ENGINEERING CHANGE NOTICE

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13a. Description of Change

13b. Design Baseline Document? [ ] Yes [X] No

This ECN was generated in order to revise the document to the new format per Department of Energy performance agreements.

14a. Justification (mark one)

Criteria Change	[ ]	Design Improvement	[ ]	Environmental	[ ]	Facility Deactivation	[ ]
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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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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

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.

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21. Approvals

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Design Authority			Design Agent		
Cog. Eng. J.G. Field	Jim G Field	3/12/97	PE		
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DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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

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U.S. Department of Energy Contract DE-AC06-87RL10930

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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-T-111, Tank T-111, T-111, T 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-T-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-T-111

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LIST OF TERMS

224	lanthanum fluoride waste
2C	second-cycle decontamination waste
2C1	second-cycle decontamination waste (generated from 1944-49)
2C2	second-cycle decontamination waste (generated from 1950-56)
ANOVA	analysis of variance
Btu/hr	British thermal units per hour
CF	concentration factor
Ci	curies
cm	centimeters
df	degrees of freedom
DQO	data quality objectives
DSC	differential scanning calorimetry
DW	decontamination waste
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ft	feet
g	grams
g/L	grams per liter
g/mL	grams per milliliter
GC	gas chromatography
GEA	gamma energy analysis
HDW	Hanford defined waste
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inches
J	joules
J/g	joules per gram
kg	kilograms
kg/L	kilograms per liter
kgal	kilogallons
kL	kiloliters
LANL	Los Alamos National Laboratory
LL	lower limit
m	meters
M	moles per liter
mL	milliliters
mm	millimeters
mPa	millipascals

LIST OF TERMS (Continued)

mR/hr	milliroentgens per hour
MS	mass spectrometer
MT	metric tons
n/a	not applicable
NPH	normal paraffin hydrocarbon
n/d	not detected
N/D	not decided
n/r	not reported
NR	not resolved
ORNL	Oak Ridge National Laboratories
Pa	pascals
PF	partitioning factor
PHMC	Project Hanford Management Contractor
PNNL	Pacific Northwest National Laboratory
ppm	parts per million
ppmv	parts per million by volume
QC	quality control
REML	restricted maximum likelihood estimation
RPD	relative percent difference
RSD	relative standard deviation
SMM	supernatant mixing model
TCLP	toxicity characteristic leaching procedure
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
vol%	volume percent
VSS	vapor sampling system
W	watts
WHC	Westinghouse Hanford Company
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
ΔH	change in enthalpy
μCi/g	microcuries per gram
μCi/gal	microcuries per gallon
μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter

LIST OF TERMS (Continued)

μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg C/mL	micrograms of carbon per milliliter
μg/mL	micrograms per milliliter
μm	micrometer

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1.0 INTRODUCTION

One of the major functions of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis, along with other available information about a tank, are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-T-111. The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-T-111 waste; and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. The response to technical issues is summarized in Section 2.0, and the best-basis inventory estimate is presented in Section 3.0. Recommendations regarding safety status and additional sampling needs are provided in Section 4.0. Supporting data and information are contained in the appendices. 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

Characterization information presented in this report originated from sample analyses and known historical sources. The most recent sampling of tank 241-T-111 (October/November 1991) predates the existence of data quality objectives (DQOs). An investigation of the technical issues from the currently applicable DQOs has been made using the data from the 1991 sampling events. Historical information for tank 241-T-111, provided in Appendix A, includes surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

The recent sampling events listed in Table 1-1, as well as sample data obtained prior to 1989, are summarized in Appendix B along with the sampling results. The 1991 core sampling effort was directed by the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991). The analytical results were reported in *Single-Shell Tank Characterization Project and Safety Analysis Project Core 31 and 33, Validation Report Tank 241-T-111* (McKinney et al. 1993). The 1995 vapor sampling event satisfied the data requirements for this tank specified in *Tank 241-T-111 Tank Characterization Plan* (Homi 1995). All analytical results from the vapor sampling were reported in *Tank 241-T-111 Headspace Gas and Vapor Characterization Results for Samples Collected in January 1995* (Huckaby and Bratzel 1995).

The statistical analysis and numerical manipulation of data used in issue resolution are reported in Appendix C. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation.
A bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-T-111 and its respective waste types is contained in

Appendix E. A majority of the reports listed in Appendix E may be found in the Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/Date[1]	Phase	Location	Segment Portion	% Recovery
Core 31 (10/22/91)	Solid	Riser 6	1	27
			2	80-100
			3	95-100
			4	80-100
			5	100
			6	0
			7	90-100
			8	100
			9	100
Core 33 (11/5/91 and 11/7/91)	Solid	Riser 3	1	100
			2	100
			3	87-100
			4	75-85
			5	88
			6	100
			7	100
			8	100
			9	100
Grab Samples (3/5/1994)	Liquid	Riser 13	3, 100 mL samples	100
Vapor sample (1/20/95)	Gas	Tank headspace, riser 3	n/a	n/a

Notes:

n/a = not applicable

[1]Dates are provided in the mm/dd/yy format.

1.2 TANK BACKGROUND

Tank 241-T-111 is located in the 200 West Area T Tank Farm on the Hanford Site. It is the second tank in a three-tank cascade series. The tank went into service in 1945, receiving second cycle decontamination (2C) waste cascaded from tank 241-T-110. The entire cascade was filled with 2C waste in 1946. In 1947, the supernatant was transferred to crib T-006. During the first quarter of 1948, the cascading of 2C waste resumed. This pattern of filling/crib transfer continued until 1952. In 1952, the tank was used to cascade 2C and lanthanum fluoride waste. Upon conclusion of cascading in 1956, no further waste was received by tank 241-T-111. The final transfer out of the tank occurred during salt well pumping from May 1994 to February 1995.

A description of tank 241-T-111 is summarized in Table 1-2. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 1,688 kL (446 kgal) of non-complexed waste (Hanlon 1996). The tank was added to the Organic Watch List in 1994 (Public Law 101-510).

Table 1-2. Description of Tank 241-T-111.[1] (2 sheets)

TANK DESCRIPTION	
Type	Single-Shell
Constructed	1943-1944
In-service	1945
Diameter	22.9 m (75.0 ft)
Operating depth	5.18 m (17.0 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Non-complexed
Total waste volume	1,688 kL (446 kgal)
Supernatant volume	0 kL (0 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	1,688 kL (446 kgal)
Drainable interstitial liquid volume	129 kL (34 kgal)
Waste surface level (11/18/96)[2]	430 cm (169.42 in.)[2]
Temperature (2/11/76 to 11/18/96)	8.8 °C (48 °F) to 31 °C (87 °F)
Integrity	Assumed leaker
Watch List	Organic

Table 1-2. Description of Tank 241-T-111.[1] (2 sheets)

SAMPLING DATE	
Core samples	October/November 1991
Grab sample	March 1994
Vapor samples	January 1995
SERVICE STATUS	
Removed from service	1974
Partially interim isolated	1982
Interim stabilized	1995

Notes:

[1]Waste volume is estimated from surface level measurements.

[2]Dates are provided in the mm/dd/yy format.

2.0 RESPONSE TO TECHNICAL ISSUES

Three technical issues have been identified for tank 241-T-111 (Brown et al. 1996). They are:

- **Safety Screening:** Does the waste pose or contribute to any recognized potential safety problems?
- **Organic Complexants:** Does a potential exist for an exothermic organic complexant reaction in the waste that could produce a radioactive release?
- **Vapor Screening:** Do the gases and vapors in the tank headspace pose any flammability or toxicity problems?

As stated in Section 1.1, the core sampling of tank 241-T-111 (October/November 1991) occurred prior to the existence of DQOs. Using the 1991 data, an attempt has been made to respond to the first issue as outlined in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), and the second issue as outlined in *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The vapor sampling event (January 1995) was used to address the last issue according to *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1995).

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-T-111 for potential safety problems are documented in the safety screening DQO (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste; flammable gases in the waste and/or tank headspace; and criticality conditions in the waste. Each of these conditions is addressed separately below.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that there is not enough fuel in tank 241-T-111 to cause a safety hazard. Because of this requirement, energetics in the tank waste were evaluated. The threshold limit for energetics is 480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated that the top three segments of both core samples contained substantial exotherms.

The maximum dry weight exothermic value was 3,316 J/g for core 33, segment 2. The results show that a significant fuel source is located in the top layers of the waste. Generally, the water content of these segments was over 60 percent. Therefore, there is little probability of a propagating exothermic reaction occurring.

2.1.2 Flammable Gas

The determination of the tank headspace flammability was not required when the tank was sampled in 1991. Vapor samples taken in 1995 were not measured for overall flammability with a combustible gas meter. Individual gas constituents were evaluated against their respective lower flammability limits, and it was determined that there were no flammability concerns (Huckaby and Bratzel 1995).

2.1.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu and using a maximum measured density of 1.35 g/mL, 1 g/L of ^{239}Pu is equivalent to 45.6 μCi/g of alpha activity. The total alpha activity in all samples was well below this limit. The upper limit to a 95 percent confidence interval on the mean was 1.93 μCi/g, much less than 45.6 μCi/g. Therefore, criticality is not a concern for this tank.

2.2 VAPOR SCREENING

The characterization of tank headspace vapors is needed to address the possibility of explosion/fire from flammable constituents and worker safety associated with the toxicity of released vapors. These issues were evaluated using the data from the 1995 vapor sampling.

The presence of flammable constituents in the vapors of Hanford Site waste tanks is a safety question that must be resolved prior to conducting any type of intrusive sampling, stabilization, or remedial activities in or around the tanks (Osborne et al. 1995). As stated in Section 2.1.2, no flammability concerns were found. Ammonia was the only analyte present at levels that exceeded the toxicity notification limit (150 ppmv). The measured ammonia concentration was 226 ppmv. This level of ammonia would not contribute appreciably to the flammability of the headspace or the tank toxicity (Huckaby and Bratzel 1995). Notification procedures were followed as described in the tank characterization plan (Homi 1995).

2.3 ORGANIC EVALUATION

Tank 241-T-111 was added to the organic Watch List in 1994 due to the energetic results from the safety screening analyses. Although the 1991 core sampling event predated the DQO process, the analytical data was evaluated according to *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The organic DQO defines the type, quantity, and quality of data required to categorize the tank, and to resolve the safety issues. The specific issues addressed by the organic DQO are the exothermic conditions in the waste, fuel content determined by total organic carbon (TOC), and the moisture content of the waste. Each of these issues are discussed in Sections 2.3.1 and 2.3.2.

2.3.1 Exothermic Conditions and Moisture Content

As discussed in section 2.1.1, tank exotherms exceeded the threshold limit of 480 J/g (dry weight). Because all waste samples contained greater than 60 percent water, there is little probability of a propagating exothermic reaction occurring (Turner et al. 1995).

2.3.2 Organics

Total organic carbon was analyzed for the purpose of determining the fuel content of the tank waste. The organic DQO established a decision threshold of 30,000 μg/g (dry weight basis) for TOC. All individual results were well below the action limit after being converted to dry weight. However, the upper limit to a one-sided 95 percent confidence interval on the tank mean was 45,800 μg/g on a dry weight basis, which exceeds the threshold level. However, Because of the high moisture content of the waste, the TOC results do not impact tank safety.

2.4 OTHER TECHNICAL ISSUES

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load calculated using best-basis radionuclide inventory values in Section 3.0 was 92.8 W (317 Btu/hr). The Agnew et al. (1996) estimate of heat load based on the tank process history was 2.23 W (7.61 Btu/hr), while the heat load estimate based on the tank headspace temperature was 241 W (822 Btu/hr) (Kummerer 1994). All of these estimates are low, and are well below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986).

2.5 SUMMARY

A comparison between analytical data and the decision limits of the safety screening, organic, and vapor DQOs, identified two safety issues. These issues are 1) the top three segments had exothermic reactions which exceeded the safety screening, and 2) organic DQO limits and ammonia was found in the headspace vapor samples in concentrations above the toxicity threshold of the vapor DQO. A summary of the DQO comparisons are presented in Table 2-1.

Table 2-1. Summary of Safety Screening and Vapor Results.

Issue	Sub-issue	Result
Safety screening	Energetics	Segments 1-3 of core 31 and segments 1 and 2 of core 33 exceeded the action limit of 480 J/g, dry weight basis. The high moisture level precludes a propagating reaction.
	Flammable gas	Vapor measurement using a combustible gas meter were not performed. Individual gas flammability measurements demonstrated that a flammability concern does not exist.
	Criticality	All total alpha results were well below the action limit of 45.6 μCi/g. The upper limit to a 95 percent confidence interval on the tank mean was 1.93 μCi/g. Criticality is not an issue.
Organic	Energetics	See energetics issue for safety screening above.
	Organic content	All total organic carbon results were well below the action limit of 30,000 μg/g (dry weight) with a mean of 13,000 μg/g. The upper limit to a 95 percent confidence interval on the tank mean was 45,800 μg/g, dry weight. The high moisture level precludes a propagating reaction.
	Moisture	All weight percent water results were greater than 17 weight percent.
Vapor	Flammable gas	See flammable gas issue for safety screening above.
	Toxicity characterization	Ammonia concentration of 226 ppmv exceeded the notification limit (150 ppmv). Appropriate notifications were made, and this was determined not to be a concern.

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as regulatory issues. These 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 them into a form that is suitable for long-term storage. Chemical and radiological inventory information are derived using the following three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the Hanford Defined Waste (HDW) model based on process knowledge and historical information, and (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage and other operating data. The information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). The results from this evaluation support using the sampling data as the basis for the best estimate inventory to tank 241-T-111 for the following reasons:

1. Data from two core composite samples were used to estimate the component inventories. The core sample recovery was quite complete.

2. With the exception of phosphate and uranium, results from this evaluation compare favorably with the sample-based results.

3. The inventory estimate generated by the HDW model is based on a predicted 2C:224 waste volume ratio 92:8, whereas sample analyses of components that are unique to these two waste types indicate a higher contribution of 224 waste, for example 80:20 or 75:25.

4. The fraction precipitated basis used for the independent analysis for major components results in inventory estimates that compare favorably with sample analyses. The concentration factors calculated for fully precipitated components (for example, bismuth) were based on comparing flowsheet concentrations with analytical-based concentrations. The relative concentrations of components in the waste solids are consistent with those expected for waste resulting from bismuth phosphate process 2C and 224 process flowsheets. For almost all components, the calculated concentration factor (CF) and partitioning factor (PF) resulted in inventories that are consistent with the predicted chemical behaviors of the components in alkaline media.

5. The flowsheet bases and waste volumes used for this assessment reflect the processing conditions more closely than those that govern the HDW model inventories.

Best-basis inventory estimates for tank 241-T-111 are presented in Tables 3-1 and 3-2. Component inventories are rounded to two significant figures.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	1,200	S	---
Bi	56,000	S	---
Ca	5,300	S	---
Cl	980	S	Based on analysis of water leach only.
TIC as CO_3	1,800	S	Based on analysis of water leach only.
Cr	4,300	S	---
F	5,000	S	Based on analysis of water leach only.
Fe	40,000	S	---
Hg	3	S	---
K	2,500	S	---
La	9,200	S	---
Mn	14,000	S	---
Na	80,000	S	---
Ni	290	S	---
NO_2	1,700	S	Based on analysis of water leach only.
NO_3	90,000	S	Based on analysis of water leach only.
OH	70,000	M	No sample basis
Pb	790	S	---
P as PO_4	70,000	S	---
Si	12,000	S	---

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
S as SO_4	8,000	S	---
Sr	650	S	---
TOC	6,800	S	Based on analysis of water leach only.
U_{TOTAL}	6,100	S	Method/sample prep: (Fluorimetry/ Fusion)
Zr	0	M	No sample basis

Notes:
[1]S = Sample-based (see Appendix B)
M = Hanford Defined Waste model-based
E = Engineering assessment-based

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Tank Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	<DL	S	Based on analysis of water leach only
^{14}C	<DL	S	Based on analysis of water leach only
^{59}Ni	0.11	S	---
^{60}Co	0.8	S	---
^{63}Ni	12	S	---
^{79}Se	<DL	S	---
^{90}Sr	11,800	S	---
^{90}Y	11,800	S	---
^{99}Tc	17	S	Based on analysis of water leach only.
^{129}I	<DL	S	---

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Tank Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{137}Cs	360	S	---
^{137m}Ba	340	S	---
$^{239/240}Pu$	300	S	---
^{241}Am	92	S	---

Notes:

[1]S = Sample-based (see Appendix B)
M = Hanford Defined Waste model-based
E = Engineering assessment-based
DL = detection limit

4.0 RECOMMENDATIONS

Core sampling and analysis performed for tank 241-T-111 in October/November 1991 and vapor sampling and analysis performed in January 1995 meet all requirements for the safety screening DQO (Dukelow 1995), the organic complexants DQO (Turner et al. 1995), and the vapor screening DQO (Osborne et al. 1995). Energetics in the top of the tank waste exceeded the 480 J/g threshold limit for exothermic activity. However, because the water content of the waste was over 60 percent (by weight) there is little probability of an exothermic reaction occurring.

Table 4-1 summarizes the status of Project Hanford Management Contractor (PHMC) TWRS Program Office review and acceptance of the sampling and analysis results reported in this TCR. All DQO issues addressed by sampling and analysis are listed in column 1 of Table 4-1. Column 2 indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered with a "yes" or "no." Column 3 indicates concurrence and acceptance by the PHMC program responsible for the DQO that the sampling and analysis activities were performed adequately and 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/information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown in the column.

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

Issue	Evaluation Performed	TWRS[1] Program Acceptance
Safety screening DQO	Yes	Yes
Organic DQO	Yes	Yes
Vapor DQO	Yes	Yes

Note:
[1]PHMC TWRS Program

Table 4-2 summarizes the status of the PHMC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The three evaluations specifically outlined in this report are, 1) to determine if there is an organic safety concern, 2) to determine whether the tank is safe, conditionally safe, or unsafe, and 3) to determine if the headspace gases pose flammability or toxicity concerns. Column 1 lists the different evaluations performed in this report. Columns 2 and 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-T-111.

Issue	Evaluation Performed	TWRS[1] Program Acceptance
Safety categorization (tank is safe)	Yes	Yes
Organic safety characterization	Yes	Yes
Do headspace vapors pose a safety concern?	Yes	Yes

Note:

[1]PHMC TWRS Program

5.0 REFERENCES

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-T-111 based on historical information. For this report, historical information includes any information about the fill history, waste types, surveillance, or modeling data about the tank. This information may be useful for supporting or challenging conclusions based on sampling and analysis.

This appendix contains the following information:

- **Section A1:** Current status of the tank, including the current waste levels as well as the isolation status of the tank.
- **Section A2:** Information about 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 for tank 241-T-111, 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-T-111 contained 1,688 kL (446 kgal) of non-complexed waste (Hanlon 1996). The waste volumes were estimated using an ENRAF[1] gauge and a manual tape. The volumes of the waste phases found in the tank are shown in Table A1-1. The solids volume was last updated on April 18, 1994.

Tank 241-T-111 was removed from service in 1974, partially interim isolated in 1982, and interim stabilized in 1995. Tank 241-T-111 is passively ventilated, categorized as an assumed leaker, and is on the Organic Watch List (Public Law 101-510). All monitoring systems were in compliance with documented standards as of September 30, 1996 (Hanlon 1996).

[1]ENRAF is a trademark of ENRAF Corporation, Houston, Texas.

Table A1-1. Estimated Tank Contents.[1]

Waste Form	Estimated Volume	
	kL	kgal
Total waste	1,688	446
Supernatant liquid	0	0
Sludge	1,688	446
Saltcake	0	0
Drainable interstitial liquid	129	34
Drainable liquid remaining	129	34
Pumpable liquid remaining	110	29

Note:

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

A2.0 TANK DESIGN AND BACKGROUND

The T Tank Farm was constructed between 1943 and 1944 in the 200 West Area. The tank farm contains four 200-series and twelve 100-series single-shell tanks. Tank 241-T-111 has a capacity of 2,010 kL (530 kgal), a diameter of 22.9 m (75.0 ft), and an operating depth of 5.18 m (17.0 ft). These tanks were designed to hold concentrated, non-boiling supernatant. The maximum design temperature for liquid storage is 104 °C (220 °F) (Brevick et al. 1995).

Tank 241-T-111 entered service in 1945 and is second in a three tank cascading series. These 100-series single-shell tanks are constructed of 30-cm (1.0-ft) thick reinforced concrete with a 6.35-mm (0.25-in.) mild carbon steel liner, and a 38-cm (1.25-ft) thick domed concrete top. These tanks have a dished bottom with a 1.2-m (4-ft) radius knuckle. The tanks are set on a reinforced concrete foundation.

The surface level is monitored through riser 4 with an ENRAF™ gauge, which replaced a Food Instrument Corporation gauge in July 1995. Riser 5 contains a thermocouple tree. The interior tank photograph from 1994 shows a salt well screen located in riser 13. A list of tank 241-T-111 risers showing their sizes and general use is provided in Table A2-1. Figure A2-1 is a plan view of the riser configuration. A tank cross section showing the approximate waste level, along with a schematic of the tank equipment, is shown in

Figure A2-2. Tank 241-T-111 has nine risers. Risers 2, 3, and 6 are tentatively available for sampling (Lipnicki 1996). These risers are all 30 cm (12 in.) in diameter.

Tank 241-T-111 has four process inlet nozzles, one cascade overflow inlet, and one cascade overflow outlet. The cascade overflow nozzles are both located approximately 4.8 m (188 in.) from the tank bottom (as measured at the tank wall).

Table A2-1. Tank 241-T-111 Risers.[1,2,3]

Riser Number	Diameter		Description and Comments
	cm	in.	
1	10	4	Cap welded, below grade, (bench mark December 11, 1986)
2[4]	30	12	Blind flange
3[4]	30	12	Observation port
4	10	4	ENRAF™ (as of July 1995)
5	10	4	Thermocouple tree, (bench mark December 12, 1986)
6[4]	30	12	Flange with bale
7	30	12	B-436 liquid observation well (low)
8	10	4	Below grade, capped and welded
13	30	12	Salt well screen, (bench mark December 12, 1986)
N1	8	3	Overflow-inlet nozzle
N2	8	3	Overflow-outlet nozzle
N3	8	3	Spare nozzle
N4	8	3	Spare nozzle
N5	8	3	Line V689
N6	8	3	Spare nozzle

Notes:

[1]Alstad (1993)
[2]Tran (1993)
[3]Vitro Engineering Corporation (1988)
[4]Risers tentatively identified for sampling (Lipnicki 1996).

Figure A2-1. Riser Configuration for Tank 241-T-111.

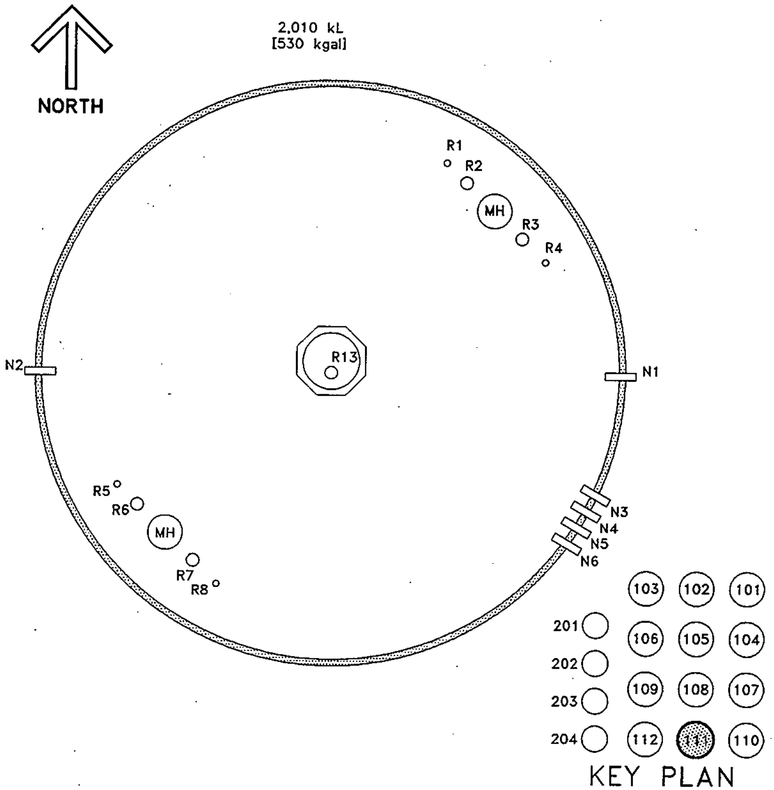
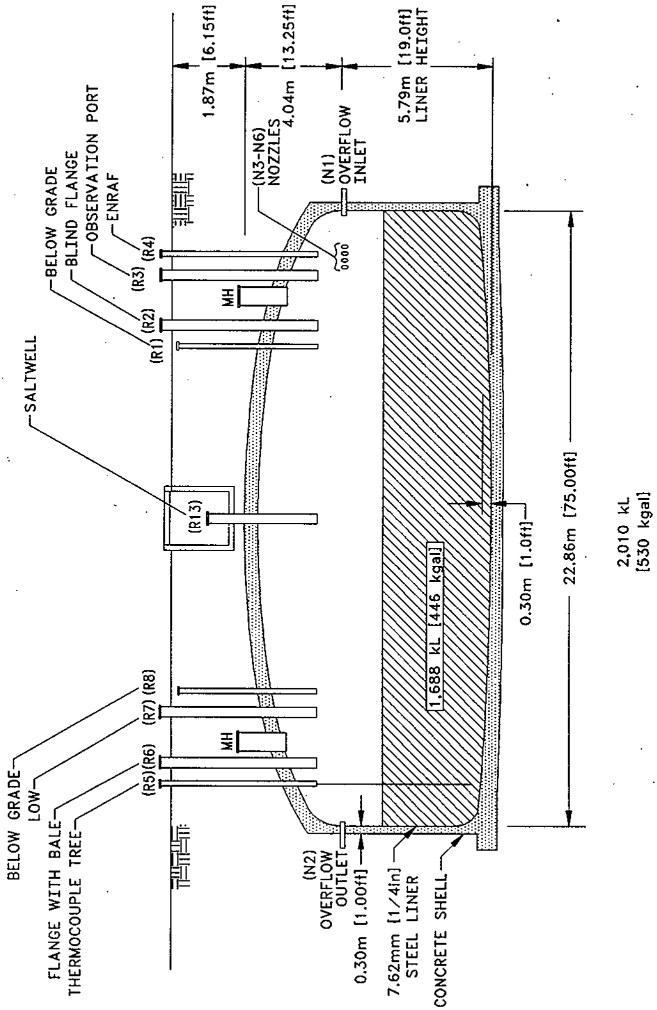


Figure A2-2. Tank 241-T-111 Cross Section and Schematic.



A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the transfer history of tank 241-T-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-T-111. The tank was brought into service during the fourth quarter of 1945 with a cascade from tank 241-T-110 of second cycle decontamination (2C) waste (Agnew et al. 1996b). The tank was filled with 2C waste, at which time the waste was cascaded to tank 241-T-112. Cascading continued until the third quarter of 1946, when tank 241-T-112 was filled. During the third and fourth quarters of 1947, nearly all of the supernatant of tank 241-T-111 was transferred to crib T-006. The cascading of 2C waste resumed in the first quarter of 1948. When the entire cascade became full, waste from tank 241-T-112 was transferred to a crib. This cycle continued until the fourth quarter of 1952. From 1952 to 1956, tank 241-T-111 was used to cascade 2C and lanthanum fluoride waste (224) from the lanthanum fluoride finishing process in T Plant to a crib. In 1995, supernatant waste was transferred from the tank to crib T-005.

The tank contents remained unchanged until the second quarter of 1974. From 1974 to 1976, 238 kL (63 kgal) of supernatant were transferred to tanks 241-S-110, 241-T-101, 241-T-109, and 241-TX-109. Salt well liquid was pumped from the tank in support of tank stabilization efforts in the fourth quarter of 1990, the fourth quarter of 1994, and the first quarter of 1995.

Table A3-1. Summary of Tank 241-T-111 Major Waste Transfers. (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Volume[1,2]	
				kL	kgal
241-T-110	---	Second-cycle decontamination	1945-1952	26,290	6,945
---	241-T-112	Second-cycle decontamination	1945-1952	-22,277	-5,885
---	Crib T-006	Supernatant	1947	-1,911	-505
241-T-110	---	Second-cycle decontamination/224 waste	1952-1956	56,849	15,018

Table A3-1. Summary of Tank 241-T-111 Major Waste Transfers. (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Volume[1,2]	
				kL	kgal
---	241-T-112	Second-cycle decontamination/224 waste	1952-1956	-54,631	-14,432
---	Crib T-005	Supernatant	1955	-2,218	-586
---	241-S-110, 241-T-101, 241-T-109, and 241-TX-109	Supernatant	1974-1976	-238	-63
---	241-AN-101	Salt well liquid	1990, 1994, 1995	-150	-39.6

Notes:

[1]Unless otherwise noted, data are derived from Agnew et al. (1996b).

[2]Because only major transfers are listed, the sum of these transfers will not equal the current waste volume.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for this estimate are from the following sources:

- Waste Status and Transaction Record Summary for the Southwest Quadrant of the Hanford 200 East Area (WSTRS) (Agnew et al. 1996a). WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3 (Agnew et al. 1996b). This document contains the Hanford Defined Waste (HDW) list, the Supernatant Mixing Model (SMM), and the Tank Layer Model (TLM).

- Historical Tank Content Estimate for the (Northeast, Northwest, Southeast, Southwest) Quadrant of the Hanford 200 (East or West) Area (HTCE). This set of four documents compiles and summarizes much of the process history, design, and technical information regarding the underground waste storage tanks in the 200 Areas.

- Tank Layer Model (TLM). The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

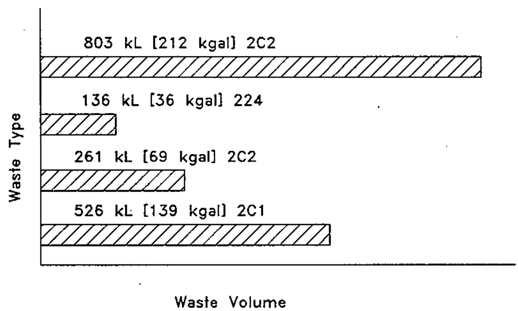
- Supernatant Mixing Model (SMM). This is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

Using these records, the TLM defines the sludge and saltcake layers in each tank. The SMM uses information from both the WSTRS and the TLM to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, and SMM determine each tank's inventory estimate. These model predictions are considered estimates that require further evaluation using analytical data.

