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Tank Characterization Report for Single-Shell Tank 241-BY-102

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-BY-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

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Tank Characterization Report for Single-Shell Tank 241-BY-102

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LIST OF TERMS

1C	first-cycle decontamination waste
ANOVA	analysis of variance
ASTM	American Society for Testing and Materials
Btu/hr	British thermal units per hour
BYSltCk	saltcake blend from ITS in BY tank farm
Ci	curies
Ci/L	curies per liter
cm	centimeters
c/s	counts per second
CW	cladding waste
df	degrees of freedom
DL	drainable liquid
DOE	U.S. Department of Energy
DQO	data quality objectives
DSC	differential scanning calorimetry
DSI	"Don't Say It - Write It" correspondence
EB	evaporator bottoms
Ecology	Washington State Department of Ecology
EVAP	evaporator feed
ft	feet
FP	fission product waste
g	grams
g/L	grams per liter
g/mL	grams per milliliter
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inches
I.S.	insufficient sample to perform analysis
ITS	in-tank solidification
IX	ion exchange waste
J/g	joules per gram
kg	kilograms
kg/L	kilograms per liter
kgal	kilogallons
kL	kiloliters
LANL	Los Alamos National Laboratory
LEL	lower explosive limit
LFL	lower flammability limit
LL	lower limit

LIST OF TERMS (Continued)

m	meters
M	moles per liter
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mm	millimeters
MW	metal waste
n/a	not applicable
n/d	not determined
n/r	not reviewed
NR	not reported
N/R	not required
OWW	organic wash waste
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
SAP	sampling and analysis plan
SACS	Surveillance Analysis Computer System
SMM	supernatant mixing model
SU	supernatant
Subseg	subsegment
SWLIQ	saltwell liquid
TBP	tributyl phosphate
TCP	tank characterization plan
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
W	watts
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μg C/g	micrograms carbon per gram
μg C/mL	micrograms carbon per milliliter
μCi/g	microcuries per gram

LIST OF TERMS (Continued)

μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter

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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 appendixes serve as the TCR for single-shell tank 241-BY-102.

The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-BY-102 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 appendixes. This report also supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996) Milestone M-44-10.

1.1 SCOPE

Characterization information presented in this report originated from sample analyses and known historical sources. While only the results of recent sample events will be used to fulfill the requirements of the data quality objectives (DQOs), other information can be used to support (or question) conclusions derived from these results. Historical information for tank 241-BY-102, provided in Appendix A, included 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 results of the 1996 sampling events, also reported in the laboratory data package (Fritts 1996a, 1996b), partially satisfied the data requirements specified in the tank characterization plan (TCP) for this tank (Winkelman 1996). 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-BY-102 and its respective waste types is contained in Appendix E. The 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	Phase	Location	Segmentation	% Recovery
Vapor sample (November 1995)	Gas	Tank headspace	n/a	n/a
Core sample (June 1996)	Solid	Riser 10A	Divided into half- and quarter-segments	Segment recoveries 0 to 83 percent (46 percent overall)[1]
Core sample (July 1996)	Solid	Riser 5	n/a	0 percent
Vapor samples (June 1996, July 1996)	Gas	Tank headspace, Risers 5 and 10A, 6 m (20 ft) below top of riser	n/a	n/a

Notes:
n/a = not applicable

[1]Based on the values provided in Table 2 of Fritts (1996a).

1.2 TANK BACKGROUND

Tank 241-BY-102 is located in the 200 East Area BY Tank Farm on the Hanford Site. It is the fifth tank in a six-tank cascade series that includes tanks 241-BX-101, 241-BX-102, 241-BX-103, 241-BY-101, 241-BY-102, and 241-BY-103. The tank went into service in the third quarter of 1950, receiving metal waste (MW) cascaded from tank 241-BY-101. Supernatant was transferred both into and out of the tank from 1953 to 1957.

The tank was sluiced in 1954 and the waste was sent for uranium recovery. In 1955, waste was again transferred out for uranium recovery. The tank was chosen to be in-tank solidification unit #1 (ITS#1) in 1966, at which time a heater was placed in the tank to promote evaporation. Tank 241-BY-102 continued as ITS#1 until 1971, receiving supernatant from multiple sources. Additional supernatant transfers into and out of the tank occurred from 1971 to 1978. Other waste types received by tank 241-BY-102 during its service life include tributyl phosphate waste, cladding waste, evaporator bottoms, fission product waste, organic wash waste, and ion exchange waste. The tank was declared inactive in 1976 and was interim stabilized in 1995.

A description of tank 241-BY-102 is summarized in Table 1-2. The tank has an operating capacity of 2,870 kL (758 kgal) and presently contains an estimated 1,050 kL (277 kgal) of non-complexed waste (Hanlon 1996). The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-BY-102.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1948-1949
In-service	1950
Diameter	22.9 m (75.0 ft)
Operating depth	7 m (23 ft)
Capacity	2,870 kL (758 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Non-complexed
Total waste volume[1]	1,050 kL (277 kgal)
Supernatant volume	0 kL (0 kgal)
Saltcake volume	1,050 kL (277 kgal)
Sludge volume	0 kL (0 kgal)
Drainable interstitial liquid volume	42 kL (11 kgal)
Waste surface level (October 10, 1996)[2]	180 cm (72 in.)
Temperature (1974 - 1979)[3]	3.9 °C (39 °F) to 37 °C (99 °F)
Integrity	Sound
Watch List	None
SAMPLING DATE	
Vapor samples	November 1995
Core samples	June/July 1996
Headspace flammability	June/July 1996
SERVICE STATUS	
Declared inactive	1976
Partial interim isolation	1982
Interim stabilization	1995

Notes:

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

[2]The waste surface level measurement does not correspond directly to the waste volume estimate. The measurements are made near the center of the tank; photographs show that the waste level is higher along the tank wall and lower in the middle of the tank.

[3]There are currently no functioning thermocouples in the tank.

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2.0 RESPONSE TO TECHNICAL ISSUES

The following technical issues have been identified for tank 241-BY-102 (Brown et al. 1996). They are:

Safety screening:

- Does the waste pose or contribute to any recognized potential safety problems?

Organic safety issue:

- Does the waste contain organics in concentrations that can support a propagating chemical reaction?

Hazardous vapor safety screening:

- Does the vapor headspace exceed 25 percent of the lower flammability limit (LFL)? If so, what are the principal fuel components?

- Are compounds of technological significance present in the tank at such a level that the industrial hygiene group shall be alerted to their presence so adequate breathing zone monitoring can be accomplished and future activities in and around the tank can be performed in a safe manner?

Organic solvents:

- Does an organic solvent pool exist that may cause an organic solvent pool fire or ignition of organic solvents entrained in waste solids?

The TCP (Winkelman 1996) provides the types of sampling and analysis used to address the above issues. Data from the recent analysis of a core sample and tank headspace sampling and flammability measurements, as well as available historical information, provided the means to respond to these issues. This response is detailed in the following sections. See Appendix B for sample and analysis data for tank 241-BY-102.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-BY-102 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, criticality conditions, and the presence of a separable organic layer in the waste. No separable organic layer was observed in any of the samples. The remaining safety issues are addressed separately below.

For a proper safety assessment, the safety screening DQO requires two full-depth profiles of the waste. Because waste was recovered from only one core, the sampling requirements of the DQO were not met. In addition, for the core that did recover material, the bottom 48 cm (19 in.) of tank waste was not sampled. As a result, a vertical profile was not obtained.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that there are not enough exothermic constituents in tank 241-BY-102 to cause a safety hazard. Because of this requirement, energetics in tank 241-BY-102 were evaluated. The safety screening DQO required that the waste sample profile be tested for energetics every 24 cm (9.5 in.) to determine if the energetics exceeded the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis.

Results obtained using differential scanning calorimetry (DSC) indicated that although small exotherms (< 150 J/g on a dry weight basis) were observed in some of the samples, the threshold limit was not exceeded on any of the samples. Additionally, the highest upper limit of the one-sided 95 percent confidence interval for these results was less than the threshold limit of 480 J/g on a dry weight basis (approximately 170 J/g on a dry weight basis). The method used to calculate confidence limits is contained in Appendix C. Because only one of the two core samples contained any sample, the requirement for measuring energetics could be met for only one core sample. However, there is no indication that energetics is a concern for this tank.

Historically, there is no evidence that substantial quantities of any exothermic agent should exist in this tank's waste. Waste transfer records indicate that the major waste type expected to be in the tank is BY saltcake (Agnew et al. 1996b). BY saltcake is not expected to contain ferrocyanide constituents, and organic compounds are expected to be present at less than 1 wt% (Agnew et al. 1996a). However, the tank was recently added to the organic DQO as discussed in Section 2.2.

2.1.2 Flammable Gas

Vapor samples were taken in November 1995. Vapor phase measurements were taken in the tank headspace during core sampling in June and July 1996. The vapor samples and vapor phase measurements indicate that flammable gases were well below the threshold limit of 25 percent of the LFL. All combustible gas meter readings were zero percent of the LFL. The vapor samples were also well below the threshold limit. Data from these vapor phase measurements are presented in Appendix B.

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 1.86 g/mL, 1 g/L of ^{239}Pu is equivalent to 33.1 μCi/g of alpha activity. The total alpha activity of the waste samples was determined, and concentrations in all samples were well below this limit. Additionally, the upper limit of the one-sided 95 percent confidence interval for these results was less than 0.8 μCi/g, well below the threshold limit of 33.1 μCi/g. The method used to calculate confidence limits is contained in Appendix C. Because only one of the two core samples contained any sample, the requirement for performing total alpha analysis was met for only one core sample. However, there is no indication that criticality is a concern for this tank.

2.2 ORGANIC EVALUATION

Although tank 241-BY-102 is not a Watch List tank, samples were analyzed and evaluated according to *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The organic DQO was expanded to include tank 241-BY-102 by *Scope Increase of "Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue"* (Cash 1996).

The organic DQO defines the type, quantity, and quality of data required to categorize the tank and to resolve the safety issue. The specific issues addressed by the organic DQO are the exothermic conditions in the waste, the total organic carbon (TOC) concentration, and the moisture content of the waste. Each of these issues is discussed separately below.

2.2.1 Exothermic Conditions (Energetics)

This is the same requirement as the safety screening energetics requirement. See Section 2.1.1 for a treatment of the energetics issue.

2.2.2 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 results were well below the action limit after being converted to dry weight. Additionally, as required by the DQO, the upper limit of the one-sided 95 percent confidence interval for these results was less than 30,000 μg/g on a dry weight basis. The highest mean concentration observed was approximately 14,206 μg/g on a dry weight basis and the highest upper limit of the one-sided 95 percent confidence interval was approximately 17,700 μg/g on a dry weight basis. Because only one of the two core samples contained any sample, the requirement for measuring TOC could only be met for one core sample.

2.2.3 Moisture

The moisture content of the waste was determined by thermogravimetric analysis (TGA). A propagating exothermic reaction is unlikely when the weight percent water is greater than 17 percent. However, tank water content is secondary to the exothermic capabilities of the tank waste. Several of the segment results were below 17 weight percent, but as shown in Table 2-1, the DSC results were far below the notification limit of 480 J/g in these segments. Because of the low energetics of the tank waste, those TGA results below 17 weight percent are not expected to adversely impact tank safety.

Table 2-1. Weight Percent Water Results from Core 157.

Sample Location	Percent Water (Segment Mean)	Lower Limit of 95 Percent Confidence Interval	Dry Weight DSC Result (Upper Limit of 95 Percent Confidence Interval)
	wt%	wt%	J/g (dry)
Segment 2, lower half	23.19	13.41	47.2
Segment 4, qtr seg A	27.10	4.96	106.1
Segment 4, qtr seg B	26.79	14.73	169.9
Segment 5A, upper half	16.77	16.29	0
Segment 5A, lower half	27.63	0	0
Segment 7, qtr seg A	27.00	8.97	41.5
Segment 7, qtr seg B	22.61	16.11	0
Segment 7, qtr seg D	33.52	14.35	144.2
Segment 1, lower half	11.66	10.17	0

Note:

qtr seg = quarter segment

2.3 HAZARDOUS VAPOR SAFETY SCREENING

The data required to support vapor screening are documented in *Data Quality Objective for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). The vapor screening DQO addresses the following two technical issues: 1) are potential flammable levels of gases and vapors generated or released in waste storage tank headspaces above 25 percent of the LFL and 2) is there a potential for worker hazards associated with the toxicity of constituents in any fugitive vapor emissions from these tanks? These problems will be dealt with in this section for tank 241-BY-102.

2.3.1 Flammable Gas

This is the same requirement as the safety screening flammability requirement. See Section 2.1.2 for a treatment of the flammability issue.

