,200	6,660
PO ₄	61,600	51,800	500,000	69,000
SO ₄	14,400	12,400	96,300	7,930

Table D3-7. Comparison of Tank 241-B-111 Inventory Estimates to 241-B-110 Cascade Receipts.

Waste Component (kg)	Sample-Based Inventory Estimate (kg)	HDW Model Inventory Estimate (kg)	Calculated Inventory Discharged to Cascade (kg)
Bi	21,500	6,790	24,000
Cr	1,180	408	1,170
F	1,660	1,650	53,800
Fe	18,900	51,800	28,000
Na	102,000	31,800	706,000
NO ₃	87,400	32,700	1,070,000
Si	11,100	1,700	13,200
PO ₄	51,800	51,800	500,000
SO ₄	12,400	3,400	96,300

D3.3 DOCUMENT ELEMENT BASIS

Bismuth, chromium, iron, silicon, phosphate, and sulfate in the flowsheet analysis are assumed to fully precipitate. The flowsheet analysis for the Bi, Cr, Fe, and Si agrees with the sample-based estimate; however, for the PO₄ and SO₄, the HDW model reconciles better with the sample-based estimate.

Fluoride, sodium, nitrate, and nitrite inventories can not be reconciled because these components are relatively soluble and would have exited the tank by the cascade system. The best source of information with respect to these compounds is the sample-based estimate.

Overall agreement of the sample-based inventories for the 241-B-110 cascade with the flowsheet projected inventory for the cascade is poor.

With respect to the sample-based inventory and the HDW-model inventory, several significant differences are apparent, for example, Al, Bi, Ca, Cl, Cr, Fe, Hg, K, Mn, Na, NH₄, Ni, NO₂, NO₃, Pb, PO₄, Si, S, U, and Zr vary by a factor of two or more.

**D4.0 ESTABLISH THE BEST-BASIS AND ESTABLISH
COMPONENT INVENTORIES**

The results from this evaluation are based on sampling data for tank 241-B-111 for the following reasons.

- Analytical results from two widely spaced core samples were used to estimate the component inventories. There is no reason to dispute the analytical results.
- Statistically, there was no horizontal stratification of the tank.
- Analytical results for the core samples are consistent with receipt of 2C waste.

These results are subject to future review because of the lack of reconciliation with the flowsheet projected inventory. Tables D4-1 and D4-2 show the best-basis inventory estimates for tank 241-B-111.

Table D4-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-111 (September 30, 1996).

Analyte	Total Inventory (kg)	Basis (S, M, or E) ¹	Comment RSD %
Al	958	S	7
Bi	21,500	S	1
Ca	734	S	23
Cl	1,090	S	2
TIC as CO ₃	23,800	S	11
Cr	1,180	S	5
F	1,660	S	2
Fe	18,900	S	5
Hg	9.93	S	50
K	718	S	18
La	12	S	27
Mn	84.1	S	6
Na	102,000	S	2
Ni	22.1	S	7
NO ₂	47,900	S	9
NO ₃	87,400	S	8
Pb	1,670	S	7
P as PO ₄	51,800	S	8
Si	11,100	S	8
S as SO ₄	12,400	S	1
Sr	232	S	2
TOC	932	S	12
U _{TOTAL}	210	S	4
Zr	15.3	S	29

Note:

¹S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E) ¹	Comment RSD %
³ H	n/r		
¹⁴ C	1.7	S	36
⁵⁹ Ni	n/r		
⁶⁰ Co	< 4.12	S	
⁶³ Ni	n/r		
⁷⁹ Se	n/r		
⁹⁰ Sr	264,000	S	22
⁹⁰ Y	n/r		
⁹³ Zr	n/r		
^{93m} Nb	n/r		
⁹⁹ Tc	121	S	10
¹⁰⁶ Ru	n/r		
^{113m} Cd	n/r		
¹²⁵ Sb	n/r		
¹²⁶ Sn	n/r		
¹²⁹ I	n/r		
¹³⁴ Cs	n/r		
¹³⁷ Cs	168,000	S	9
^{137m} Ba	n/r		
¹⁵¹ Sm	n/r		
¹⁵² Eu	n/r		
¹⁵⁴ Eu	181	S	26
¹⁵⁵ Eu	n/r		
²²⁶ Ra	n/r		
²²⁷ Ac	n/r		