Based on the Tank Layer Model, the tank consists of 1,730 kL (456 kgal)* of sludge. The sludge layer is further defined (from the top down) as 803 kL (212 kgal) of second cycle decontamination waste generated from 1952 to 1956 (2C2), 136 kL (36 kgal) of 224 waste, 261 kL (69 kgal) of 2C2 waste, and 526 kL (139 kgal) of second cycle decontamination waste generated from 1944 to 1949 (2C1).

Figure A3-1 shows a graphical representation of the estimated waste types and volumes. Table A3-2 presents the historical tank inventory estimate of the expected waste constituents and concentrations for tank 241-T-111.

Figure A3-1. Tank Layer Model for Tank 241-T-111.



*Note: The overall waste volume predicted by Agnew et al. (1996a) differs from that in Hanlon (1996). Agnew's estimate is based on the solids level at the beginning of 1994. As stated in Section A1.0, the solids level was revised in April 1994. The Hanlon estimate reflects this revision.

Table A3-2. Tank 241-T-111 Historical Tank Inventory Estimate.[1,2] (2 sheets)

Total Inventory Estimate			
Physical Properties			
Total waste	2.05E+06 kg (456 kgal)		
Heat load	2.23 W (7.61 Btu/hr)		
Bulk density[3]	1.18 g/mL		
Water wt%[3]	75.9		
TOC wt%C (wet)[3]	0.102		
Chemical Constituents	*M*	ppm	kg
Na^{+}	2.36	45,800	94,000
Al^{3+}	0	0	0
Fe^{3+} (total Fe)	0.680	32,100	65,900
Cr^{3+}	0.00441	194	398
Bi^{3+}	0.0579	10,200	21,000
La^{3+}	0.0186	2,190	4,480
Hg^{2+}	0	0	0
Zr (as $ZrO(OH)_2$)	0	0	0
Pb^{2+}	0	0	0
Ni^{2+}	0.00142	70.3	144
Sr^{2+}	0.123	9,120	18,700
Mn^{4+}	3.03E-04	14.1	28.9
Ca^{2+}	0.232	7,870	16,100
K^{+}	0.0216	713	1,460
OH^{-}	2.38	34,200	70,200
NO_3^{-}	0.800	41,900	86,000
NO_2^{-}	0.00152	59.3	121
CO_3^{2-}	0.232	11,800	24,200
PO_4^{3-}	0.402	32,300	66,200
SO_4^{2-}	0.0275	2,230	4,580
Si (as SiO_3^{2-})	0.0350	830	1,700

Table A3-2. Tank 241-T-111 Historical Tank Inventory Estimate.[1,2] (2 sheets)

Total Inventory Estimate			
Chemical Constituents (Cont'd.)	*M*	ppm	kg
F^-	0.279	4,490	9,200
Cl^-	0.0190	568	1,160
$C_6H_5O_7^{3-}$	0	0	0
$EDTA^{4-}$	0	0	0
$HEDTA^{3-}$	0	0	0
$Glycolate^-$	0	0	0
$Acetate^-$	0	0	0
$Oxalate^{2-}$	0.0505	3,760	7,710
DBP	0	0	0
Butanol	0	0	0
NH_3	4.89E-08	7.03E-04	0.00144
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	Ci/L	μCi/g	Ci
Pu	---	0.0108	0.370 (kg)
U	5.62E-05 (M)	11.3 (μg/g)	23.2 (kg)
Cs	2.23E-04	0.189	386
Sr	3.61E-05	0.0306	62.6

Notes:

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

A4.0 SURVEILLANCE DATA

Tank 241-T-111 surveillance data consist of surface level measurements (liquid and solid), temperature monitoring inside the tank (waste and vapor space), and leak detection well monitoring for radioactive liquids outside the tank. Surveillance data provide the basis for determining tank integrity.

A4.1 SURFACE LEVEL READINGS

Waste surface level monitoring in tank 241-T-111 is performed with an ENRAF™ gauge at riser 4. The waste surface level on November 18, 1996, was 430 cm (169.42 in.), which is approximately 1,688 kL (446 kgal). A graphical representation of the volume measurements is presented as a level history graph in Figure A4-1.

A4.2 INTERNAL TANK TEMPERATURES

Twelve thermocouple probes are on a single thermocouple tree in riser 5 of tank 241-T-111. Information on probe elevations is not available (Tran 1993). Temperature data for tank 241-T-111 have been recorded since 1976. All thermocouples, except thermocouple 12, have temperature data from 1976 to 1997. Not all the thermocouples have data covering the entire period (Brevick et al. 1995). The minimum temperature on November 18, 1996, was 16.7 °C (62.1 °F) on thermocouple 2; the maximum temperature on the same date was 18.6 °C (65.5 °F) on thermocouple 11.

Temperature data were evaluated from the Surveillance Analysis Computer System recorded from 1976 to 1996. The average temperature during this period was 17.6 °C (63.7 °F) with a minimum of 8.8 °C (48 °F) and a maximum of 31 °C (87 °F). A graph of the weekly high temperature data is shown in Figure A4-2.

A4.3 TANK 241-T-111 PHOTOGRAPHS

The montage assembled from 1994 photographs for tank 241-T-111 is of high quality and shows a tank nearly filled with solid waste. The surface shows a cracked, moist to hard mud-like surface with a liquid pool on one side of the tank. The waste appears to be medium brown and has some depressed areas in it which probably resulted from equipment removal. Corrosion of the tank liner is indicated by the rust on the sludge around the tank perimeter. A Food Instrument Corporation level probe, a salt well screen, a liquid observation well, a temperature probe, and some nozzles and risers are apparent in the montage. The montage may not represent current tank contents due to stabilization efforts in 1995.

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

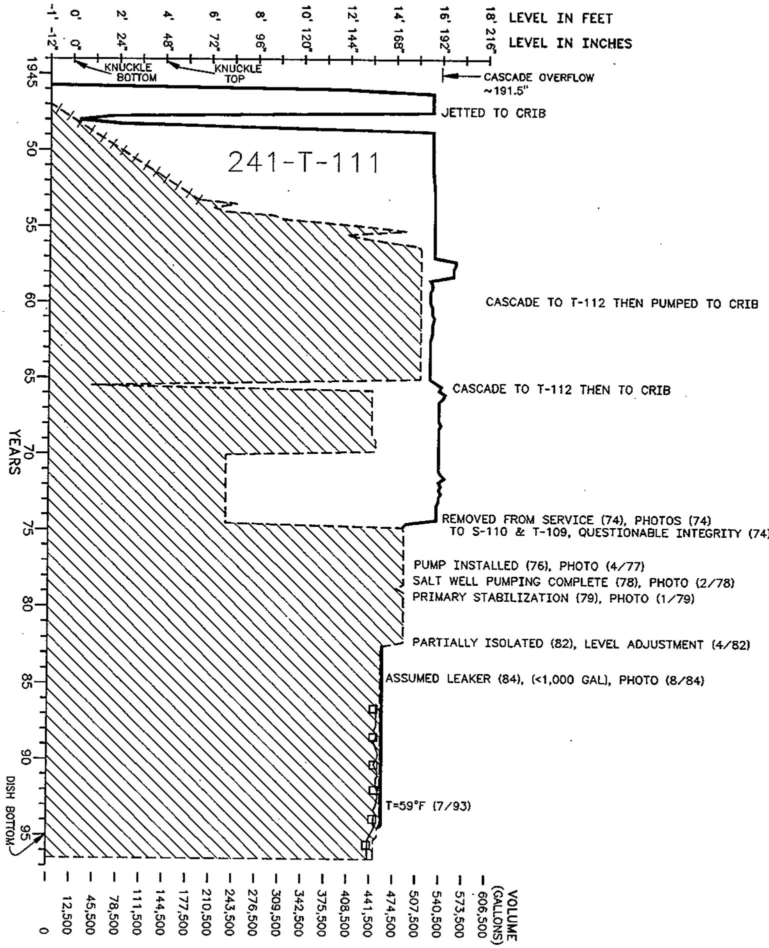
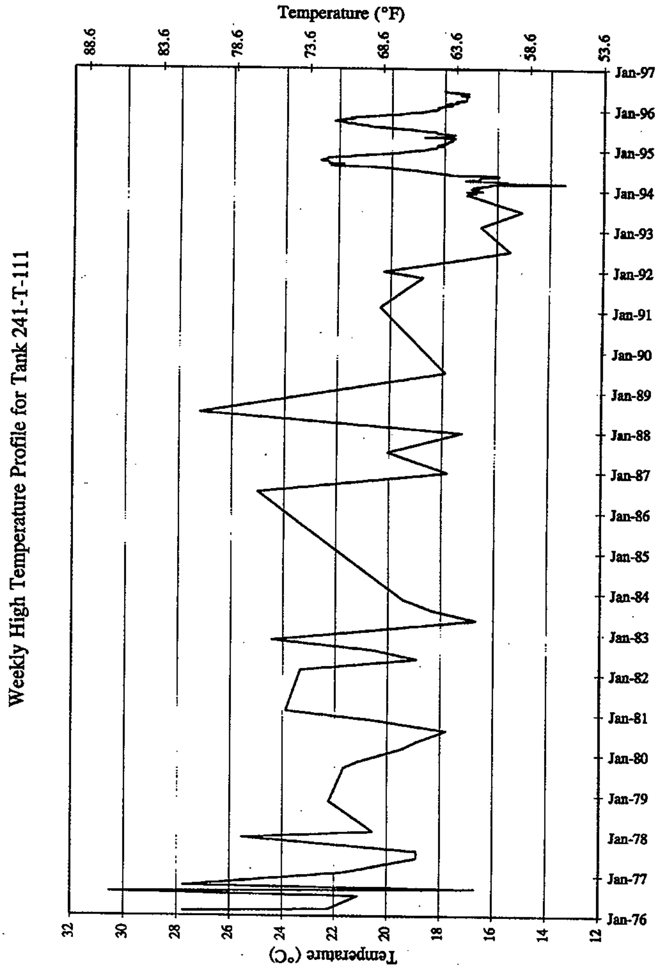


Figure A4-2. Tank 241-T-111 Weekly High Temperature Plot.



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APPENDIX B

SAMPLING OF TANK 241-T-111

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APPENDIX B

SAMPLING OF TANK 241-T-111

Appendix B provides sampling and analysis information for each known sampling event for tank 241-T-111 and an assessment of the core sample results.

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

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

B1.0 TANK SAMPLING OVERVIEW

Appendix B describes all known sampling events for tank 241-T-111, and presents the analytical results for each event. The sampling events listed include: the 1991 core sampling event, the 1994 grab sampling event, the 1995 vapor sampling event, and the 1965 and 1974 (2) historical supernatant events.

Core samples were taken in October/November 1991. Although not taken according to current DQOs, the analytical results have been used for comparison with the requirements of the safety screening (Dukelow et al. 1995) and organic (Turner et al. 1995) DQOs. The sampling and analysis were performed in accordance with the single-shell waste characterization plan (Hill et al. 1991). Results from the sampling event were reported in McKinney et al. (1993).

Supernatant grab samples were retrieved on March 5, 1994 for compatibility analysis. Sampling and analysis were conducted in accordance with Westinghouse Hanford Company (1994b).

Tank headspace samples were taken in January 1995 to satisfy vapor requirements (Osborne et al. 1995). The sampling and analysis were performed in accordance with the tank characterization plan (Homi 1995). The results were reported in *Tank 241-T-111 Headspace Gas and Vapor Characterization Results for Samples Collected in January 1995* (Bratzel and Huckaby 1995).

Sampling and analytical requirements from the safety screening, organic, and vapor DQOs are summarized in Table B1-1.

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-T-111.[1,2,3]

Sampling event	Applicable DQOs	Sampling Requirements	Analytical Requirements
1991 core samples	Safety screening[4]	Core samples from a minimum of two risers separated radially to the maximum extent possible.	▶Energetics ▶Moisture content ▶Total alpha ▶Bulk density
	Organic		▶Energetics ▶Moisture content ▶Total organic carbon
1995 vapor samples	Vapor	Measurement in a minimum of one location within tank vapor space.	▶Gases (ammonia, CO_2, CO, NO, NO_2, N_2O, TOC, tributyl phosphate, n-dodecane, and n-tridecane) ▶Vapor flammability

Notes:

[1]Dukelow et al. (1995)
[2]Turner et al. (1995)
[3]Osborne et al. (1995)

Three historical supernatant sampling events were reported for tank 241-T-111. There was one event in 1965 and two in 1974. No information was available regarding sample handling and analysis for the samples, therefore, only analytical results and references are reported. Section B2.3 presents the results from these sampling events.

B2.0 DESCRIPTION OF SAMPLING EVENTS

The 1991 core sampling event, 1994 grab sampling event and 1995 vapor sampling event are described in this section. Analytical results are presented in Tables B2-3 through B2-126.

B2.1 1991 CORE SAMPLING EVENT

B2.1.1 Description of 1991 Core Sampling Event

Tank 241-T-111 was push-mode core sampled through three risers between October 22, 1991 and November 7, 1991. The core samples were obtained using a specially designed core sampling truck. A review of the tank farm operating records and a field inspection of the tank risers determine which risers can be used in the sampling operation. During sampling, a riser is opened and the truck is positioned over the riser. The sampler is lowered into the tank through the drill string and pushed into the waste. Nine segments were expected from each core sample; each segment is approximately 48 cm (19 in.) long. Core 31 was taken from riser 6 on October 22, 1991, and core 32 was taken from riser 2 on October 24 and 25, 1991. Core 33 was taken from riser 3 between November 5, 1991 and November 7, 1991.

The sampler is constructed of stainless steel, is 48 cm (19 in.) long, has a 2.2-cm (7/8-in.) inside diameter, and a volume of 187 mL (0.05 gal). A hydrostatic fluid of normal paraffin hydrocarbons (NPH), similar to kerosene, was used in establishing a head balance while taking these cores. Objections involving sample degradation and contamination were raised regarding the use of this fluid, and the practice has since been discontinued. For cores 31 and 33, nearly full recovery was achieved in every case. There were little or no drainable liquids observed in the sample liners or in the samplers upon extrusion of the samples, and although hydraulic permeability measurements were not taken as part of the characterization effort, the waste did not appear porous. Thus, sample contamination from the hydrostatic fluid is not deemed to be a significant issue with the analysis of the sample or the interpretation of the results.

Although DQOs were not applicable to this sampling event, a comparison of the sampling conditions required by the safety screening and organic DQOs was made with the 1991 sampling conditions. The riser locations from the 1991 sampling event were separated radially to the maximum extent possible as required by the DQO. One sampling requirement of the safety screening DQO that was not met during the 1991 sampling event was a determination of the flammability of the tank headspace gases.

B2.1.2 1991 Core Sample Handling

The casks were transported to the 222-S Laboratory for characterization analysis. Some of the physical tests, organic analyses and uranium and plutonium isotopic analyses were performed at the 325 Laboratory, operated by Battelle, Pacific Northwest National Laboratory (PNNL).

The location of the risers, the dished bottom of the tank, and safety margins in the sampling protocol preclude obtaining samples from the entire waste depth in the tank. In addition, the sampling protocol establishes that segments will be calculated from the bottom up. Thus, depending on the waste depth, maximum recovery for the top segment from tank 241-T-111 is not necessarily going to be a full segment. For cores 31 and 33, sample recovery was excellent; overall recoveries were in excess of 80 percent. Segment recoveries were based on the maximum recoverable volume for the segment regardless of solid/liquid ratio. The core recoveries reported in the data package are determined based on a visual inspection of the sample length and apparent volume at the time the samples are extruded. Table B2-1 presents the initial measurements and observations regarding the core samples on extrusion, and an estimated range of the core recovery on a volume basis for cores 31 and 33.

Table B2-1. Tank 241-T-111 Core 31 Sample Description Summary. (3 sheets)

Segment	Drill String Dose Rate mR/hr	Total Mass g	Core Recovery (Volume Basis)	Comments
Core 31, Riser 6				
1	4.5	64	27%	Sampler was nearly empty; contained approximately 50 mL of black/brown low viscosity solids. Apparently homogeneous.
2	2.4	178.7	80-100%	Sampler was almost completely filled with solids. The material was dark brown or black with a fluid or gel-like consistency, and appeared to be homogeneous. A small amount of liner liquid was observed. The liquid was observed to be two phase (NPH and aqueous phases).
3	2.5	162.2	95-100%	Sampler was almost completely filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous.
4	2	153.5	80-100%	Sampler was almost completely filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous. The top eighth contained waste material that appeared to be more fluid than the rest of the sample. No sampler liquid or liner liquid was observed.

Table B2-1. Tank 241-T-111 Core 31 Sample Description Summary. (3 sheets)

Segment	Drill String Dose Rate mR/hr	Total Mass g	Core Recovery (Volume Basis)	Comments
Core 31, Riser 6				
5	1.5	190.9	100%	Similar to previous observations; no sampler or liner liquid.
6	1.5	NA	0%	Sampler empty.
7	0.5	186.4	90-100%	Sampler was almost completely filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous.
8	1.5	186.4	100%	Similar to previous observations; no sampler or liner liquid.
9	0.3	203.1	100%	Sample was not homogeneous. Sample began as before (dark brown and viscous), but gradually became lighter as a function of depth. Sample was divided into two portions, a light end (133.4 g) and a dark end (69.7 g). Consistency of the sample remained the same throughout.
Core 33, Riser 3				
1	3	159.2	100%	Sampler was full of black/brown low viscosity solids. Apparently homogeneous, with no drainable liquid.
2	2.5	207.6	100%	Sampler was completely filled with solids. The material was dark brown or black with a viscous consistency, and appeared to be homogeneous.
3	10	167.9	87-100%	Sampler was nearly filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous.
4	5	182.1	75-85%	Sampler was 75-85% filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous. The valve was observed to be open prior to extrusion. No sampler liquid or liner liquid was observed.

Table B2-1. Tank 241-T-111 Core 31 Sample Description Summary. (3 sheets)

Segment	Drill String Dose Rate mR/hr	Total Mass g	Core Recovery (Volume Basis)	Comments
Core 33, Riser 3				
5	< 0.5	174.3	88%	Similar to previous observation, the valve was observed open. The sampler had approximately 88% solids. No drainable or liner liquid was seen.
6	2	217.4	100%	Sampler was almost completely filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous.
7	1.5	196.9	100%	Sampler was almost completely filled with solids. The waste was dark brown with a thick, viscous consistency, and appeared to be completely homogeneous.
8	1	199.8	100%	Similar to previous observations. No sampler or liner liquid.
9	1	191	100%	Sample was not homogeneous. Sample began as before (dark brown and viscous) but gradually became lighter in color as a function of depth, similar to core 31. Aliquots from the light and dark portions were taken for volatile organics and energetics analyses. Consistency of the sample remained the same throughout.

Although samples for core 32 were taken from riser 2, the materials obtained at all levels appeared to be particulate suspended in an aqueous solution, with slight traces of normal paraffin-hydrocarbon contamination observed in a few samples. These samples did not correspond to the observed conditions in the tank and were considered non-representative. The results of the core 32 sampling exercise were attributed to sampler failure, and because no acceptable samples were acquired, no assays were performed. Therefore, no results for core 32 will be reported. Valve failures were reported routinely for all three core samples at deeper positions in the tank. The full data package (McKinney et al. 1993) containing all of the assay results is available from the Hanford Site Central Files.

General characteristics of tank 241-T-111 waste materials are as follows:

- Very little drainable liquid was associated with these samples either in the liner or in the extruder.

- Core samples generally were dark brown or black in color. The brown solids were streaked through with grey/white material.

- The samples had a viscous or gel-like consistency. They were thick, relatively smooth sludges (swamp mud was the descriptive term used by the hot-cell observer). The core materials all appeared to be saturated with liquid, which did not drain.

B2.1.3 1991 Core Sample Analysis

The segment and core composite samples were homogenized using a mechanical mixer before analysis. Two core composite samples were made for each core from homogenized solid segment waste, and a sample was taken from each composite. This was done so that aliquots removed for analysis would be representative of the entire segment or core composite. Aliquots of the homogenized tank waste from core 33, segments 1, 3, 5, 7, and 9, were taken to determine the efficacy of the homogenization procedure. The samples were split into duplicates, acid digested, and assayed by inductively coupled plasma spectroscopy (ICP) and gamma energy analysis (GEA). This procedure determined if the degree of mixing achieved by the as-planned homogenization procedure was sufficient to achieve sample homogeneity. Because the homogenization samples are evaluated concurrently or after the other core samples, the results provide only an estimate of subsampling error (or variation). They were not used in this case to ensure that homogenization was achieved before analysis. After review of the results, it appears that homogenization of the samples was satisfactory.

Physical tests completed at the 222-S Laboratory included particle size analysis, thermogravimetric analysis (TGA), DSC, specific gravity, and percent water analyses. The physical properties measured at PNNL included weight percent solids, settling behavior, and weight percent dissolved solids. Rheological testing on these samples was performed at PNNL and included shear strength and shear stress as a function of shear rate. Three segments from core 31 (segments 2, 4, and 8) were selected for the full suite of rheological and physical measurements, in addition to the particle size assay done on each segment. Viscosity, settling properties, fluid behavior, and shear strength were some of the primary characteristics investigated, and were not evaluated on homogenized samples.

Most of the chemical and radionuclide analyses were performed at the 222-S Laboratory. Organic analyses and the uranium and plutonium isotopic analyses were performed at PNNL.

B2.1.4 1991 Core Sampling Analytical Results

This section summarizes the 1991 sampling and analytical results for tank 241-T-111. The chemical, radiochemical, physical, and organic results associated with this tank are presented within this document as indicated in Table B2-2. The following subsections discuss the methods used in analyzing the core samples. Due to the large size of the data set, all discussion of the analytical procedures has been presented first, followed by the data tables.

Table B2-2. Analytical Presentation Tables.

Analysis	Table Number
Summary data for rheological properties	B2-3 through B2-7
Summary data for particle size analyses	B2-8 and B2-9
Summary data for physical properties	B2-10 and B2-11
Summary data for thermodynamic analyses	B2-12 through B2-16
Summary data for non-detected analytes	B2-17 through B2-19
Summary data for inorganic analyses	B2-20 through B2-59
Summary data for carbon analyses	B2-60 and B2-61
Summary data for organic analyses	B2-62 through B2-85
Summary data for radiochemical analyses	B2-86 through B2-110
Summary data for physical analyses	B2-111 through B2-120
Summary data for percent water analyses	B2-121 and B2-122
1995 vapor sampling data	B2-123
Historical sampling data	B2-124 through B2-126

The four quality control (QC) parameters assessed in conjunction with the tank 241-T-111 samples were standard recoveries, spike recoveries, duplicate analyses, and blanks. The QC criteria applied to the data were 90 to 110 percent recovery for standards, 80 to 120 percent recovery for spikes (75 to 125 percent for metals), and ≤ 20 percent for the relative percent difference (RPD) between duplicates (Hill et al. 1991). These criteria applied to all of the analytes. The only QC parameter for which limits are not specified is blank contamination. The limits for blanks are set forth in guidelines followed by the laboratory, and all data results presented in this report have met those guidelines. Sample and duplicate pairs in which any of the QC parameters were outside of these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, or f as follows:

- "a" indicates that the standard recovery was below the QC limit.
- "b" indicates that the standard recovery was above the QC limit.
- "c" indicates that the spike recovery was below the QC limit.
- "d" indicates that the spike recovery was above the QC limit.
- "e" indicates that the RPD was above the QC limit.
- "f" indicates that there was blank contamination.

The following tables present the analytical results for the 1991 sampling event. All mean results presented in the tables were obtained by calculating an average concentration value from the initial and duplicate results. If an analyte was detected in the original but not in the duplicate, or if both sample results were nondetect, the mean was reported as a nondetect. For analytes not detected in any of the samples, the highest nondetect result is reported in Tables B2-12 through B2-14.

B2.1.4.1 Inductively Coupled Plasma Spectroscopy. The following analytes were evaluated by ICP according to procedure LA-505-151: aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, cerium, chromium, cobalt, copper, iron, lanthanum, lead, magnesium, manganese, nickel, potassium, phosphorus, selenium, silicon, silver, sodium, strontium, sulfur, tin, titanium, vanadium, zinc and zirconium. Bismuth, iron, phosphorus, and sodium were the most abundant metals in tank 241-T-111.

B2.1.4.2 Graphite Furnace Atomic Absorption Spectroscopy. In addition to ICP, arsenic and selenium were determined by graphite furnace atomic absorption spectroscopy according to procedures PNL-ALO-214 and PNL-ALO-215, respectively. All results were nondetect.

B2.1.4.3 Cold Vapor Atomic Absorption Spectroscopy. Mercury was analyzed by cold vapor atomic absorption spectroscopy according to procedure LA-325-102.

B2.1.4.4 Ion Chromatography. The following anions were determined by ion chromatography (IC) according to procedure LA-533-105: chloride, fluoride, nitrate, nitrite, phosphate, and sulfate. Nitrite was also determined spectrophotometrically by procedure LA-645-001. All of the analytes were present in tank 241-T-111.

B2.1.4.5 Kjeldahl. The ammonia analysis was performed by procedure LA-634-101. All results were nondetected.

B2.1.4.6 Distillation/Spectrometric Analysis. Cyanide was determined according to procedure LA-695-101. All results were nondetected.

B2.1.4.7 Carbon. Total inorganic carbon (TIC), total organic carbon (TOC), total extractable organic halides (TOX/EOX), and volatile/semivolatile organic constituents were required analytes of the 1991 samples. The following subsections discuss these results.

B2.1.4.8 Total Inorganic Carbon. Total inorganic carbon was determined by coulometry measurements of the CO_2 evolved following sample acidification, as established in procedure LA-344-105.

B2.1.4.9 Total Organic Carbon. Total organic carbon was determined by using procedure LA-622-102.

B2.1.4.10 Total Extractable Organic Halides. Total extractable organic halides were determined by using procedure PNL-ALO-320.

B2.1.4.11 Volatile Organic Compounds. Volatile organic compounds were determined according to procedure PNL-ALO-335. No volatile EPA target compounds in concentrations above the contract required quantification limits were observed in the core samples. Kerosene constituents such as decane, undecane, dodecane, and tridecane were observed, and are the result of contamination by the NPH solution used during sampling.

B2.1.4.12 Semivolatile Organic Compounds. Semivolatile organic compounds were determined according to procedure PNL-ALO-345. Compounds consistent with NPH contamination were detected in the core samples, as well as tributyl phosphate.

B2.1.4.13 Gamma Energy Analysis. The activities of the following radionuclides were determined by GEA according to procedure LA-548-121: ^{241}Am, ^{137}Cs, ^{60}Co, and $^{154/155}$Eu. The activity of ^{129}I and ^{59}Ni were determined by low energy gamma analysis according to procedures LA-378-104 and PNL-ALO-464. The results from the gamma analyses are presented in Tables B2-81 through B2-86, with the exception of ^{59}Ni. All of these results were nondetected.

B2.1.4.14 Alpha Energy Analysis. The following were evaluated by alpha spectrometry according to procedure LA-503-156: ^{241}Am, ^{238}Pu, and $^{239/240}$Pu. The sample results for ^{241}Am and $^{239/240}$Pu are presented in Tables B2-87 and B2-88. All results for ^{238}Pu were nondetected.

B2.1.4.15 Liquid Scintillation. Tritium, ^{14}C, ^{63}Ni, ^{79}Se, and ^{99}Tc were analyzed by liquid scintillation according to procedures LA-218-114, LA-348-104, PNL-ALO-474, LA-365-132, and LA-438-101, respectively. The sample results for ^{63}Ni, and ^{99}Tc are presented in Tables B2-89 and B2-90. All sample results for tritium, ^{14}C, and ^{79}Se were nondetected.

B2.1.4.16 Laser Fluorimetry. Total uranium was determined by laser fluorimetry according to procedure LA-925-106.

B2.1.4.17 Alpha Proportional Counting. Alpha proportional counting was used to determine total alpha activity and ^{237}Np activity according to procedures LA-508-101 and LA-933-141, respectively. The sample results for total alpha activity are presented in Tables B2-92 through B2-94. All results for ^{237}Np were nondetected.

B2.1.4.18 Beta Proportional Counting. Beta proportional counting was used to determine total beta activity and ^{90}Sr activity according to procedures LA-508-101 and LA-220-101, respectively.

B2.1.4.19 Isotopic Uranium and Plutonium By Mass Spectrometry. Mass spectrometry was used to determine the isotopic distribution of uranium and plutonium according to procedure PNL-MA-597.

B2.1.4.20 Density and Physical Measurements. Upon extrusion, a density calculation was made for each segment from both cores by dividing the mass recovered for that segment by its volume. In addition, analytical density determinations were performed on both core samples. These values are reported in Table B2-106. Other physical measurements performed on the samples include weight percent solids, centrifuged solids and liquid density, volume percent centrifuged solids, volume percent settled solids, weight percent centrifuged solids, weight percent solids, and weight percent undissolved solids.

Rheological assays were performed on unhomogenized material from three segments of core 31 (segments 2, 4, and 8). Particle size measurements were conducted on each segment of core 31. The data from segment 4 are not considered valid for these assays because they had dried before the measurements were taken. The results from most of these assays will not be presented, however, in some cases it is useful to compare and contrast the results from the "representative" samples with the samples that had dried.

B2.1.4.21 Rheological Properties. Rheological properties measured on segments 2, 4, and 8 of core 31 included shear stress and viscosity as a function of shear rate, and shear strength.

Results are shown in Tables B2-3 through B2-5. For additional detail on test results, refer to the laboratory data package (McKinney et al. 1993).

Table B2-3. Shear Stress as a Function of Shear Rate: Direct Sample.

Sample: Core 31	Sample Number	Temperature (°C)	Point A Shear Stress Range (Pa)	Qualitative Behavior of Rheogram	Point B Shear Stress (Pa)
Segment 2	80701	34	88 - 220	Wide variation at low shear, converging to a single value at high shear.	165
Segment 2	80703	33	200 - 680	Same	70
Segment 8	123201	33	36 - 108	Same	77
Segment 8	123202	33	0 - 108	Same	50

Table B2-4. Shear Stress as a Function of Shear Rate: 1 to 1 Dilution, Water to Sample.