2.3.2 Toxicity

The vapor screening DQO requires the analysis of ammonia, carbon dioxide (CO_2), carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N_2O), and nitrogen dioxide (NO_2) from a sample. The vapor screening DQO specifies a threshold limit for each of the above listed compounds. Data from the November 1995 vapor sampling event (Thomas et al. 1996), presented in Appendix B, will be used to address the issue of toxicity. Ammonia was the only analyte present at levels (175 parts per million by volume [ppmv]) which exceeded the toxicity notification limit (150 ppmv). Appropriate notifications were made. Notification levels and procedures are described in the sampling and analysis plan (Homi 1995).

2.4 ORGANIC SOLVENTS

The data required to support the organic solvent screening issue are documented in the 93-5 implementation plan (DOE-RL 1996). A new DQO is currently being developed to address the organic solvent issue. In the interim, tanks are to be sampled for total non-methane hydrocarbons to determine if an organic extractant pool greater than 1 m^2 (10.8 ft^2) exists (Cash 1996). The purpose of this assessment is to ensure that the organic solvent pool is sufficiently small to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur. The size of the organic extractant pool will be determined by the organics program based on the vapor data, tank headspace temperature, and tank ventilation rate.

2.5 OTHER TECHNICAL ISSUES

Heat generation and temperature of the waste are factors in assessing tank safety. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on analytical data from the 1996 sampling event is not possible because radionuclide analyses were not required. However, the heat load estimate based on the tank process history was 2,270 W (7,750 Btu/hr) (Agnew et al. 1996a). The heat load estimate based on the tank headspace temperature was 1,620 W (5,540 Btu/hr) (Kummerer 1995). Both of these estimates are quite 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).

2.6 SUMMARY

The results from all analyses performed to address potential safety issues showed that no primary analyte exceeded safety decision threshold limits. One toxicity limit of the vapor safety screening DQO was exceeded. The results of the analyses are summarized in Table 2-2.

Table 2-2. Summary of Safety Screening, Organic, and Vapor Results.

Issue	Sub-issue	Result
Safety screening	Energetics	All exotherms and all one-sided upper limits of 95 percent confidence intervals were well below 480 J/g, dry weight basis. Highest one-sided upper limit of 95 percent confidence interval was 170 J/g, dry weight basis.
	Flammable gas	Vapor measurement using combustible gas meter reported zero percent of LFL.
	Criticality	All total alpha results and one-sided upper limits of 95 percent confidence intervals were well below 33.1 μCi/g total alpha. Highest one-sided upper limit of 95 percent confidence interval was 0.703 μCi/g.
	Separable organics	All segments showed no separable organics.
Organic	Energetics	Same as safety screening.
	Organic content	All total organic carbon results and one-sided upper limits of 95 percent confidence intervals were well below 30,000 μg/g, dry weight. Highest one-sided upper limit of 95 percent confidence interval was 17,700 μg/g.
	Moisture	Several results were less than 17 wt% water. However, energetics were well below the decision limit.
Hazardous vapor	Flammability	See safety screening - flammable gas
	Toxicity	Ammonia concentration of 175 ppmv exceeded the notification limit (150 ppmv).
Organic solvent	Solvent pool size	Concentration of total non-methane hydrocarbons was 19.87 mg/m^3. Organic solvent pool size to be determined.

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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 generally derived using 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; or 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). As part of this effort, an evaluation of available chemical information for tank 241-BY-102 was performed, including the following:

- Data from a push mode 1996 core sample (Fritts 1996b)
- An inventory estimate generated by the HDW model (Agnew et al. 1996a)
- Evaluation of the first-cycle/cladding waste and tributyl phosphate process flowsheets
- Comparison with three similar BY tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-102 for those analytes for which sampling information was available. In general, sample-based TCR results were preferred. The HDW model was used only where no other data were available. On several occasions the average concentrations of analytes from the other BY Farm TCR's were used in calculating an engineering inventory for analytes. The best-basis inventory for tank 241-BY-102 is presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)	Comment
Al	67,500	S	---
Bi	100	E	Used average concentration from other tanks in BY Farm.
Ca	3,320	S	---
Cl	2,540	S	---
TIC as CO_3	219,000	S	---
Cr	2,990	S	---
F	28,300	S	---
Fe	2,920	S	---
Hg	8.6	M	---
K	3,070	E	Used average concentration from other tanks in BY Farm
La	0.55	M	---
Mn	585	S	---
Na	4.30E+05	S	---
Ni	7,580	S	---
NO_2	25,200	S	---
NO_3	1.56E+05	S	---
OH	NR	---	---
Pb	147	E	Used average concentration from other tanks in BY Farm
P as PO_4	45,800	S	---
Si	6,860	S	---
S as SO_4	91,200	S	---
Sr	115	E	Used average concentration from other tanks in BY Farm
TOC	6,940	S	---

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)	Comment
U_{TOTAL}	674	E	Used average concentration from other tanks in BY Farm. May be low; the sample was < 15,900 kg.
Zr	15.6	E	Used average concentration from other tanks in BY Farm

Notes:

1C = first-cycle decontamination waste
CW = cladding waste
S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
NR = not reported
TIC = total inorganic carbon

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997).

Analyte	Total Inventory (kg)	Basis (S, M, or E)	Comment
^{90}Sr	40,500	E	HDW estimate was 1.59E+05 Ci
^{90}Y	40,500	E	Based on Sr estimate
^{137}Cs	1.50E+05	E	HDW estimate was 2.61E+05 Ci
^{137m}Ba	1.42E+05	E	Based on Cs estimate
^{239}Pu	34.6	E	HDW estimate was 207 Ci

Notes:

S = Sample-based
M = Hanford defined waste model-based
E = Engineering assessment-based
HDW = Hanford defined waste model

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4.0 RECOMMENDATIONS

All analytical results for the safety screening and organic DQOs were well within the safety notification limits. However, samples were recovered from only one core sample. Therefore, the tank cannot yet be classified as "safe." All of the analyses that were performed were done in accordance with the applicable DQO documents. Furthermore, a characterization best-basis inventory was developed for the tank contents.

Table 4-1 summarizes the status of the Project Hanford Management Contract (PHMC) TWRS Program office review and acceptance of the sampling and analysis results reported in this TCR. All DQO issues required to be addressed by sampling and analysis are listed in column one of Table 4-1. The second column indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered with a "Yes" or "No." The third column indicates concurrence and acceptance by the program in TWRS that is responsible for ensuring that sampling and analysis activities were performed adequately and meet the requirements of the DQO. A "Yes" or "No" in column three 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 determined, "n/d" is shown in the column. If the results have not been reviewed, "n/r" is shown in the column. Because only one core sample could be analyzed, the safety screening and organic DQOs have been only partially satisfied. Therefore, "partial" is shown in column two for these DQOs. However, one of the core samples was obtained and analyzed in accordance with the safety screening and organic DQOs and accepted by the responsible TWRS programs.

Table 4-1. Acceptance of Tank 241-BY-102 Sampling and Analysis.

Issue	Sampling and Analysis Performed	PMHC Program Office Acceptance
Safety screening DQO	Partial	Partial
Organic DQO	Partial	Partial
Hazardous vapor safety screening DQO	Yes	Yes
Organic solvent	Yes	Yes

Table 4-2 summarizes the status of the PMHC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations specifically outlined in this report are the evaluation to determine if there is an organic safety concern, and the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column one lists the different evaluations performed in this report. Columns two and three 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. The organic evaluation and safety categorization of the tank are listed as "partial" in Table 4-2 because only one core sample could be analyzed. However, none of the analyses performed on the core sample indicate any safety problems.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-BY-102.

Issue	Evaluation Performed	PHMC Program Office Acceptance
Safety categorization (tank is safe)	Partial	Partial
Hazardous vapor	Yes	Yes
Organic solvent	No	n/r

Note:
n/r = not reviewed.

Additional waste samples from tank 241-BY-102 may be needed to provide a second full-depth core samples in order to complete evaluation of the tank in accordance with the safety screening and organic DQOs. The information available on tank 241-BY-102 should be evaluated further to determine if additional samples are needed to categorize the tank as "safe."

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-BY-102 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 is necessary to provide a balanced assessment of the sampling and analytical results.

This appendix contains the following information.

- **Section A1**: Current status of the tank, including the current waste levels as well as the tank's stabilization and isolation status.
- **Section A2**: Information about the tank design.
- **Section A3**: Process knowledge of the tank, i.e., the waste transfer history and the estimated tank contents based on modeling data.
- **Section A4**: Surveillance data for tank 241-BY-102, including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5**: References for Appendix A.

Historical sampling results (results from samples obtained prior to 1989) are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of September 30, 1996, tank 241-BY-102 contained an estimated 1,050 kL (277 kgal) of waste classified as non-complexed (Hanlon 1996). Liquid waste volumes are estimated using a combination of a manual tape and a photographic evaluation. The solid waste volumes are estimated using a manual tape. The solid waste volume was last updated on May 1, 1995. The amounts of the various waste phases in the tank are presented in Table A1-1.

Tank 241-BY-102 is out of service, as are all single-shell tanks, and is not on the Watch List (Public Law 101-510). This tank is categorized as sound with interim stabilization and partial interim isolation completed (Hanlon 1996). The tank is passively ventilated. All monitoring systems, except for the temperature monitoring equipment (which is out of service), were in compliance with documented standards as of September 30, 1996 (Hanlon 1996).

Table A1-1. Tank Contents Status Summary (Hanlon 1996).

Waste Type	kL (kgal)
Total waste	1,050 (277)
Supernatant liquid	0 (0)
Sludge	0 (0)
Saltcake	1,050 (277)
Drainable interstitial liquid	42 (11)
Drainable liquid remaining	42 (11)
Pumpable liquid remaining	0 (0)

A2.0 TANK DESIGN AND BACKGROUND

The 241-BY Tank Farm was constructed from 1948 to 1949 in the 200 East Area. The tank farm contains twelve 100-series tanks, each with a capacity of 2,870 kL (758 kgal) and a diameter of 22.9 m (75.0 ft) (Leach & Stahl 1993). The 241-BY Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Brevick et al. 1996). A cascade line 75 mm (3 in.) in diameter connects tank 241-BY-102 as fifth in a cascade series of six tanks beginning with tanks 241-BX-101, 241-BX-102, and 241-BX-103 in the BX Tank Farm and tank 241-BY-101 in the BY Tank Farm and cascading into tank 241-BY-103 (Hanlon 1996). Each tank in the cascade series is set 30.5 cm (1 ft) lower in elevation from the preceding tank.

The tank has a dished bottom with a 1.2-m (4-ft) radius knuckle. Tank 241-BY-102 was designed with a primary mild steel liner (ASTM A283 Grade C) and a concrete dome with various risers. The tank is set on a reinforced concrete foundation. A three-ply asphalt waterproofing was applied over the foundation and steel tank. Two coats of primer were sprayed on all exposed interior tank surfaces. The tank ceiling dome was covered with three applications of magnesium zinc fluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the risers in the tank dome. The tank was waterproofed on the sides and top with tar and welded wire reinforced concrete (Rutherford 1948).

Tank 241-BY-102 has 17 risers according to the drawings and engineering change notices. The risers range in diameter from 100 mm (4 in.) to 1.1 m (42 in.). Table A2-1 shows numbers, diameters, and descriptions of the risers and the nozzles. A plan view that depicts the riser and nozzle configurations is shown as Figure A2-1. According to Lipnicki (1996), risers 4 (100 mm [4 in.] in diameter) and risers 5 and 10A (300 mm [12 in.] in diameter) are available for use. Recent tank farm walkdowns have shown that riser 4 is bent and unavailable for sampling. Figure A2-2 is a tank cross-section showing the approximate waste level along with a schematic of the tank equipment.

A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the history of the major waste transfers that involved tank 241-BY-102; 2) describe the process wastes that were transferred; and 3) give an estimate of the tank's current contents based on the waste transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-BY-102 (Agnew et al. 1996b). Tank 241-BY-102 first received waste in the third quarter of 1950, with a cascade of MW from tank 241-BY-101. The MW began cascading from tank 241-BY-102 to tank 241-BY-103 during the fourth quarter of 1950, and the cascade continued until the first quarter of 1951. In 1953, the tank received water repeatedly and supernatant was sent to tanks 241-B-103, 241-C-106, and 241-BX-103. The tank was emptied in the third quarter of 1954 when the waste was sent for uranium recovery. Water and tributyl phosphate (TBP) waste were sent to the tank in the first quarter of 1955 and supernatant cascaded to tank 241-BY-103. Tank 241-BY-102 received supernatant from tanks 241-BY-105 and 241-BY-110 during the second quarter of 1955. Waste was again sent for uranium recovery.