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E) ¹	Comment RSD %
²²⁸ Ra	n/r		
²²⁸ Th	n/r		
²³¹ Pa	n/r		
²³² Th	n/r		
²³² U	n/r		
²³³ U	n/r		
²³⁴ U	n/r		
²³⁵ U	n/r		
²³⁶ U	n/r		
²³⁷ Np	0.0761	S	22
²³⁸ Pu	n/r		
²³⁸ U	n/r		
^{239/240} Pu	104	S	5
²⁴¹ Am	90.1	S	25
²⁴¹ Pu	n/r		
²⁴² Cm	n/r		
²⁴² Pu	n/r		
²⁴³ Am	n/r		
^{243/244} Cm	0.501	S	57

Note:

¹ S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based

D5.0 APPENDIX D REFERENCES

- Agnew, S. F., J. Boyer, R. a. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, Draft, March 5, 1996, Los Alamos National Laboratory, Los Alamos, New Mexico.
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- Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.
- Giamberardini, K. K., 1993, *PNL 325 Laboratories Single-Shell Tank Waste Characterization, Tank B-111 Cores 29 and 30*, WHC-SD-WM-DP-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Hanlon, B. M., 1996, *Tank Farm Surveillance and Waste Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.
- Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.
- Kupfer, M. J., 1996, *Interim Report: Best Basis Total Chemical and Radionuclide Inventories in Hanford Site Tank Waste*, WHC-SD-WM-TI-740, Rev. E-Draft, Westinghouse Hanford Company, Richland, Washington.
- Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-B-111

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-B-111

Appendix E is a bibliography that supports the characterization of tank 241-B-111. This bibliography represents an in-depth literature search of all information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-B-111 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references which have been broken down into subgroups.

I. NONANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA

- IIa. Sampling of Tank 241-B-111 Waste
- IIb. Sampling and Analysis of Similar Waste Types

III. COMBINED ANALYTICAL/NONANALYTICAL DATA

- IIIa. Inventories from both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into appropriate sections of material with an annotation at the end of each reference describing the information source. Where possible, a reference is provided for information sources. A majority of this information can be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

I. NONANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, 1990, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste type information up to 1981.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

- Sorts tanks into groups by waste type.

Jungfleisch, F. M., B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- A model based on process knowledge and radioactive decay estimations using ORIGEN for different compositions of process waste streams assembled for total, solution, and solids compositions per tank. Provides assumptions about waste and waste types and solubility parameters and constraints.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

- Contains compositions of process stream waste before transfer to 200 Area waste tanks.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Waste Status and Transaction Record Summary for the Northeast Quadrant*, WHC-SD-WM-TI-615, Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains spreadsheets showing available data on tank additions and transfers for the northeast quadrant.

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste type information up to 1981.

Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-RE-TI-053, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

- Shows tank riser locations in relation to tank aerial view and a description of risers and associated equipment.

Dasgupta, A., 1995, *Interim Stabilization Status of SSTs B-104, B-110, B-111, T-102, T-112, and U-110*, WHC-SD-WM-ER-516, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains the results of investigation to determine whether six single-shell tanks continue to meet interim stabilization criteria. It concluded tanks 241-B-111, 241-B-110, and 241-U-110 meet the criteria.

Hanlon, B. M., 1996, *Tank Farm Surveillance and Waste Status Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

- Most recent release of a series of summaries including fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information. The series includes monthly summaries from December 1947 to present; however, Hanlon has only compiled the monthly summaries from November 1989 to present.

Leach, C. E. and S. M. Stahl, 1996, *Hanford Site Tank Farm Facilities Interim Safety Basis Volume I and II*, WHC-SD-WM-ISB-001, Rev. 0L, Westinghouse Hanford Company, Richland, Washington.

- Provides a ready reference to the tank farms safety envelope.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Assesses riser locations for each tank; however, not all tanks are included/completed. Includes an estimate of risers available for sampling.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Compiles information on thermocouples and the status for Hanford Site waste tanks.