Sample: Core 31	Sample Number	Temperature (°C)	Point A Shear Stress Range (Pa)	Qualitative Behavior of Rheogram	Point B Shear Stress (Pa)
Segment 2	1	27	0.6 - 4.2	Wide variation at low shear, converging to a single value at high shear.	2.4
Segment 2	2	27	1.2	Linear	2.8
Segment 2	3	95	1.0 - 7.0	Wide variation at low shear, converging to a single value at high shear.	2.0
Segment 2	4	95	0.7 - 1.1	Linear	1.2 - 1.4
Segment 2	5	95	1.0 - 2.4	Linear	2.2

Table B2-5. Shear Stress as a Function of Shear Rate: 1 to 1 Dilution, Water to Sample.

Sample: Core 31	Sample Number	Temperature (°C)	Point A Shear Stress Range (Pa)	Qualitative Behavior of Rheogram	Point B Shear Stress (Pa)
Segment 8	1	27	0.4 - 0.6	Linear	2.8
Segment 8	2	27	0.6	Linear	2.8
Segment 8	3	95	0.6	Linear	2.0
Segment 8	4	95	2.0 - 5.0	Erratic, non-linear	2.0
Segment 8	5	95	0.2	Linear	0.7 - 0.9

Table B2-6. Shear Stress as a Function of Shear Rate: 3 to 1 Dilution, Water to Sample.

Sample: Core 31	Sample Number	Temperature (°C)	Point A Shear Stress Range (Pa)	Qualitative Behavior of Rheogram	Point B Shear Stress (Pa)
Segment 2	1	27	0.05 - 0.25	Linear	0.75 - 1.1
Segment 2	2	27	0.2 - 0.35	Linear	1.2
Segment 2	3	95	0.2	Linear	0.8
Segment 2	4	95	0.3	Linear	1.0
Segment 8	3	95	Not defined	Erratic, non-linear	0.4
Segment 8	4	95	0.3	Linear	1.0

Table B2-7. Viscosity as a Function of Shear Rate: 1 to 1 Dilution, Water to Sample.

Sample: Core 31	Sample Number	Temperature (°C)	Point A Viscosity (mPa)	Qualitative Description of Rheogram	Point B Viscosity (mPa)	Point C Viscosity (mPa)
Segment 2	1	30	0.65	Rises, levels off, then gradually declines	1.8 - 2.0	1.5 - 1.7
Segment 2	2	30	0.56	Slightly sinusoidal	0.6	0.6
Segment 2	3	30	0.80	Rises, levels off, then gradually declines	1.0	0.9
Segment 8	3	30	0.75	Flattened exponential growth and decay curve	1.0	0.75
Segment 8	4	30	0.85	Flattened exponential growth and decay curve	0.95	0.9

B2.1.4.22 Particle Size Analysis. Particle size was analyzed by placing a small amount of sample in water. Samples from each segment of core 31 were prepared and assayed. The prepared sample was placed in a particle size analyzer which estimates the shortest length (or diameter) across particles. The mean particle size for tank 241-T-111 waste samples ranged from 0.93 to 1.23 μm in diameter. Table B2-8 presents the summary results of the measurements.

The insolubility of the waste matrix suggests that the particle size data acquired should be acceptable.

Table B2-8. Core 31 Particle Size Distribution by Number.

Segment	Mean (μm)	Standard Deviation	Median (μm)
1	1.23	0.89	0.94
2	1.13	0.80	0.88
3	1.17	1.00	0.91
4	0.93	0.60	0.80
5	0.95	0.63	0.81
6	---	---	---
7	0.97	0.60	0.83
8	1.02	0.85	0.82
9	1.02	0.83	0.83

Table B2-9 presents the summary results of the volume distribution measurements. Assuming that the density of the solid material within the tank is constant, the volume distribution is also the best estimation of the mass particle size distribution of the tank.

Table B2-9. Core 31 Particle Size Distribution by Volume.

Segment	Mean (μm)	Standard Deviation	Median (μm)
1	28.56	35.92	5.81
2	14.91	20.76	4.79
3	64.99	46.19	58.69
4	24.87	34.15	5.63
5	37.87	47.91	12.31
6	---	---	---
7	7.95	11.88	4.02
8	24.72	28.18	10.02
9	59.69	49.04	58.97

B2.1.4.23 Settling Behavior. This section analyzes the settling behavior and physical properties of the as-received 1 to 1 and 3 to 1 water to sample dilutions. The physical properties reported here include settling rates and volume percent for settled solids and weight percent and volume percent for centrifuged solids. The experimental procedures used to take these measurements were reported previously (McKinney et al. 1993). The physical properties for core 31 samples are summarized in Table B2-10.

No settling was observed in the as-received segment samples over a period of three days. There was no standing liquid obtained from the samples. Two dilutions each of 1 to 1 and 3 to 1 water to sample ratios were prepared, and the volume-percent settled solids for each of the dilutions were plotted as a function of settling time.

The 1 to 1 dilution for segment 2 reached a final volume percent settled solids of 85 to 87 percent. Settling was observed throughout the three-day period, but the majority of the settling was observed in the first 10 hours. The 3 to 1 dilution reached a final volume-percent settled solids of approximately 52 percent. Settling was observed over three days, however, the majority of the solids settled in the first 10 hours.

Table B2-10. Physical Properties Summary.

Property		Sample	
		Core 31, Segment 2	Core 31, Segment 8
Settled solids (vol%)	As-Received	100%	100%
Wt% solids		22.4	29.3
Wt% undissolved solids		19	25.4
Density (g/mL)		1.19	1.28
Vol%	1 hour at 1,000 gravities	65.8	71.9
Wt%		67.3	75.9
Centrifuged supernatant density (g/mL)		1.07	1.1
Centrifuged solid density (g/mL)		1.22	1.34

The 1 to 1 and 3 to 1 dilutions for segment 4 were compromised by drying the sample before its assay. Most settling was completed after 3 to 4 hours, and fully completed after 10 hours. This behavior suggests that segment 4 samples may be a collection of discrete particles with no interaction between them.

The 1 to 1 dilution for segment 8 reached a final volume-percent settled solids of about 80 percent. Settling was observed throughout the three-day period, but the majority of the settling was observed in the first 10 hours. The 3 to 1 dilution reached a final volume-percent settled solids of approximately 40 percent. Settling was observed over three days and the majority of the solids settled in the first 10 hours. Table B2-6 summarizes the settling behavior for the samples investigated. For additional information on settling behavior over time see McKinney et al. (1993).

Table B2-11. Settling Comparison for 1 to 1 and 3 to 1 dilutions for Core 31 Segments 2, 4, and 8.

Analyte	Segment 2		Segment 4		Segment 8	
Dilution: water to sample	1:1	3:1	1:1	3:1	1:1	3:1
Final volume % solids	87	52	22	22	80	40

B2.1.4.25 pH. The pH of the samples was measured according to procedure LA-212-103. The pH values ranged from 9.7 to 10.2.

B2.1.4.26 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the temperature of the sample is heated at a constant rate. A gas such as nitrogen or air is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically. The results from the DSC analysis are presented in Tables B2-7 and B2-8. The DSC analyses were performed under air using procedure LA-514-113, Rev. A-0 on a Mettler[1] instrument.

Table B2-12. Differential Scanning Calorimetry Energetics Results from Tank 241-T-111, Core 31.[1,2]

Core 31	Transition 1		Transition 2		
	Range °C	ΔH range[3] J/g	Range °C	ΔH range[3] J/g	Dry weight J/g
Segment 1	43-141	1,088 to 1,406	200-387	-259 to -273	-1,985 to -2,092
Segment 2	46-149	1,108 to 1,643	200-398	-256 to -264	-1,969 to -2,031
Segment 3	45-160	1,210 to 1,233	195-405	-263 to -448	-1,753 to -2,987
Segment 4	44-165	1,235	200-390	-55.7	-324
Segment 5	NR	NR	n/a	0	---
Segment 6	n/a	---	---	n/a	---
Segment 7	50-164	1,488	165-400	0	---
Segment 8	50-153	1,534	154-400	0	---
Segment 9	61-158	1,437	159-400	0	---
Composite 1	NR	NR	256-339	-23.6 to -37.0	-88.4 to -139
Composite 2	NR	NR	260-334	-18.5 to -22.9	-62.1 to -76.8

Notes:
[1]To convert from J to cal, divide by 4.18.
[2]Negative ΔH indicates an exotherm.
[3]ΔH range is given because of difficulty in interpreting DSC analyses (see McKinney 1993)

n/a = Not applicable
NR = Not resolved.

[1]Mettler is a trademark of Mettler Instrument Corporation, Anaheim, California.

Table B2-13. Differential Scanning Calorimetry Energetics Results from Tank 241-T-111, Core 33.[1,2]

Core 33	Transition 1		Transition 2		
	Range	ΔH range[3]	Range	ΔH range[3]	Dry weight
	°C	J/g	°C	J/g	J/g
Segment 1	49-168	958 to 1,604	168-374	-218 to -293	-982 to -1,320
Segment 2	45-179	1,346 to 1,496	168-438	-454 to -645	-2,334 to -3,316
Segment 3	n/a	NR	237-400	-49.3	-429
Segment 4	n/a	NR	n/a	0	---
Segment 5	n/a	NR	n/a	0	---
Segment 6	n/a	NR	n/a	0	---
Segment 7	n/a	NR	n/a	0	---
Segment 8	n/a	NR	n/a	0	---
Segment 9	n/a	NR	n/a	0	---
Composite 1	n/a	NR	n/a	0	---
Composite 2	n/a	NR	n/a	0	---

Notes:

[1]To convert from J to cal, divide by 4.18.
[2]Negative ΔH indicates an exotherm.
[3]ΔH range is given because of difficulty in interpreting DSC analyses (see McKinney 1993)

n/a = Not applicable
NR = Not resolved.

The first transition in each sample is endothermic, begins at the lower temperature limit of the analysis (30 °C [86 °F]), and essentially is complete between 140 and 180 °C (280 and 360 °F). The most likely phenomenon occurring in this region is the release of the bulk and interstitial water in the core sample material. The endotherms exhibited in this region are substantial (typically in excess of 1,000 J/g). These values are per gram of wet sample. If divided by the mass fraction lost during analysis, they range from 1,600 to 1,900 J/g (dry) and correspond roughly with the heat of vaporization of water (2,260 J/g).

When there is a second transition it is usually substantial and the energetic behavior is readily quantifiable in all of the samples analyzed where exotherms are observed. The results for the samples from segments 1, 2, and 3, which are from the upper portion of the tank, indicate significant differences in thermal behavior compared to other samples from deeper in the tank, further suggesting a difference in waste type.

Because of the very large and unexpected exotherms discovered in the top segments of both core samples, additional physical properties work was performed in 1994 on samples that had been archived (WHC 1994a, Delegard 1994). Table B2-14 presents additional energetics results for core 33, segments 1 and 2. These samples were dried under a vacuum at 60 °C (140 °F) before analysis, using either air or nitrogen as a cover gas. Even after drying, the samples retained 10 to 12 weight percent water. Table B2-15 presents a brief summary of the average analytical results for the properties of the as-received samples, as well as for samples from core 31, segments 3 and 7, and core 33, segments 1 and 7, which had been centrifuged at 500 gravities for 113 hours prior to analysis.

Table B2-14. Differential Scanning Calorimetry Energetics Results from Tank 241-T-111, Core 33 (Dry Basis).[1,2]

Laboratory-Core Sample-Air/N_2	Transition 1		Transition 2	
	Range	ΔH Range[3]	Range	ΔH Range[3]
	°C	J/g	°C	J/g
222-S core 33, seg. 1, Air	---	NR--Dried	158 - 405	-1,857 to -1,882
222-S core 33, seg. 2, Air	---	NR--Dried	130 - 425	-251 to -269
222-S core 33, seg. 2, N_2	---	NR--Dried	130 - 430	-288 to -309
222-S core 33, seg. 2, N_2	---	NR--Dried	128 - 418	-180 to -187
222-S core 33, seg. 2, N_2	---	NR--Dried	123 - 421	-163 to -175
222-S core 33, seg. 2, N_2	---	NR--Dried	121 - 438	-336
325 core 33, seg. 2, N_2	---	NR--Dried	107 - 394	-836 to -898

Notes:

[1]To convert from J to cal, divide by 4.18.
[2]Negative ΔH indicates an exotherm.
[3]ΔH range is given because of difficulty in interpreting DSC analyses (see McKinney 1993)

NR = Not resolved.

Table B2-15. Additional Segment-Level Physical Properties Measurements.[1,2]

Analyte	Core 31, Segment 3		Core 31, Segment 7		Core 33, Segment 1		Core 33, Segment 7	
	As-Received	Centrifuged	As-Received	Centrifuged	As-Received	Centrifuged	As-Received	Centrifuged
Gravimetric water (%)	79.53	64.96	74.72	62.06	79.56	65.49	74.07	59.95
TGA (%)	76.72	55.36	74.06	55.83	78.08	51.37	78.1	45.15
Density (g/mL)	1.24	1.09	1.19	1.2	1.16	1.19	1.2	1.29
ΔH exotherm range (wet weight) (J/g)	-112 to -191	-465.3 to -546.9	-10.2 to -33.1	0	-249 to -254	-822.4 to -838.1	-37.5 to -41.4	0

Notes:

[1]Delegard (1994)
[2]WHC (1994a)

B2.1.4.27 Thermogravimetric Analysis. Thermogravimetric analysis measures the mass of a sample while its temperature is increased at a constant rate. Nitrogen (or air) is passed over the sample during heating to remove any released gases. Any decrease in the weight of a sample during TGA represents a loss of gaseous matter from the sample, either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 °F to 390 °F]) is due to water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well. The TGA analyses were performed under air using procedure LA-560-112, Rev. 0-A on a Perkin-Elmer[2] instrument.

Gravimetric analysis was also used to determine the weight percent water. The gravimetric determination of the weight percent water is measured by the loss of mass in the sample after being held in a drying oven at 105 °C (221 °F) for 12 to 24 hours. Results for the two analyses are summarized in Table B2-11. As can be seen, all data results were quite high, ranging from approximately 70 percent water to nearly 90 percent water.

Table B2-16. Percent Water Analyses Results from Tank 241-T-111. (2 sheets)

	Core 31		Core 33	
	Gravimetric	TGA	Gravimetric	TGA
Sample I.D.	Wt%	Wt%	Wt%	Wt%
Segment 1	80.3	87.0	80.4	77.8
Segment 2	82.4	87.0	85.7	80.6
Segment 3	92.3	85.0	81.7	88.5
Segment 4	72.3	82.8	79.9	89.5
Segment 5	83.4	88.0	78.2	88.8
Segment 6	No sample	No sample	78.5	84.4
Segment 7	76.8	84.8	71.7	85.8
Segment 8	76.6	85.6	75.4	84.8
Segment 9	75.8	71.0	76.0	85.2
Segment 9B	70.4	72.1	---	---

[2]Perkin-Elmer is a trademark of Perkins Research & Mfg. Co, Inc., Canoga Park, California.

Table B2-16. Percent Water Analyses Results from Tank 241-T-111. (2 sheets)

	Core 31		Core 33	
	Gravimetric	TGA	Gravimetric	TGA
Sample I.D.	Wt%	Wt%	Wt%	Wt%
Composite 1	74.6	73.3	76.5	81.6
Composite 2	75.9	70.2	77.1	80.8

B2.1.5 Analytical Data Tables

Table B2-17. Non-Detected Inorganic and Radiochemical Analytes.

Analyte	Highest Non-Detect Result	Analyte	Highest Non-Detect Result
	µCi/g		µg/g
Plutonium-238	< 0.0113	Ammonium	< 4,500
Iodine-129	< 0.0240	Selenium (AA)	< 1.5
Tritium	< 3.15E-04	Arsenic (AA)	< 3.3
Neptunium-237	< 0.0325	Cyanide	< 4.90
Selenium-79	< 1.29E-04	---	---

Table B2-18. Non-Detected Volatile Organic Compounds.

Analyte	Highest Non-Detect Result	Analyte	Highest Non-Detect Result
	µg/g		µg/g
1,1,2,2-Tetrachloroethane	< 22	Chlorobenzene	< 22
1,1,2-Trichloroethane	< 22	Chloroethane	< 43
1,1-Dichloroethane	< 22	Chloroform	< 22
1,1-Dichloroethene	< 22	cis-1,3-Dichloropropane	< 22
1,2-Dichloroethane	< 22	Dibromochloroethane	< 22
1,2-Dichloroethylene	< 22	Ethylbenzene	< 22
1,2-Dichloropropane	< 22	Hexone	< 43
2-Hexanone	< 43	Methylene chloride	< 22
Benzene	< 22	Styrene	< 22
Bromodichloromethane	< 22	trans-1,3-Dichloropropene	< 22
Bromoform	< 22	Trichloroethene	< 22
Bromomethane	< 43	Vinyl acetate	< 43
Carbon disulfide	< 22	Vinyl chloride	< 43
Carbon tetrachloride	< 22	---	---

Table B2-19. Non-Detected Semivolatile Organic Compounds. (2 sheets)

Analyte	Highest Non-Detect Result µg/g	Analyte	Highest Non-Detect Result µg/g
1,2-Dichlorobenzene	< 25	Benzo(k)fluoranthene	< 25
1,3-Dichlorobenzene	< 25	Benzoic acid	< 120
1,4-Dichlorobenzene	< 25	Benzyl alcohol	< 25
2,4,5-Trichlorophenol	< 120	Bis(2-chloroethoxy)methane	< 25
2,4,6-Trichlorophenol	< 25	Bis(2-chloroethyl) ether	< 25
2,4-Dichlorophenol	< 25	Bis(2-chloroisopropyl) ether	< 25
2,4-Dimethylphenol	< 25	Bis(2-ethylhexyl) phthalate	< 25
2,4-Dinitrophenol	< 120	Butylbenzylphthalate	< 25
2,4-Dinitrotoluene	< 25	Chrysene	< 25
2,6-Dinitrotoluene	< 25	Di-n-butylphthalate	< 25
2-Chloronaphthalene	< 25	Di-n-octylphthalate	< 25
2-Chlorophenol	< 25	Dibenz[a,h]anthracene	< 25
2-Methylnaphthalene	< 25	Dibenzofuran	< 25
2-Methylphenol	< 25	Diethyl phthalate	< 25
2-Nitroaniline	< 120	Dimethyl phthalate	< 25
2-Nitrophenol	< 25	Fluoranthene	< 25
3,3-Dichlorobenzidine	< 50	Fluorene	< 25
3-Nitroaniline	< 120	Hexachlorobenzene	< 25
4,6-Dinitro-o-cresol	< 120	Hexachlorobutadiene	< 25
4-Bromodiphenyl ether	< 25	Hexachloropentadiene	< 25
4-Chloro-3-methylphenol	< 25	Hexachloroethane	< 25
4-Chloroaniline	< 25	Indeno(1,2,3-cd)pyrene	< 25
4-Chlorodiphenyl ether	< 25	Isophorone	< 25
4-Methylphenol	< 25	N-Nitroso-di-n-dipropylamine	< 25

Table B2-19. Non-Detected Semivolatile Organic Compounds. (2 sheets)

Analyte	Highest Non-Detect Result µg/g	Analyte	Highest Non-Detect Result µg/g
4-Nitroaniline	< 120	N-Nitrosodiphenylamine	< 25
4-Nitrophenol	< 120	Naphthalene	< 25
Acenaphthene	< 25	Nitrobenzene	< 25
Acenaphthylene	< 25	Pentachlorophenol	< 120
Anthracene	< 25	Phenanthrene	< 25
Benzo(a)anthracene	< 25	Phenol	< 25
Benzo(a)pyrene	< 25	Pyrene	< 25
Benzo(b)fluoranthene	< 25	---	---

Table B2-20. Tank 241-T-111 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	148	151	150[QC:c]
398	33: 1	Homogenized test 1	398	430	414[QC:d]
399		Homogenized test 2	417	412	415[QC:d]
402	33: 3	Homogenized test 1	549	544	547[QC:d]
403		Homogenized test 2	530	532	531[QC:d]
404	33: 5	Homogenized test 1	625	645	635[QC:d]
405		Homogenized test 2	608	584	596[QC:d]
408	33: 7	Homogenized test 1	168	155	162[QC:d]
409		Homogenized test 2	170	169	170[QC:d]
410	33: 9	Homogenized test 1	128	113	121[QC:d]
411		Homogenized test 2	116	126	121[QC:d]

Table B2-20. Tank 241-T-111 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
449	Core 31	Solid Composite	588	580	584[QC:b,c]
450		Solid Composite	707	703	705[QC:b,c]
453	Core 33	Solid Composite	473	471	472[QC:b,c]
454		Solid Composite	404	405	405[QC:b,c]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	656	632	644
467		Solid Composite	706	680	693
470	Core 33	Solid Composite	485	483	484
471		Solid Composite	459	459	459
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	6.43	6.99	6.71
459		Solid Composite	10.2	10.4	10.3
462	Core 33	Solid Composite	17.7	13.4	15.6[QC:e]
463		Solid Composite	10.2	11.9	11.1

Table B2-21. Tank 241-T-111 Analytical Results: Antimony (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	< 17.7	< 17.7	< 17.7
398	33: 1	Homogenized test 1	28.5	27.8	28.2
399		Homogenized test 2	19.7	20.4	20.1
402	33: 3	Homogenized test 1	< 16.9	19.5	< 18.2
403		Homogenized test 2	25.2	26.4	25.8

Table B2-21. Tank 241-T-111 Analytical Results: Antimony (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
404	33: 5	Homogenized test 1	37.1	43.3	40.2
405		Homogenized test 2	42.9	30	36.5[QC:e]
408	33: 7	Homogenized test 1	26.8	21.3	24.1[QC:e]
409		Homogenized test 2	36.6	27.7	32.2[QC:e]
410	33: 9	Homogenized test 1	31.1	21.3	26.2[QC:e]
411		Homogenized test 2	20.1	23.3	21.7
449	Core 31	Solid Composite	21.9	39.0	30.5[QC:e]
450		Solid Composite	36.9	36.1	36.5
453	Core 33	Solid Composite	51.8	20.0	35.9[QC:a,c,e]
454		Solid Composite	26.1	19.1	22.6[QC:a,c,e]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	88.5	88.7	88.6
467		Solid Composite	< 88.3	< 88.3	< 88.3
470	Core 33	Solid Composite	< 88.5	129	< 109
471		Solid Composite	< 88.3	< 88.5	< 88.4
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 17.7	< 17.7	< 17.7[QC:c]
459		Solid Composite	< 17.7	< 17.7	< 17.7[QC:c]
462	Core 33	Solid Composite	< 17.7	< 17.7	< 17.7
463		Solid Composite	< 17.7	< 17.7	< 17.7

Table B2-22. Tank 241-T-111 Analytical Results: Arsenic (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	< 3.00	< 3.00	< 3.00
398	33: 1	Homogenized test 1	4.84	4.72	4.78
399		Homogenized test 2	4.14	3.46	3.80
402	33: 3	Homogenized test 1	< 2.86	< 2.94	< 2.90
403		Homogenized test 2	4.27	3.93	4.10
404	33: 5	Homogenized test 1	4.02	3.62	3.82
405		Homogenized test 2	3.97	4.42	4.20
408	33: 7	Homogenized test 1	4.55	3.61	4.08[QC:e]
409		Homogenized test 2	4.90	4.70	4.80
410	33: 9	Homogenized test 1	3.90	3.61	3.76
411		Homogenized test 2	3.41	3.95	3.68
449	Core 31	Solid Composite	3.17	3.13	3.15[QC:c]
450		Solid Composite	< 2.81	3.02	< 2.92[QC:c]
453	Core 33	Solid Composite	3.50	3.39	3.45[QC:c]
454		Solid Composite	< 2.90	3.23	< 3.07[QC:c]
Solids: acid digest (TCLP)			μg/mL	μg/mL	μg/mL
485	Core 31	Solid Composite	< 0.150	---	< 0.150
643		Solid Composite	< 0.150	< 0.150	< 0.150
611	Core 33	Solid Composite	< 0.150	< 0.150	< 0.150
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	< 15.0	< 15.0	< 15.0[QC:c]
467		Solid Composite	< 15.0	< 15.0	< 15.0[QC:c]
470	Core 33	Solid Composite	< 15.0	< 15.0	< 15.0[QC:c]
471		Solid Composite	< 15.0	< 15.0	< 15.0[QC:c]
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	< 3.00	< 3.00	< 3.00[QC:c]
459		Solid Composite	< 3.00	< 3.00	< 3.00[QC:c]
462	Core 33	Solid Composite	< 2.99	< 2.99	< 2.99[QC:c]
463		Solid Composite	< 3.00	< 2.99	< 3.00[QC:c]

Table B2-23. Tank 241-T-111 Analytical Results: Barium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	571	565	568[QC:a]
398	33: 1	Homogenized test 1	58.1	64.8	61.5
399		Homogenized test 2	61.7	60.2	60.95
402	33: 3	Homogenized test 1	25.1	24.9	25.0
403		Homogenized test 2	24.6	23.7	24.2
404	33: 5	Homogenized test 1	181	188	185
405		Homogenized test 2	182	174	178
408	33: 7	Homogenized test 1	29.5	24.6	27.1
409		Homogenized test 2	24.0	24.6	24.3
Solids: acid digest			µg/g	µg/g	µg/g
410	33: 9	Homogenized test 1	251	252	252
411		Homogenized test 2	238	245	242
449	Core 31	Solid Composite	57.5	56.6	57.1
450		Solid Composite	64.6	65.3	65.0
453	Core 33	Solid Composite	67.0	66.7	66.9
454		Solid Composite	87.9	86.7	87.3
Solids: acid digest (TCLP)			µg/mL	µg/mL	µg/mL
485	Core 31	Solid Composite	0.0441	---	0.0441[QC:c]
643		Solid Composite	0.0273	0.0150	0.0212[QC:c,e]
611	Core 33	Solid Composite	0.0212	0.0302	0.0257[QC:c,e]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	60.4	57.2	58.8
467		Solid Composite	61.5	59.6	60.6
470	Core 33	Solid Composite	64.8	66.0	65.4
471		Solid Composite	73.0	74.5	73.8
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.300	0.309	< 0.305
459		Solid Composite	0.532	< 0.300	< 0.416
462	Core 33	Solid Composite	0.715	0.378	0.547[QC:e]
463		Solid Composite	0.501	0.532	0.517

Table B2-24. Tank 241-T-111 Analytical Results: Beryllium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	< 0.100	< 0.100	< 0.100
398	33: 1	Homogenized test 1	0.161	0.157	0.159
399		Homogenized test 2	0.111	0.115	0.113
402	33: 3	Homogenized test 1	< 0.0954	< 0.0978	< 0.0966
403		Homogenized test 2	0.143	0.131	0.137[QC:e]
404	33: 5	Homogenized test 1	0.134	0.121	0.128
405		Homogenized test 2	0.132	0.148	0.140
408	33: 7	Homogenized test 1	0.152	0.121	0.137
409		Homogenized test 2	0.163	0.157	0.160
410	33: 9	Homogenized test 1	0.130	0.121	0.126
411		Homogenized test 2	0.114	0.132	0.123
449	Core 31	Solid Composite	0.106	0.104	0.105
450		Solid Composite	< 0.0938	0.101	< 0.0974
453	Core 33	Solid Composite	0.120	0.113	0.117
454		Solid Composite	< 0.100	0.108	< 0.104
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	< 0.500	0.501	0.501
467		Solid Composite	< 0.499	< 0.499	< 0.499
470	Core 33	Solid Composite	< 0.500	< 0.499	< 0.500
471		Solid Composite	< 0.499	< 0.500	< 0.500
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	< 0.0999	< 0.100	< 0.100
459		Solid Composite	< 0.0999	< 0.0999	< 0.0999
462	Core 33	Solid Composite	< 0.0998	< 0.0998	< 0.0998
463		Solid Composite	< 0.0999	< 0.0998	< 0.0999

Table B2-25. Tank 241-T-111 Analytical Results: Bismuth (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	25,900	26,000	26,000[QC:a,c]
398	33: 1	Homogenized test 1	704	783	744[QC:a]
399		Homogenized test 2	784	766	775[QC:a]
402	33: 3	Homogenized test 1	24,800	24,600	24,700[QC:a]
403		Homogenized test 2	23,800	23,600	23,700[QC:a]
404	33: 5	Homogenized test 1	33,500	34,600	34,100[QC:a]
405		Homogenized test 2	33,400	32,100	32,800[QC:a]
408	33: 7	Homogenized test 1	34,700	34,000	34,400[QC:a]
409		Homogenized test 2	35,000	35,000	35,000[QC:a]
410	33: 9	Homogenized test 1	24,200	23,800	24,000[QC:a]
411		Homogenized test 2	23,700	24,600	24,200[QC:a]
450		Solid Composite	23,200	23,300	23,300[QC:a,c]
Solids: acid digest			µg/g	µg/g	µg/g
449	Core 31	Solid Composite	23,700	23,400	23,600[QC:a,c]
453	Core 33	Solid Composite	28,600	28,400	28,500[QC:a,d]
454		Solid Composite	28,200	28,600	28,400[QC:a,d]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	21,400	20,500	21,000
467		Solid Composite	20,100	20,200	20,200
470	Core 33	Solid Composite	26,300	26,600	26,500[QC:c]
471		Solid Composite	26,100	27,300	26,700[QC:c]
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	147	83.4	115[QC:c,e]
459		Solid Composite	205	176	191[QC:c]
462	Core 33	Solid Composite	258	205	232[QC:c,e]
463		Solid Composite	267	273	270[QC:c]