During the second quarter of 1957, tank 241-BY-102 received supernatant from tank 241-C-112. Waste was sent to tanks 241-C-109 and 241-C-111 for ferrocyanide scavenging. Supernatant was received from tanks 241-BX-105, 241-BX-106, 241-C-105, and 241-BY-107 during the third and fourth quarters of 1957. Also, during this time, supernatant was sent from tank 241-BY-102 to Cribs B-032, B-033, B-034, and B-035.

Tank 241-BY-102 was static until 1964. During the fourth quarter of 1964 and the second and third quarters of 1965, the tank received supernatant containing cladding waste from tank 241-C-102.

Figure A2-1. Riser Configuration for Tank 241-BY-102.

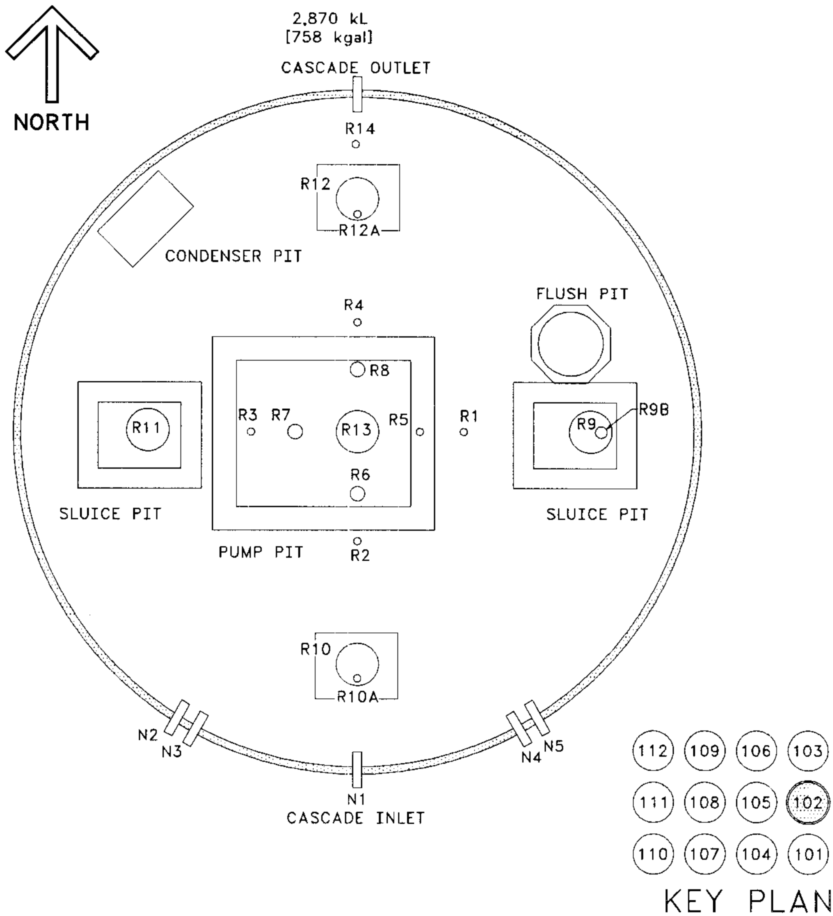


Table A2-1. Tank 241-BY-102 Risers.[1,2,3,4,5]

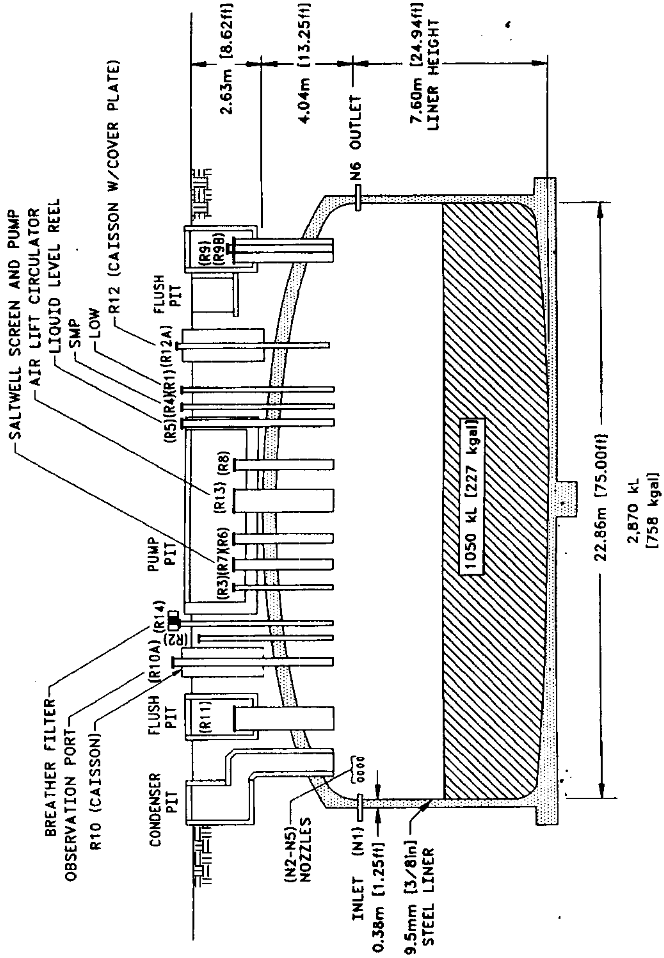
Number	Diameter		Description and Comments
	cm	in.	
R1	10	4	B-436 liquid observation well (LOW)
R2	10	4	Covered w/ concrete, below grade
R3	10	4	Pit drain
R4	10	4	Sludge measurement port
R5[6]	30	12	Liquid level reel [bench mark CEO-36522 12/11/86]
R6	30	12	Covered w/ concrete
R7	30	12	Saltwell screen and pump
R8	30	12	Covered w/ concrete
R9	110	42	Weather covered
R9B	30	12	Slurry pump, weather covered
R10	110	42	Condensate drain, weather covered
R10A[6]	30	12	Observation port/B-222
R11	110	42	Weather covered
R12	110	42	Instrumentation pit, weather covered
R12A	5	2	Weather covered
R13	110	42	Air circulator, contains 18 in. pipe
R14	10	4	Breather filter
N1	8	3	Cascade inlet, plugged
N2	8	3	Spare, plugged
N3	8	3	Spare, plugged
N4	8	3	Spare, plugged
N5	8	3	Spare, plugged
N6	8	3	Cascade outlet, plugged

Notes:

CEO = change engineering order

[1]Alstad (1993)
[2]Tran (1993)
[3]ARHCO (1973)
[4]Vitro Engineering Corporation (1973)
[5]Vitro Engineering Corporation (1988)
[6]Indicates risers tentatively available for sampling (Lipnicki 1996).

Figure A2-2. Tank 241-BY-102 Cross Section and Schematic.



Tank 241-BY-102 became in-tank solidification unit #1 (ITS#1) in 1966 (after the pilot experiment in tank 241-BY-101 in 1965). A heater was placed in the tank to cause evaporation. In the fourth quarter of 1966, the tank received waste from 241-BY-101. Then tank 241-BY-103 became the feed tank (source of supernatant) for ITS#1 from late 1966 to 1970. Waste was also received from tank 241-B-110 during 1967.

In the fourth quarter of 1966, waste was sent to tank 241-C-102. Waste was sent to tanks 241-BY-105 and 241-BY-112 in 1968 (tank 241-BY-112 had become ITS#2 in 1968). Supernatant was sent to tank 241-BY-102 from tank 241-BY-109 during the third quarter of 1968. Tank 241-BY-102 received waste from tanks 241-BX-103, 241-BX-104, 241-BX-105, 241-BX-106, 241-BX-107, 241-BX-108, 241-BX-109, 241-BX-110, 241-BX-111, and 241-BX-112 during the third quarter of 1969. Supernatant was sent to tank 241-BY-105 from 1969 to 1971. Tank 241-BY-102 received supernatant from tank 241-BX-102 during the first quarter of 1970, and from tank 241-BX-103 throughout 1970 and most of 1971. Supernatant was transferred to tank 241-BY-102 from tank 241-BY-109 in the third quarter of 1970. Supernatant was also received from tank 241-BX-106 during the second quarter of 1971. Waste was exchanged between tank 241-BY-102 and tank 241-BY-112 from the third quarter of 1971 to the fourth quarter of 1974 while 241-BY-112 functioned as ITS#2. Supernatant was sent from tank 241-BY-102 to tanks 241-BY-110 and 241-BX-111 during 1974.

During 1977 and 1978, waste was sent from tank 241-BY-102 to tank 241-A-102. Waste was also sent to tank 241-BX-105 during 1978. In 1983, waste was sent to tank 241-AN-103. Waste was sent to tank 241-AN-101 in 1991. Tank 241-BY-102 was salt well jet pumped in March 1995, removing a total of 602 kL (159 kgal) of liquid. The tank was declared interim stabilized in April 1995 following the pumping (Hanlon 1995).

Table A3-1. Tank 241-BY-102 Major Waste Transfers.[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
241-BY-101	---	MW	1950-1951	5,071	1,340
---	241-BY-103	MW	1950-1951	-2 230	-588
---	241-B-103, 241-C-106, 241-BX-103	SU	1953, 1954	-2 870	-758
---	241-BY-103	Flush Water	1955	190	51
---	U Plant	MW	1954	-1 881	-497
241-BY-105, 241-BY-110	---	SU	1955	3,510	928

Table A3-1. Tank 241-BY-102 Major Waste Transfers.[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
Miscellaneous	---	Flush Water	1953 - 1955	3,310	874
---	U Plant	SU	1955	-2,020	-534
241-C-112, 241-BX-105, 241-BX-106, 241-C-105, 241-BY-107	---	SU	1957	5,538	1,463
---	241-C-109, 241-C-111	TBP	1957	-2,670	-706
---	Cribs B-032, B-033, B-034, B-035	SU	1957	-5,579	-1,474
241-C-102	---	SU	1964-1965	2,570	680
241-BY-101	---	CW	1966	220	57
241-BY-103	---	SU	1966-1970	40,950	10,819
---	Evaporated	BY condensate	1966-1971	-35,270	-9,318
---	241-C-102	SU	1966	-72	-19
241-B-110	---	FP	1967	260	68
---	241-BY-105	SU	1968	-3,270	-865
---	241-BY-112	SU	1968	-12,530	-3,311
241-BY-109	---	SU	1968	753	199
241-BX-103, -104, -105, -106, -107, -108, -109, -110, -111, -112	---	CW, EB, IX, OWW, TBP	1969	1,230	326
---	241-BY-105	SU	1969-1971	-7,836	-2,070
241-BX-102	---	SU	1970	1,510	399
241-BX-103	---	SU	1970-1971	14,050	3,712
---	241-BY-109	SU	1970	-250	-66

Table A3-1. Tank 241-BY-102 Major Waste Transfers.[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
241-BX-106	---	SU	1971	160	43
241-BY-112	---	EB	1971-1974	799	211
---	241-BY-112	SU	1971-1974	-662	-175
---	241-BY-110, 241-BX-111	SU	1974	-432	-114
---	241-A-102	EVAP	1977, 1978	-791	-209
---	241-BX-105	SU	1978	-53	-14
---	241-AN-103	SWLIQ	1983	-95	-25
---	241-AN-101	SWLIQ	1991	-190	-51
---	241-AN-101	SWLIQ	1995	-602	-159

Notes:

BYSltCk	Saltcake blend from ITS in BY Tank Farm
CW	Cladding waste
EB	Evaporator bottoms
EVAP	Evaporator feed waste
FP	Fission product waste from cesium and strontium recovery in B Plant
IX	Ion exchange waste
MW	Metal waste from the bismuth phosphate process (which extracted plutonium) containing all of the uranium, approximately 90 percent of the original fission product activity, and approximately 1 percent of the product. The term "metal" was the code word for plutonium,
OWW	Organic Wash Waste from plutonium-uranium extraction (PUREX). Evidently, this was combined with PUREX high-level waste in 1960 - 61, but usually kept separate. The solvent used in PUREX was treated before reuse by washing with potassium permanganate and sodium carbonate, followed by dilute nitric acid and then a sodium carbonate wash.
SU	Supernatant
SWLIQ	Dilute, non-complexed waste from 200-East Area single-shell tanks
TBP	Tributyl phosphate (uranium recover) waste

[1]Agnew et al. 1996b

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

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 Northeast Quadrant of the Hanford 200 East Area* (WSTRS) (Agnew et al. 1996b). 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. 1996a). 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.