Vitro Engineering, 1986, "Pipe Waste Tank Isolation 241-B-111," Drawing No. H-2-73287, Rev. 2, Vitro Engineering Corporation, Richland, Washington.

- Includes riser and nozzle configuration for the tank.

Welty, R. K., *Waste Storage Tank Status and Leak Detection Criteria, Volumes I and II*, WHC-SD-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Describes the nature, scope, and frequency of surveillance used for waste storage tanks, states action criteria for response to data deviations, and presents tank data reviews between June 15, 1973, and June 15, 1988.

Id. Sample Planning/Tank Prioritization

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- Describes sampling and analysis requirements of the stored evaporator feeds.

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- Summarizes the technical basis for characterizing waste in tanks and assigns a priority number to each tank.

Hill, J. G., W. I. Winters, L. Jensen, B. C. Simpson, J. W. Buck, P. J. Chamberlain, and V. L. Hunter, 1991, *Waste Characterization Plan for the Hanford Site Single-Shell Tanks*, WHC-EP-0210, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Characterization planning document. Includes test plan for sampling and analysis of tank 241-B-111.

Kupfer, M. J., M. D. LeClair, W. W. Schultz, and L. W. Shelton, 1995, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Defines method for selecting data and method for best basis inventory.

Ie. Data Quality Objectives/Customers of Characterization Data

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Determines whether tanks are within safe operating conditions.

II. ANALYTICAL DATA

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- Contains sample analyses from 1991 core sampling event.

Heasler, P. G., C. M. Anderson, D. B. Baird, R. J. Serne, and P. D. Whitney, 1993, *Statistical Evaluation of Core Samples from Hanford Tank B-111*, PNL-8745, Pacific Northwest Laboratory, Richland, Washington.

- Statistical evaluation of results from 1991 core sampling event.

Remund, K. M., J. M. Tingey, P. G. Heasler, J. J. Toth, F. M. Ryan, S. A. Hartley, D. B. Simpson, and B. C. Simpson, 1994, *Tank Characterization Report for Single-Shell Tank B-111*, PNL-10099, Pacific Northwest Laboratory.

- Original tank characterization report based on 1991 core sampling event.

IIb. Sampling and Analysis of Similar Waste Types

Amato, L. C., D. S. De Lorenzo, A. T. DiCenso, J. H. Rutherford, R. H. Stephens, P. G. Heasler, T. M. Brown, and B. C. Simpson, 1994, *Tank Characterization Report for Single-Shell Tank 241-B-110*, WHC-SD-WM-ER-368, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Discusses analyses of 1989 and 1990 sampling events and analysis of tank 241-B-110, which contains 2C and P2 wastes.

III. COMBINED ANALYTICAL/NONANALYTICAL DATA

IIIa. Inventories from Campaign and Analytical Information

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- Contains summary information from the supporting documents for Tank Farms A, AX, B, BX, BY, and C, and in-tank photo collages and the solid (including the interstitial liquid) composite inventory estimates.

Kupfer, M. J., 1996, *Interim Report: Best Basis Total Chemical and Radionuclide Inventories in Hanford Site Tank Waste*, WHC-SD-WM-TI-740, Rev. B-Draft, Westinghouse Hanford Company, Richland, Washington.

- Contains a global component inventory for 200 Area waste tanks; 14 chemical and 2 radionuclide components are currently inventoried.

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- Contains a tank inventory estimate based on analytical information.
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- Contains a tank inventory estimate based on analytical information.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Brevick, C. H., L. A. Gaddis, and W. W. Pickett, 1995, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 Areas*, WHC-SD-WM-ER-349, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains summary information from the supporting documents for Tank Farms A, AX, B, BX, BY, and C, and in-tank photo montages and the solid (including the interstitial liquid) composite inventory estimates.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995, *Tank Waste Source Term Inventory Validation, Vol I & II.*, WHC-SD-WM-ER-400, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a quick reference to sampling information in spreadsheet or graphical form for 23 chemicals and 11 radionuclides for all tanks.

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