Table B2-26. Tank 241-T-111 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	28.6	32.8	30.7[QC:b,c]
398	33: 1	Homogenized test 1	0.968	0.943	0.956[QC:a,c]
399		Homogenized test 2	0.667	0.691	0.679[QC:a,c]
402	33: 3	Homogenized test 1	< 0.573	< 0.587	< 0.580[QC:a,c]
403		Homogenized test 2	0.855	0.785	0.820[QC:a,c]
Solids: acid digest			µg/g	µg/g	µg/g
404	33: 5	Homogenized test 1	0.804	0.725	0.765[QC:a,c]
405		Homogenized test 2	0.794	0.885	0.840[QC:a,c]
408	33: 7	Homogenized test 1	0.909	0.723	0.816[QC:a,c,e]
409		Homogenized test 2	0.980	0.940	0.960[QC:a,c]
410	33: 9	Homogenized test 1	0.779	0.723	0.751[QC:a,c]
411		Homogenized test 2	0.682	0.790	0.736[QC:a,c]
449	Core 31	Solid Composite	30.8	23.4	27.1[QC:c,e]
450		Solid Composite	21.6	25.3	23.5[QC:c]
453	Core 33	Solid Composite	29.6	29.2	29.4[QC:c]
454		Solid Composite	32.3	32.0	32.2[QC:c]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	< 3.00	3.01	< 3.01
467		Solid Composite	< 2.99	< 2.99	< 2.99
470	Core 33	Solid Composite	< 4.32	< 5.36	< 4.84
471		Solid Composite	< 5.10	< 4.58	< 4.84
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	3.11	3.50	3.31
459		Solid Composite	3.12	3.27	3.20
462	Core 33	Solid Composite	5.54	5.54	5.54
463		Solid Composite	4.06	4.44	4.25

Table B2-27. Tank 241-T-111 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	2.58	2.47	2.53
398	33: 1	Homogenized test 1	23.0	15.3	19.2[QC:e]
399		Homogenized test 2	14.3	14.1	14.2
402	33: 3	Homogenized test 1	2.28	2.06	2.17
403		Homogenized test 2	2.01	2.06	2.04
404	33: 5	Homogenized test 1	2.89	3.04	2.97
405		Homogenized test 2	3.00	3.07	3.04
408	33: 7	Homogenized test 1	3.75	3.38	3.57
409		Homogenized test 2	3.51	3.88	3.70
410	33: 9	Homogenized test 1	3.21	3.17	3.19
411		Homogenized test 2	3.42	3.81	3.62
449	Core 31	Solid Composite	7.25	7.19	7.22
450		Solid Composite	7.94	7.78	7.86
453	Core 33	Solid Composite	4.70	4.09	4.40
454		Solid Composite	3.80	3.64	3.72
Solids: acid digest (TCLP)			μg/mL	μg/mL	μg/mL
485	Core 31	Solid Composite	0.0203	---	0.0203
643		Solid Composite	0.0200	0.0200	0.0200
611	Core 33	Solid Composite	0.0200	0.0350	0.0275[QC:e]
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	9.16	7.34	8.25[QC:e]
467		Solid Composite	14.1	7.18	10.6[QC:e]
470	Core 33	Solid Composite	6.08	6.76	6.42
471		Solid Composite	7.48	6.86	7.17
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	< 0.400	< 0.400	< 0.400
459		Solid Composite	< 0.400	< 0.400	< 0.400
462	Core 33	Solid Composite	< 0.399	< 0.399	< 0.399
463		Solid Composite	< 0.400	< 0.399	< 0.400

Table B2-28. Tank 241-T-111 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	895	929	912[QC:b,c]
398	33: 1	Homogenized test 1	4,490	5,190	4,840[QC:b,d]
399		Homogenized test 2	4,730	4,880	4,810[QC:b,d]
402	33: 3	Homogenized test 1	1,110	1,160	1,140[QC:b,d]
403		Homogenized test 2	1,140	1,030	1,090[QC:b,d]
404	33: 5	Homogenized test 1	1,290	1,340	1,320[QC:b,d]
405		Homogenized test 2	1,300	1,290	1,300[QC:b,d]
408	33: 7	Homogenized test 1	1,080	1,040	1,060[QC:b,d]
409		Homogenized test 2	1,060	1,370	1,220[QC:b,d,e]
Solids: acid digest			µg/g	µg/g	µg/g
410	33: 9	Homogenized test 1	952	966	959[QC:b,d]
411		Homogenized test 2	924	977	951[QC:b,d]
449	Core 31	Solid Composite	2,260	2,130	2,200[QC:b,c]
450		Solid Composite	2,610	2,360	2,490[QC:b,c]
453	Core 33	Solid Composite	1,500	1,490	1,500
454		Solid Composite	1,340	1,350	1,350
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	2,930	2,580	2,760
467		Solid Composite	2,830	2,490	2,660
470	Core 33	Solid Composite	1,930	2,500	2,220[QC:e]
471		Solid Composite	1,920	2,180	2,050
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	51.2	50.5	50.9
459		Solid Composite	68.9	54.3	61.6[QC:e]
462	Core 33	Solid Composite	61.3	71.6	66.5
463		Solid Composite	41.5	93.5	67.5[QC:e]

Table B2-29. Tank 241-T-111 Analytical Results: Cerium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	63.9	60.9	62.4
398	33: 1	Homogenized test 1	16.3	19.4	17.9
399		Homogenized test 2	15.5	11.6	13.6[QC:e]
402	33: 3	Homogenized test 1	37.1	36.8	37.0
403		Homogenized test 2	38.3	41.9	40.1
404	33: 5	Homogenized test 1	46.1	49.5	47.8
405		Homogenized test 2	49.2	44.7	47.0
408	33: 7	Homogenized test 1	38.6	34.2	36.4
409		Homogenized test 2	33.3	32.7	33.0
410	33: 9	Homogenized test 1	43.1	43.6	43.4
411		Homogenized test 2	43.4	45.6	44.5
449	Core 31	Solid Composite	31.3	33.9	32.6
450		Solid Composite	28.3	29.0	28.7
453	Core 33	Solid Composite	35.7	40.0	37.9
454		Solid Composite	38.9	32.8	35.9
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	< 50.5	50.6	< 50.6
467		Solid Composite	< 50.4	< 50.4	< 50.4
470	Core 33	Solid Composite	< 50.5	< 50.4	< 50.5
471		Solid Composite	< 50.4	< 50.5	< 50.5
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 10.1	< 10.1	< 10.1
459		Solid Composite	< 10.1	< 10.1	< 10.1
462	Core 33	Solid Composite	< 10.1	< 10.1	< 10.1
463		Solid Composite	< 10.1	< 10.1	< 10.1

Table B2-30. Tank 241-T-111 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	1,970	1,990	1,980[QC:c]
398	33: 1	Homogenized test 1	460	512	486[QC:d]
399		Homogenized test 2	503	480	492[QC:d]
402	33: 3	Homogenized test 1	1,220	1,200	1,210[QC:d]
403		Homogenized test 2	1,160	1,140	1,150[QC:d]
404	33: 5	Homogenized test 1	2,030	2,100	2,070[QC:d]
405		Homogenized test 2	2,010	1,950	1,980[QC:d]
408	33: 7	Homogenized test 1	2,520	2,450	2,490[QC:d]
409		Homogenized test 2	2,520	2,550	2,540[QC:d]
410	33: 9	Homogenized test 1	2,020	1,990	2,010[QC:d]
411		Homogenized test 2	1,960	2,050	2,010[QC:d]
449	Core 31	Solid Composite	1,890	1,830	1,860[QC:c]
450		Solid Composite	1,840	1,840	1,840[QC:c]
453	Core 33	Solid Composite	2,080	2,050	2,070[QC:d]
454		Solid Composite	2,130	2,160	2,150[QC:d]
Solids: acid digest (TCLP)			µg/mL	µg/mL	µg/mL
485	Core 31	Solid Composite	8.87	---	8.87[QC:c]
643		Solid Composite	8.69	8.52	8.61[QC:c]
611	Core 33	Solid Composite	7.52	7.57	7.55
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	1,920	1,860	1,890
467		Solid Composite	1,730	1,670	1,700
470	Core 33	Solid Composite	1,760	1,810	1,790
471		Solid Composite	1,820	1,820	1,820
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	207	211	209
459		Solid Composite	230	228	229
462	Core 33	Solid Composite	226	222	224
463		Solid Composite	209	212	211

Table B2-31. Tank 241-T-111 Analytical Results: Cobalt (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	3.91	3.43	3.67
398	33: 1	Homogenized test 1	4.83	4.74	4.79
399		Homogenized test 2	4.63	4.51	4.57
402	33: 3	Homogenized test 1	3.49	3.36	3.43
403		Homogenized test 2	3.62	3.77	3.70
404	33: 5	Homogenized test 1	13.1	3.34	8.22[QC:e]
405		Homogenized test 2	3.50	3.54	3.52
408	33: 7	Homogenized test 1	3.05	2.47	2.76[QC:e]
409		Homogenized test 2	2.47	3.42	2.95[QC:e]
410	33: 9	Homogenized test 1	2.61	2.42	2.52
411		Homogenized test 2	2.43	2.69	2.56
449	Core 31	Solid Composite	3.38	3.42	3.40
450		Solid Composite	11.7	3.79	7.75[QC:e]
453	Core 33	Solid Composite	3.10	3.15	3.13
454		Solid Composite	2.70	3.13	2.92
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	10.5	9.70	10.1
467		Solid Composite	10.5	11.1	10.8
470	Core 33	Solid Composite	13.0	13.7	13.4
471		Solid Composite	14.8	8.90	11.9[QC:e]
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.799	< 0.800	< 0.800
459		Solid Composite	0.851	< 0.799	< 0.825
462	Core 33	Solid Composite	0.843	< 0.798	< 0.821
463		Solid Composite	< 0.799	0.850	< 0.825

Table B2-32. Tank 241-T-111 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	9.27	9.03	9.15
398	33: 1	Homogenized test 1	88.6	89.9	89.3
399		Homogenized test 2	84.3	83.2	83.8
402	33: 3	Homogenized test 1	6.43	6.51	6.47
403		Homogenized test 2	6.62	5.83	6.23
404	33: 5	Homogenized test 1	7.61	8.33	7.97
405		Homogenized test 2	8.20	7.54	7.87
408	33: 7	Homogenized test 1	7.26	7.05	7.16
409		Homogenized test 2	7.55	7.65	7.60
410	33: 9	Homogenized test 1	7.20	7.71	7.46
411		Homogenized test 2	7.06	7.34	7.20
449	Core 31	Solid Composite	25.7	24.8	25.3
450		Solid Composite	31.7	127	79.4[QC:e]
453	Core 33	Solid Composite	16.5	16.4	16.5
454		Solid Composite	13.0	12.9	13.0
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	35.9	36.8	36.4
467		Solid Composite	34.2	34.1	34.2
470	Core 33	Solid Composite	22.6	21.6	22.1
471		Solid Composite	26.1	23.0	24.6
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.400	< 0.400	< 0.400
459		Solid Composite	< 0.400	< 0.400	< 0.400
462	Core 33	Solid Composite	< 0.399	< 0.399	< 0.399
463		Solid Composite	< 0.400	< 0.399	< 0.400

Table B2-33. Tank 241-T-111 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	15,200	15,400	15,300[QC:b,c]
398	33: 1	Homogenized test 1	20,600	16,300	18,500[QC:c,e]
399		Homogenized test 2	16,000	16,200	16,100[QC:c]
402	33: 3	Homogenized test 1	12,000	11,900	12,000[QC:c]
403		Homogenized test 2	11,400	11,300	11,400[QC:c]
404	33: 5	Homogenized test 1	16,200	16,700	16,500[QC:c]
405		Homogenized test 2	16,000	15,500	15,800[QC:c]
408	33: 7	Homogenized test 1	18,300	17,600	18,000[QC:c]
409		Homogenized test 2	18,100	18,300	18,200[QC:c]
410	33: 9	Homogenized test 1	16,600	16,300	16,500[QC:c]
411		Homogenized test 2	16,400	17,300	16,900[QC:c]
449	Core 31	Solid Composite	19,500	18,900	19,200[QC:c]
450		Solid Composite	20,000	20,100	20,100[QC:c]
453	Core 33	Solid Composite	17,600	17,400	17,500[QC:d]
454		Solid Composite	17,200	17,500	17,400[QC:d]
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	20,800	20,200	20,500
467		Solid Composite	19,700	19,500	19,600
470	Core 33	Solid Composite	15,700	16,200	16,000
471		Solid Composite	16,100	16,100	16,100
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	102	57.0	79.5[QC:e]
459		Solid Composite	151	130	141
462	Core 33	Solid Composite	147	116	132[QC:e]
463		Solid Composite	158	160	159

Table B2-34. Tank 241-T-111 Analytical Results: Lanthanum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	4,560	4,610	4,590[QC:c]
398	33: 1	Homogenized test 1	2.26	3.21	2.74[QC:e]
399		Homogenized test 2	2.97	1.61	2.29[QC:e]
402	33: 3	Homogenized test 1	4,030	4,000	4,020
403		Homogenized test 2	3,820	3,790	3,810
404	33: 5	Homogenized test 1	5,150	5,360	5,260
405		Homogenized test 2	5,120	4,910	5,020
408	33: 7	Homogenized test 1	4,950	4,810	4,880
409		Homogenized test 2	4,930	4,960	4,950
410	33: 9	Homogenized test 1	4,230	4,240	4,240
411		Homogenized test 2	4,060	4,210	4,140
449	Core 31	Solid Composite	3,780	3,660	3,720[QC:c]
450		Solid Composite	3,590	3,640	3,620[QC:c]
453	Core 33	Solid Composite	4,670	4,610	4,640[QC:d]
454		Solid Composite	4,860	4,910	4,890[QC:d]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	3,750	3,630	3,690
467		Solid Composite	3,450	3,380	3,420
470	Core 33	Solid Composite	4,450	4,580	4,520
471		Solid Composite	4,780	4,840	4,810
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	7.05	5.00	6.03[QC:e]
459		Solid Composite	9.35	7.69	8.52
462	Core 33	Solid Composite	15.5	12.2	13.9[QC:e]
463		Solid Composite	15.8	15.7	15.8

Table B2-35. Tank 241-T-111 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	98.6	98.5	98.6
398	33: 1	Homogenized test 1	857	974	916
399		Homogenized test 2	954	885	920
402	33: 3	Homogenized test 1	104	114	109
403		Homogenized test 2	108	100	104
404	33: 5	Homogenized test 1	107	130	119
405		Homogenized test 2	115	114	115
408	33: 7	Homogenized test 1	120	118	119
409		Homogenized test 2	125	122	124
410	33: 9	Homogenized test 1	141	136	139
411		Homogenized test 2	134	142	138
449	Core 31	Solid Composite	481	469	475[QC:c]
450		Solid Composite	544	542	543[QC:c]
453	Core 33	Solid Composite	201	200	201
454		Solid Composite	169	167	168
Solids: acid digest (TCLP)			μg/mL	μg/mL	μg/mL
485	Core 31	Solid Composite	0.451	---	0.451[QC:c]
643		Solid Composite	0.391	0.311	0.351[QC:c,e]
611	Core 33	Solid Composite	0.884	0.472	0.678[QC:c,e]
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	453	427	440
467		Solid Composite	486	482	484
470	Core 33	Solid Composite	272	262	267
471		Solid Composite	267	272	270
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	< 6.19	7.91	< 7.05
459		Solid Composite	8.92	6.93	7.93[QC:e]
462	Core 33	Solid Composite	6.28	< 6.19	< 6.24
463		Solid Composite	< 6.19	< 6.19	< 6.19

Table B2-36. Tank 241-T-111 Analytical Results: Magnesium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	225	235	230[QC:c]
398	33: 1	Homogenized test 1	758	841	800
399		Homogenized test 2	803	790	797
402	33: 3	Homogenized test 1	202	201	202
403		Homogenized test 2	193	188	191
404	33: 5	Homogenized test 1	219	234	227
405		Homogenized test 2	227	210	219
408	33: 7	Homogenized test 1	206	205	206
409		Homogenized test 2	203	210	207
410	33: 9	Homogenized test 1	233	222	228
411		Homogenized test 2	239	234	237
449	Core 31	Solid Composite	438	432	435[QC:c]
450		Solid Composite	482	475	479[QC:c]
453	Core 33	Solid Composite	307	302	305
454		Solid Composite	292	288	290
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	452	424	438
467		Solid Composite	456	431	444
470	Core 33	Solid Composite	258	278	268
471		Solid Composite	269	274	272
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	3.22	2.67	2.95
459		Solid Composite	4.23	3.66	3.95
462	Core 33	Solid Composite	4.08	3.60	3.84
463		Solid Composite	3.72	3.95	3.84

Table B2-37. Tank 241-T-111 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	4,990	5,040	5,020[QC:c]
398	33: 1	Homogenized test 1	21,500	25,200	23,400[QC:d]
399		Homogenized test 2	24,100	24,600	24,400[QC:d]
402	33: 3	Homogenized test 1	3,870	3,820	3,850[QC:d]
403		Homogenized test 2	3,700	3,620	3,660[QC:d]
404	33: 5	Homogenized test 1	2,790	2,900	2,850[QC:d]
405		Homogenized test 2	2,760	2,650	2,710[QC:d]
408	33: 7	Homogenized test 1	4,180	4,060	4,120[QC:d]
409		Homogenized test 2	4,170	4,220	4,195[QC:d]
410	33: 9	Homogenized test 1	4,650	4,640	4,650[QC:d]
411		Homogenized test 2	4,470	4,640	4,560[QC:d]
449	Core 31	Solid Composite	6,310	6,070	6,190[QC:c]
450		Solid Composite	6,140	6,140	6,140[QC:c]
453	Core 33	Solid Composite	6,770	6,650	6,710[QC:d]
454		Solid Composite	6,230	6,320	6,280[QC:d]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	6,470	6,290	6,380
467		Solid Composite	6,020	5,860	5,940
470	Core 33	Solid Composite	6,150	6,290	6,220
471		Solid Composite	6,590	6,590	6,590
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	19.3	10.1	14.7[QC:e]
459		Solid Composite	27.0	23.1	25.1
462	Core 33	Solid Composite	30.4	20.4	25.4[QC:e]
463		Solid Composite	34.2	33.4	33.8

Table B2-38. Tank 241-T-111 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	89.2	90.6	89.9
398	33: 1	Homogenized test 1	222	248	235
399		Homogenized test 2	236	229	233
402	33: 3	Homogenized test 1	70.1	68.6	69.4
403		Homogenized test 2	66.3	65.8	66.1
404	33: 5	Homogenized test 1	85.7	89.3	87.5
405		Homogenized test 2	84	96.1	90.1
408	33: 7	Homogenized test 1	70.8	68.8	69.8
409		Homogenized test 2	70.6	71.8	71.2
410	33: 9	Homogenized test 1	88.5	87.6	88.1
411		Homogenized test 2	84.4	86.5	85.5
449	Core 31	Solid Composite	154	149	152
450		Solid Composite	157	157	157
453	Core 33	Solid Composite	110	109	110
454		Solid Composite	108	109	109
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	5,610	5,940	5,780
467		Solid Composite	3,400	7,490	5,450[QC:e]
470	Core 33	Solid Composite	9,090	9,490	9,290
471		Solid Composite	14,300	9,810	12,100[QC:e]
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 1.7	< 1.70	< 1.70
459		Solid Composite	< 1.7	< 1.70	< 1.70
462	Core 33	Solid Composite	< 1.7	< 1.70	< 1.70
463		Solid Composite	< 1.7	< 1.70	< 1.70

Table B2-39. Tank 241-T-111 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	16,700	16,900	16,800[QC:c]
398	33: 1	Homogenized test 1	4,210	4,510	4,360[QC:c]
399		Homogenized test 2	4,230	4,510	4,370[QC:c]
402	33: 3	Homogenized test 1	4,800	4,780	4,790[QC:c]
403		Homogenized test 2	4,900	4,830	4,865[QC:c]
404	33: 5	Homogenized test 1	8,760	8,980	8,870[QC:c]
405		Homogenized test 2	9,560	9,040	9,300[QC:c]
408	33: 7	Homogenized test 1	12,200	12,000	12,100[QC:c]
409		Homogenized test 2	12,400	12,100	12,300[QC:c]
410	33: 9	Homogenized test 1	15,600	14,600	15,100[QC:c]
411		Homogenized test 2	15,400	15,700	15,600[QC:c]
449	Core 31	Solid Composite	10,000	10,200	10,100[QC:d]
450		Solid Composite	9,980	9,940	9,960[QC:d]
453	Core 33	Solid Composite	9,750	9,970	9,860[QC:d]
454		Solid Composite	11,400	11,300	11,400[QC:d]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	11,900	11,200	11,600
467		Solid Composite	11,100	11,100	11,100
470	Core 33	Solid Composite	9,150	8,990	9,070
471		Solid Composite	9,910	9,910	9,910
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	5,890	5,630	5,760
459		Solid Composite	6,110	5,810	5,960
462	Core 33	Solid Composite	5,340	5,260	5,300
463		Solid Composite	5,740	5,660	5,700

Table B2-40. Tank 241-T-111 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	383	402	393
398	33: 1	Homogenized test 1	1,020	1,120	1,070[QC:d]
399		Homogenized test 2	1,120	1,110	1,120[QC:d]
402	33: 3	Homogenized test 1	1,630	1,630	1,630[QC:d]
403		Homogenized test 2	1,750	1,570	1,660[QC:d]
404	33: 5	Homogenized test 1	1,060	1,100	1,080[QC:d]
405		Homogenized test 2	1,080	1,020	1,050[QC:d]
408	33: 7	Homogenized test 1	691	684	688[QC:d]
409		Homogenized test 2	683	681	682[QC:d]
410	33: 9	Homogenized test 1	485	476	481[QC:d]
411		Homogenized test 2	479	497	488[QC:d]
449	Core 31	Solid Composite	1,110	1,080	1,100[QC:c]
450		Solid Composite	1,200	1,220	1,210[QC:c]
453	Core 33	Solid Composite	1,220	1,210	1,220
454		Solid Composite	1,020	1,020	1,020
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	< 56.0	56.1	< 56.1
467		Solid Composite	< 55.9	< 55.9	< 55.9
470	Core 33	Solid Composite	< 56.0	< 55.9	< 56.0[QC:c]
471		Solid Composite	< 55.9	< 56.0	< 56.0[QC:c]
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	728	740	734
459		Solid Composite	783	783	783
462	Core 33	Solid Composite	719	704	712
463		Solid Composite	650	647	649

Table B2-41. Tank 241-T-111 Analytical Results: Selenium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	< 7.60	< 7.60	< 7.60[QC:c]
398	33: 1	Homogenized test 1	12.3	11.9	12.1
399		Homogenized test 2	8.44	8.76	8.60
402	33: 3	Homogenized test 1	< 7.25	< 7.44	< 7.35[QC:a]
403		Homogenized test 2	10.8	9.95	10.38[QC:a]
404	33: 5	Homogenized test 1	10.2	9.18	9.69[QC:a]
405		Homogenized test 2	10.1	11.2	10.7[QC:a]
408	33: 7	Homogenized test 1	11.5	9.16	10.3[QC:c]
409		Homogenized test 2	12.4	11.9	12.2
410	33: 9	Homogenized test 1	9.87	9.16	9.52
411		Homogenized test 2	8.64	10	9.32
449	Core 31	Solid Composite	8.04	7.92	7.98[QC:c]
450		Solid Composite	< 7.13	7.66	< 7.40[QC:c]
453	Core 33	Solid Composite	12.0	8.60	10.3[QC:e]
454		Solid Composite	< 7.40	8.18	< 7.79
Solids: acid digest (TCLP)			µg/mL	µg/mL	µg/mL
485	Core 31	Solid Composite	0.860	---	0.860[QC:b]
643		Solid Composite	1.21	1.34	1.275[QC:b]
611	Core 33	Solid Composite	0.380	0.380	0.380
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	< 38.0	< 38.1	< 38.1
467		Solid Composite	< 37.9	< 37.9	< 37.9
470	Core 33	Solid Composite	< 38.0	< 37.9	< 38.0
471		Solid Composite	< 37.9	< 38.0	< 38.0
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 7.59	< 7.60	< 7.60
459		Solid Composite	8.44	< 7.59	< 8.02
462	Core 33	Solid Composite	< 7.58	< 7.58	< 7.58
463		Solid Composite	< 7.59	< 7.58	< 7.59

Table B2-42. Tank 241-T-111 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	405	418	412[QC:b,d]
398	33: 1	Homogenized test 1	436	434	435[QC:a,d]
399		Homogenized test 2	332	320	326[QC:a,d]
402	33: 3	Homogenized test 1	371	383	377[QC:a,d]
403		Homogenized test 2	575	385	480[QC:a,d,e]
404	33: 5	Homogenized test 1	365	347	356[QC:a,d]
405		Homogenized test 2	381	534	458[QC:a,d,e]
408	33: 7	Homogenized test 1	423	404	414[QC:a,d]
409		Homogenized test 2	518	455	487[QC:a,d]
410	33: 9	Homogenized test 1	588	449	519[QC:a,d,e]
411		Homogenized test 2	385	393	389[QC:a,d]
449	Core 31	Solid Composite	436	529	483[QC:b,c]
450		Solid Composite	524	418	471[QC:b,c,e]
453	Core 33	Solid Composite	480	575	528[QC:b,c]
454		Solid Composite	298	490	394[QC:b,c,e]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	6,040	5,880	5,960[QC:a]
467		Solid Composite	5,890	5,780	5,840[QC:a]
470	Core 33	Solid Composite	5,390	5,520	5,460[QC:a,c]
471		Solid Composite	5,410	5,410	5,410[QC:a,c]
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	530	345	438[QC:e]
459		Solid Composite	589	530	560
462	Core 33	Solid Composite	671	668	670
463		Solid Composite	618	622	620

Table B2-43. Tank 241-T-111 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	1.14	0.928	1.034[QC:a,c,e]
398	33: 1	Homogenized test 1	422	404	413[QC:c]
399		Homogenized test 2	744	384	564[QC:c,e]
402	33: 3	Homogenized test 1	2.08	1.31	1.70[QC:c,e]
403		Homogenized test 2	1.26	1.54	1.40[QC:c,e]
404	33: 5	Homogenized test 1	1.41	1.12	1.27[QC:c,e]
405		Homogenized test 2	1.32	0.789	1.05[QC:c,e]
408	33: 7	Homogenized test 1	1.46	1.64	1.55[QC:c]
409		Homogenized test 2	1.55	2.99	2.27[QC:c,e]
410	33: 9	Homogenized test 1	1.24	1.24	1.24[QC:c]
411		Homogenized test 2	1.24	1.36	1.30[QC:c]
449	Core 31	Solid Composite	203	202	203
450		Solid Composite	228	225	227
453	Core 33	Solid Composite	43.9	44.8	44.4
454		Solid Composite	31.9	28.1	30.0
Solids: acid digest (TCLP)			µg/mL	µg/mL	µg/mL
485	Core 31	Solid Composite	0.0991	---	0.0991[QC:c]
643		Solid Composite	0.0411	0.0250	0.0331[QC:c,e]
611	Core 33	Solid Composite	0.0250	0.0347	0.0299[QC:c,e]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	218	210	214
467		Solid Composite	226	217	222
470	Core 33	Solid Composite	40.0	38.9	39.5
471		Solid Composite	37.4	36.9	37.2
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.500	0.780	< 0.640
459		Solid Composite	1.07	1.26	1.17
462	Core 33	Solid Composite	0.608	< 0.499	< 0.554
463		Solid Composite	< 0.500	< 0.499	< 0.500

Table B2-44. Tank 241-T-111 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	40,100	40,400	40,300[QC:b,c]
398	33: 1	Homogenized test 1	21,100	23,000	22,100[QC:b,d]
399		Homogenized test 2	22,900	22,800	22,900[QC:b,d]
402	33: 3	Homogenized test 1	26,200	26,200	26,200[QC:d]
403		Homogenized test 2	25,600	25,300	25,500[QC:d]
404	33: 5	Homogenized test 1	31,800	32,900	32,400[QC:d]
405		Homogenized test 2	32,900	31,000	32,000[QC:d]
408	33: 7	Homogenized test 1	36,100	35,500	35,800[QC:b,d]
409		Homogenized test 2	36,400	36,100	36,300[QC:b,d]
410	33: 9	Homogenized test 1	40,700	40,200	40,500[QC:b,d]
411		Homogenized test 2	40,300	41,800	41,100[QC:b,d]
449	Core 31	Solid Composite	38,000	37,100	37,600[QC:b,c]
450		Solid Composite	38,600	38,700	38,700[QC:b,c]
453	Core 33	Solid Composite	35,000	34,900	35,000[QC:b,d]
454		Solid Composite	36,200	36,300	36,300[QC:b,d]
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	40,100	39,600	39,900
467		Solid Composite	39,400	38,500	39,000
470	Core 33	Solid Composite	33,600	34,100	33,900
471		Solid Composite	35,200	35,100	35,200
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	33,900	34,100	34,000[QC:c]
459		Solid Composite	35,000	35,100	35,100[QC:c]
462	Core 33	Solid Composite	30,900	30,600	30,800
463		Solid Composite	32,200	31,900	32,100

Table B2-45. Tank 241-T-111 Analytical Results: Strontium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	417	419	418
398	33: 1	Homogenized test 1	99.0	110	105
399		Homogenized test 2	104	102	103
402	33: 3	Homogenized test 1	177	176	177
403		Homogenized test 2	177	167	172
404	33: 5	Homogenized test 1	321	333	327
405		Homogenized test 2	320	307	314
408	33: 7	Homogenized test 1	693	420	557[QC:e]
409		Homogenized test 2	321	344	333
410	33: 9	Homogenized test 1	379	375	377
411		Homogenized test 2	368	383	376
449	Core 31	Solid Composite	285	278	282
450		Solid Composite	280	280	280
453	Core 33	Solid Composite	308	301	305
454		Solid Composite	332	337	335
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	298	308	303
467		Solid Composite	291	270	281
470	Core 33	Solid Composite	284	297	291
471		Solid Composite	336	298	317
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	1.48	0.937	1.21[QC:e]
459		Solid Composite	2.29	1.97	2.13
462	Core 33	Solid Composite	2.38	1.97	2.18
463		Solid Composite	2.29	2.39	2.34

Table B2-46. Tank 241-T-111 Analytical Results: Sulfur (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	1,470	1,490	1,480[QC:c]
398	33: 1	Homogenized test 1	751	827	789
399		Homogenized test 2	803	801	802
402	33: 3	Homogenized test 1	739	730	735[QC:b]
403		Homogenized test 2	721	708	715[QC:b]
404	33: 5	Homogenized test 1	1,050	1,090	1,070[QC:b]
405		Homogenized test 2	1,070	1,020	1,050[QC:b]
408	33: 7	Homogenized test 1	1,230	1,220	1,230
409		Homogenized test 2	1,240	1,240	1,240
410	33: 9	Homogenized test 1	1,460	1,410	1,440
411		Homogenized test 2	1,430	1,480	1,460
449	Core 31	Solid Composite	1,240	1,210	1,230
450		Solid Composite	1,270	1,260	1,270
453	Core 33	Solid Composite	1,140	1,140	1,140
454		Solid Composite	1,220	1,220	1,220
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	1,360	1,350	1,360
467		Solid Composite	1,330	1,290	1,310
470	Core 33	Solid Composite	1,080	1,080	1,080
471		Solid Composite	1,160	1,160	1,160
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	1,180	1,210	1,200
459		Solid Composite	1,210	1,190	1,200
462	Core 33	Solid Composite	1,070	1,050	1,060
463		Solid Composite	1,140	1,140	1,140