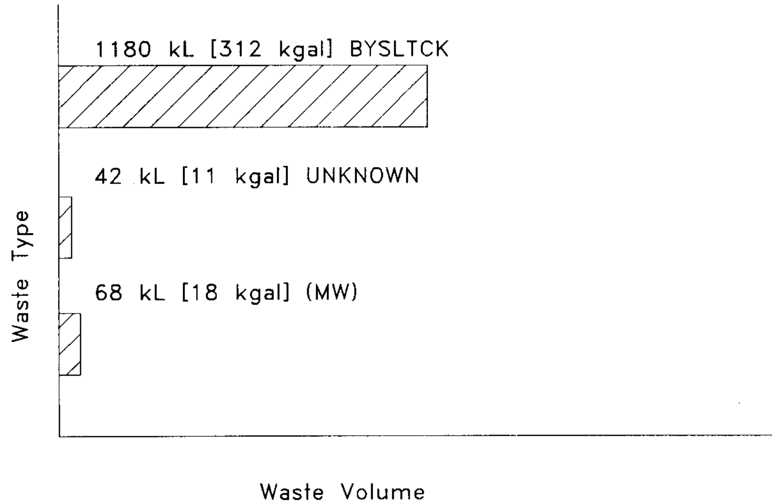
- Tank Layer Model (TLM). The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- 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 supernates 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 TLM and SMM, tank 241-BY-102 contains a top layer of 1,180 kL (312 kgal) of BY saltcake (BYSltCk) above a layer of 42 kL (11 kgal) of unknown, and a bottom layer of 68 kL (18 kgal) of MW. The parentheses around the MW indicate that the layer comes from an unknown origin and was assigned as per the history of the tank. Figure A3-1 shows a graph representing the estimated waste type and volume for each waste layer.

Figure A3-1. Tank Layer Model.



Note that the overall waste volume predicted by Agnew et al. (1996a) differs from that in Hanlon (1996). Agnew's estimate is based on 1994 waste levels, and does not take into account the 1995 saltwell pumping. The solid and drainable interstitial liquid waste levels were reevaluated after the pumping, and the levels reported in Hanlon (1996) were established.

The MW (bottom waste layer) should contain, from highest concentration above one weight percent, the following major constituents: uranium, hydroxide, sodium, carbonate, and phosphate. Constituents contained in this layer above a tenth of a weight percent are sulfate, iron, nitrate, and calcium. The BYSltCk layer should contain, from highest concentration above one weight percent, the following constituents: nitrate, sodium, hydroxide, nitrite, aluminum, carbonate, and sulfate. Constituents contained in this layer above a tenth of a weight percent are phosphate, uranium, dibutyl phosphate, citrate, chloride, calcium, chromium, silicate, acetate, and butanol. Radiological activity will be found in this layer because of the quantity of cesium present. Table A3-2 shows an estimate of the expected waste constituents and their concentrations.

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

Total Inventory Estimate			
Physical Properties			
Total solid waste	2.09E+06 kg (341 kgal)		
Heat load	2,270 W (7,750 Btu/hr)		
Bulk density	1.62 (g/mL)		
Water wt%	38.3		
Total Organic Carbon wt% Carbon (wet)	0.440		
Chemical Constituents	***M***	**ppm**	**kg**
Na^{+}	11.8	1.68E+05	3.51E+05
Al^{3+}	2.00	33,400	69,600
Fe^{3+} (total Fe)	0.021	727	1,520
Cr^{3+}	0.0472	1,520	3,170
Bi^{3+}	8.47E-04	110	229
La^{3+}	3.05E-06	0.263	0.547
Hg^{2+}	3.34E-05	4.15	8.64
Zr (as $ZrO(OH)_2$)	2.80E-04	15.8	32.9
Pb^{2+}	0.00522	670	1,400
Ni^{2+}	0.0124	452	942
Sr^{2+}	3.32E-06	0.180	0.375
Mn^{4+}	0.00308	105	218
Ca^{2+}	0.0719	1,780	3,720
K^{+}	0.0356	863	1,800
OH^{-}	9.22	97,000	2.02E+05
NO_3^{-}	5.94	2.28E+05	4.75E+05
NO_2^{-}	1.64	46,800	97,700
CO_3^{2-}	0.568	21,100	44,000
PO_4^{3-}	0.0858	5,040	10,500
SO_4^{2-}	0.185	11,000	23,000
Si (as SiO_3^{2-})	0.0728	1,270	2,640
F^{-}	0.0561	660	1,380
Cl^{-}	0.120	2,640	5,500
$C_6H_5O_7^{3-}$	0.0227	2,650	5,530
$EDTA^{4-}$	0.00557	993	2,070
$HEDTA^{3-}$	0.00168	284	593

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

Total Inventory Estimate			
Chemical Constituents (Cont'd)	***M***	**ppm**	**kg**
glycolate$^-$	0.0173	803	1,670
acetate$^-$	0.0302	1,100	2,300
oxalate^{2-}	2.61E-06	0.142	0.297
DBP	0.0240	3,960	8,250
Butanol	0.0240	1,100	2,300
NH_3	0.00980	103	215
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	**Ci/L**	**μCi/g**	**Ci**
Pu	---	0.0989	3.44 (kg)
U	0.129 (*M*)	1,350 (μg/g)	39,500 (kg)
Cs	0.202	125	2.61E+05
Sr	0.121	74.6	1.56E+05

Notes:

[1]Agnew et al. (1996a)

[2]These predictions have not been validated and should be used with caution.

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A4.0 SURVEILLANCE DATA

Tank 241-BY-102 surveillance includes surface-level measurements (liquid and solid) and temperature monitoring inside the tank (waste and headspace). The data provide the basis for determining tank integrity.

Liquid-level measurements may indicate the tank has a major leak. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers.

A4.1 SURFACE LEVEL READINGS

A manual tape is used to monitor the waste surface level in tank 241-BY-102 through riser 5. On October 10, 1996, the waste surface level was 1.8 m (72 in.), as measured by the manual tape. On November 5, 1996, the liquid observation well reading from riser 1 was 2.2 m (87 in.). No explanation for the difference in these levels could be found. A graphical representation of the volume measurements is presented as a level history graph in Figure A4-1.

A4.2 DRYWELL READINGS

Tank 241-BY-102 has five drywells. Drywells 22-02-01 (active prior to 1990, current readings > 200 c/s) and 22-02-09 (active prior to 1990, current readings < 200 c/s) have readings greater than the 50 c/s background radiation. However, the tank is categorized as sound.

A4.3 INTERNAL TANK TEMPERATURES

Tank 241-BY-102 no longer contains a thermocouple tree. Temperature data from 14 thermocouples recorded from August 5, 1974 through April 22, 1979 and one reading on November 2, 1991 were obtained from the Surveillance Analysis Computer System (SACS) (LMHC 1996). The average temperature of the SACS data is 20.4 °C (68.7 °F), the minimum is 3.9 °C (39 °F), and the maximum is 37 °C (99 °F). Because there are no current temperature data for tank 241-BY-102, statistics on the last year and current readings could not be generated. A graph of the weekly high temperatures can be found in Figure A4-2. Plots of the individual thermocouple readings can be found in *Supporting Document for the Historical Tank Content Estimate for BY Tank Farm* (Brevick et al. 1996).

A4.4 TANK 241-BY-102 PHOTOGRAPHS

The September 1987 photographic montage (Brevick et al. 1996) of the interior of tank 241-BY-102 shows an outer crust of saltcake with an inner pool of supernatant. Various pieces of equipment and risers that are identifiable have been labeled. The waste level has changed since the photographs were taken; therefore, this photographic montage does not accurately represent the current appearance of the tank's waste. Still photographs from an April 11, 1995 videotaping, obtained from the Lockheed Martin Services, Inc. VIDON database, show an outer ring of saltcake with a large pit where the supernatant used to be.

Figure A4-1. Tank 241-BY-102 Level History.

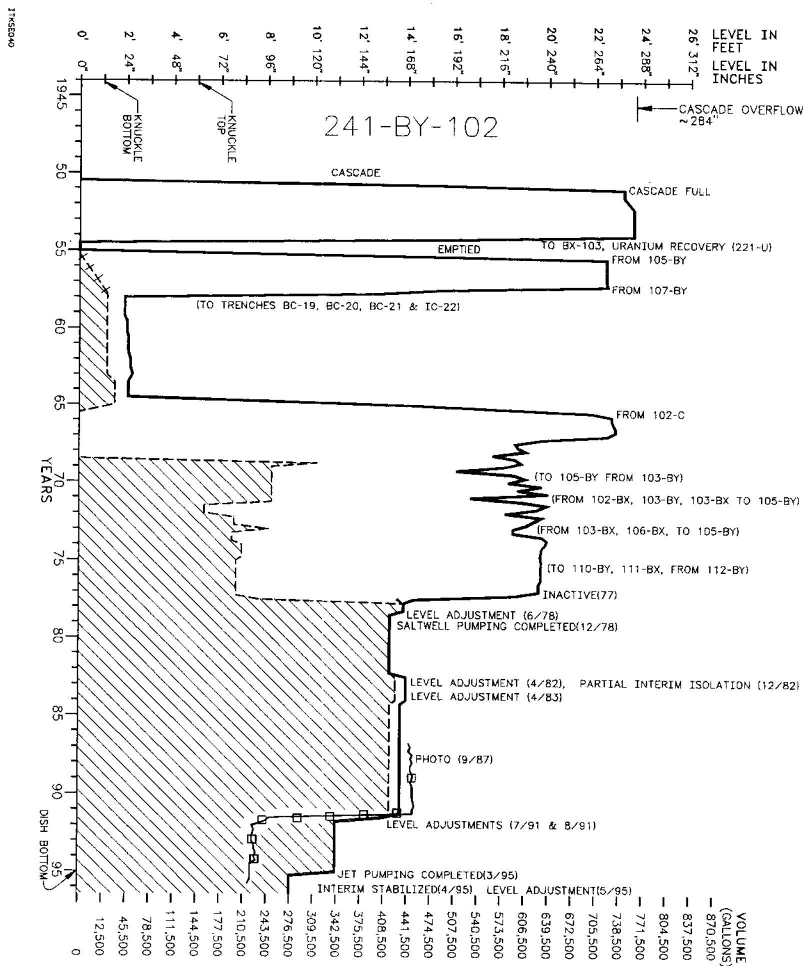
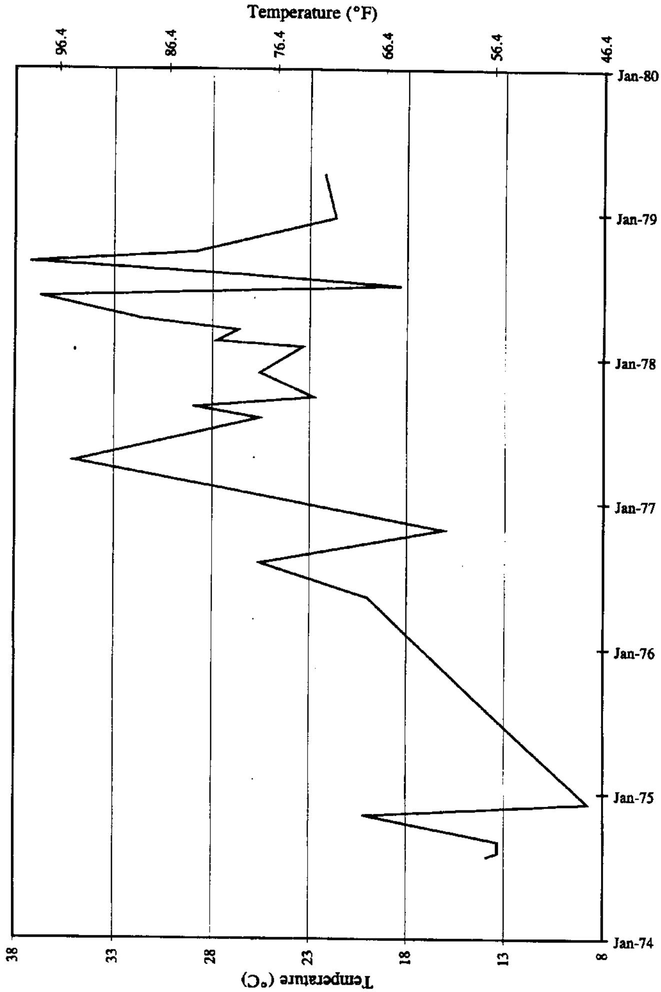


Figure A4-2. Tank 241-BY-102 Weekly High Temperature Plot.



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APPENDIX B

SAMPLING OF TANK 241-BY-102

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APPENDIX B

SAMPLING OF TANK 241-BY-102

Appendix B provides sampling and analysis information for each known sampling event for tank 241-BY-102 and provides an assessment of the 1996 core sampling 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-BY-102 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

Appendix B describes all known sampling events for tank 241-BY-102, and presents the analytical results for each event. The sampling events listed include the 1996 core sampling event, the 1995 vapor sampling event, and the 1990 historical supernatant event.

Core samples were taken in June/July 1996 to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The sampling and analysis were performed in accordance with the *Tank 241-BY-102 Push Mode Core Sampling and Analysis Plan* (Winkelman 1996). The analytical results of the sampling event were published in the final data report (Fritts 1996b). Before and during core sampling, the flammability of the tank headspace was measured to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995).

Tank headspace samples were taken in November 1995 to satisfy the requirements of the *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution* (Osborne et al. 1995). The sampling and analysis were performed in accordance with the *Vapor Sampling and Analysis Plan* (Homi 1995). The results were reported in *Headspace Vapor Characterization of Hanford Waste Tank 241-BY-102: Results from Samples Collected on 11/21/95* (Thomas et al. 1996).

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-BY-102.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
1996 core sampling	Safety screening	Core samples from a minimum of two risers separated radially to the maximum extent possible.	▸ Energetics ▸ Moisture content ▸ Total alpha ▸ Bulk density ▸ Separable organic layer
	Organic		▸ Energetics ▸ Moisture content ▸ Total organic carbon
Combustible gas meter reading	Safety screening	Measurement in a minimum of one location within tank headspace.	▸ Flammable gas concentration
1995 vapor phase measurements	Hazardous vapor[2]	Measurement in a minimum of one location within tank headspace.	▸ Gases (ammonia, CO_2, CO, NO, NO_2, N_2O, TOC, tributyl phosphate, n-dodecane, and n-tridecane) ▸ Vapor flammability
	Organic solvent[3]		▸ Total non-methane hydrocarbons

Notes:
[1]Winkelman (1996)
[2]Osborne et al. (1995)
[3]Cash (1996)

One historical sampling event was reported for tank 241-BY-102 (Edrington 1991). The supernatant sample was taken in 1990 prior to the 1991 transfer of saltwell liquor. No information was available regarding sample handling and analysis for the samples; therefore, only analytical results and references are reported.

B2.0 SAMPLING EVENTS

B2.1 1996 CORE SAMPLING EVENT

B2.1.1 Description of 1996 Core Sampling Event

Two core samples, one each from riser 10A and riser 5, were planned to be taken from tank 241-BY-102. One nine-segment push-mode core sample (core 157) was obtained from riser 10A. Segment 1 was taken on June 19, 1996. Segments 2 through 5 and 5A were taken on June 20. The acquisition of segment 5 was stopped due to high downforces after taking approximately 20 cm (8 in.) of sample. The sampler was replaced, and another 18 cm (7 in.) of sample, designated segment 5A, was taken to complete segment 5. Segments 6 through 8 were taken on June 21, completing the core. Only three push-mode segments (core 159) were taken from riser 5 before high downforces prevented further sampling. Segments 1 and 2 were obtained on July 8. Pushing of segment 2 stopped at 46 cm (18 in.) because of high downforces. Segment 3 could only be pushed 0.3 cm (1/8 in.). Water, containing a lithium bromide tracer, was used during core sampling in an attempt to soften the wastes when high downforces were reached.

The segments from core 159 contained no sample. Therefore, only one core sample was sampled and analyzed; as a result, the sampling event did not meet the sampling and analysis plan (SAP) and DQO requirements for two full depth cores.

Vapor phase measurements were made prior to and during the core sampling event. The vapor phase measurements were made through risers 5 and 10A in the tank headspace, 6 m (20 ft) below the top of the riser. A number of measurements were made through riser 10A on June 19, June 20, and July 8, 1996 and through riser 5 on July 3 and July 8, 1996. These measurements were obtained in the field, (i.e., no gas sample was sent to the laboratory for analysis). Results from these measurements are shown in Section B2.1.4.6.

B2.1.2 1996 Core Sample Handling

The tank 241-BY-102 core samples were received at the Westinghouse Hanford Company 222-S Laboratory between June 25 and August 2, 1996. Samples were extruded between July 1 and August 7, 1996. All subsamples were manually homogenized prior to analysis. Sample descriptions, along with recoveries and subsampling information, are provided in Table B2-1. In addition to the segments and the field blank, a sample of the lithium bromide solution used during sampling operations was provided to the laboratory.

Table B2-1. Tank 241-BY-102, Core 157 and 159 Sample Description.[1] (2 sheets)

Core	Seg.	Sample ID	Expected Sample Length (cm)	Sample Recovered (cm)	Sample Weight (g)		Sample Description
					Drainable Liquid	Solid	
157	1	96-354	32	5	0	37.1 (lower half)	Solids were mostly white with some slight tan coloration, and resembled a dry saltcake.
	2	96-355	48	20	0	146.5 (lower half)	Solids were light brown to black and resembled a dry, crumbly saltcake.
	3	96-356	48	15	0	99.87 (lower half)	Solids were brown to light grey on the outside. The inside was white. The solids resembled a dry, flaky saltcake. The ends of the sample were crumbly.
	4	96-357	48	23	0	90.0 (qtr seg A) 30.0 (qtr seg B) 26.1 (qtr seg C)	Solids were yellow to brown and resembled a dry saltcake.
	5	96-358	24	20	0	93.2 (lower half)	Solids were yellow to gray in color and resembled a dry saltcake.
	5A	96-358A	24	18	0	33.5 (upper half) 66.2 (lower half)	Solids were yellow to brown and resembled a dry saltcake.
	6	96-359	48	18	0	178.42 (upper half) 93.56 (lower half)	Solids were a light green with a brown tint and resembled a mixture of wet sludge and saltcake.

Table B2-1. Tank 241-BY-102, Core 157 and 159 Sample Description.[1] (2 sheets)

Core	Seg.	Sample ID	Expected Sample Length (cm)	Sample Recovered (cm)	Sample Weight (g)		Sample Description
					Drainable Liquid	Solid	
157	7	96-360	46	38	74.4	48.7 (qtr seg A) 57.7 (qtr seg B) 61.9 (qtr seg C) 115.6 (qtr seg D)	The drainable liquid was green and opaque. The solids were light to dark gray and resembled a wet saltcake.
	8	96-361	0	Not measurable	96.47	0	The drainable liquid was green and opaque. A small amount of solid, gray material was extruded near the piston. This was subsampled as part of the drainable liquid.
159	1	96-374	40	0	0	0	No solids or liquids recovered.
	2	96-375	46	0	0	0	No solids or liquids recovered. Solids were present on the outside of the sampler but were not retained.
	3	96-376	0.3	0	0	0	No solids or liquids recovered.
FB	n/a	n/a	n/a	n/a	188.2	0	The field blank liquid was clear and colorless.

Notes:

FB = field blank
Seg. = segment
Qtr = quarter

[1]Fritts (1996a)

B2.1.3 1996 Core Sample Analysis

The analyses performed on the core samples were limited to those required by the safety screening and organic DQOs (total alpha activity, energetics, water content, bulk density/specific gravity, total organic carbon [TOC], lithium, and bromide). The SAP did not require the bulk density and total alpha analyses to be performed on the upper half of the segments. A check was also made on the samples for a separable organic layer. Additional anions, metals, and total inorganic carbon (TIC) were obtained on an opportunistic basis as a result of the analyses for bromide, lithium, and TOC, respectively (Kristofzski 1995). Headspace gas flammability, required by the safety screening DQO, was measured in the tank headspace using a combustible gas meter.

Samples were homogenized by manual mixing prior to analysis. Because of the small amount of sample, quarter segment C of segment 4 was not homogenized. Depending on the analysis, solid subsamples were analyzed directly or after a fusion or water digestion. Drainable liquid subsamples were analyzed directly or after dilution with water or acid. The water content was determined by thermogravimetric analysis (TGA). The fuel content of the waste was determined by differential scanning calorimetry (DSC). Total alpha activity was measured by counting in an alpha proportional counter. Metals were measured using inductively coupled plasma/atomic emission spectroscopy (ICP). Anions were measured using ion chromatography (IC). Total organic carbon was measured using hot persulfate oxidation and coulometry, and total inorganic carbon was measured by coulometry.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table B2-2. The procedure numbers are presented in the discussion in Section B2.1.4.

Table B2-2. Sample Analysis Summary.[1] (4 sheets)

Core	Segment	Sample Portion	Sample Number	Analyses
157	1	lower half	S96T004293	Bulk density
			S96T004294	DSC, TGA, TIC, TOC
			S96T004295	ICP, total alpha
			S96T004938	IC
	2	lower half	S96T003632	Bulk density
			S96T003633	DSC, TGA, TIC, TOC
			S96T003635	ICP, total alpha
			S96T003636	IC

Table B2-2. Sample Analysis Summary.[1] (4 sheets)

Core	Segment	Sample Portion	Sample Number	Analyses
157 (Cont'd)	3	lower half	S96T003641	Bulk density
			S96T003644	DSC, TGA, TIC, TOC
			S96T003650	ICP, total alpha
			S96T003653	IC
	4	qtr seg A	S96T004145	DSC, TGA, TIC, TOC
			S96T004160	ICP
			S96T004169	IC
		qtr seg B	S96T004124	Bulk density
			S96T004146	DSC, TGA, TIC, TOC
			S96T004164	ICP, total alpha
			S96T004170	IC
		qtr seg C	S96T004125	Bulk density
			S96T004147	DSC, TGA, TIC, TOC
			S96T004165	ICP, total alpha
			S96T004171	IC
	5	lower half	S96T004340	Bulk density
			S96T004341	DSC, TGA, TIC, TOC
			S96T004343	ICP, total alpha
			S96T004344	IC
	5A	upper half	S96T004148	DSC, TGA, TIC, TOC
			S96T004161	ICP
			S96T004172	IC
		lower half	S96T004127	Bulk density
			S96T004149	DSC, TGA, TIC, TOC
			S96T004166	ICP, total alpha
			S96T004173	IC

Table B2-2. Sample Analysis Summary.[1] (4 sheets)

Core	Segment	Sample Portion	Sample Number	Analyses
157 (Cont'd)	6	upper half	S96T003645	DSC, TGA, TIC, TOC
			S96T003651	ICP
			S96T003654	IC
		lower half	S96T003643	Bulk density
			S96T003646	DSC, TGA, TIC, TOC
			S96T003652	ICP, total alpha
			S96T003655	IC
	7	qtr seg A	S96T004150	DSC, TGA, TIC, TOC
			S96T004162	ICP
			S96T004174	IC
		qtr seg B	S96T004151	DSC, TGA, TIC, TOC
			S96T004163	ICP
			S96T004175	IC
	7	qtr seg C	S96T004130	Bulk density
			S96T004152	DSC, TGA, TIC, TOC
			S96T004167	ICP, total alpha
			S96T004176	IC
		qtr seg D	S96T004131	Bulk density
			S96T004153	DSC, TGA, TIC, TOC
			S96T004168	ICP, total alpha
			S96T004177	IC
		drainable liquid	S96T004133	Specific gravity, DSC, TGA, TIC, TOC, ICP, total alpha, IC
	8	drainable liquid	S96T003657	Specific gravity, DSC, TGA, TIC, TOC, ICP, total alpha, IC

Table B2-2. Sample Analysis Summary.[1] (4 sheets)

Core	Segment	Sample Portion	Sample Number	Analyses
Field blank	n/a	liquid	S96T004300	Specific gravity, DSC, TGA, TIC, TOC, ICP, total alpha, IC
LiBr solution	n/a	liquid	S96T004014	ICP, IC

Note:

[1]Fritts (1996a, 1996b)

B2.1.4 1996 Core Sampling Analytical Results

This section summarizes the sampling and analytical results associated with the June/July 1996 sampling and analysis of tank 241-BY-102. Analytical results are indexed in Table B2-3. These results are documented in Fritts (1996a, 1996b).

Table B2-3. Analytical Presentation Tables.

Analysis	Table Number
Non-detected ICP results	Table B2-4
Metals by ICP	Tables B2-5 through B2-20
Anions by IC	Tables B2-21 through B2-28
Total inorganic carbon	Table B2-29
Total organic carbon	Table B2-30
Total alpha activity	Table B2-31
Bulk density	Table B2-32
Specific gravity	Table B2-33
Differential scanning calorimetry	Table B2-34
Percent water	Table B2-35
Headspace measurements	Table B2-36
1995 vapor sampling data	Table B2-37
Historical sampling data	Tables B2-38 and B2-39

The four quality control (QC) parameters assessed in conjunction with the tank 241-BY-102 samples were standard recoveries, spike recoveries, duplicate analyses (relative percent difference [RPD]), and blanks. The QC criteria specified in the SAP (Winkelman 1996) were: 1) 80 to 120 percent standard recoveries for ICP, IC, DSC, TGA, TIC, and TOC and 70 to 130 percent for total alpha; 2) 75 to 125 percent spike recoveries for ICP and total alpha for both liquid and solid samples and IC, TOC, and TIC for solid samples; and 3) ≤ 20 percent RPD for ICP, IC, DSC, TGA, TIC, TOC, and total alpha. The only QC parameter for which limits are not specified in the SAP 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 blank contamination.