Table B2-47. Tank 241-T-111 Analytical Results: Tin (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	3.05	5.00	4.03[QC:e]
398	33: 1	Homogenized test 1	26.0	25.5	25.8
399		Homogenized test 2	21.6	18.5	20.1
402	33: 3	Homogenized test 1	8.22	9.52	8.87
403		Homogenized test 2	12.5	10.8	11.7
404	33: 5	Homogenized test 1	13.7	13.9	13.8
405		Homogenized test 2	15.1	15.6	15.4
408	33: 7	Homogenized test 1	25.0	19.5	22.3[QC:e]
409		Homogenized test 2	27.0	26.2	26.6
410	33: 9	Homogenized test 1	21.4	18.9	20.2
411		Homogenized test 2	18.6	23.7	21.2[QC:e]
449	Core 31	Solid Composite	4.13	4.28	4.21
450		Solid Composite	3.13	1.74	2.44[QC:e]
453	Core 33	Solid Composite	1.80	1.81	1.81
454		Solid Composite	< 1.50	1.72	< 1.61
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	< 8.00	8.02	< 8.01
467		Solid Composite	< 7.98	< 7.98	< 7.98
470	Core 33	Solid Composite	< 8.00	< 7.98	< 7.99
471		Solid Composite	< 7.98	< 8.00	< 7.99
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 1.60	< 1.60	< 1.60
459		Solid Composite	< 1.60	< 1.60	< 1.60
462	Core 33	Solid Composite	< 1.60	< 1.60	< 1.60
463		Solid Composite	< 1.60	< 1.60	< 1.60

Table B2-48. Tank 241-T-111 Analytical Results: Titanium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	4.45	4.25	4.35
398	33: 1	Homogenized test 1	69.0	73.7	71.4
399		Homogenized test 2	70.6	69.4	70.0
402	33: 3	Homogenized test 1	4.88	< 0.391	< 2.64
403		Homogenized test 2	0.570	0.524	0.547
404	33: 5	Homogenized test 1	2.00	2.48	2.24[QC:e]
405		Homogenized test 2	1.26	3.08	2.17[QC:e]
408	33: 7	Homogenized test 1	2.55	2.46	2.51
409		Homogenized test 2	2.49	6.73	4.61[QC:e]
410	33: 9	Homogenized test 1	3.27	3.00	3.14
411		Homogenized test 2	3.13	2.92	3.03
449	Core 31	Solid Composite	29.3	29.6	29.5
450		Solid Composite	32.7	33.4	33.1
453	Core 33	Solid Composite	8.80	9.00	8.90
454		Solid Composite	6.50	6.42	6.46
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	72.5	73.2	72.9
467		Solid Composite	73.4	71.3	72.4
470	Core 33	Solid Composite	22.2	22.5	22.4
471		Solid Composite	23.1	25.1	24.1
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.400	< 0.400	< 0.400
459		Solid Composite	< 0.400	< 0.400	< 0.400
462	Core 33	Solid Composite	< 0.399	< 0.399	< 0.399
463		Solid Composite	< 0.400	< 0.399	< 0.400

Table B2-49. Tank 241-T-111 Analytical Results: Vanadium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	1.38	1.52	1.45
398	33: 1	Homogenized test 1	14.7	16.7	15.7
399		Homogenized test 2	17.1	17.1	17.1
402	33: 3	Homogenized test 1	30.0	29.5	29.8
403		Homogenized test 2	35.2	28.8	32.0[QC:e]
404	33: 5	Homogenized test 1	10.3	11.9	11.1
405		Homogenized test 2	18.8	12.3	15.6[QC:e]
408	33: 7	Homogenized test 1	5.25	4.11	4.68[QC:e]
409		Homogenized test 2	4.39	4.97	4.68
410	33: 9	Homogenized test 1	1.30	1.04	1.17[QC:e]
411		Homogenized test 2	1.09	1.42	1.26[QC:e]
449	Core 31	Solid Composite	13.1	12.3	12.7
450		Solid Composite	21.5	21.3	21.4
453	Core 33	Solid Composite	14.2	13.5	13.9
454		Solid Composite	10.4	9.58	9.99
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	13.2	11.1	12.2
467		Solid Composite	17.4	15.5	16.5
470	Core 33	Solid Composite	16.9	13.8	15.4[QC:e]
471		Solid Composite	15.1	14.2	14.7
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.500	< 0.500	< 0.500
459		Solid Composite	0.82	0.594	0.707[QC:e]
462	Core 33	Solid Composite	< 0.499	< 0.499	< 0.499
463		Solid Composite	0.676	0.921	0.799[QC:e]

Table B2-50. Tank 241-T-111 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	21.0	20.4	20.7
398	33: 1	Homogenized test 1	258	285	272
399		Homogenized test 2	267	265	266
402	33: 3	Homogenized test 1	15.5	16.6	16.1
403		Homogenized test 2	17.0	15.0	16.0
404	33: 5	Homogenized test 1	19.6	20.0	19.8
405		Homogenized test 2	19.5	19.7	19.6
408	33: 7	Homogenized test 1	23.2	23.0	23.1
409		Homogenized test 2	23.5	30.4	27.0[QC:e]
410	33: 9	Homogenized test 1	22.7	23.6	23.2
411		Homogenized test 2	21.2	22.1	21.7
449	Core 31	Solid Composite	82.0	76.8	79.4
450		Solid Composite	106	96.8	101
453	Core 33	Solid Composite	44.7	43.6	44.2
454		Solid Composite	35.4	34.5	35.0
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	111	97.1	104
467		Solid Composite	100	111	106
470	Core 33	Solid Composite	100	110	105
471		Solid Composite	119	102	111
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	< 0.300	< 0.300	< 0.300
459		Solid Composite	< 0.300	< 0.300	< 0.300
462	Core 33	Solid Composite	< 0.299	< 0.299	< 0.299
463		Solid Composite	< 0.300	< 0.299	< 0.300

Table B2-51. Tank 241-T-111 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	< 0.800	< 0.800	< 0.800
398	33: 1	Homogenized test 1	1.29	1.26	1.28[QC:c]
399		Homogenized test 2	0.889	0.922	0.906[QC:c]
402	33: 3	Homogenized test 1	< 0.763	0.783	< 0.773[QC:c]
403		Homogenized test 2	1.14	1.05	1.10[QC:c]
404	33: 5	Homogenized test 1	1.07	0.966	1.02[QC:c]
405		Homogenized test 2	1.06	1.18	1.12[QC:c]
408	33: 7	Homogenized test 1	1.21	0.964	1.09[QC:c,e]
409		Homogenized test 2	1.31	1.25	1.28[QC:c]
410	33: 9	Homogenized test 1	1.04	0.964	1.00[QC:c]
411		Homogenized test 2	0.909	1.05	0.980[QC:c]
449	Core 31	Solid Composite	0.847	0.834	0.841[QC:c]
450		Solid Composite	< 0.751	0.807	< 0.779[QC:c]
453	Core 33	Solid Composite	0.920	0.905	0.913
454		Solid Composite	< 0.770	0.861	< 0.816
Solids: fusion digest			μg/g	μg/g	μg/g
466	Core 31	Solid Composite	< 4.00	4.01	< 4.01
467		Solid Composite	< 3.99	< 3.99	< 3.99
470	Core 33	Solid Composite	< 4.00	< 3.99	< 4.00
471		Solid Composite	< 3.99	< 4.00	< 4.00
Solids: water digest			μg/g	μg/g	μg/g
457	Core 31	Solid Composite	< 0.799	< 0.800	< 0.800
459		Solid Composite	< 0.799	< 0.799	< 0.799
462	Core 33	Solid Composite	< 0.798	< 0.798	< 0.798
463		Solid Composite	< 0.799	< 0.798	< 0.799

Table B2-52. Tank 241-T-111 Analytical Results: Mercury (CVAA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
426	Core 31	Solid Composite	1.48	1.70	1.59
427		Solid Composite	1.88	1.79	1.84
430	Core 33	Solid Composite	1.22	1.18	1.20
431		Solid Composite	1.15	1.02	1.09
Solids: acid digest (TCLP)			μg/mL	μg/mL	μg/mL
485	Core 31	Solid Composite	< 0.0440	---	< 0.0440
632		Solid Composite	< 0.0450	< 0.0450	< 0.0450
608	Core 33	Solid Composite	< 0.0310	< 0.0300	< 0.0305

Table B2-53. Tank 241-T-111 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
414	31: 9	Lower 1/2	943	753	848[QC:e]
457	Core 31	Solid Composite	466	473	470
459		Solid Composite	475	518	497
462	Core 33	Solid Composite	362	440	401
463		Solid Composite	423	440	432

Table B2-54. Tank 241-T-111 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	4,770	4,240	4,510
457	Core 31	Solid Composite	3,030	3,140	3,090
459		Solid Composite	3,090	3,160	3,130
462	Core 33	Solid Composite	1,260	1,470	1,370
463		Solid Composite	1,590	1,670	1,630

Table B2-55. Tank 241-T-111 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	61,200	54,800	58,000
457	Core 31	Solid Composite	44,100	44,500	44,300
459		Solid Composite	43,900	43,600	43,800
462	Core 33	Solid Composite	36,100	37,600	36,900
463		Solid Composite	40,300	39,800	40,100

Table B2-56. Tank 241-T-111 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	842	656	749[QC:e]
457	Core 31	Solid Composite	< 1,099	< 1,100	< 1,100
459		Solid Composite	< 1,099	871	< 985
462	Core 33	Solid Composite	704	842	773
463		Solid Composite	704	759	732

Table B2-57. Tank 241-T-111 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	28,800	26,200	27,500
457	Core 31	Solid Composite	16,700	15,600	16,200
459		Solid Composite	17,700	17,100	17,400
462	Core 33	Solid Composite	13,500	13,600	13,600
463		Solid Composite	15,000	15,100	15,100

Table B2-58. Tank 241-T-111 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
414	31: 9	Lower 1/2	5,510	4,720	5,120
457	Core 31	Solid Composite	3,690	3,690	3,690
459		Solid Composite	3,750	3,720	3,740
462	Core 33	Solid Composite	3,340	3,230	3,290
463		Solid Composite	3,520	3,410	3,470

Table B2-59. Tank 241-T-111 Analytical Results: Nitrite (Spectrophotometric).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
457	Core 31	Solid Composite	955	949	952
459		Solid Composite	527	522	525
462	Core 33	Solid Composite	884	872	878
463		Solid Composite	860	774	817

Table B2-60. Tank 241-T-111 Analytical Results: Total Inorganic Carbon (CO_3).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
92-05856-J1	33: 2	Whole	990	1,130	1,060
457	Core 31	Solid Composite	650	< 500	< 575
459		Solid Composite	999	649	824[QC:e]
426	Core 33	Solid Composite	898	749	824
463		Solid Composite	1,400	799	1,100[QC:e]

Table B2-61. Tank 241-T-111 Analytical Results: Total Organic Carbon (Furnace Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
92-05856-J1	33:-2	Whole	3,440	3,480	3,460
457	Core 31	Solid Composite	3,680	3,300	3,490
459		Solid Composite	3,850	4,120	3,990
462	Core 33	Solid Composite	2,000	2,000	2,000
463		Solid Composite	3,000	3,000	3,000

Table B2-62. Tank 241-T-111 Analytical Results: EOX (Extractable Organic Halides).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-F1	Core 31	Solid Composite	5.0	n/d	< 5.0[QC:f]
92-08279-F1		Solid Composite	n/d	0.4	< 0.4[QC:f]
92-08283-F1	Core 33	Solid Composite	1.0	n/d	< 1.0[QC:f]

Note:

n/d = not detected

Table B2-63. Tank 241-T-111 Analytical Results: Acetone (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	6.9	27	17[QC:f]
92-05843-M1	31: 3	Whole	5.8	5.4	5.6[QC:f]
92-05844-M1	31: 5	Whole	4.9	2.7	3.8[QC:f]
92-05845-M1	31: 7	Whole	4.6	3.8	4.2[QC:f]
92-05846-M1	31: 9	Upper 1/2	2.5	1.9	2.2[QC:f]
92-05848-M1	33: 1	Whole	9.5	11	10[QC:f]
92-05849-M1	33: 3	Whole	n/d	1.5	< 1.5[QC:f]
92-05850-M1	33: 5	Whole	6.5	2.1	4.3[QC:f]
92-05851-M1	33: 7	Whole	14	4.1	9.1[QC:f]
92-05852-M1	33: 9	Whole	n/d	3	< 3.0[QC:f]

Notes:

n/d = not detected

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-64. Tank 241-T-111 Analytical Results: 2-Butanone (VOA).[1] (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	2.8	27	15[QC:f]
92-5843-M1	31: 3	Whole	< 4.4	< 3.7	< 4.05
92-05844-M1	31: 5	Whole	< 3.3	< 2.3	< 2.8
92-05845-M1	31: 7	Whole	< 2.7	< 2.3	< 2.5
92-5846-M1	31: 9	Upper 1/2	< 3.3	< 2.6	< 2.95
92-05848-M1	33: 1	Whole	1.6	n/d	< 1.6
92-05849-M1	33: 3	Whole	n/d	5.9	< 5.9[QC:f]
92-05850-M1	33: 5	Whole	3.2	4.0	3.6[QC:f]

Table B2-64. Tank 241-T-111 Analytical Results: 2-Butanone (VOA).[1] (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
92-05851-M1	33: 7	Whole	< 28	< 3.8	< 15.9
92-05852-M1	33: 9	Whole	< 2.7	< 3.8	< 3.25

Notes:
n/d = not detected

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-65. Tank 241-T-111 Analytical Results: Chloromethane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
92-05842-M1	31: 1	Whole	< 4.0	< 43	< 23.5
92-5843-M1	31: 3	Whole	< 4.4	< 3.7	< 4.1
92-05844-M1	31: 5	Whole	< 3.3	< 2.3	< 2.8
92-05845-M1	31: 7	Whole	< 2.7	< 2.3	< 2.5
92-5846-M1	31: 9	Upper 1/2	< 3.3	< 2.6	< 3.0
92-05848-M1	33: 1	Whole	n/d	0.36	< 0.36
92-5849-M1	33: 3	Whole	< 4.4	< 6.7	< 5.6
92-5850-M1	33: 5	Whole	< 3.2	< 4.2	< 3.7
92-05851-M1	33: 7	Whole	6.6	1.8	4.2
92-05852-M1	33: 9	Whole	0.39	0.20	0.30

Notes:
n/d = not detected

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-66. Tank 241-T-111 Analytical Results: Decahydronaphthalene (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	3.9	n/d	< 3.9
92-05843-M1	31: 3	Whole	8.7	7.5	8.1
92-05848-M1	33: 1	Whole	5.0	4.5	4.8

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-67. Tank 241-T-111 Analytical Results: Decane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	16	n/d	< 16
92-05843-M1	31: 3	Whole	29	23	26
92-05848-M1	33: 1	Whole	27	26	27
92-05849-M1	33: 3	Whole	3.1	3.9	3.5
92-05851-M1	33: 7	Whole	n/d	1.9	< 1.9

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-68. Tank 241-T-111 Analytical Results: Dodecane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	40	27	34
92-05843-M1	31: 3	Whole	49	24	37
92-05844-M1	31: 5	Whole	16	11	14
Solids			µg/g	µg/g	µg/g
92-05845-M1	31: 7	Whole	5.8	7.0	6.4
92-05846-M1	31: 9	Upper 1/2	7.6	9.8	8.7
92-05848-M1	33: 1	Whole	11	11	11
92-05849-M1	33: 3	Whole	19	40	30
92-05850-M1	33: 5	Whole	26	63	45
92-05851-M1	33: 7	Whole	30	16	23
92-05852-M1	33: 9	Whole	12	8.0	10

Note:

[1]Tentatively identified compound based on best match to mass spectral data base; compound may or may not actually exist in tank waste.

Table B2-69. Tank 241-T-111 Analytical Results: Nonane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	4.0	n/d	< 4.0
92-05843-M1	31: 3	Whole	n/d	6.1	< 6.1

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral data base; compound may or may not actually exist in tank waste.

Table B2-70. Tank 241-T-111 Analytical Results: Tetrachloroethene (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	< 2	< 22	< 12
92-5843-M1	31: 3	Whole	< 2.2	< 1.9	< 2.1
92-05844-M1	31: 5	Whole	< 1.6	< 1.2	< 1.4
92-05845-M1	31: 7	Whole	< 1.3	< 1.2	< 1.3
92-5846-M1	31: 9	Upper 1/2	< 1.6	< 1.3	< 1.5
92-05848-M1	33: 1	Whole	0.35	0.27	0.31
92-5849-M1	33: 3	Whole	< 2.2	< 3.3	< 2.8
92-5850-M1	33: 5	Whole	< 1.6	< 2.1	< 1.9
92-05851-M1	33: 7	Whole	< 14	< 1.9	< 8.0
92-05852-M1	33: 9	Whole	< 1.3	< 1.9	< 1.6

Note:

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-71. Tank 241-T-111 Analytical Results: Tetradecane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05846-M1	31: 9	Upper 1/2	2.1	n/d	< 2.1
92-05849-M1	33: 3	Whole	n/d	4.6	< 4.6
92-05850-M1	33: 5	Whole	6.0	23	15

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-72. Tank 241-T-111 Analytical Results: Toluene (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	0.70	n/d	< 0.70
92-05843-M1	31: 3	Whole	26	27	27
92-05844-M1	31: 5	Whole	< 1.6	< 1.2	< 1.4
92-05845-M1	31: 7	Whole	< 1.3	< 1.2	< 1.3
92-5846-M1	31: 9	Upper 1/2	< 1.6	< 1.3	< 1.5
92-05848-M1	33: 1	Whole	0.51	0.43	0.47
92-5849-M1	33: 3	Whole	< 2.2	< 3.3	< 2.8
92-5850-M1	33: 5	Whole	< 1.6	< 2.1	< 1.9
92-05851-M1	33: 7	Whole	< 14	< 1.9	< 8.0
92-05852-M1	33: 9	Whole	< 1.3	< 1.9	< 1.6

Notes:

n/d = not detected

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-73. Tank 241-T-111 Analytical Results: 1,1,1-Trichloroethane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
92-05842-M1	31: 1	Whole	0.57	n/d	< 0.57
92-5843-M1	31: 3	Whole	< 2.2	< 1.9	< 2.1
92-05844-M1	31: 5	Whole	< 1.6	< 1.2	< 1.4
92-05845-M1	31: 7	Whole	< 1.3	< 1.2	< 1.3
92-5846-M1	31: 9	Upper 1/2	< 1.6	< 1.3	< 1.5
92-05848-M1	33: 1	Whole	0.39	0.23	0.31
92-5849-M1	33: 3	Whole	< 2.2	< 3.3	< 2.8
Solids			μg/g	μg/g	μg/g
92-5850-M1	33: 5	Whole	< 1.6	< 2.1	< 1.9
92-05851-M1	33: 7	Whole	n/d	0.59	< 0.59
92-05852-M1	33: 9	Whole	< 1.3	< 1.9	< 1.6

Notes:

n/d = not detected

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-74. Tank 241-T-111 Analytical Results: Tridecane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	28	30	29
92-05843-M1	31: 3	Whole	48	24	36
92-05844-M1	31: 5	Whole	4.5	4.2	4.4
92-05845-M1	31: 7	Whole	3.0	4.0	3.5
92-05846-M1	31: 9	Upper 1/2	6.6	5.5	6.1
92-05848-M1	33: 1	Whole	n/d	13	< 13
92-05849-M1	33: 3	Whole	8.6	26	17
92-05850-M1	33: 5	Whole	25	85	55
92-05851-M1	33: 7	Whole	27	5.7	16
92-05852-M1	33: 9	Whole	5.2	2.7	4.0

Notes:
n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-75. Tank 241-T-111 Analytical Results: Undecane (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	20	n/d	< 20
92-05843-M1	31: 3	Whole	53	25	39
92-05848-M1	33: 1	Whole	30	29	30

Notes:
n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-76. Tank 241-T-111 Analytical Results: Xylenes (Total) (VOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-05842-M1	31: 1	Whole	< 2	< 22	< 12
92-05843-M1	31: 3	Whole	0.51	0.70	0.61
92-05844-M1	31: 5	Whole	< 1.6	< 1.2	< 1.4
92-05845-M1	31: 7	Whole	< 1.3	< 1.2	< 1.3
92-5846-M1	31: 9	Upper 1/2	< 1.6	< 1.3	< 1.5
92-05848-M1	33: 1	Whole	0.96	0.82	0.89
92-5849-M1	33: 3	Whole	< 2.2	< 3.3	< 2.8
92-5850-M1	33: 5	Whole	< 1.6	< 2.1	< 1.9
92-05851-M1	33: 7	Whole	< 14	< 1.9	< 8.0
92-05852-M1	33: 9	Whole	< 1.3	< 1.9	< 1.6

Note:

[1]U.S. EPA Contract Laboratory Program target compound.

Table B2-77. Tank 241-T-111 Analytical Results: Decane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	n/d	9.9	< 9.9
92-08279-E1		Solid Composite	8.2	9.2	8.7

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-78. Tank 241-T-111 Analytical Results: Dodecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	51	170	111
92-08279-E1		Solid Composite	150	160	160
92-08281-E1	Core 33	Solid Composite	130	110	120
92-08283-E1		Solid Composite	140	130	140

Note:

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-79. Tank 241-T-111 Analytical Results: Heptadecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	n/d	14	< 14
92-08279-E1		Solid Composite	14	15	15

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-80. Tank 241-T-111 Analytical Results: Hexadecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	n/d	16	< 16
92-08279-E1		Solid Composite	16	16	16

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-81. Tank 241-T-111 Analytical Results: Hexadecanoic acid (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	n/d	32	< 32
92-08279-E1		Solid Composite	12	8.6	10

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-82. Tank 241-T-111 Analytical Results: Pentadecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	9.3	31	20
92-08279-E1		Solid Composite	28	30	29
92-08281-E1	Core 33	Solid Composite	13	12	13
92-08283-E1		Solid Composite	15	13	14

Note:

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-83. Tank 241-T-111 Analytical Results: Tetradecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	100	320	210
92-08279-E1		Solid Composite	290	310	300
92-08281-E1	Core 33	Solid Composite	290	250	270
92-08283-E1		Solid Composite	290	250	270

Note:

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-84. Tank 241-T-111 Analytical Results: Tridecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	140	460	300
92-08279-E1		Solid Composite	400	410	410
92-08281-E1	Core 33	Solid Composite	390	330	360
92-08283-E1		Solid Composite	390	350	370

Note:

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-85. Tank 241-T-111 Analytical Results: Undecane (SVOA).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
92-08277-E1	Core 31	Solid Composite	n/d	16	< 16
92-08279-E1		Solid Composite	13	14	14

Notes:

n/d = not detected

[1]Tentatively identified compound based on best match to mass spectral database; compound may or may not actually exist in tank waste.

Table B2-86. Tank 241-T-111 Analytical Results: Americium-241 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.136	0.136	0.136
399		Homogenized test 2	0.140	0.139	0.140
402	33: 3	Homogenized test 1	0.0141	0.0140	0.0141
403		Homogenized test 2	0.0136	0.0140	0.0138
404	33: 5	Homogenized test 1	0.0210	0.0200	0.0205
405		Homogenized test 2	0.0210	0.0200	0.0205
408	33: 7	Homogenized test 1	0.0136	0.0136	0.0136
409		Homogenized test 2	0.0141	0.0131	0.0136
410	33: 9	Homogenized test 1	0.0506	0.0498	0.0502
411		Homogenized test 2	0.0498	0.0511	0.0505
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	0.0288	0.0284	0.0286
466	Core 31	Solid Composite	0.0480	0.0437	0.0459
467		Solid Composite	0.0416	0.0402	0.0409
470	Core 33	Solid Composite	0.0379	0.0395	0.0387
471		Solid Composite	0.0461	0.0424	0.0443

Table B2-87. Tank 241-T-111 Analytical Results: Cesium-137 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.406	0.407	0.407
399		Homogenized test 2	0.396	0.400	0.398
402	33: 3	Homogenized test 1	0.137	0.137	0.137
403		Homogenized test 2	0.145	0.139	0.142
404	33: 5	Homogenized test 1	0.0880	0.0880	0.0880
405		Homogenized test 2	0.0910	0.0860	0.0885
408	33: 7	Homogenized test 1	0.0234	0.0230	0.0232
409		Homogenized test 2	0.0243	0.0229	0.0236
410	33: 9	Homogenized test 1	0.0135	0.0134	0.0135
411		Homogenized test 2	0.0132	0.0138	0.0135
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	0.0103	0.00972	0.0100
466	Core 31	Solid Composite	0.211	0.212	0.212
467		Solid Composite	0.238	0.236	0.237
470	Core 33	Solid Composite	0.112	0.115	0.114
471		Solid Composite	0.104	0.103	0.104

Table B2-88. Tank 241-T-111 Analytical Results: Cobalt-60 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.00632	0.00586	0.00609
399		Homogenized test 2	0.00516	0.00513	0.00515
402	33: 3	Homogenized test 1	4.60E-04	< 7.30E-05	< 2.67E-04
403		Homogenized test 2	6.40E-04	< 4.40E-04	< 5.40E-04
404	33: 5	Homogenized test 1	< 9.50E-05	< 8.40E-05	< 8.95E-05
405		Homogenized test 2	< 9.10E-05	< 1.10E-04	< 1.01E-04[QC:a]
408	33: 7	Homogenized test 1	4.43E-04	< 8.30E-05	< 2.63E-04
409		Homogenized test 2	5.80E-04	< 3.60E-04	< 4.70E-04
410	33: 9	Homogenized test 1	< 9.80E-05	< 8.10E-05	< 8.95E-05
411		Homogenized test 2	< 8.00E-05	< 8.90E-05	< 8.45E-05
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	< 8.70E-05	< 7.60E-05	< 8.15E-05
466	Core 31	Solid Composite	< 3.39E-04	< 4.21E-04	< 3.80E-04
467		Solid Composite	< 3.75E-04	< 3.85E-04	< 3.80E-04
470	Core 33	Solid Composite	< 3.70E-04	< 3.45E-04	< 3.58E-04
471		Solid Composite	< 3.45E-04	< 3.29E-04	< 3.37E-04

Table B2-89. Tank 241-T-111 Analytical Results: Europium-154 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.0213	0.0217	0.0215
399		Homogenized test 2	0.0209	0.0213	0.0211
402	33: 3	Homogenized test 1	8.60E-04	8.70E-04	8.65E-04
403		Homogenized test 2	9.85E-04	< 3.10E-04	< 6.48E-04
404	33: 5	Homogenized test 1	< 3.20E-04	< 2.50E-04	< 2.85E-04
405		Homogenized test 2	< 3.10E-04	< 3.10E-04	< 3.10E-04
408	33: 7	Homogenized test 1	< 3.60E-04	< 2.90E-04	< 3.25E-04
409		Homogenized test 2	< 3.30E-04	< 3.10E-04	< 3.20E-04
410	33: 9	Homogenized test 1	< 2.82E-04	8.45E-04	< 5.64E-04
411		Homogenized test 2	< 2.47E-04	< 2.47E-04	< 2.47E-04
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	< 2.48E-04	< 2.22E-04	< 2.35E-04
466	Core 31	Solid Composite	0.00107	0.00109	0.00108
467		Solid Composite	0.00324	< 0.00106	< 0.00215
470	Core 33	Solid Composite	< 0.00101	< 0.00111	< 0.00106
471		Solid Composite	< 9.64E-04	< 0.00105	< 0.00101

Table B2-90. Tank 241-T-111 Analytical Results: Europium-155 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.0276	0.0271	0.0274
399		Homogenized test 2	0.0273	0.0265	0.0269
402	33: 3	Homogenized test 1	0.00160	0.00160	0.00160
403		Homogenized test 2	0.00300	< 0.00190	< 0.00245
Solids: acid digest			µCi/g	µCi/g	µCi/g
404	33: 5	Homogenized test 1	< 5.10E-04	< 4.70E-04	< 4.90E-04
405		Homogenized test 2	< 5.20E-04	< 5.20E-04	< 5.20E-04
408	33: 7	Homogenized test 1	< 3.50E-04	< 2.80E-04	< 3.15E-04
409		Homogenized test 2	< 3.30E-04	< 3.29E-04	< 3.30E-04
410	33: 9	Homogenized test 1	< 2.87E-04	< 2.82E-04	< 2.85E-04
411		Homogenized test 2	< 2.67E-04	< 2.67E-04	< 2.67E-04
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	< 2.16E-04	< 1.89E-04	< 2.03E-04
466	Core 31	Solid Composite	< 0.00209	< 0.00208	< 0.00209
467		Solid Composite	< 0.00212	< 0.00213	< 0.00213
470	Core 33	Solid Composite	0.00316	0.00297	0.00307
471		Solid Composite	< 0.00149	< 0.00149	< 0.00149

Table B2-91. Tank 241-T-111 Analytical Results: Nickel-59 (Ni).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µCi/g	µCi/g	µCi/g
92-08278-H1	Core 31	Solid Composite	7.16E-05	9.43E-05	8.30E-05[QC:e]
92-08280-H1		Solid Composite	6.53E-05	3.33E-05	4.93E-05[QC:e]
92-08282-H1	Core 33	Solid Composite	4.74E-05	4.14E-05	4.44E-05
92-08284-H1		Solid Composite	3.76E-05	4.37E-05	4.07E-05

Note:

[1]Analysis date approximately October 9, 1992.

Table B2-92. Tank 241-T-111 Analytical Results: Americium-241 (Alpha Spec).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
466	Core 31	Solid Composite	0.0385	0.0443	0.0414
467		Solid Composite	0.0396	0.0466	0.0431
470	Core 33	Solid Composite	0.0394	0.0371	0.0383
471		Solid Composite	0.0511	0.0444	0.0478

Table B2-93. Tank 241-T-111 Analytical Results: Plutonium-239/40 (Alpha Spec).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
466	Core 31	Solid Composite	0.141	0.135	0.138
467		Solid Composite	0.137	0.134	0.136
470	Core 33	Solid Composite	0.129	0.139	0.134
471		Solid Composite	0.142	0.153	0.148

Table B2-94. Tank 241-T-111 Analytical Results: Nickel-63 (Liq. Scin.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µCi/g	µCi/g	µCi/g
92-08278-H1	Core 31	Solid Composite	0.00734	0.0113	0.00932[QC:e]
92-08280-H1		Solid Composite	0.00732	0.00358	0.00545[QC:e]
92-08282-H1	Core 33	Solid Composite	0.00636	0.00454	0.00545[QC:e]
92-08284-H1		Solid Composite	0.00426	0.00492	0.00459

Note:
[1]Analysis date approximately October 9, 1992

Table B2-95. Tank 241-T-111 Analytical Results: Technetium-99 (Liq. Scin.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
466	Core 31	Solid Composite	0.00533	0.00495	0.00514[QC:b]
467		Solid Composite	0.00456	0.00490	0.00473[QC:b]
470	Core 33	Solid Composite	0.0116	0.0112	0.0114
471		Solid Composite	0.0105	0.0103	0.0104

Table B2-96. Tank 241-T-111 Analytical Results: Total Uranium (LF).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µg/g	µg/g	µg/g
466	Core 31	Solid Composite	2,210	2,140	2,175
467		Solid Composite	3,750	4,000	3,875
92-08278-H1		Solid Composite	3,580	4,390	3,990[QC:e]
92-08280-H1		Solid Composite	7,020	3,300	5,160[QC:e]
470	Core 33	Solid Composite	3,340	3,010	3,175[QC:e]
471		Solid Composite	1,820	2,070	1,945[QC:e]
92-08282-H1		Solid Composite	4,760	4,160	4,460
92-08284-H1		Solid Composite	3,300	3,670	3,490

Table B2-97. Tank 241-T-111 Analytical Results: Total Alpha (from Pu) (Alpha Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
92-08278-H1	Core 31	Solid Composite	0.422	0.814	0.618[QC:e]
92-08280-H1		Solid Composite	0.781	0.348	0.565[QC:e]
92-08282-H1	Core 33	Solid Composite	0.208	0.430	0.319[QC:e]
92-08284-H1		Solid Composite	0.209	0.527	0.368[QC:e]

Note:

[1]Analysis date July 31, 1992

Table B2-98. Tank 241-T-111 Analytical Results: Total Alpha (Alpha Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
414	31: 9	Lower 1/2	0.153	0.183	0.168[QC:b]
466	Core 31	Solid Composite	0.358	0.359	0.359
467		Solid Composite	0.369	0.350	0.360
470	Core 33	Solid Composite	0.376	0.378	0.377
471		Solid Composite	0.397	0.397	0.397

Table B2-99. Tank 241-T-111 Analytical Results: Total Alpha (Alpha Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µCi/g	µCi/g	µCi/g
398	33: 1	Homogenized test 1	0.623	0.672	0.648
399		Homogenized test 2	0.670	0.632	0.651
402	33: 3	Homogenized test 1	0.197	0.205	0.201
403		Homogenized test 2	0.129	0.133	0.131
404	33: 5	Homogenized test 1	0.551	0.560	0.556
405		Homogenized test 2	0.468	0.528	0.498
408	33: 7	Homogenized test 1	0.305	0.328	0.317
409		Homogenized test 2	0.319	0.448	0.384[QC:e]
410	33: 9	Homogenized test 1	0.275	0.235	0.255
411		Homogenized test 2	0.270	0.267	0.269

Table B2-100. Tank 241-T-111 Analytical Results: Total Beta (Beta).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
466	Core 31	Solid Composite	20.7	20.4	20.6
467		Solid Composite	21.3	21.6	21.5
470	Core 33	Solid Composite	9.32	9.86	9.59
471		Solid Composite	8.71	8.95	8.83

Table B2-101. Tank 241-T-111 Analytical Results: Strontium-90 (Beta).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			µCi/g	µCi/g	µCi/g
466	Core 31	Solid Composite	7.34	6.97	7.155[QC:a]
467		Solid Composite	7.31	7.55	7.43[QC:a]
470	Core 33	Solid Composite	3.62	3.67	3.645
471		Solid Composite	3.48	3.37	3.425

Table B2-102. Tank 241-T-111 Analytical Results: U-234 to U mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.0045	0.0122	0.0084
92-08280-H1		Solid Composite	0.0072	0.0062	0.0067
92-08282-H1	Core 33	Solid Composite	0.0062	0.0053	0.0058
92-08284-H1		Solid Composite	0.0058	0.0059	0.0059

Note:
[1]Analysis date August 19, 1992

Table B2-103. Tank 241-T-111 Analytical Results: U-235 to U mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.6698	0.6811	0.6755
92-08280-H1		Solid Composite	0.6760	0.6762	0.6761
92-08282-H1	Core 33	Solid Composite	0.6817	0.6705	0.6761
92-08284-H1		Solid Composite	0.6664	0.6770	0.6717

Note:
[1]Analysis date August 19, 1992

Table B2-104. Tank 241-T-111 Analytical Results: U-236 to U mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.0062	0.0115	0.0089
92-08280-H1		Solid Composite	0.0071	0.0077	0.0074
92-08282-H1	Core 33	Solid Composite	0.0070	0.0044	0.0057
92-08284-H1		Solid Composite	0.0059	0.0067	0.0063

Note:
[1]Analysis date August 19, 1992

Table B2-105. Tank 241-T-111 Analytical Results: U-238 to U mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	99.3195	99.2952	99.3073
92-08280-H1		Solid Composite	99.3097	99.3099	99.3098
92-08282-H1	Core 33	Solid Composite	99.3051	99.3198	99.3124
92-08284-H1		Solid Composite	99.3219	99.3103	99.3161

Note:
[1]Analysis date August 19, 1992

Table B2-106. Tank 241-T-111 Analytical Results: Pu-238 to Pu mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.005	0.005	0.005
92-08280-H1		Solid Composite	0.016	0.005	0.011
92-08282-H1	Core 33	Solid Composite	0.004	0.004	0.004
92-08284-H1		Solid Composite	0.017	0.004	0.011

Note:
[1]Analysis date August 20, 1992

Table B2-107. Tank 241-T-111 Analytical Results: Pu-239 to Pu mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	96.6924	96.7474	96.7199
92-08280-H1		Solid Composite	96.5344	96.7358	96.6351
92-08282-H1	Core 33	Solid Composite	96.747	96.7609	96.7540
92-08284-H1		Solid Composite	96.4481	96.6516	96.5498

Note:
[1]Analysis date August 20, 1992

Table B2-108. Tank 241-T-111 Analytical Results: Pu-240 to Pu mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	3.2238	3.198	3.2109
92-08280-H1		Solid Composite	3.347	3.2197	3.2834
92-08282-H1	Core 33	Solid Composite	3.0688	3.1403	3.1046
92-08284-H1		Solid Composite	3.4006	3.2866	3.3436

Note:
[1]Analysis date August 20, 1992

Table B2-109. Tank 241-T-111 Analytical Results: Pu-241 to Pu mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.0373	0.0331	0.0352
92-08280-H1		Solid Composite	0.0658	0.0334	0.0496
92-08282-H1	Core 33	Solid Composite	0.1275	0.0867	0.1071
92-08284-H1		Solid Composite	0.0840	0.0401	0.0621

Note:
[1]Analysis date August 20, 1992

Table B2-110. Tank 241-T-111 Analytical Results: Pu-242 to Pu mass percent (Mass Spec.).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion digest			mass %	mass %	mass %
92-08278-H1	Core 31	Solid Composite	0.0136	0.0165	0.0151
92-08280-H1		Solid Composite	0.0369	0.0061	0.0215
92-08282-H1	Core 33	Solid Composite	0.0524	0.0841	0.0683
92-08284-H1		Solid Composite	0.0501	0.0172	0.0337

Note:

[1]Analysis date August 20, 1992

Table B2-111. Tank 241-T-111 Analytical Results: Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
None	31: 2	Whole	0.99	---	0.99
92-05853		Whole	1.19	1.20	1.20
None	31: 8	Whole	1.0358	---	1.0358
92-05855		Whole	1.28	---	1.28
None	31: 9	Whole	1.13	---	1.13
None	33: 2	Whole	1.16	---	1.16
None	33: 4	Whole	1.35	---	1.35
None	33: 5	Whole	1.11	---	1.11
None	33: 6	Whole	1.21	---	1.21
None	33: 7	Whole	1.09	---	1.09
None	33: 8	Whole	1.11	---	1.11
None	33: 9	Whole	1.06	---	1.06

Table B2-112. Tank 241-T-111 Analytical Results: Weight Percent Solids (Percent Solids).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Wt %	Wt %	Wt %
92-08278-K1	Core 31	Solid Composite	29.85	31.92	30.89
92-08280-K1		Solid Composite	31.11	35.61	33.36
92-05856-K1	33: 2	Whole	20.11	19.83	19.97
92-08282-K1	Core 33	Solid Composite	29.81	30.17	29.99
92-08284-K1		Solid Composite	25.73	26.91	26.32

Table B2-113. Tank 241-T-111 Analytical Results: Centrifuged Solids Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
92-05853	31: 2	Whole	1.25	1.19	1.22
92-05855	31: 8	Whole	1.35	1.33	1.34

Table B2-114. Tank 241-T-111 Analytical Results: Centrifuged Supernatant Density (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
92-05853	31: 2	Whole	1.05	1.09	1.07
92-05855	31: 8	Whole	1.09	1.11	1.10

Table B2-115. Tank 241-T-111 Analytical Results: Volume Percent Centrifuged Solids (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Vol %	Vol %	Vol %
92-05853	31: 2	Whole	62.8	68.8	65.8
92-05855	31: 8	Whole	71.0	72.8	71.9

Table B2-116. Tank 241-T-111 Analytical Results: Volume Percent Settled Solids (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Vol %	Vol %	Vol %
92-05853	31: 2	Whole	100	100	100
92-05855	31: 8	Whole	100	100	100

Table B2-117. Tank 241-T-111 Analytical Results: Weight Percent Centrifuged Solids (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Wt %	Wt %	Wt %
92-05853	31: 2	Whole	66.3	68.3	67.3
92-05855	31: 8	Whole	75.1	75.9	75.5

Table B2-118. Tank 241-T-111 Analytical Results: Weight Percent Solids (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Wt %	Wt %	Wt %
92-05853	31: 2	Whole	22.3	22.5	22.4
92-05855	31: 8	Whole	29.2	29.3	29.3

Table B2-119. Tank 241-T-111 Analytical Results: Weight Percent Undissolved Solids (Physical Properties).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			Wt %	Wt %	Wt %
92-05853	31: 2	Whole	18.8	19.1	19.0
92-05855	31: 8	Whole	25.2	25.5	25.4

Table B2-120. Tank 241-T-111 Analytical Results: pH Measurement (pH).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			unitless	unitless	unitless
457	Core 31	Solid Composite	10.17	10.19	10.18
459		Solid Composite	9.94	9.91	9.925
462	Core 33	Solid Composite	10.04	10.05	10.045
463		Solid Composite	9.81	9.72	9.765

Table B2-121. Tank 241-T-111 Analytical Results: Percent Water (Gravimetric).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
309	31: 1	Whole	80.8	79.8	80.3
310	31: 2	Whole	82.4	52.6	67.5[QC:e]
311	31: 3	Whole	87.2	97.3	92.25
312	31: 4	Whole	72.3	59.6	65.95
313	31: 5	Whole	78.4	88.4	83.4
316	31: 7	Whole	76.4	77.2	76.8
317	31: 8	Whole	76.7	76.4	76.55
318	31: 9	Upper 1/2	76.9	74.7	75.8
414		Lower 1/2	69.5	71.2	70.35
319	33: 1	Whole	81.1	79.6	80.35
323	33: 2	Whole	85.6	85.8	85.7
324	33: 3	Whole	81.7	---	81.7
325	33: 4	Whole	80.4	79.3	79.85
326	33: 5	Whole	79.3	77.0	78.15
329	33: 6	Whole	78.3	78.6	78.45
330	33: 7	Whole	74.7	68.6	71.65
331	33: 8	Whole	75.4	---	75.4
332	33: 9	Whole	77.0	74.9	75.95
416/417	Core 31	Solid Composite	74.4	74.8	74.6
418/419		Solid Composite	75.9	75.9	75.9
420	Core 33	Solid Composite	75.7	77.2	76.45
422		Solid Composite	76.4	77.8	77.1

Table B2-122. Tank 241-T-111 Analytical Results: Percent Water (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
309	31: 1	Whole	87	86.9	86.95
310	31: 2	Whole	87	---	87
311	31: 3	Whole	85	---	85
312	31: 4	Whole	82.8	---	82.8
313	31: 5	Whole	88	---	88
316	31: 7	Whole	85.1	84.4	84.75
317	31: 8	Whole	85.6	---	85.6
318	31: 9	Upper 1/2	71	---	71
414		Lower 1/2	72.1	72	72.05
319	33: 1	Whole	77.8	---	77.8
323	33: 2	Whole	80.5	80.6	80.55
324	33: 3	Whole	88.5	---	88.5
325	33: 4	Whole	89.5	---	89.5
326	33: 5	Whole	88.8	---	88.8
329	33: 6	Whole	84.7	84	84.35
330	33: 7	Whole	85.8	---	85.8
331	33: 8	Whole	84.8	---	84.8
332	33: 9	Whole	85.2	---	85.2
433	Core 31	Solid Composite	85.3	61.3	73.3[QC:e]
434		Solid Composite	71.2	69.2	70.2
436	Core 33	Solid Composite	82.2	81	81.6
437		Solid Composite	83	78.6	80.8

B2.2 1994 GRAB SAMPLE

B2.2.1 Description of the 1994 Grab Sampling Event

Grab samples were obtained on March 5, 1994 (Sutey 1994). Three 100 mL supernatant samples were retrieved from riser #13 (salt well screen) in accordance with waste compatibility program requirements (WHC 1994b). The compatibility samples were taken for emergency pumping of tank 241-T-111 to tank 241-SY-102.

B2.2.2 Analytical Results

The samples were sent to the 222-S laboratory for analysis on March 25, 1994. A summary of analytical results is presented in Table B2-123. Quality control analyses for the three grab samples were not conducted.

B2.3 1995 VAPOR SAMPLING

B2.3.1 Description of 1995 Vapor Sampling Event

Vapor sampling to support the vapor DQO (Osborne et al. 1995) was performed on January 20, 1995 using the vapor sampling system (VSS). Air from the tank 241-T-111 headspace was withdrawn via a 6.1 m (20 ft)-long heated sampling probe mounted in riser 3, and transferred through heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 50 °C (120 °F) (Huckaby and Bratzel 1995).

Samples were collected in SUMMA[3] canisters or various types of sorbent traps. Samples collected in a triple sorbent trap device were analyzed by Oak Ridge National Laboratories (ORNL) for organic vapors. Pacific Northwest National Laboratory analyzed both SUMMA™ and sorbent trap devices for inorganic and organic vapors. Due to differences in documenting quality assurance measures between ORNL and PNNL, PNNL SUMMA™ sample results should be considered the primary organic vapor data for tank 241-T-111.

Detailed descriptions of the sampling event are reported in *Vapor and Gas Sampling of Single-Shell Tank 241-T-111 Using the Vapor Sampling System* (Caprio 1995).

[3]SUMMA is a trademark of Molectric, Cleveland, Ohio.

Table B2-123. Tank 241-T-111 1994 Grab Sample Results.

Sample No.	T546	T548	T550
Depth (cm)	666	264	274
Appearance	Yellow, Clear < 1% solids	Yellow, Clear < 1% solids	Yellow, Clear < 1% solids
SpG	1.04	1.04	1.03
DSC	no exotherms	no exotherms	no exotherms
TGA (% H_20)	91.2	91.7	90.2
pH	11.6	11.6	11.8
Gravimetric (% H_20)	92.7	92.9	92.9
Total Beta (μCi/mL)	0.221	0.231	0.248
Total Alpha (μCi/mL)	0.0023	0.0023	0.0025
TOC (μg C/mL)	473	418	380
TIC (μg C/mL)	800	790	407
NH_4 (μg/mL)	361	370	522
OH (μg/mL)	3,540	2,700	2,890
^{137}Cs (μCi/mL)	0.0896	0.092	0.088
Na (μg/mL)	24,000	24,300	26,000
Al (μg/mL)	<5.05	<5.05	<5.05
Fe (μg/mL)	<5.05	<5.05	<5.05
Cr (μg/mL)	222	232	248
K (μg/mL)	858	858	864
F (μg/mL)	1,960	2,160	2,188
Cl (μg/mL)	477	498	512
NO_2 (μg/mL)	1,335	1,378	1,407
NO_3 (μg/mL)	29,100	30,010	31,670
PO_4 (μg/mL)	8,066	8,248	8,840
SO_4 (μg/mL)	2,782	2,852	3,146
CN (μg/mL)	2.71	1.84	2.39
$^{239/240}$Pu (μCi/mL)	9.99E-05	8.08E-05	2.43E-05
^{241}Am (μCi/mL)	<3.97E-05	<2.76E-05	<2.81E-05
^{237}Np (μCi/mL)	<1.38E-05	<2.89E-05	<2.68E-05
^{90}Sr (μCi/mL)	7.09E-04	2.10E-04	1.21E-03

B2.3.2 Analytical Results

A summary of the results of the vapor sampling event is presented in Table B2-124. Because the target analyte lists differ between ORNL and PNNL, not every analyte will have two results listed. Both PNNL and ORNL report target analyte concentrations in ppmv of analyte in dry air. The results given may be corrected for the measured water vapor content of tank 241-T-111 to obtain concentration in ppmv of analyte in moist tank air by multiplying the dry-air ppmv concentrations by 0.985 (Huckaby and Bratzel 1995).

Table B2-124. Quantitatively Measured Compounds Collected from the Headspace of Tank 241-T-111.[1] (2 sheets)

Analyte	Vapor Concentration (PNNL) ppmv	Vapor Concentration (ORNL) ppmv
Inorganic analytes		
NH_3	226	---
CO_2	68.6	---
CO	< 12	---
H_2	< 94	---
NO	≤ 0.06	---
NO_2	≤ 0.09	---
N_2O	< 12.6	---
H_2O	15,700	---
Organic analytes		
Acetonitrile	0.051	0.057
Acetone	0.16	0.073
Trichlorofluoromethane	0.005	---
Methylene chloride	0.008	---
Inorganic analytes		
Propanenitrile	0.009	---
1-Propanol	0.007	---
2-Butanone	0.015	---
Chloroform	0.010	---

Table B2-124. Quantitatively Measured Compounds Collected from the Headspace of Tank 241-T-111.[1] (2 sheets)

Analyte	Vapor Concentration (PNNL) ppmv	Vapor Concentration (ORNL) ppmv
Inorganic analytes (Cont'd)		
Pyridine	0.013	---
Toluene	0.012	0.015
Tetrachloroethylene	0.014	---
Total xylenes	0.006	---
n-Decane	0.027	0.024
Methane	< 61	---
2-Hexanone	---	0.0069
n-Hexanenitrile	---	0.0049
2-Heptanone	---	0.009
n-Nonane	---	0.015
n-Heptanenitrile	---	0.0042
2-Octanone	---	0.0048
n-Undecane	---	0.013

Note:
[1]Huckaby and Bratzel (1995)

B2.4 HISTORICAL SAMPLING EVENTS

B2.4.1 September 24, 1965 - Supernatant Sample

Analysis of a liquid sample from tank 241-T-111, believed to have been taken in 1965, was reported in Godfrey (1965). The tank was sampled to determine the usability of the waste as feedstock for the 242-T Evaporator. The results are provided in Table B2-125. No information was available regarding sample handling or analytical methods. No QC information was provided with the results.

Table B2-125. Grab Sample Results from September 24, 1965, for Tank 241-T-111.[1,2]

Component	Lab Value	Lab Unit
Physical Data		
Specific gravity	1.032	---
pH	9.5	---
Chemical Analysis		
Free NaOH	0.701	*M*
AlO_2	0.022	g/L
Cl^-	15.8	g/L
Na^+	21.0	g/L
NO_3^-	2.47	g/L
Radiological Analysis		
Gamma scan		
^{95}ZrNb	348	μCi/L
^{106}RuRh	1,210	μCi/L
^{137}Cs	1,150	μCi/L

Note:

[1]Godfrey (1965)

[2]This historical data has not been validated and should be used with caution.

B2.4.2 June 7, 1974 - Supernatant Sample

Analysis of a liquid sample from tank 241-T-111, believed to have been taken in 1974, was reported in Wheeler (1974a). The results are provided in Table B2-126. No information was available regarding sample handling or analytical methods. No QC information was provided with the results.

Table B2-126. Grab Sample Results from June 7, 1974, for Tank 241-T-111.[1,2]

Component	Lab Value	Lab Unit
Physical Data		
Vis-OTR	Clear, yellow, 30 % like rust. Filtrate < 10 mR/hr.	
Percent water	98.24	%
Specific gravity	1.018	---
pH	13.25	---
Differential Thermal Analysis	No exotherm	n/a
Chemical Analysis		
OH	0.254	*M*
Al	< 6.48E-04	*M*
Na	0.446	*M*
NO_2^-	0.00439	*M*
NO_3^-	0.083	*M*
SO_4^{2-}	0.00379	*M*
PO_4^{3-}	0.0216	*M*
F	0.0356	*M*
CO_3^-	0.024	*M*
Pu	1.17E-06	g/L
Radiological Analysis		
^{134}Cs	1.13	μCi/gal
^{137}Cs	369	μCi/gal
^{125}Sb	4.66	μCi/gal

Notes:

[1]Wheeler (1974a)

[2]This historical data has not been validated and should be used with caution.

n/a = not applicable

B2.4.3 September 24, 1974 - Supernatant Sample

Analysis of a liquid sample from tank 241-T-111, believed to have been taken in 1974, was reported in Wheeler (1974b). The results are provided in Table B2-127. No information was available regarding sample handling or analytical methods. Also, no QC information was provided with the results.

Table B2-127. Grab Sample Results From September 24, 1974, For Tank 241-T-111.[1,2]

Component	Lab Value	Lab Unit
Physical Data		
Vis-OTR	Black, 90 % solids. Filtrate < 10 mR/hr.	
Percent water	95.45	%
Specific gravity	1.0202	---
pH	12.9	---
Differential Thermal Analysis	No exotherm (below 200 °C)	
Chemical Analysis		
OH	0.206	*M*
Al	7.75E-04	*M*
Na	0.188	*M*
NO_2^-	0.00517	*M*
NO_3^-	0.109	*M*
SO_4^{2-}	0.00448	*M*
PO_4^{3-}	0.0233	*M*
F^-	0.0428	*M*
CO_3^{2-}	0.00659	*M*
Pu	< 1.41E-06	g/L
Radiological Analysis		
^{137}Cs	572	μCi/gal

Note:
[1]Wheeler (1974b)
[2]This historical data has not been validated and should be used with caution.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-T-111, and to present the results of the calculation of an analytical-based inventory.

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

B3.1 FIELD OBSERVATIONS

Sampler valve failures were observed in individual segments from all three cores. No analyses were performed on core 32 because all of the segments were considered to be completely compromised due to valve failure. The waste recovery from the remaining two cores was quite good, although not 100 percent. This raises some question about how representative the recovered waste is of the entire tank contents, and creates the possibility of bias in the mean concentration and inventory estimates. In addition, the location of the risers, the dished bottom of the tank, and safety margins in the sampling protocol precluded obtaining samples from the entire waste depth (Simpson 1996). Many of the analyses for cores 31 and 33 exceeded their respective maximum holding time criteria. The only analyses that came close to meeting these criteria were for the radionuclides and metals. Although exceeding the holding times weakens the defensibility of the analytical results for some uses, it is anticipated that the overall effect relative to waste management and disposal information needs is minimal (Simpson 1996).

B3.2 QUALITY CONTROL ASSESSMENT

The QC assessment for tank 241-T-111 examines the two distinct sampling events separately. The QC results from the 1991 core sampling event are discussed in Section B3.2.1, while the QC results from the 1995 vapor sampling event are discussed in Section B3.2.2.

B3.2.1 Quality Control Assessment for the 1991 Core Sampling Event

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent quality control tests were conducted on the 1991 core samples, allowing a full assessment regarding the accuracy and precision of the data. The specific criteria for all QC checks were given in Hill et al. (1991). Sample and duplicate pairs that had one or more QC results outside the specified criteria were identified by subscripts in the data summary tables (see Section B2.1.4).

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. Many analytes had minor deviations from the standard recovery criteria, but these were not substantial enough to affect the evaluations. One of the spike recoveries was outside the target level for total alpha activity. This may have been caused by high dissolved solids content on the sample mount and subsequent self-shielding. Spike recoveries outside the limits for sodium and other major ICP analytes were probably due to the high dilutions required. These high dilution factors can cause poor or meaningless spike recoveries and RPDs for those ICP elements that had either very high concentrations or were close to the detection limit. All fusion digested results require high dilutions, which affect all analytes. Low recoveries for many analytes were due to matrix effects. The high spike recoveries for silicon were caused by hydrofluoric acid in the standard matrix reacting with the glassware. High spike recoveries for calcium were probably due to the powder used on the analysts' gloves when performing the analyses (Simpson 1996).

The precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred. The RPDs were exceeded for many analytes with concentrations near the detection limit (for example, antimony, boron, and cadmium), because this adversely impacts the reproducibility of the results. Some of the high RPDs may be attributable to sample homogeneity problems. Regarding the water digestion data, most or all of those analytes with large RPDs were largely insoluble, a characteristic that probably contributed to the observed variability (Simpson 1996). None of the samples exceeded the criteria for method blanks; thus, contamination was not a problem.

In summary, the vast majority of the QC results for the core samples were within the boundaries specified in Hill et al. (1991). The discrepancies mentioned here and footnoted in the data summary tables should not impact either the validity or the use of the data.

B3.2.2 Quality Control Assessment for the 1995 Vapor Sampling Event

Regarding the vapor samples, the only QC criteria specified in the governing document (Burnum 1995) was that the relative standard deviation (RSD) must be less than 25 percent. The RSD is a measure of variability defined as the standard deviation divided by the mean, times one hundred.

Positive identification of organic analytes involves matching the gas chromatograph (GC) retention times and mass spectrometer (MS) data from a sample with that obtained from analysis of standards. The concentration of an analyte in the sample is said to be quantitatively measured if the response of the GC/MS has been established at several known concentrations of that analyte (the GC/MS has been calibrated for that analyte), and the MS response to the analyte in the sample is between the lowest and highest responses to the known concentrations (the analyte is within the calibration range). In this QC summary, only those detected gases that were defined as inorganic or those organic gases defined as quantitatively measured or positively identified will be assessed (Huckaby and Bratzel 1995). Tentatively identified compounds do not have a strict QC criteria applied to them due to the errors inherent in quantifying compounds near the detection limit.

Three inorganic gases were detected, and all of them met the QC criteria. Fourteen organic gases analyzed in SUMMA™ samples were defined as quantitatively measured, and all but one of these met the criteria. Eleven organic gases analyzed in triple sorbent trap samples were defined as quantitatively measured, and all but two of these met the criteria. Thirteen organic analytes were positively identified, but the results cannot be considered quantitative, and thus may not be accurate to within the ≤ 25 percent criteria established by Burnum (1995). Ten of these gases did not exceed their holding times, and of these ten, all but one met the QC criteria. The other three organic gases that were positively identified exceeded their holding times, but none of these exceeded the QC criteria (Huckaby and Bratzel 1995).

B3.3 DATA CONSISTENCY CHECKS

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Several correlations were possible with the data set provided by the two core samples. Comparisons were made between total alpha and the sum of the alpha emitters, total beta and the sum of the beta emitters, phosphorus by ICP and phosphate by IC, and sulfur by ICP and sulfate by IC. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. A close correlation between the two methods strengthens the credibility of both results, whereas a poor correlation brings the reliability of the data into question. All analytical mean results were taken from Table B3-5.

The analytical phosphorus mean of samples prepared by fusion digestion and analyzed by ICP was 10,400 μg/g, which represents total phosphorus. This amount of phosphorus converts to 31,900 μg/g of phosphate. In a check of soluble phosphate, samples prepared by water digestion and analyzed by ICP produced a phosphorus mean of 5,680 μg/g, which converts to 17,400 μg/g of phosphate. The ICP result agrees well with the IC phosphate result of 15,500 μg/g.

The analytical sulfur mean of samples prepared by fusion digestion and analyzed by ICP was 1,230 μg/g, which represents total sulfur. This amount of sulfur converts to 3,690 μg/g of sulfate. In a check of soluble sulfate, samples prepared by water digestion and analyzed by ICP produced a sulfur mean of 1,150 μg/g, which converts to 3,450 μg/g of sulfate. The ICP result compared very well to the IC sulfate mean result of 3,540 μg/g.

Total alpha and total beta were compared to the sum of the alpha and beta emitters in Table B3-1. As shown in the table, the sum of all analyzed alpha emitters accounts for 49 percent of the total alpha result, while the sum of beta emitters accounts for 73 percent of the total beta result. Note that the ^{90}Sr activity must be multiplied by 2 to account for its daughter product, ^{90}Y.

Table B3-1. Comparison of Alpha and Beta Emitters with Total Alpha and Total Beta Results.

Analytes for Alpha Comparison	Mean µCi/g	Analytes for Beta Comparison	Mean µCi/g
$^{239/240}$Pu	0.139	^{137}Cs	0.166
^{241}Am	0.0426	^{99}Tc	0.00792
---		2 x ^{90}Sr	10.8
Sum of alpha emitters	0.182	Sum of beta emitters	11.0
Total alpha activity	0.373	Total beta activity	15.1

There is a large discrepancy in the results between both sets of methods. Total alpha results were difficult to obtain because of interference from the high salts resulting from the fusion preparation. Therefore, small sample sizes were used to minimize the amount of salts on the mount. Normally, plutonium and americium account for >95 percent of the total alpha results. The results appear to show a higher total alpha concentration than the sum of the representative isotopes ($^{239\backslash 240}$Pu and ^{241}Am). The higher total alpha concentration may be due to: 1) high counting error; 2) the activity of the samples is so low that the offset used to discriminate between alpha and beta was not sufficient to provide accurate readings; and/or 3) another alpha emitting isotope may be present which is not identified or quantified.