In most of the tables of analytical results in this section, a mean value is presented. The mean is the average of the individual results for each sample (usually the result and duplicate values). All values, including those below the detection level (denoted by the less-than symbol, "<"), were averaged. If both sample and duplicate values were non-detected, the mean is expressed as a non-detected value. If one value was detected while the other was not, the mean is expressed as a non-detected value.

B2.1.4.1 Inorganic Analyses

B2.1.4.1.1 Inductively Coupled Plasma Spectroscopy. Samples were analyzed using ICP per procedure LA-505-161 Rev. B-1. Solid samples were prepared using a fusion digestion per procedure LA-549-141, Rev. F-0 prior to analysis by ICP. The solids were fused using potassium hydroxide in a nickel crucible. Therefore, no potassium results are reported for the solid samples, and the nickel results for the solid samples are likely biased high. Although a full suite of analytes is reported, the SAP required only lithium to be analyzed. The SAP specified no QC requirements for ICP elements other than lithium. Lithium analysis was required to evaluate the extent of any lithium bromide solution contamination in the samples.

Twenty-one of the 37 ICP elements were not detected in any of the tank 241-BY-102 samples; these are summarized in Table B2-4. For these analytes, the highest non-detected value has been included in Table B2-4 (instead of a mean of the non-detected results). The concentrations of the detected metals are shown in Tables B2-5 through B2-20. The lithium analyses did not indicate any LiBr solution contamination of the samples, but the bromide analyses indicated contamination of one drainable liquid sample. The lithium results for this sample did not indicate contamination; however, lithium may have precipitated from the sample and therefore was not detected. The ICP analysis indicated high concentrations of sodium and aluminum and lower concentrations of chromium and nickel. Results for other ICP elements were generally below detection limits.

Table B2-4. Tank 241-BY-102 Analytical Results: Non-Detected Analytes (ICP).

Analyte	Solids: Fusion	Liquids
	µg/g	µg/mL
Antimony	< 1,240	< 36.1
Arsenic	< 2,070	< 60.1
Barium	< 1,040	< 30.1
Beryllium	< 104	< 3
Bismuth	< 2,070	< 60.1
Boron	< 1,040	< 30.1
Cadmium	< 104	< 3
Cerium	< 2,070	< 60.1
Cobalt	< 414	< 12
Lanthanum	< 1,040	< 30.1
Lithium	< 207	< 6.01
Magnesium	< 2,070	< 60.1
Neodymium	< 2,070	< 60.1
Samarium	< 2,070	< 60.1
Selenium	< 2,070	< 60.1
Strontium	< 207	< 6.01
Thallium	< 4,140	< 120
Titanium	< 207	< 6.01
Uranium	< 10,400	< 300
Vanadium	< 1,040	< 30.1
Zirconium	< 207	< 6.01

Table B2-5. Tank 241-BY-102 Analytical Results: Aluminum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004295F	157: 1	Lower ½	2.250E+05	2.150E+05	2.200E+05
S96T003635F	157: 2	Lower ½	33,100	42,800	37,950[QC:e]
S96T003650F	157: 3	Lower ½	9,350	8,780	9,065
S96T004160F	157: 4	Subseg A	11,400	11,300	11,350
S96T004164F		Subseg B	5,890	8,220	7,055[QC:e]
S96T004165F		Subseg C	7,030	5,770	6,400
S96T004343F	157: 5	Lower ½	8,940	8,620	8,780
S96T004161F	157: 5A	Upper ½	6,390	6,090	6,240
S96T004166F		Lower ½	16,400	14,300	15,350
S96T003651F	157: 6	Upper ½	15,300	15,300	15,300
S96T003652F		Lower ½	24,000	24,700	24,350
S96T004162F	157: 7	Subseg A	15,100	14,400	14,750
S96T004163F		Subseg B	11,100	12,400	11,750
S96T004167F		Subseg C	23,000	26,500	24,750
S96T004168F		Subseg D	23,300	21,500	22,400
Liquids			µg/mL	µg/mL	µg/mL
S96T004133D	157: 7	DL	56,800	56,300	56,550[QC:e]
S96T003657D	157: 8	DL	42,500	47,400	44,950[QC:d]

Note:

DL = Drainable liquid

Table B2-6. Tank 241-BY-102 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	2,960	2,480	2,720
S96T003635F	157: 2	Lower ½	3,070	< 2,060	< 2,565[QC:e]
S96T003650F	157: 3	Lower ½	< 2,040	< 2,070	< 2,055
S96T004160F	157: 4	Subseg A	< 1,980	< 2,040	< 2,010
S96T004164F		Subseg B	< 2,040	< 2,070	< 2,055
S96T004165F		Subseg C	< 2,040	< 2,000	< 2,020
S96T004343F	157: 5	Lower ½	< 2,030	< 2,050	< 2,040
S96T004161F	157: 5A	Upper ½	< 2,060	< 2,070	< 2,065
S96T004166F		Lower ½	< 2,020	< 2,050	< 2,035
S96T003651F	157: 6	Upper ½	< 2,000	< 1,980	< 1,990
S96T003652F		Lower ½	< 2,020	< 2,040	< 2,030
S96T004162F	157: 7	Subseg A	< 2,060	< 2,060	< 2,060
S96T004163F		Subseg B	< 1,990	< 1,980	< 1,985
S96T004167F		Subseg C	< 2,020	< 2,010	< 2,015
S96T004168F		Subseg D	< 1,970	< 1,990	< 1,980
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	< 60.1	< 60.1	< 60.1
S96T003657D	157: 8	DL	< 60.1	< 60.1	< 60.1

Table B2-7. Tank 241-BY-102 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	468	523	495.5
S96T003635F	157: 2	Lower ½	2,960	3,230	3,095
S96T003650F	157: 3	Lower ½	1,850	1,670	1,760
S96T004160F	157: 4	Subseg A	1,880	2,000	1,940
S96T004164F		Subseg B	2,550	2,590	2,570
S96T004165F		Subseg C	1,690	1,370	1,530[QC:e]
S96T004343F	157: 5	Lower ½	1,980	1,830	1,905
S96T004161F	157: 5A	Upper ½	1,250	1,250	1,250
S96T004166F		Lower ½	2,170	2,050	2,110
S96T003651F	157: 6	Upper ½	3,160	3,060	3,110
S96T003652F		Lower ½	2,840	2,950	2,895
S96T004162F	157: 7	Subseg A	1,070	1,030	1,050
S96T004163F		Subseg B	616	641	628.5
S96T004167F		Subseg C	1,310	1,390	1,350
S96T004168F		Subseg D	1,160	1,210	1,185
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	1,830	1,800	1,815
S96T003657D	157: 8	DL	210	235	222.5

Table B2-8. Tank 241-BY-102 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	342	294	318
S96T003635F	157: 2	Lower ½	< 200	< 206	< 203
S96T003650F	157: 3	Lower ½	< 204	< 207	< 205.5
S96T004160F	157: 4	Subseg A	< 198	< 204	< 201
S96T004164F		Subseg B	< 204	< 207	< 205.5
S96T004165F		Subseg C	< 204	< 200	< 202
S96T004343F	157: 5	Lower ½	< 203	< 205	< 204
S96T004161F	157: 5A	Upper ½	< 206	< 207	< 206.5
S96T004166F		Lower ½	< 202	< 205	< 203.5
S96T003651F	157: 6	Upper ½	< 200	< 198	< 199
S96T003652F		Lower ½	< 202	< 204	< 203
S96T004162F	157: 7	Subseg A	< 206	< 206	< 206
S96T004163F		Subseg B	< 199	< 198	< 198.5
S96T004167F		Subseg C	< 202	< 201	< 201.5
S96T004168F		Subseg D	< 197	< 199	< 198
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	< 6.01	< 6.01	< 6.01
S96T003657D	157: 8	DL	< 6.01	< 6.01	< 6.01

Table B2-9. Tank 241-BY-102 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	6,700	20,500	13,600[QC:e]
S96T003635F	157: 2	Lower ½	1,100	< 1,030	< 1,065
S96T003650F	157: 3	Lower ½	< 1,020	< 1,030	< 1,025
S96T004160F	157: 4	Subseg A	< 990	< 1,020	< 1,005
S96T004164F		Subseg B	< 1,020	< 1,030	< 1,025
S96T004165F		Subseg C	< 1,020	< 998	< 1,009
S96T004343F	157: 5	Lower ½	< 1,010	< 1,020	< 1,015
S96T004161F	157: 5A	Upper ½	< 1,030	< 1,040	< 1,035
S96T004166F		Lower ½	< 1,010	< 1,030	< 1,020
S96T003651F	157: 6	Upper ½	< 1,000	< 990	< 995
S96T003652F		Lower ½	< 1,010	< 1,020	< 1,015
S96T004162F	157: 7	Subseg A	< 1,030	< 1,030	< 1,030
S96T004163F		Subseg B	< 993	< 990	< 991.5
S96T004167F		Subseg C	< 1,010	< 1,000	< 1,005
S96T004168F		Subseg D	< 987	< 995	< 991
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	< 30.1	< 30.1	< 30.1
S96T003657D	157: 8	DL	66.4	73.3	69.85

Table B2-10. Tank 241-BY-102 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	< 2,050	< 2,060	< 2,055
S96T003635F	157: 2	Lower ½	< 2,000	< 2,060	< 2,030
S96T003650F	157: 3	Lower ½	< 2,040	< 2,070	< 2,055
S96T004160F	157: 4	Subseg A	< 1,980	< 2,040	< 2,010
S96T004164F		Subseg B	< 2,040	< 2,070	< 2,055
S96T004165F		Subseg C	< 2,040	< 2,000	< 2,020
S96T004343F	157: 5	Lower ½	< 2,030	< 2,050	< 2,040
S96T004161F	157: 5A	Upper ½	< 2,060	< 2,070	< 2,065
S96T004166F		Lower ½	< 2,020	< 2,050	< 2,035
S96T003651F	157: 6	Upper ½	< 2,000	< 1,980	< 1,990
S96T003652F		Lower ½	< 2,020	< 2,040	< 2,030
S96T004162F	157: 7	Subseg A	< 2,060	< 2,060	< 2,060
S96T004163F		Subseg B	< 1,990	< 1,980	< 1,985
S96T004167F		Subseg C	< 2,020	< 2,010	< 2,015
S96T004168F		Subseg D	< 1,970	< 1,990	< 1,980
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157:7	DL	109	116	112.5
S96T003657D	157:8	DL	90.3	108	99.15

Table B2-11. Tank 241-BY-102 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S96T004295F	157: 1	Lower ½	< 205	247	< 226
S96T003635F	157: 2	Lower ½	1,760	1,920	1,840
S96T003650F	157: 3	Lower ½	393	314	353.5[QC:e]
S96T004160F	157: 4	Subseg A	250	340	295[QC:e]
S96T004164F		Subseg B	1,020	641	830.5[QC:e]
S96T004165F		Subseg C	223	< 200	< 211.5
S96T004343F	157: 5	Lower ½	< 203	< 205	< 204
S96T004161F	157: 5A	Upper ½	< 206	< 207	< 206.5
S96T004166F		Lower ½	< 202	< 205	< 203.5
S96T003651F	157: 6	Upper ½	< 200	< 198	< 199
S96T003652F		Lower ½	< 202	< 204	< 203
S96T004162F	157: 7	Subseg A	< 206	< 206	< 206
S96T004163F		Subseg B	< 199	< 198	< 198.5
S96T004167F		Subseg C	< 202	< 201	< 201.5
S96T004168F		Subseg D	< 197	< 199	< 198
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S96T004133D	157: 7	DL	< 6.01	< 6.01	< 6.01
S96T003657D	157: 8	DL	< 6.01	< 6.01	< 6.01

Table B2-12. Tank 241-BY-102 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004295F	157: 1	Lower ½	< 1,020	< 1,030	< 1,025
S96T003635F	157: 2	Lower ½	< 998	< 1,030	< 1,014
S96T003650F	157: 3	Lower ½	< 1,020	< 1,030	< 1,025
S96T004160F	157: 4	Subseg A	< 990	< 1,020	< 1,005
S96T004164F		Subseg B	< 1,020	< 1,030	< 1,025
S96T004165F		Subseg C	< 1,020	< 998	< 1,009
S96T004343F	157: 5	Lower ½	< 1,010	< 1,020	< 1,015
S96T004161F	157: 5A	Upper ½	< 1,030	< 1,040	< 1,035
S96T004166F		Lower ½	< 1,010	< 1,030	< 1,020
S96T003651F	157: 6	Upper ½	< 1,000	< 990	< 995
S96T003652F		Lower ½	< 1,010	< 1,020	< 1,015
S96T004162F	157: 7	Subseg A	< 1,030	< 1,030	< 1,030
S96T004163F		Subseg B	< 993	< 990	< 991.5
S96T004167F		Subseg C	< 1,010	< 1,000	< 1,005
S96T004168F		Subseg D	< 987	< 995	< 991
Liquids			µg/mL	µg/mL	µg/mL
S96T004133D	157: 7	DL	56.9	58	57.45
S96T003657D	157: 8	DL	43.1	46.6	44.85