Each beta isotope has a different energy and each isotope has a different detector efficiency. This may explain the discrepancy in the beta activity comparison. Total beta activity results from the 222-S Laboratory are based on the efficiency of the detector for ^{60}Co. Emissions from other isotopes have lower or higher efficiencies based on their energies. Because ^{60}Co is lower in energy than the isotopes usually present in Hanford Site waste, the total beta activity results are usually biased high.

B3.3.2 Mass and Charge Balances

The principal objective in performing mass and charge balances is to determine if the measurements are consistent. In calculating the balances, only analytes listed in Section B3.4 detected at a concentration of 2,000 μg/g or greater were considered. In the case of multiple ICP digestions for a given analyte, the method that produced the largest result was used.

Table B3-2 presents the cation mass and charge data. Based on ICP water digest data, bismuth, calcium, iron, lanthanum, manganese, silicon, and uranium were assumed to be insoluble and present as oxides or hydroxides. Based on the ICP phosphorus and IC phosphate comparison (see Section B3.3.1), it was determined that approximately 50 percent of the phosphorus existed in an insoluble form. Phosphorus was assumed to be present as the following insoluble compounds: $BiPO_4$ and Na_3PO_4. Because precipitates are neutral species, all positive charge was attributed to the sodium portion existing in soluble form. The anionic analytes listed in Table B3-3 were assumed to be present as sodium salts and were expected to balance the positive charge. The concentrations of cationic species in Table B3-2, the anionic species in Table B3-3, and the percent water were ultimately used to calculate the mass balance in Table B3-4.

The mass balance was calculated from the formula below. The factor of 0.0001 is the conversion factor from μg/g to weight percent.

$$\text{Mass balance} = \text{Percent water} + 0.0001 \times \{\text{Total Analyte Concentration}\}$$
$$= \text{Percent water} + 0.0001 \times \{BiPO_4 + Ca(OH)_2 + Fe(OH)_2 + La(OH)_3 + Mn(OH)_2 + Na_3PO_4 + SiO_2 + UO_3 + Na^+ + F^- + NO_3^- + PO_4^{3-} + SO_4^{2-} + C_2H_3O_2^-\}$$

The total analyte concentrations from the above equation is 215,000 μg/g (wet weight). The mean weight percent water obtained from thermogravimetric analysis was 76.5 percent, or 765,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 98.0 percent (Table B3-4).

The following equations demonstrate the derivation of total cations and total anions, and the charge balance is the ratio of these two values. To derive the results as shown in the equations, all concentrations must first be converted to a μg/g basis.

Total cations (μeq/g) = $[Na^+]/23.0$ = 1,470 μeq/g

Total anions (μeq/g) = $[F^-]/19.0 + [NO_3^-]/62.0 + [PO_4^{3-}]/31.7 + [SO_4^{2-}]/48.0 + [C_2H_3O_2^-]/59.0$ = 1,480 μeq/g

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.99.

Table B3-2. Cation Mass and Charge Data.

Analyte	Concentration μg/g	Assumed Species	Concentration of Assumed Species μg/g	Charge μeq/g
Bismuth	25,900	$BiPO_4$	37,700	0
Calcium	2,420	$Ca(OH)_2$	4,470	0
Iron	18,500	$Fe(OH)_2$	29,800	0
Lanthanum	4,220	$La(OH)_3$	5,770	0
Manganese	6,330	$Mn(OH)_2$	10,200	0
Phosphorus[1]	5,340	Na_3PO_4	7,940	0
		$BiPO_4$	See above	
Sodium[2]	37,000	Na^+	33,700	1,470
		Na_3PO_4	See above	0
Silicon	5,670	SiO_2	12,100	0
Uranium	2,790	UO_3	3,350	0
Total			145,000	1,470

Notes:

[1]A mean of 10,400 μg/g of phosphorus was found in the tank. Of that amount, 5,060 μg/g were assumed to be present as soluble phosphate (see Section B3.3.1). The remaining phosphorus was assumed to be present as the insoluble compounds $BiPO_4$ and Na_3PO_4.

[2]The amount of sodium assumed to be present as the insoluble compound Na_3PO_4 (3,340 μg/g) agrees well with the amount of insoluble sodium determined by subtracting the mean ICP water digest result from the mean ICP fusion digest result (4,000 μg/g).

Table B3-3. Anion Mass and Charge Data.

Analyte	Concentration µg/g	Assumed Species	Concentration of Assumed Species µg/g	Charge µeq/g
Fluoride	2,300	F^-	2,300	121
Nitrate	41,200	NO_3^-	41,200	665
Phosphate	15,500	PO_4^{3-}	15,500	489
Sulfate	3,540	SO_4^{2-}	3,540	74
TOC	3,120	$C_2H_3O_2^-$	7,670	130
Total			70,200	1,480

Table B3-4. Mass Balance Totals.

Totals	Concentrations µg/g
Total from Table B3-2	145,000
Total from Table B3-3	70,200
Percent water	765,000
Grand Total	980,000

In summary, the above calculations yield very good (close to 1.00 for charge balance and 100 percent for mass balance) mass and charge balance values, indicating that the analytical results are consistent.

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The statistics in this section were calculated using analytical data from the most recent sampling event of tank 241-T-111. Analysis of variance (ANOVA) techniques were used to estimate the mean, and calculate confidence limits on the mean, for all analytes that were above the detection limit. These estimates were computed based on core composite samples from cores 31 and 33. Two core composite samples were formed from material from each core, and chemical analyses were performed on sub-samples from each core composite sample.

The concentration estimates are based on results from ANOVA models fit to the data. An ANOVA model was fit to the data for all analytes that did not have any "less than" values. Table B3-5 reports a mean concentration and a 95 percent confidence interval on the mean. The summary statistics are reported by analyte for ICP acid digestion, ICP water leach, ICP KOH/Ni fusion dissolution, radiochemistry, IC, and the other analyses. For some analytes, the 95 percent confidence lower limit (LL) was negative. Because concentrations are greater than or equal to zero, any negative 95% LL values were set equal to zero. The statistical model used to analyze the core composite data is outlined in Section B3.4.1.

Table B3-5. Concentration Estimate Statistics. (3 sheets)

Analyte	Units	$\hat{y}$	$\hat{\sigma}^2(\hat{y})$	df	95% LL	95% UL
$Ag_{ICP.a.}$	μg/g	126	7,860	1	0	1,250
$Al_{ICP.a.}$	μg/g	541	10,600	1	0	1,850
$B_{ICP.a.}$	μg/g	28.0	7.56	1	0	63.0
$Ba_{ICP.a.}$	μg/g	69.0	64.6	1	0	171
$Bi_{ICP.a.}$	μg/g	25,900	6.38E+06	1	0	58,000
$Ca_{ICP.a.}$	μg/g	1,880	2.12E+05	1	0	7,720
$Cd_{ICP.a.}$	μg/g	5.80	3.03	1	0	27.9
$Ce_{ICP.a.}$	μg/g	33.7	9.69	1	0	73.3
$Co_{ICP.a.}$	μg/g	4.30	1.63	1	0	20.5
$Cr_{ICP.a.}$	μg/g	1,980	16,300	1	357	3,600
$Cu_{ICP.a.}$	μg/g	33.5	353	1	0	272
$Fe_{ICP.a.}$	μg/g	18,500	1.21E+06	1	4,550	32,500
$K_{ICP.a.}$	μg/g	1,140	2,240	1	534	1,740
$La_{ICP.a.}$	μg/g	4,220	3.00E+05	1	0	11,200
$Mg_{ICP.a.}$	μg/g	377	6,360	1	0	1,390
$Mn_{ICP.a.}$	μg/g	6,330	26,800	1	4,250	8,410
$Na_{ICP.a.}$	μg/g	36,900	1.56E+06	1	21,000	52,700
$Ni_{ICP.a.}$	μg/g	132	512	1	0	419
$P_{ICP.a.}$	μg/g	10,300	1.21E+05	1	5,900	14,700
$Pb_{ICP.a.}$	μg/g	347	26,400	1	0	2,410
$S_{ICP.a.}$	μg/g	1,210	1,060	1	800	1,630
$Sb_{ICP.a.}$	μg/g	31.4	16.5	1	0	83.0
$Si_{ICP.a.}$	μg/g	469	917	1	84.0	854
$Sr_{ICP.a.}$	μg/g	300	375	1	53.9	546
$Ti_{ICP.a.}$	μg/g	19.5	139	1	0	169

Table B3-5. Concentration Estimate Statistics. (3 sheets)

Analyte	Units	$\bar{y}$	$\hat{\sigma}^2(\bar{y})$	df	95% LL	95% UL
$V_{ICP.a.}$	µg/g	14.5	6.58	1	0	47.1
$Zn_{ICP.a.}$	µg/g	65.0	646	1	0	388
$Ag_{ICP.f.}$	µg/g	128	8,050	1	0	1,270
$Al_{ICP.f.}$	µg/g	570	9,700	1	0	1,820
$Ba_{ICP.f.}$	µg/g	64.6	24.5	1	1.73	128
$Bi_{ICP.f.}$	µg/g	23,600	9.08E+06	1	0	61,800
$Ca_{ICP.f.}$	µg/g	2,420	82,700	1	0	6,070
$Cd_{ICP.f.}$	µg/g	8.12	1.76	1	0	25.0
$Co_{ICP.f.}$	µg/g	11.5	1.16	1	0	25.2
$Cr_{ICP.f.}$	µg/g	1,800	1,560	1	1,300	2,300
$Cu_{ICP.f.}$	µg/g	23.9	35.6	1	0	105
$Fe_{ICP.f.}$	µg/g	18,000	4.05E+06	1	0	43,600
$La_{ICP.f.}$	µg/g	4,110	3.08E+05	1	0	11,200
$Mg_{ICP.f.}$	µg/g	355	7,310	1	0	1,440
$Mn_{ICP.f.}$	µg/g	6,280	18,800	1	4,540	8,020
$Na_{ICP.f.}$	µg/g	37,000	6.00E+06	1	5,820	68,100
$Ni_{ICP.f.}$	µg/g	8,140	6.41E+06	1	0	40,300
$P_{ICP.f.}$	µg/g	10,400	8.42E+05	1	0	22,100
$Pb_{ICP.f.}$	µg/g	365	9,380	1	0	1,600
$S_{ICP.f.}$	µg/g	1,230	11,300	1	0	2,580
$Si_{ICP.f.}$	µg/g	5,670	54,100	1	2,710	8,620
$Sr_{ICP.f.}$	µg/g	298	62.4	1	197	398
$Ti_{ICP.f.}$	µg/g	47.9	609	1	0	362
$V_{ICP.f.}$	µg/g	14.7	0.832	1	3.06	26.2
$Zn_{ICP.f.}$	µg/g	106	7.17	1	72.2	140
$Al_{ICP.w.}$	µg/g	10.9	5.75	1	0	41.4
$B_{ICP.w.}$	µg/g	4.07	0.677	1	0	14.5
$Bi_{ICP.w.}$	µg/g	202	2,400	1	0	824
$Ca_{ICP.w.}$	µg/g	61.6	33.2	1	0	135
$Cr_{ICP.w.}$	µg/g	218	24.5	1	155	281
$Fe_{ICP.w.}$	µg/g	128	311	1	0	352
$K_{ICP.w.}$	µg/g	719	1,540	1	221	1,220
$La_{ICP.w.}$	µg/g	11.0	14.2	1	0	58.9

Table B3-5. Concentration Estimate Statistics. (3 sheets)

Analyte	Units	$\bar{y}$	$\hat{\sigma}^2(\bar{y})$	df	95% LL	95% UL
$Mg_{ICP.w.}$	µg/g	3.64	0.0545	1	0.675	6.61
$Mn_{ICP.w.}$	µg/g	24.7	23.6	1	0	86.5
$Na_{ICP.w.}$	µg/g	33,000	2.44E+06	1	13,100	52,800
$P_{ICP.w.}$	µg/g	5,680	32,400	1	3,390	7,970
$S_{ICP.w.}$	µg/g	1,150	2,380	1	529	1,770
$Si_{ICP.w.}$	µg/g	572	5,350	1	0	1,500
$Sr_{ICP.w.}$	µg/g	1.96	0.0865	1	0	5.70
$Cl_{IC.w.}$	µg/g	450	1,110	1	25.6	874
$F_{IC.w.}$	µg/g	2,300	6.46E+05	1	0	12,500
$NO3_{IC.w.}$	µg/g	41,200	7.77E+06	1	5,820	76,700
$PO4_{IC.w.}$	µg/g	15,500	1.53E+06	1	0	31,300
$SO4_{IC.w.}$	µg/g	3,540	28,500	1	1,400	5,690
GEA.Am-241	µCi/g	0.0424	2.61E-06	1	0.0219	0.0629
GEA.Cs-137	µCi/g	0.166	0.00335	1	0	0.902
Gross alpha	µCi/g	0.373	1.96E-04	1	0.195	0.551
Gross beta	µCi/g	15.1	34.8	1	0	90.0
TGA. % H20	wt%	76.5	22.3	1	16.4	137
Am-241	µCi/g	0.0426	6.65E-05	1	0.0426	0.0426
Hg	µg/g	1.43	0.153	1	0	6.40
Spec.w.NO2	µg/g	793	8,760	1	0	1,980
Pu-239/40	µCi/g	0.139	9.19E-06	1	0.100	0.177
Sr-90	µCi/g	5.41	3.53	1	0	29.3
TOC	µg/g	3,120	3.83E+05	1	0	11,000
Tc-99	µCi/g	0.00792	8.90E-06	1	0	0.0458
U	µg/g	2,790	2.01E+05	1	0	8,500
pH	---	9.98	0.00779	1	8.86	11.1

Notes:

df = degrees of freedom
UL = upper limit

B3.4.1 ANOVA Models For Core Composite Data

The statistical model that describes the structure of the core composite data is

$$y_{ijk} = \mu + S_i + C_{ij} + A_{ijk}, \quad i = 1,\ldots a,\ j = 1,\ldots b_i,\ k = 1,\ldots n_{ij}, \tag{3.1}$$

where

y_{ijk}	=	laboratory results from the k^{th} duplicate of the j^{th} composite of the i^{th} core from the tank
μ	=	the grand mean
S_i	=	the effect of the i^{th} core (spatial effect)
C_{ij}	=	the effect of the j^{th} composite sample from the i^{th} core
A_{ijk}	=	the analytical error associated with the k^{th} duplicate in the j^{th} composite from the i^{th} core
a	=	the number of cores
b_i	=	the number of composite samples in the i^{th} core
n_{ij}	=	the number of analytical results from the j^{th} composite sample in the i^{th} core.

There were two core samples (that is, $a=2$) and two composite samples per core (that is, $b_i = 2$).

The variables S_i and C_{ij} are random effects. It is assumed that S_i, C_{ij}, and A_{ijk} are each distributed normally with mean zero and variances $\sigma^2(S)$, $\sigma^2(C)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$, $\sigma^2(C)$, and $\sigma^2(A)$ were obtained using Restricted Maximum Likelihood Estimation (REML). This method of variance component estimation is described in Harville (1977).

The mean concentration of each analyte was calculated using the following equation:

$$\bar{y} = \frac{1}{a}\sum_{i=1}^{a}\bar{y}_{i++} = \frac{1}{a}\sum_{i=1}^{a}\frac{\sum_{j=1}^{b_i}\sum_{k=1}^{n_{ij}} y_{ijk}}{n_{i+}} = \frac{1}{a}\sum_{i=1}^{a}\frac{\sum_{j=1}^{b_i}\sum_{k=1}^{n_{ij}}(\mu + S_i + C_{ij} + A_{ijk})}{n_{i+}}, \tag{3.2}$$

where

$$\bar{y}_{i++} = \frac{\sum_{j=1}^{b_i}\sum_{k=1}^{n_{ij}} y_{ijk}}{n_{i+}} \quad \text{and} \quad n_{i+} = \sum_{j=1}^{b_i} n_{ij}. \tag{3.3}$$

This mean gives the results from each core the same weight regardless of the unbalance that may exist for a particular analyte.

The variance of $\bar{y}$ is

$$\sigma^2(\bar{y}) = C_1\sigma^2(S) + C_2\sigma^2(C) + C_3\sigma^2(A) \tag{3.4}$$

where

$$C_1 = \frac{1}{a},\quad C_2 = \frac{1}{a^2}\sum_{i=1}^{a}\left(\frac{1}{n_{i+}}\right)^2\left(\sum_{j=1}^{b_i} n_{ij}^2\right),\quad C_3 = \frac{1}{a^2}\sum_{i=1}^{a}\left(\frac{1}{n_{i+}}\right). \tag{3.5}$$

Using $\hat{\sigma}^2(S)$, $\hat{\sigma}^2(C)$, and $\hat{\sigma}^2(A)$ (REML variance component estimates), an estimated variance of $\bar{y}$ is

$$\hat{\sigma}^2(\bar{y}) = C_1\hat{\sigma}^2(S) + C_2\hat{\sigma}^2(C) + C_3\hat{\sigma}^2(A). \tag{3.6}$$

The approximate degrees of freedom associated with $\hat{\sigma}^2(\bar{y})$ is the number of cores samples with data minus one.

The lower and upper 95% CI limits (95% LL and 95% UL, respectively) on the mean concentration are

$$95\%\ LL = \bar{y} - t_{0.025}\sqrt{\hat{\sigma}^2(\bar{y})} \quad \text{and} \quad 95\%\ UL = \bar{y} + t_{0.025}\sqrt{\hat{\sigma}^2(\bar{y})} \tag{3.7}$$

where

$t_{0.025}$ is the quantile from Student's t-distribution for a two-sided 95 percent confidence interval with degrees of freedom associated with $\hat{\sigma}^2(\bar{y})$. In this case, there is one degree of freedom and $t_{0.025} = 12.706$.

There was incomplete core recovery from the two core samples (cores 31 and 33) taken from tank 241-T-111, as shown previously in Table B2-1. Each core was expected to consist of nine segments. In the laboratory, two core composite samples were constructed from the homogenized segments from each core. Due to the incomplete core recovery the chemical results and statistical results based on the composite samples may be biased. The magnitude of the bias is unknown.

The total inventory of each analyte based on the core composite data can be calculated using an average density of 1.24 g/mL and a waste volume of 1,690 kL (446 kgal).

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C includes data investigations required for the applicable DQOs for tank 241-T-111. Specifically, statistical and other numerical manipulations required in the DQOs are documented in this appendix. The analyses required for tank 241-T-111 are reported as follows:

- **Section C1.0**: Statistical analysis and numerical manipulations supporting the Safety Screening DQO (Dukelow et al. 1995).
- **Section C2.0**: Statistical analysis and numerical manipulations supporting the organic complexants DQO (Turner et al. 1995).
- **Section C3.0**: References for Appendix C.

C1.0 STATISTICS FOR SAFETY SCREENING DQO

The safety screening DQO (Dukelow et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this section one-sided confidence limits supporting the safety screening DQO are calculated for tank 241-T-111. All data in this section are from the final laboratory data package for the 1991 core sampling event for tank 241-T-111 (McKinney et al. 1993).

Because a range of values were given for DSC, confidence intervals on the means could not be computed. As discussed in Section 2.0, some of the DSC results exceeded the safety threshold limit of 480 J/g. Because samples contain 60 to 80 percent water, the probability of a propagating reaction is small.

The sample numbers and confidence intervals for Alpha, core composite analytical data are provided in Table C1-1. The upper limit (UL) of a one-sided 95 percent confidence interval on the mean is

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95% confidence interval. For the tank 241-T-111 data, df equals the number of observations minus one.

The upper limit of the 95 percent confidence interval for each sample number based on alpha data is listed in Table C1-1. As shown in Table C1-1, all values are well below the threshold limit of 41 μCi/g.

Table C1-1. 95% Confidence Interval Upper Limits for Alpha for Tank 241-T-111 (Units are μCi/g).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
92-08278-H1	Core 31, Composite 1	6.18E-01	1.96E-01	1.86E+00
92-08280-H1	Core 31, Composite 2	5.65E-01	2.17E-01	1.93E+00
92-08282-H1	Core 33, Composite 1	3.19E-01	1.11E-01	1.02E+00
92-08284-H1	Core 33, Composite 2	3.68E-01	1.59E-01	1.37E+00

C2.0 STATISTICS FOR THE ORGANIC DQO

The organic DQO (Turner et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. All data considered in this section are taken from the final laboratory data package for the 1991 core sampling event for tank 241-T-111 (McKinney et al. 1993).

Confidence intervals were computed for each sample number from tank 241-T-111 core composite analytical data. The sample numbers and confidence intervals are provided in Table C1-2 for percent water and Table C1-3 for TOC.

For percent water, the lower limit (LL) of a one-sided 95 percent confidence interval for the mean is

$$\hat{\mu} - t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}$$

and for TOC, the upper limit (UL) of a one-sided 95 percent confidence interval for the mean is

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

For these equations, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95% confidence interval. For the tank 241-T-111 data, df equals the number of observations minus one.

The lower limit to a 95 percent confidence interval on the mean for each sample number based on percent water data is listed in Table C1-2. The table shows that most values were significantly greater than the threshold level of 17 percent. Because of the variability between the TGA results for the sample (85.3 percent) and duplicate for core 51, composite 1, the lower limit to a 95 percent confidence interval on the mean was 0.0.

The upper limit of the 95 percent confidence interval for each sample number based on TOC data is listed in Table C1-3. Each lower 95% confidence interval to the mean was much lower than a TOC limit of 30,000 μg/g.

Table C1-2. 95% Confidence Interval Lower Limits for Percent Water for Tank 241-T-111 (Units are in %).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	LL
433	Core 31, Composite 1	7.33E+01	1.20E+01	0.00E+00
434	Core 31, Composite 2	7.02E+01	1.00E+00	6.39E+01
436	Core 33, Composite 1	8.16E+01	6.00E-01	7.78E+01
437	Core 33, Composite 2	8.08E+01	2.20E+00	6.69E+01

Table C1-3. 95% Confidence Interval Upper Limits for TOC for Tank 241-T-111 (Units are in μg/g-Dry).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
457	Core 31, Composite 1	1.48E+04	8.08E+02	1.99E+04
459	Core 31, Composite 2	1.69E+04	5.74E+02	2.06E+04
462	Core 33, Composite 1	8.50E+03	0.00E+00	8.50E+03
463	Core 33, Composite 2	1.28E+04	0.00E+00	1.28E+04

C3.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR SINGLE-SHELL TANK 241-T-111

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR SINGLE-SHELL TANK 241-T-111

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

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

Characterization results from the most recent core sampling event of the tank solids were originally reported in Revision 0 of the tank 241-T-111 TCR (Simpson 1996) and have been reproduced in this TCR in Section B3.4. Two core samples were obtained and analyzed in 1991. Table B3-5 summarizes the results from the statistical analysis of data from the two core composites, and provides confidence intervals around the mean values. Component inventories can be calculated by multiplying the concentration of an analyte by the current tank volume and by the density of the waste. The HDW model document (Agnew et al. 1996a) provides tank content estimates, derived from the Los Alamos National Laboratory (LANL) model, in terms of component concentrations and inventories. A complete list of data sources used in this evaluation is provided at the end of this section.

D2.0 COMPARE COMPONENT INVENTORY VALUES AND NOTE SIGNIFICANT DIFFERENCES

Sample-based inventories derived from analytical concentration data, and HDW model inventories (Agnew et al. 1996a), are compared in Tables D2-1 and D2-2. The tank volume used to calculate the sample-based inventories is 1,688 kL (446 kgal) (Hanlon 1996). This volume is 37.5 kL (10 kgal) less than that reported by Agnew et al. (1996a). Some compaction of the waste and some losses from stabilization have occurred, since the core sampling event in 1991. Consequently, this assessment uses the lower volume. The density used to calculate the sample-based component inventories is 1.28 g/mL, which is the maximum analytically measured value reported in Simpson (1996), but is justified by the waste compactions. The HDW model density is estimated to be 1.18 g/mL (Agnew et al. 1996a). Note the significant differences between the sample-based and HDW model inventories for several of the bulk components, for example, Ca, Bi, La, Mn, and Sr.

Table D2-1. Sample- and Historical Tank Content-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-111.

Analyte	Sampling Inventory Estimate[1] (kg)	HDW Model Inventory Estimate[2] (kg)	Analyte	Sampling Inventory Estimate[1] (kg)	HDW Model Inventory Estimate[2] (kg)
Ag	280	n/r	NH_3	n/r	1.44E-03
Al	1,200	n/r	Ni	290	140
Ba	150	n/r	NO_2	1,700[3]	120
Bi	56,000	21,000	NO_3	90,000[3]	86,000
Ca	5,300	16,000	OH	n/r	70,000
Ce	73	n/r	oxalate	n/r	7,700
Cd	13	n/r	Pb	790	n/r
Cl	980	1,200	P as PO_4	70,000	66,000
Co	9.0	n/r	Sb	70	n/r
Cr	4,300	400	Si	12,000	1,700
Cu	63	n/r	S as SO_4	8,000	4,600
F	5,000[3]	9,200	Sr	650	19,000
Fe	40,000	66,000	TIC as CO_3	1,800[3]	24,000
Hg	3.0	n/r	TOC	6,800[3]	n/r
K	2,500	1,500	U_{TOTAL}	6,100	23
La	9,200	4,500	V	31	n/r
Mg	820	n/r	Zn	230	n/r
Mn	14,000	29	H_2O (wt%)	72%	76%
Na	80,000	94,000	density (kg/L)	1.26	1.18

Notes:
n/r = Not reported

[1]Simpson (1996)
[2]Agnew et al. (1996a)
[3]Based on analysis of water leach only

Table D2-2. Sample- and Historical Tank Content-based Inventory Estimates for Radioactive Components in Tank 241-T-111.

Analyte	Sampling Inventory Estimate[1] (Ci)	HDW model Inventory Estimate[2] (Ci)	Analyte	Sampling Inventory Estimate[1] (Ci)	HDW model Inventory Estimate[2] (Ci)
^{90}Sr	11,800	63	^{137}Cs	360	386
^{99}Tc	17[3]	n/r	$^{239/240}Pu$	660	22
^{241}Am	92	n/r			

Notes:

[1]Simpson (1996)
[2]Agnew et al. (1996a)
[3]Based on analysis of water leach only.

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

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

D3.1 CONTRIBUTING WASTE TYPES

Reported Waste Types in Tank 241-T-111

Anderson (1990) and Hill et al. (1995): 2C, 224, DW
Agnew et al. (1996a): 2C, 224

Model-Based Current Inventory (Agnew et al. 1996a)

Waste Type	Waste Vol. kL (kgal)
2C1	526 (139)
2C2	1,064 (281)
224	136 (36)

2C1 = Second decontamination cycle $BiPO_4$ waste (1944 to 1949).
2C2 = Second decontamination cycle $BiPO_4$ waste (1950 to 1956).

224 = Waste from final decontamination stage of $BiPO_4$ process
DW = Wash solution from equipment decontamination at T Plant.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste compositions from flowsheets for 2C and 224 waste streams are provided in Table D3-1 (from Schneider 1951). The comparative LANL defined waste streams from Agnew et al. (1996a) are also provided in Table D3-1. The 2C defined waste stream in Agnew et al. (1996a) appears to be a "second generation" flowsheet waste stream, derived by Jungfleisch (1984) for an earlier modeling effort. The 224 defined waste in Agnew et al. (1996a) is from Lucas (1989 draft), and is based on the *Bismuth Phosphate Process Technical Manual* (GE 1944). The flowsheet information from Schneider (1951) for 2C and 224 waste is based on actual processing history from 1944 to 1951, and thus is considered a better approximation of flowsheet conditions than those provided in (GE 1944).

Table D3-1. Technical Flowsheet and Los Alamos National Laboratory Defined Waste Streams.

Analyte	Flowsheet 2C[1] (*M*)	HDW model 2C[2] (*M*)	Flowsheet 224[1] (*M*)	HDW Model 224[3] (*M*)
NO_3	0.988	0.848	1.06	1.58
NO_2	NR	0	0	0
SO_4	0.060	0.0333	0.0014	0.0016
Bi	0.00623	0.0066	0.00595	0.0062
Fe	0.030	0.0318	0	0.016
Si	0.0257	0.0244	0	0
U	2.4E-05	6.7E-05	0	0
$Cr^{3+/6+}$	0.00123	0.00507	0.00362	0.0041
PO_4	0.241	0.139	0.0323	0.0492
F	0.154	0.145	0.272	0.310
Na	1.59	1.55	1.62	1.80
K	0	0.0045	0.223	0.271
La	0	0	0.00376	0.015
Mn	0	0	0.00514	0.046
$C_2O_4^{-2}$	0	0	0.0459	0.03

Notes:
M = moles per liter

[1]Schneider (1951)
[2]Appendix B of Agnew et al. (1996a). Includes 2C1 and 2C2.
[3]Appendix B of Agnew et al (1996a)

D3.3 ASSUMPTIONS FOR RECONCILING WASTE INVENTORIES

Because of the major differences in the analytical based inventories and the inventories estimated in the HDW model (Agnew et al. 1996a) reference inventories were estimated using an independent assessment that is based on a set of simplified assumptions. The predicted inventories were then compared with the sample-based inventories and the HDW model inventories. The assumptions and observations were based on best technical judgement pertaining to input information that can significantly influence tank inventories. This includes: (1) prediction of contributing waste types, correct relative proportions of the waste types, (2) predictions of flowsheet conditions, fuel processed, and waste volumes, (3) prediction of component solubilities, and (4) predictions of physical parameters such as density and percent solids. By using this evaluation, the assumptions can be modified as necessary to provide a basis for identifying potential errors and/or missing information that could influence the sample- and model-based inventories. Following are the simplified assumptions and observations used for the evaluation.

1. The 2C and 224 waste streams contributed to solids formation. The relative proportions of 224 waste to 2C waste used for comparison, were, respectively 25:75 based on analytical data (see Section D3.4). This compares to 8:92 based on Appendix D of Agnew et al. (1996a). Using the 25:75 basis, the respective volumes of 224 and 2C waste on tank 241-T-111 are 416 kL (110 kgal) and 1,270 kL (336 kgal).

2. Components listed in the process flowsheets from Schneider (1951) were used for the evaluation (see Table D3-1).

3. Tank waste mass is calculated using the tank volume listed in Hanlon (1996). Both the analytical-based and the model-based inventories are derived using volumes that are quite comparable (that is, 1,688 kL [446 kgal] from Hanlon [1996] and 1,730 kL [458 kgal] from Agnew et al. [1996]). As a result, inventory comparisons are made on essentially the same volume basis.