Table B2-13. Tank 241-BY-102 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	19,600	7,190	13,395[QC:e]
S96T003635F	157: 2	Lower ½	6,510	4,910	5,710[QC:e]
S96T003650F	157: 3	Lower ½	1,250	1,110	1,180
S96T004160F	157: 4	Subseg A	1,900	4,290	3,095[QC:e]
S96T004164F		Subseg B	4,970	5,860	5,415
S96T004165F		Subseg C	4,120	5,160	4,640[QC:e]
S96T004343F	157: 5	Lower ½	1,190	2,780	1,985[QC:e]
S96T004161F	157: 5A	Upper ½	2,510	4,220	3,365[QC:e]
S96T004166F		Lower ½	7,540	3,700	5,620[QC:e]
S96T003651F	157: 6	Upper ½	3,660	2,060	2,860[QC:e]
S96T003652F		Lower ½	1,210	< 407	< 808.5[QC:e]
S96T004162F	157: 7	Subseg A	5,160	4,830	4,995
S96T004163F		Subseg B	3,960	7,130	5,545[QC:e]
S96T004167F		Subseg C	5,930	4,410	5,170[QC:e]
S96T004168F		Subseg D	8,030	7,330	7,680
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	< 12	< 12	< 12
S96T003657D	157: 8	DL	< 12	< 12	< 12

Table B2-14. Tank 241-BY-102 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S96T004295F	157: 1	Lower ½	14,300	15,200	14,750
S96T003635F	157: 2	Lower ½	8,370	12,200	10,285[QC:e]
S96T003650F	157: 3	Lower ½	9,580	9,050	9,315
S96T004160F	157: 4	Subseg A	17,800	13,500	15,650[QC:e]
S96T004164F		Subseg B	< 4,080	< 4,140	< 4,110
S96T004165F		Subseg C	< 4,090	< 3,990	< 4,040
S96T004343F	157: 5	Lower ½	< 4,050	< 4,100	< 4,075
S96T004161F	157: 5A	Upper ½	< 4,130	< 4,140	< 4,135
S96T004166F		Lower ½	27,700	22,200	24,950[QC:e]
S96T003651F	157: 6	Upper ½	28,300	27,700	28,000
S96T003652F		Lower ½	4,340	< 4,070	< 4,205
S96T004162F	157: 7	Subseg A	< 4,120	< 4,120	< 4,120
S96T004163F		Subseg B	< 3,970	< 3,960	< 3,965
S96T004167F		Subseg C	< 4,030	< 4,010	< 4,020
S96T004168F		Subseg D	< 3,950	9,880	< 6,915[QC:e]
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S96T004133D	157: 7	DL	621	631	626
S96T003657D	157: 8	DL	1,120	1,270	1,195

Table B2-15. Tank 241-BY-102 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			µg/mL	µg/mL	µg/mL
S96T004133D	157: 7	DL	7,190	7,080	7,135[QC:c]
S96T003657D	157: 8	DL	6,120	6,720	6,420[QC:d]

Table B2-16. Tank 241-BY-102 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004295F	157: 1	Lower ½	15,000	14,700	14,850
S96T003635F	157: 2	Lower ½	5,680	5,170	5,425
S96T003650F	157: 3	Lower ½	3,720	3,610	3,665
S96T004160F	157: 4	Subseg A	4,250	4,460	4,355
S96T004164F		Subseg B	1,070	1,840	1,455[QC:e]
S96T004165F		Subseg C	2,500	1,380	1,940[QC:e]
S96T004343F	157: 5	Lower ½	< 1,010	< 1,020	< 1,015
S96T004161F	157: 5A	Upper ½	1,380	< 1,040	< 1,210[QC:e]
S96T004166F		Lower ½	10,700	8,550	9,625[QC:e]
S96T003651F	157: 6	Upper ½	2,620	2,750	2,685
S96T003652F		Lower ½	2,290	2,250	2,270
S96T004162F	157: 7	Subseg A	< 1,030	< 1,030	< 1,030
S96T004163F		Subseg B	< 993	< 990	< 991.5
S96T004167F		Subseg C	< 1,010	1,090	< 1,050
S96T004168F		Subseg D	1,170	< 995	< 1,082.5
Liquids			µg/mL	µg/mL	µg/mL
S96T004133D	157: 7	DL	125	119	122
S96T003657D	157: 8	DL	238	250	244

Table B2-17. Tank 241-BY-102 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	< 205	< 206	< 205.5
S96T003635F	157: 2	Lower ½	< 200	< 206	< 203
S96T003650F	157: 3	Lower ½	< 204	< 207	< 205.5
S96T004160F	157: 4	Subseg A	< 198	< 204	< 201
S96T004164F		Subseg B	< 204	< 207	< 205.5
S96T004165F		Subseg C	< 204	< 200	< 202
S96T004343F	157: 5	Lower ½	< 203	< 205	< 204
S96T004161F	157: 5A	Upper ½	< 206	< 207	< 206.5
S96T004166F		Lower ½	< 202	< 205	< 203.5
S96T003651F	157: 6	Upper ½	< 200	< 198	< 199
S96T003652F		Lower ½	< 202	< 204	< 203
S96T004162F	157: 7	Subseg A	< 206	< 206	< 206
S96T004163F		Subseg B	< 199	< 198	< 198.5
S96T004167F		Subseg C	< 202	< 201	< 201.5
S96T004168F		Subseg D	< 197	< 199	< 198
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	17.1	16	16.55
S96T003657D	157: 8	DL	16.5	18.7	17.6

Table B2-18. Tank 241-BY-102 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	95,200	93,100	94,150
S96T003635F	157: 2	Lower ½	2.720E+05	2.360E+05	2.540E+05[QC:c]
S96T003650F	157: 3	Lower ½	2.930E+05	2.910E+05	2.920E+05
S96T004160F	157: 4	Subseg A	2.710E+05	2.860E+05	2.785E+05
S96T004164F		Subseg B	2.770E+05	2.880E+05	2.825E+05
S96T004165F		Subseg C	3.260E+05	3.400E+05	3.330E+05
S96T004343F	157: 5	Lower ½	3.360E+05	3.460E+05	3.410E+05
S96T004161F	157: 5A	Upper ½	3.380E+05	3.450E+05	3.415E+05[QC:d]
S96T004166F		Lower ½	2.820E+05	2.820E+05	2.820E+05
S96T003651F	157: 6	Upper ½	2.590E+05	2.520E+05	2.555E+05
S96T003652F		Lower ½	2.490E+05	2.290E+05	2.390E+05[QC:c]
S96T004162F	157: 7	Subseg A	3.200E+05	3.010E+05	3.105E+05
S96T004163F		Subseg B	3.150E+05	3.130E+05	3.140E+05
S96T004167F		Subseg C	2.700E+05	2.490E+05	2.595E+05[QC:c]
S96T004168F		Subseg D	2.610E+05	2.630E+05	2.620E+05
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	2.370E+05	2.320E+05	2.345E+05[QC:c]
S96T003657D	157: 8	DL	2.310E+05	2.580E+05	2.445E+05[QC:d]

Table B2-19. Tank 241-BY-102 Analytical Results: Sulfur (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	< 2,050	< 2,060	< 2,055
S96T003635F	157: 2	Lower ½	41,700	35,200	38,450
S96T003650F	157: 3	Lower ½	14,600	12,200	13,400
S96T004160F	157: 4	Subseg A	21,000	21,000	21,000
S96T004164F		Subseg B	13,800	8,920	11,360[QC:e]
S96T004165F		Subseg C	31,600	31,200	31,400
S96T004343F	157: 5	Lower ½	20,900	19,300	20,100
S96T004161F	157: 5A	Upper ½	18,800	18,600	18,700
S96T004166F		Lower ½	24,500	25,800	25,150
S96T003651F	157: 6	Upper ½	17,400	16,800	17,100
S96T003652F		Lower ½	12,000	13,200	12,600
S96T004162F	157: 7	Subseg A	8,600	7,820	8,210
S96T004163F		Subseg B	2,310	2,410	2,360
S96T004167F		Subseg C	10,600	12,100	11,350
S96T004168F		Subseg D	10,700	11,900	11,300
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	965	975	970
S96T003657D	157: 8	DL	1,660	1,850	1,755

Table B2-20. Tank 241-BY-102 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S96T004295F	157: 1	Lower ½	< 205	< 206	< 205.5
S96T003635F	157: 2	Lower ½	953	669	811[QC:e]
S96T003650F	157: 3	Lower ½	816	280	548[QC:e]
S96T004160F	157: 4	Subseg A	< 198	< 204	< 201
S96T004164F		Subseg B	< 204	< 207	< 205.5
S96T004165F		Subseg C	< 204	< 200	< 202
S96T004343F	157: 5	Lower ½	< 203	< 205	< 204
S96T004161F	157: 5A	Upper ½	657	762	709.5
S96T004166F		Lower ½	625	273	449[QC:e]
S96T003651F	157: 6	Upper ½	484	353	418.5[QC:e]
S96T003652F		Lower ½	643	720	681.5
S96T004162F	157: 7	Subseg A	730	677	703.5
S96T004163F		Subseg B	< 199	< 198	< 198.5
S96T004167F		Subseg C	< 202	< 201	< 201.5
S96T004168F		Subseg D	< 197	< 199	< 198
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133D	157: 7	DL	18.3	17.9	18.1
S96T003657D	157: 8	DL	31.5	35.9	33.7

B2.1.4.1.2 Ion Chromatography. Samples for IC were prepared by water digestion using procedure LA-504-101, Rev. E-0. The IC analyses were performed using procedure LA-533-105, Rev. D-1. Although a full suite of analytes was reported, the SAP required only bromide to be analyzed. The SAP specified no QC requirements for anions other than bromide. Bromide analysis was required to evaluate the extent of any lithium bromide solution contamination in the samples.

The concentration of anions in the samples are shown in Tables B2-21 through B2-28. Bromide results were less than the detection limits for all samples except sample S96T003657, the drainable liquid for core 157, segment 8. The result for this sample indicated that it consisted of over 50 percent LiBr solution. The IC analysis indicated fairly high concentrations of all the IC analytes, including chloride, fluoride, and oxalate.

Table B2-21. Tank 241-BY-102 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T004938W	157: 1	Lower ½	< 279.7	< 273	< 276.35
S96T003636W	157: 2	Lower ½	< 514.3	< 516	< 515.15
S96T003653W	157: 3	Lower ½	< 512.1	< 512	< 512.05
S96T004169W	157: 4	Subseg A	< 1,012	< 1,010	< 1,011
S96T004170W		Subseg B	< 1,014	< 1,010	< 1,012
S96T004171W		Subseg C	< 1,008	< 1,020	< 1,014
S96T004344W	157: 5	Lower ½	< 1,022	< 1,040	< 1,031
S96T004172W	157: 5A	Upper ½	< 1,032	< 1,020	< 1,026
S96T004173W		Lower ½	< 837.2	< 842	< 839.6
S96T003654W	157: 6	Upper ½	< 535.4	< 2,490	< 1,512.7[QC:e]
S96T003655W		Lower ½	< 518.3	< 528	< 523.15
S96T004174W	157: 7	Subseg A	< 512.6	< 512	< 512.3
S96T004175W		Subseg B	< 1,045	< 1,000	< 1,022.5
S96T004176W		Subseg C	< 999.2	< 996	< 997.6
S96T004177W		Subseg D	< 998.5	< 1,020	< 1,009.25
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133	157: 7	DL	< 649	< 649	< 649
S96T003657	157: 8	DL	14,920	14,700	14,810

Table B2-22. Tank 241-BY-102 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T004938W	157: 1	Lower ½	< 38.04	< 37.1	< 37.57
S96T003636W	157: 2	Lower ½	2,442	363	1,402.5[QC:e]
S96T003653W	157: 3	Lower ½	555.6	2,670	1,612.8[QC:e]
S96T004169W	157: 4	Subseg A	712.8	676	694.4
S96T004170W		Subseg B	978.2	783	880.6[QC:e]
S96T004171W		Subseg C	701.5	708	704.75
S96T004344W	157: 5	Lower ½	892.4	684	788.2[QC:e]
S96T004172W	157: 5A	Upper ½	718.8	672	695.4
S96T004173W		Lower ½	1,017	826	921.5
S96T003655W	157: 6	Lower ½	2,802	2,440	2,621
S96T003654W		Upper ½	1,996	1,910	1,953
S96T004174W	157: 7	Subseg A	1,555	1,630	1,592.5
S96T004175W		Subseg B	1,465	1,210	1,337.5
S96T004176W		Subseg C	2,553	2,580	2,566.5
S96T004177W		Subseg D	2,644	1,560	2,102[QC:e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133	157: 7	DL	13,580	12,700	13,140
S96T003657	157: 8	DL	16,790	16,600	16,695