4. Tanks 241-B-201 and 241-B-110, which contain only one waste type (224 and 2C, respectively) helped provide the analytical basis for inventories for the 224 and 2C waste types.

5. No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion control are factored into this assessment.

6. All Bi, Fe, Mn, Si, and U precipitate as water insoluble components. These assumptions are based on the known chemistry of the components in alkaline solutions. The HDW model predicts varying solubilities for the components.

7. All Na, K, NO_3, NO_2, and C_2O_4 remain dissolved in the interstitial liquid associated with the solids.

8. La, PO_4, SO_4, Cr, and F partition between the liquid and solid phases based on known chemical solubilities and properties of compounds in alkaline solutions.

9. Interstitial liquid is a composite of all wastes. Contributions of dissolved components are weighted by volume: 2C - 0.75 and 224 - 0.25

10. Concentrations of components in interstitial liquid are based on a void fraction of 0.8.

D3.4 VOLUME RATIO 224 WASTE:2C WASTE

The HDW model predicts 136 kL (36 kgal) 224 waste and 1,590 kL (420 kgal) 2C waste in tank 241-T-111. Analytical information indicates that the 224 waste may comprise a much larger portion of the total waste. The relative contributions of 224 waste and 2C waste can be estimated by determining the concentrations of chemical constituents in tank 241-T-111 that are found only in one of the contributing waste types. Only 224 waste contains lanthanum, potassium, and manganese, and only 2C waste contains iron and silicon.

One simple method to determine the relative proportions of waste is to compare average analytical based concentrations for like waste types. The average reported analytical value is 0.053 MT La/kgal of 224 waste in tank 241-B-201 (Heasler et al. 1993). Simpson (1996) reports 9.2 MT La in tank 241-T-111 or 0.02 MT La/kgal of tank 241-T-111 waste.

$$\text{Thus:}\quad \frac{0.02\ \text{MT/kgal 241-T-111}}{0.071\ \text{MT/Kgal 224 Waste}} = 0.25$$

or 25 percent by volume 224 waste and 75 percent by volume 2C waste.

Similarly, the reported value for Mn in tank 241-B-201 waste based on analytical data is 0.091 MT/kgal (Heasler et al. 1993) and the reported value for Mn in tank 241-T-111 is 0.03 MT/kgal.

$$\text{Thus:}\quad \frac{0.030\ \text{MT/kgal 241-T-111}}{0.091\ \text{MT/kgal 241-B-201}} = 0.33$$

Another way to estimate the proportions and volumes of 2C and 224 waste in tank 241-T-111 is to predict the concentrations or masses of solid waste components that would be transferred to the tank based on the assumed 2C and 224 flowsheets for the bismuth phosphate process. The predicted values can then be compared to concentrations or masses of tank components determined by sample analysis. The Schneider (1951) flowsheet

Table D3-1 indicates 0.00514 moles Mn/L of 224 waste. If the assumption is that tank 241-T-111 contains only 224 waste, a total of 43 MT of Mn would be predicted for the solids. Based on the assumptions previously listed:

> 0.00514 moles Mn/L x 446 kgal x 3,785 L/kgal* x 90_{CF} x 54.9 g/mole Mn x MT/1.0E+06g = 43 MT Mn

* See Section D3.5 for estimation of CF.

The analytical-based value for Mn in tank 241-T-111 is 13.6 MT.

> Thus: [13.6 MT_{Mn}/43MT_{Mn}]100 = 32 percent of predicted value for Mn, or ratio 224:2C is 32:68.

The ratio of 224:2C waste can also be estimated based on potassium, which is expected to remain dissolved in the interstitial liquid associated with the solids.

> Thus: 0.223 moles K/L x 446 kgal x 3,785 x $0.8_{porosity}$ x 39 g/mole K x MT/1.0E+6g = 12.1 MT K if all 446 kgal were 224 waste

> Because the analysis for K in tank 241-T-111 shows 2.5 MT (Table D3-1)

$$\frac{2.5\ \text{MT}}{12.1\ \text{MT}} = 0.2$$

> or approximately 20 percent 224 and 80 percent 2C waste.

Similar calculations based on Si (unique to 2C waste) indicate a ratio of 224:2C of approximately 25:75.

A volume ratio of 25:75 for 224 2C waste is used in this evaluation based on the above estimates. This basis is equivalent to approximately 420 kL (110 kgal) of 224 waste, and 1,270 kL (336 kgal) of 2C waste in tank 241-T-111.

D3.5 SOLIDS CONCENTRATION FACTOR FOR 224 AND 2C WASTE IN TANK 241-T-111

One method of estimating the concentration of a component in 2C or 224 waste solids in tank 241-T-111 is to determine the concentration factor (CF) for that component. The CF is defined as the ratio of the concentration of components in solids fully precipitated from solution versus the concentration of that component in the neutralized waste stream. The CF has an inverse relationship with the volume percent solids in a defined waste stream, for example, the CF for precipitated components in 224 waste based on Agnew et al. (1996a) is

1 ÷ 3.9 vol% solids (100) = 25.6. It was noted earlier that this evaluation assumed Bi and other flowsheet components to be 100 percent precipitated. Bismuth can be used to determine what the CF is for both 224 and 2C waste in tank 241-T-111. This is accomplished by determining what CF would be necessary to bring the waste stream concentration multiplied by the total waste volume into agreement with sampling data. This biases the data towards the sampling results. If this CF is used for the other fully precipitated analytes and the results agree with the sampling data (that is, the CFs are nearly the same for components expected to fully precipitate), then it can be assumed that sampling data are consistent with the flowsheet basis and are quite representative of the tank contents.

The first step is to estimate the approximate CF for the two waste streams in tank 241-T-111. One method is to determine the CF for 224 and 2C waste for tanks that contain only those unique waste types (that is, tanks 241-B-201 and 241-B-110 respectively). The CFs are often consistent for the same waste type in different tanks. Schneider (1951) shows a concentration for Bi in neutralized 224 waste as 0.00595 mol/L (also see Table D3-3). The concentration for Bi in tank 241-B-201, which contains only 224 waste, is 0.565 moles Bi/L and the tank contains 13 MT Bi (Heasler et al. 1993). For 224 waste in tank 241-B-201 the CF can then be estimated:

$$\frac{0.565 \text{ moles Bi/L}}{0.00595 \text{ moles Bi/L}} = 95$$

An alternate method for calculation is:

$$0.00595 \text{ moles Bi/L} \times 29 \text{ kgal}_{B\text{-}201} \times 3{,}785 \text{ L/kgal} \times 209\text{g Bi/mole} \times \text{MT}/1.0\text{E}{+}06\text{g} \times \text{CF} = 13 \text{ MT}$$

or $0.136 \text{ MT} \times \text{CF} = 13 \text{ MT}$

Thus: CF = 95

By assuming the composition of 224 waste in tank 241-B-201 is comparable to 224 waste in tank 241-T-111, the same CF can be used for 224 waste in both tanks.

Using similar calculations from Heasler et al. (1993) for tank 241-B-201 and Table D3-1 for 224 waste, a CF of 85 is obtained based on Mn, which is the only other component in 224 waste expected to fully precipitate. For this evaluation an average CF of 90 is used for components that precipitate because this is consistent with the CF used for reconciliation of tank 241-B-201 and it results in inventories that are very consistent with analytical data.

> Note: Lanthanum is also expected to fully precipitate, but will likely have partitions between aqueous and solid phases because the CF for La is approximately 50. This could indicate conversion to other forms resulting from metathesis dissolution of the LaF_3 precipitate upon aging of the waste (see Section D3.6).

For 2C waste Bi, Fe, and Si are expected to fully precipitate. The CF for these components is estimated by comparison with analysis of Bi, Fe, and Si in tank 241-B-110 (Amato et al. 1994) which contains essentially all 2C waste solids. The CF for Bi in tank 241-B-110 is:

$$\frac{0.136 \text{ moles Bi/L}}{0.00623 \text{ moles Bi/L}} = 22$$

Alternatively the CF can be determined as follows:

0.00623 x 245* $kgal_{B\text{-}110}$ x 3,785 L/kgal x 209g Bi/mole x MT/1.0E+06g x CF = 26.4* MT

or 1.207 MT x CF = 26.4 MT

Thus: CF = 22

* Noted values are from analytical data for tank 241-B-110 (Amato et al. 1994).

Based on additional comparisons of analytical data from Amato et al. (1994) for tank 241-B-110 and flowsheet values from Table D3-1, the CF for Si and Fe is 17 and 23, respectively.

Another approach can be used for determining the CF for precipitated components in tank 241-T-111 if: (1) the source of the component in the tank is from only one of the waste types (for example, Mn from 224 waste), and (2) the volume of that waste type in the tank can be reasonably estimated. This approach is valuable because the CF for a component in a particular waste type may not necessarily be comparable for different tanks due to the large variation in waste volumes flushing through the tanks and variations in solids: liquid ratios resulting from cascading and cribbing procedures. For example as just shown, the CF for Si in 2C waste based on tank 241-B-110 is 18.5. The CF for Si in tank 241-T-111 is only 13.4 based on the flowsheet Si concentration in 2C waste from Table D3-1, an assumed 1,270 kL (336 kgal) of 2C waste in tank 241-T-111, and a calculated (sample-based) mass of 12.3 MT Si in tank 241-T-111 (Simpson 1996).

Thus: 0.0257 moles Si/L x 336 $kgal_{T\text{-}111}$ x CF x 3,785 L/kgal x 28.09 g/mole Si x MT/1.0E+06 = 12.3 MT Si

or 0.918 MT x CF = 12.3 MT

CF = 13.4

For this evaluation, an average CF of 15 was used for components in 2C waste. This CF, which is based on the calculated values just described, results in predicted inventories that are very consistent with those obtained from analytical data for tank 241-T-111.

D3.6 ESTIMATE OF PARTITIONING FACTORS FOR COMPONENTS ASSUMED TO PARTITION BETWEEN AQUEOUS AND SOLID PHASES

Some waste components are partially water soluble. The relative concentration of these components in both the solids and the aqueous phase is called the partitioning factor (PF). The PF for 224 waste components have been determined based on the inventory reconciliation process for tank 241-B-201, which contains only 224 waste. Similar PFs can be assumed approximately the same for 224 waste in other tanks (for example, tank 241-T-111) that also contain 224 waste as well as other waste types. As mentioned earlier, component concentrations in a particular waste type may not be exactly comparable due to the large variation in the waste volumes flowing through the tanks, variations in solids and liquid ratios resulting from cascading and cribbing procedures, and also because of potential for chemical reactions (for example, metathesis) of components when mixed/diluted with other waste types.

Partition factors are approximated by comparing the CF for a component in a waste type (for example, 224) with the concentration factor for a constituent known to fully precipitate (for example, Bi with CF of 22). Thus for tank 241-B-110 (all 2C waste) the phosphate PF is based on the CF for PO_4 in tank 241-B-110 (Amato et al. 1994).

Thus: 0.241 moles PO_4/L x 245 $kgal_{B-110}$ x 3,785 L/kgal x 95 g/mole PO_4 x MT/1.0E+06g x CF = 95 MT PO_4

or 21.2 MT x CF = 95 MT

CF = 4.5

Thus: the PF for PO_4 (241-B-110) = $\frac{4.5\ CF}{22.0\ CF}$ = 0.20

Using this method, the estimated PF for other components in 2C waste based on tank 241-B-110 are:

Cr: 1.0
SO_4: 0.1
F: 0.04

For 224 waste the fraction partitioned to solids for La, PO_4, SO_4, and F is as follows based on tank 241-B-201.

La: 0.5
Cr: 0.3
PO_4: 0.05
SO_4: 0.1
F: 0.01

The preceding examples provide approximations for determining inventories in other tanks that contain 2C waste. It may be found by trial and error (as above) that a better fit to the analytically derived data may require some adjustments to these estimated partition factors.

D3.7 ESTIMATED INVENTORY OF COMPONENTS

The following calculations provide estimates of tank 241-T-111 inventories. As previously described, a CF (based on Bi) of 90 is used for 224 waste and 15 for 2C waste.

Components Assumed to Precipitate 100 Percent (Bi, Mn, Si, Fe, and U)

Bi: [0.00623 moles Bi/L_{2C} x 336 kgal x $15_{CF(2C)}$ + 0.00595 moles Bi/L_{224} x 110 kgal x $90_{CF(224)}$] x [3,785 L/gal x 209 g/mole Bi x MT/1E+06g] = 71 MT

Mn: 0.00514 moles Mn/L_{224} x 110 kgal x 90_{CF224} x 3,785 L/gal x 54.9 g/mole Mn x MT/1E+06g = 10.6 MT

Si: 14 MT

Fe: 32 MT

U: 0.11 MT

Components Assumed to Remain Dissolved in Interstitial Liquid (Na, NO_3, NO_2, C_2O_4, K)

NO_3: [0.99 $moles_{NO3}/L_{2C}$ x 336 kgal + 1.06 moles $_{NO3}/L_{224}$ x 110 kgal] x 3,785 L/kgal x $0.8_{porosity}$ x 63 $g/mole_{NO3}$ x MT/1E+06g = 86 MT

NO_2: 0 MT

Na: 50 MT

K: 2.9 MT

C_2O_4: 1.3 MT

Components Assumed to Partition Between Aqueous and Solid Phases (La, PO_4, Cr, SO_4, F)

La: 0.00376 moles La/L x 110 kgal x 3,785 L/kgal x 139 $g/mole_{La}$ x 90 CF x 0.5 PF x MT/1.0E+6g = 9.8 MT

Cr: (0.00123 moles Cr/L x 336 $kgal_{2C}$ x 3,785 L/kgal x 52 $g/mole_{Cr}$ x 15 CF x MT/1.0E+6g) + (0.00362 moles Cr/L x 110 $kgal_{224}$ x 3,785 L/kgal x 52 $g/moles_{Cr}$ x 90 CF x 0.3 PF x MT/1.0E+6g) = 3.3 MT

PO_4: (0.0323 moles PO_4/L x 110 $kgal_{224}$ x 3,785 L/kgal x 95 $g/mole_{PO4}$ x 90 CF x 0.05 PF x MT/1.0E+6g) + (0.241 moles PO_4/L x 336 $kgal_{2c}$ x 3,785 L/kgal 95 $g/moles_{PO4}$ x 15 CF x 0.20 PF x MT/1.0E+6g) = 93 MT

F: The PFs for 224 (0.01) and for 2C (0.04) from Section D3.6 were not used for F for tank 241-T-111. The assumption that the F remained entirely in interstitial liquid provided for best fit with analytical data.

(0.154 moles F/L x 336 $kgal_{2C}$ x 3,785 L/kgal x 19 $g/mole_F$ x $0.8_{porosity}$ x MT/1.0E+6g) + (0.272 moles F/L x 110 $kgal_{224}$ x 3,785 L/kgal x 19 $g/mole_F$ x $0.8_{porosity}$ x MT/1.0E+6g) = 4.7 MT

SO_4: The PFs for 224 (0.1) and for 2C (0.1) from Section D3.6 were not used for SO_4 for tank 241-T-111. The assumption that all SO_4 remained in interstitial liquid provided best fit with analytical data.

> 0.0602 moles SO_4/L x 336 $kgal_{2C}$ x 3,785 L/kgal x 96 g/$mole_{SO4}$ x $0.8_{porosity}$ x MT/1.0E+6g +0.0014 moles SO_4/L x 110 $kgal_{224}$ x 3,785 L/kgal x 96 g/mole SO_4 x $0.8_{porosity}$ x MT/1.0E+6g = 5.9 MT

Estimated component inventories from this evaluation are compared with sample and HDW model-based inventories in Table D3-2. Conclusions and observations regarding these inventories are noted, by component, in the following text.

Bismuth. The reference inventory predicted by this assessment and the sample-based inventory are both significantly higher than the HDW model inventory. The HDW Model inventory reflects the assumptions that only 60 percent, 24 percent, and 35 percent, respectively, of the bismuth in the 2C1 stream, 2C2 stream, and 224 stream precipitated. This basis resulted in a significant amount of bismuth being cascaded to cribs based on the HDW model. The predicted inventory of 71 MT is 25 percent higher than the analytical-based inventory which could be the result of the following, or a combination of the following: (1) the ratio of 2C:224 waste may be closer to 80:20 than 75:25 and (2) somewhat less of the bismuth precipitated than the 100 percent assumed for this assessment. As noted, Bi was used to determine the CF for this waste tank.

Chromium. This inventory assessment predicted the total chromium content to be reasonably close to that based on sample analysis. These values are approximately 10-fold higher than that predicted by the HDW model. The HDW model defined waste streams indicate higher concentrations of chromium in the 2C and 224 wastes than given in Schneider (1951) (Table D3-2). These concentrations may be inflated somewhat from the corrosion source-terms assumed for the HDW model while no corrosion source term was used in this assessment. The HDW model assumes that none of the chromium precipitated in the 2C and 224 streams that is, the only chromium contribution to the solids is from the interstitial liquids associated with the solids. For this assessment, the assumption that a considerable amount of chromium precipitated is substantiated by the close match with analytical results for the pure waste types (224 waste-tank 241-B-201, and 2C waste-tank 241-B-110) and is corroborated by the analytical data for tank 241-T-111. Additionally, because the chromium was added primarily as chromium (III) in the $BiPO_4$ process, it is expected that the majority of the chromium will precipitate as $Cr(OH)_3$ or $Cr_2O_3 \cdot XH_2O$.

Table D3-2. Comparison of Selected Component Inventory Estimates for Tank 241-T-111 Waste.

Component	This Evaluation (MT)	Sample-based (MT)	HDW Model (MT)
Bi	71	56	21
Cr	3.3	4.3	0.4
Fe	32	40	66
K	2.9	2.5	1.5
La	9.9	9.1	4.5
Mn	10.6	14	0.029
Na	50	80	94
Si	13.8	12	1.7
Sr	n/r	0.65	19
U	0.11	6.1	0.023
F	4.7	4.7[1]	9.2
NO_3	86	85[1]	86
NO_2	n/r	1.7[1]	0.12
PO_4	93	70	66
SO_4	5.9	8.0	4.6
H_2O (%)	---	72	76

Notes:

[1]Based on analysis of water leach only.

n/r = not reported

Iron. The reference iron inventory predicted by this assessment and the sample-based inventory are both smaller than for the HDW model inventory. This evaluation does not include a corrosion source-term for iron, which may explain the smaller inventory for this assessment. The HDW model inventory prediction may be biased high based on a corrosion source-term for iron that is considered high. The difference between the measured (analytical) and calculated (this assessment) iron concentrations does not suggest a large corrosion source term.

Potassium. The reference potassium inventory predicted by this assessment and the sample-based inventory are both approximately twice that predicted by the HDW model. This is primarily due to the predicted small contribution of the 224 waste stream (8 vol%) by the HDW model for this tank versus the 25 percent contribution predicted by this assessment.

Lanthanum. The reference lanthanum inventory predicted by this assessment is close to the sample-based inventory, however, both are approximately twice that predicted by the HDW model. This assessment and the HDW model both predict approximately 50 percent of the lanthanum to precipitate. The contribution of the 224 waste stream that contains lanthanum is predicted to be only 8 vol% by the HDW model versus 25 vol% by this assessment.

Manganese. The manganese inventory predicted by this assessment is slightly lower than the sample-based inventory but both are much higher than the inventory projected by the HDW model. It is possible that the sample reflects some contribution of manganese for T Plant decontamination operations in addition to the manganese from the 224 process. Based on known chemistry of manganese in alkaline solution, this assessment predicted that all of the manganese in 224 waste will precipitate. The HDW model assumes that none of the manganese will precipitate from the 224 waste streams; that is, the only manganese contribution in the solids for the HDW model is from the interstitial liquids. Additionally, the HDW model predicts that the 224 waste contributes only 8 percent of the waste volume, as opposed to 25 percent predicted by this independent assessment.

Sodium. The sodium inventory predicted by this evaluation is lower than the sample-based inventory. The evaluation assumed that sodium would not partition to the solids. Some slight partitioning probably occurs, however the HDW model over predicts any partitioning that may occur. Sodium partitioning does not appear to be straight forward and more study should be applied to it. The sample analytical data appears to be the best estimate.

Silicon. The reference silicon inventory predicted by this assessment compares quite well with the sample-based inventory, but is approximately eight times that predicted by the HDW model. The apparent explanation is that this assessment assumes that all silicon precipitates while the HDW model assumes a significant portion of the silicon is in the aqueous stream that is sent to cribs.

Strontium. Based on $BiPO_4$ flowsheets (Schneider 1951) strontium (nonradioactive) was not added as a process chemical. This assessment predicts no strontium in tank 241-T-111 although some contribution will enter the tank as fission product (^{89}Sr, ^{90}Sr) as well as from contaminants in process chemicals. The sample analysis predicts a small amount (approximately 600 kg) of strontium. The HDW model predicts 18,700 kg (18.7 MT) with the source being attributed to 0.063*M* $Sr(NO_3)_2$ in the 224 defined waste stream. No documentation shows that strontium was added as a process chemical in the 224 flowsheet (Schneider 1951). However, $Sr(NO_3)_2$ was added as a scavenging agent to precipitate ^{90}Sr from uranium recovery waste, first-cycle decontamination wastes from T Plant, and in-farm wastes. Based on these flowsheets, the $Sr(NO_3)_2$ should be indicated as a process chemical in the ferrocyanide wastes defined in the HDW model rather than 224 waste.

Fluoride. The inventory predicted by this assessment and the sample-based inventory are nearly identical. This assessment assumed that none of the fluoride in the tank remains as insoluble compounds, that is, all is associated with the interstitial liquors. The analytical-based inventory results from analysis of the aqueous portion generated from water leaching of the sample. Both of these evaluations are about half of the inventory predicted by the HDW model. The water insoluble solids may contain fluoride, but it is not possible to determine how much until an analytical method that measures total fluoride is utilized. This assessment may therefore, significantly underestimate the fluoride content of this tank even through it matches the analytical data. The HDW model assumes that a portion of the fluoride is present in the solids as NaF although this compound should be measured by the water digestion analytical method.

Nitrate. The nitrate inventories predicted by this assessment, by the HDW model, and by sample analysis are all comparable. Both the HDW model and this evaluation assume all nitrate to remain in the aqueous. A larger nitrate inventory could be possible if the solids contain any water insoluble phase such as cancrinite, which could not dissolve in a water digestion analysis.

Nitrite. This assessment does not account for any nitrite from radiolysis of nitrate or any nitrite additions for corrosion purposes. The sample analysis and the HDW model predict only small inventories of nitrite.

Phosphate. The phosphate inventory predicted by this assessment is approximately 40 percent higher than that predicted by both the HDW model and sample analyses. As noted earlier, the assumptions used in this assessment for partitioning the phosphate between solid and aqueous phases are based on calculated PF for tanks that contain only 224 and 2C waste (that is, tanks 241-B-201 and 241-B-110, respectively). For reasons explained earlier, the PF for components with mixed waste types may vary. The analytical and HDW model bases may provide the best estimates for phosphate for this tank.

Sulfate. The HDW inventory is slightly smaller than the sample-based inventory, as is the inventory estimated by this evaluation. Both this assessment and the HDW model assumed that the sulfate partitions entirely to the aqueous phase. As shown earlier, based on analyses of tanks 241-B-110 and 241-B-201, some sulfate does partition to the solid phase. Thus, by adjusting the PF for sulfate to approximately 0.01 (only one percent partitioning to the solid phase) this assessment would predict a sulfate inventory very close to that based on the sample analysis.

Uranium. The sample analysis indicates the uranium inventory to be much larger than the independent assessment and the HDW model predict. The sample basis is considered valid because consistent analytical results for the core samples were obtained from two independent laboratories. The source of the uranium cannot be identified. Both process flowsheets and waste transaction information indicate that only minor amounts of uranium should be in the waste.

D4.0 BEST-BASIS INVENTORY ESTIMATE

The results from this evaluation support using the sampling data as the basis for the best estimate inventory to tank 241-T-111 for the following reasons:

1. Data from two core composite samples were used to estimate the component inventories. The core sample recovery was quite complete.

2. With the exception of PO_4 and U, results from this evaluation compare ~~more~~ favorably with the sample-based results.

3. The inventory estimate generated by the HDW model is based on a predicted 2C:224 waste volume ratio 92:8, whereas sample analyses of components that are unique to these two waste types indicate a higher contribution of 224 waste, for example, 80:20 or 75:25.

4. The fraction precipitated basis used for the independent analysis for major components result in inventory estimates that compare favorably with sample analyses. The concentration factors calculated for fully precipitated components (for example, Bi) were based on comparing flowsheet concentrations with analytical-based concentrations. The relative concentrations of components in the waste solids are consistent with those expected for waste resulting from $BiPO_4$ process 2C and 224 process flowsheets. For nearly all components, the calculated CF and PF resulted in inventories that are consistent with the predicted chemical behaviors of the components in alkaline media.

5. The flowsheet bases and waste volumes used for this assessment are believed to reflect the processing conditions more closely than those that govern the HDW model inventories.

Best-basis inventory estimates for tank 241-T-111 are presented in Tables D4-1 and D4-2. Component inventories are rounded to two significant figures.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components Tank 241-T-111 (July 2, 1996).

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	1,200	S	---
Bi	56,000	S	---
Ca	5,300	S	---
Cl	980	S	Based on analysis of water leach only.
TIC as CO_3	1,800	S	Based on analysis of water leach only.
Cr	4,300	S	---
F	5,000	S	Based on analysis of water leach only.
Fe	40,000	S	---
Hg	3	S	---
K	2,500	S	---
La	9,200	S	---
Mn	14,000	S	---
Na	80,000	S	---
Ni	290	S	---
NO_2	1,700	S	Based on analysis of water leach only.
NO_3	90,000	S	Based on analysis of water leach only.
OH	70,000	M	No sample basis
Pb	790	S	---
P as PO_4	70,000	S	---
Si	12,000	S	---
S as SO_4	8,000	S	---
Sr	650	S	---
TOC	6,800	S	Based on analysis of water leach only.
U_{TOTAL}	6,100	S	Method/sample prep: (Fluorimetry/ Fusion)
Zr	0	M	No sample basis

Notes:

[1]S = Sample-based, 1991 Core Samples (see Appendix B)
M = Hanford Defined Waste model-based
E = Engineering assessment-based

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components for Tank 241-T-111 (July 2, 1996).

Analyte	Tank Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	<DL	S	Based on analysis of water leach only
^{14}C	<DL	S	Based on analysis of water leach only
^{59}Ni	0.11	S	---
^{60}Co	0.8	S	---
^{63}Ni	12	S	---
^{79}Se	<DL	S	---
^{90}Sr	11,800	S	---
^{90}Y	11,800	S	---
^{99}Tc	17	S	Based on analysis of water leach only.
^{129}I	<DL	S	---
^{137}Cs	360	S	---
^{137m}Ba	340	S	---
$^{239/240}Pu$	300	S	---
^{241}Am	92	S	---

Notes:

[1]S = Sample-based, 1991 Core samples (see Appendix B)
M = Hanford Defined Waste model-based
E = Engineering assessment-based
DL = detection limit

APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. Fitzpatrick, K. Jurgensen, T. Ortiz, and B. Young, 1996a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, Los Alamos National Laboratory, Los Alamos, New Mexico.

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Amato, L. C., D. S. De Lorenzo, A. T. DiCenzo, 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.

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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 241-B-110*, PNL-8745, Pacific Northwest National Laboratory, Richland, Washington.

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-T-111

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-T-111

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

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL 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-T-111 Waste

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

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

This bibliography is broken down into the appropriate sections of material to use, 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 the information listed below may be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Agnew, S. F., 1995, *Hanford Defined Wastes: Chemical and Radionuclide Compositions*, LA-UR-96-858, Rev. 3, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains waste type summaries as well as primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids.

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/waste type information up to 1981.

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- A model based on process knowledge and radioactive decay estimations using ORIGEN for different compositions of process waste streams. Assumptions about waste types and solubility parameters are given.

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

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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 Northwest Quadrant*, WHC-SD-WM-TI-669, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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

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Ic. Surveillance/Tank Configuration

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- Shows tank riser locations in relation to tank aerial view as well as a description of riser and its contents.

Engelman, D. B., 1994, Managing the Assumed Leak from Single-Shell Tank 241-T-111, WHC-SD-WM-ER-337, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Discusses why tank 241-T-111 is an assumed leaker and describes the approach used to manage the assumed leak from this tank.

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, watchlist tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information. The series includes monthly summaries from Dec. 1947 to present; however, Hanlon has only compiled the monthly summaries from November 1989 to September 1996.

Huber, J. H., 1994, *T-111 Waste Tank Integrity Investigation*, WHC-SD-WM-ER-305, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Leach, C. E. and S. M. Stahl, 1993, *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.

- Gives an assessment of riser locations for each tank, but not all tanks are included/completed. Also includes an estimate of which risers are 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.

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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.

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Ie. Data Quality Objectives/Customers of Characterization Data

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- Contains waste type summaries, primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids, as well as SMM, TLM, and individual tank inventory estimates.

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- Contains summary information from the supporting documents for Tank Farms T, TX, and TY, as well as in-tank photo collages and the solid (including the interstitial liquid) composite inventory estimates.

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

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- Contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Pu and U waste contributions are taken at 1% of the amount used in processes. Also compares information on ^{99}Tc from both ORIGEN2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data

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- Contains summary information from the supporting documents for Tank Farms T, TX, and TY, as well as in-tank photo montages and the solid (including the interstitial liquid) composite inventory estimates.

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- Most recent release of a series of summaries including fill volumes, watchlist 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 September 1996.

Hartley, S. A., G. Chen, C. A. Lopresti, T. A. Ferryman, A. M. Liebetrau, K. M. Remund and S. A. Allen, 1996, A comparison of Historical Tank Contents Estimates (HTCE) Model, Rev. 3, and Sample-Based

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Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Shelton, L. W., 1995, Radionuclide Inventories for Single and Double Shell Tanks, (Internal Memo 71320-95-002 to F. M. Cooney, February 14), Westinghouse Hanford Company, Richland, Washington.

- Memo contains a tank inventory estimate based on analytical information.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Single Shell Tanks*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains selected sample analysis tables prior to 1993 for single-shell tanks.

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