Table B2-23. Tank 241-BY-102 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T004938W	157: 1	Lower ½	6,941	5,060	6,000.5[QC:e]
S96T003636W	157: 2	Lower ½	6,776	5,570	6,173
S96T003653W	157: 3	Lower ½	11,830	11,700	11,765
S96T004169W	157: 4	Subseg A	24,390	26,500	25,445
S96T004170W		Subseg B	50,950	45,500	48,225
S96T004171W		Subseg C	53,060	46,700	49,880
S96T004344W	157: 5	Lower ½	17,060	12,800	14,930[QC:e]
S96T004172W	157: 5A	Upper ½	15,130	14,100	14,615
S96T004173W		Lower ½	28,340	25,600	26,970
S96T003654W	157: 6	Upper ½	54,940	54,000	54,470
S96T003655W		Lower ½	12,390	11,300	11,845
S96T004174W	157: 7	Subseg A	4,309	4,640	4,474.5
S96T004175W		Subseg B	604	819	711.5[QC:e]
S96T004176W		Subseg C	724.8	556	640.4[QC:e]
S96T004177W		Subseg D	277.2	290	283.6
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133	157: 7	DL	< 66.96	< 67	< 66.98
S96T003657	157: 8	DL	< 132.6	< 133	< 132.8

Table B2-24. Tank 241-BY-102 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T004938W	157: 1	Lower ½	1,286	1,360	1,323
S96T003636W	157: 2	Lower ½	14,480	13,600	14,040
S96T003653W	157: 3	Lower ½	22,870	23,100	22,985
S96T004169W	157: 4	Subseg A	65,450	60,700	63,075
S96T004170W		Subseg B	1.109E+05	2.380E+05	1.745E+05[QC:e]
S96T004171W		Subseg C	76,020	67,300	71,660
S96T004344W	157: 5	Lower ½	65,940	67,700	66,820
S96T004172W	157: 5A	Upper ½	72,300	82,500	77,400
S96T004173W		Lower ½	2.503E+05	1.670E+05	2.087E+05[QC:e]
S96T003654W	157: 6	Upper ½	60,790	58,600	59,695
S96T003655W		Lower ½	95,680	83,600	89,640
S96T004174W	157: 7	Subseg A	1.764E+05	1.760E+05	1.762E+05
S96T004175W		Subseg B	85,430	1.000E+05	92,715
S96T004176W		Subseg C	1.831E+05	2.750E+05	2.291E+05[QC:e]
S96T004177W		Subseg D	2.024E+05	4.260E+05	3.142E+05[QC:e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S96T004133	157: 7	DL	1.478E+05	1.480E+05	1.479E+05
S96T003657	157: 8	DL	2.021E+05	2.000E+05	2.011E+05

Table B2-25. Tank 241-BY-102 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004938W	157: 1	Lower ½	< 241.7	< 236	< 238.85
S96T003636W	157: 2	Lower ½	4,733	4,440	4,586.5
S96T003653W	157: 3	Lower ½	7,047	7,270	7,158.5
S96T004169W	157: 4	Subseg A	10,390	10,300	10,345
S96T004170W		Subseg B	14,440	13,200	13,820
S96T004171W		Subseg C	10,860	10,700	10,780
S96T004344W	157: 5	Lower ½	13,950	10,600	12,275[QC:e]
S96T004172W	157: 5A	Upper ½	10,450	9,850	10,150
S96T004173W		Lower ½	15,910	13,000	14,455
S96T003654W	157: 6	Upper ½	22,330	21,600	21,965
S96T003655W		Lower ½	40,890	34,400	37,645
S96T004174W	157: 7	Subseg A	23,290	23,200	23,245
S96T004175W		Subseg B	19,900	17,400	18,650
S96T004176W		Subseg C	36,440	34,500	35,470
S96T004177W		Subseg D	37,890	22,500	30,195[QC:e]
Liquids			µg/mL	µg/mL	µg/mL
S96T004133	157: 7	DL	81,990	85,700	83,845
S96T003657	157: 8	DL	76,780	74,900	75,840

Table B2-26. Tank 241-BY-102 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
S96T004938W	157: 1	Lower ½	66,160	47,700	56,930[QC:e]
S96T003636W	157: 2	Lower ½	31,660	32,700	32,180
S96T003653W	157: 3	Lower ½	28,230	34,400	31,315
S96T004169W	157: 4	Subseg A	58,590	53,900	56,245
S96T004170W		Subseg B	14,310	5,350	9,830[QC:e]
S96T004171W		Subseg C	2,317	1,830	2,073.5[QC:e]
S96T004344W	157: 5	Lower ½	6,062	5,560	5,811
S96T004172W	157: 5A	Upper ½	4,277	4,120	4,198.5
S96T004173W		Lower ½	71,600	79,300	75,450
S96T003654W	157: 6	Upper ½	87,020	85,600	86,310
S96T003655W		Lower ½	14,330	16,000	15,165
S96T004174W	157: 7	Subseg A	6,369	6,280	6,324.5
S96T004175W		Subseg B	1,346	1,710	1,528[QC:e]
S96T004176W		Subseg C	5,170	4,000	4,585[QC:e]
S96T004177W		Subseg D	2,914	3,760	3,337[QC:e]
Liquids			μg/mL	μg/mL	μg/mL
S96T004133	157: 7	DL	2,624	2,610	2,617
S96T003657	157: 8	DL	8,031	8,080	8,055.5

Table B2-27. Tank 241-BY-102 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T004938W	157: 1	Lower ½	379.6	368	373.8
S96T003636W	157: 2	Lower ½	1.292E+05	1.410E+05	1.351E+05
S96T003653W	157: 3	Lower ½	45,200	40,500	42,850
S96T004169W	157: 4	Subseg A	82,070	85,900	83,985
S96T004170W		Subseg B	66,130	51,400	58,765[QC:e]
S96T004171W		Subseg C	99,140	1.080E+05	1.036E+05
S96T004344W	157: 5	Lower ½	62,630	44,000	53,315[QC:e]
S96T004172W	157: 5A	Upper ½	68,220	63,700	65,960
S96T004173W		Lower ½	1.003E+05	82,100	91,200
S96T003654W	157: 6	Upper ½	52,400	51,400	51,900
S96T003655W		Lower ½	44,840	41,100	42,970
S96T004174W	157: 7	Subseg A	23,000	23,000	23,000
S96T004175W		Subseg B	7,093	7,720	7,406.5
S96T004176W		Subseg C	33,510	32,200	32,855
S96T004177W		Subseg D	36,780	19,500	28,140[QC:e]
Liquids					
S96T004133	157: 7	DL	6,970	6,280	6,625
S96T003657	157: 8	DL	15,190	15,200	15,195

Table B2-28. Tank 241-BY-102 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004938W	157: 1	Lower ½	< 234.9	< 229	< 231.95
S96T003636W	157: 2	Lower ½	26,230	22,900	24,565
S96T003653W	157: 3	Lower ½	43,320	37,400	40,360
S96T004169W	157: 4	Subseg A	42,690	43,600	43,145
S96T004170W		Subseg B	63,270	57,400	60,335
S96T004171W		Subseg C	22,520	23,700	23,110
S96T004344W	157: 5	Lower ½	11,850	8,980	10,415[QC:e]
S96T004172W	157: 5A	Upper ½	26,990	27,800	27,395
S96T004173W		Lower ½	8,146	7,520	7,833
S96T003654W	157: 6	Upper ½	12,020	11,300	11,660
S96T003655W		Lower ½	11,150	12,200	11,675
S96T004174W	157: 7	Subseg A	6,385	6,380	6,382.5
S96T004175W		Subseg B	2,118	2,040	2,079
S96T004176W		Subseg C	12,050	11,300	11,675
S96T004177W		Subseg D	7,061	6,990	7,025.5
Liquids			µg/mL	µg/mL	µg/mL
S96T004133	157: 7	DL	552.5	< 541	< 546.75
S96T003657	157: 8	DL	< 1,071	1,250	< 1,160.5

B2.1.4.2 Carbon Analyses

B2.1.4.2.1 Total Inorganic Carbon and Total Organic Carbon. Total inorganic carbon was determined by coulometry and total organic carbon was determined by persulfate oxidation followed by coulometry using procedure LA-342-100, Rev. E-0.

Results for TIC and TOC are shown in Tables B2-29 and B2-30, respectively. Total organic carbon mean results ranged from 821 µg C/g to 10,400 µg C/g. Total inorganic carbon mean results ranged from 766.5 µg C/g to 55,550 µg C/g.

Table B2-29. Tank 241-BY-102 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg C/g	μg C/g	μg C/g
S96T004294	157: 1	Lower ½	779	754	766.5
S96T003633	157: 2	Lower ½	23,900	29,400	26,650[QC:e]
S96T003644	157: 3	Lower ½	49,200	47,500	48,350
S96T004145	157: 4	Subseg A	22,300	19,400	20,850
S96T004146		Subseg B	15,400	16,500	15,950[QC:d]
S96T004147		Subseg C	37,300	38,100	37,700
S96T004341	157: 5	Lower ½	52,500	51,400	51,950
S96T004148	157: 5A	Upper ½	54,100	57,000	55,550
S96T004149		Lower ½	13,700	17,300	15,500[QC:e]
S96T003645	157: 6	Upper ½	4,650	5,410	5,030
S96T003646		Lower ½	12,200	9,450	10,825[QC:e]
S96T004150	157: 7	Subseg A	13,500	16,200	14,850
S96T004151		Subseg B	46,700	48,800	47,750
S96T004152		Subseg C	22,500	26,700	24,600
S96T004153		Subseg D	34,300	35,900	35,100
Liquids			μg C/mL	μg C/mL	μg C/mL
S96T004133	157: 7	DL	1,500	1,590	1,545
S96T003657	157: 8	DL	3,310	3,440	3,375

Table B2-30. Tank 241-BY-102 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Triplicate	Mean
Solids			μg C/g	μg C/g	μg C/g	μg C/g
S96T004294	157: 1	Lower ½	747	895	---	821
S96T003633	157: 2	Lower ½	7,790	4,560	6,520	6,290[QC:c,e]
S96T003644	157: 3	Lower ½	10,500	7,920	10,300	9,573[QC:e]
S96T004145	157: 4	Subseg A	4,130	5,990	2,990	4,370[QC:e]
S96T004146		Subseg B	10,800	10,000	---	10,400[QC:e]
S96T004147		Subseg C	2,610	1,800	---	2,205[QC:e]
S96T004341	157: 5	Lower ½	3,330	4,070	---	3,700
S96T004148	157: 5A	Upper ½	6,930	6,760	---	6,845
S96T004149		Lower ½	1,410	1,130	1,820	1,453[QC:e]
S96T003645	157: 6	Upper ½	3,570	3,460	---	3,515
S96T003646		Lower ½	4,080	4,530	4,000	4,203
S96T004150	157: 7	Subseg A	2,970	2,740	---	2,855
S96T004151		Subseg B	1,040	1,100	---	1,070
S96T004152		Subseg C	5,840	5,010	---	5,425[QC:e]
S96T004153		Subseg D	2,620	2,580	---	2,600
Liquids			μg C/mL	μg C/mL	μg C/mL	μg C/mL
S96T004133	157: 7	DL	1,530	1,580	---	1,555
S96T003657	157: 8	DL	2,050	2,040	---	2,045

B2.1.4.2.2 Separable Organic Layer. Following extrusion of each segment, the samples were examined for the presence of separable organics. No separable organic layers were observed in any of the samples.

B2.1.4.3 Radiochemical Analyses. The only radiochemical analysis required by the SAP and performed on the samples was alpha proportional counting for total alpha activity.

B2.1.4.3.1 Total Alpha Activity. Analyses for total alpha activity were performed on the samples recovered from tank 241-BY-102. The samples were prepared by fusion digestion using potassium hydroxide in a nickel crucible per procedure LA-549-141, Rev. F-0 and analyzed according to procedure LA-508-101, Rev. D-2. Two fusions were prepared per sample (for duplicate results). Each fused dilution was analyzed twice; the results were averaged and reported as one value. The highest result returned was an average of 0.332 μCi/g for the lower half of segment 2 of core 157. The sample results for total alpha are given in Table B2-31.

Table B2-31. Tank 241-BY-102 Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004295F	157: 1	Lower ½	0.0218	0.017	0.0194[QC:c,e]
S96T003635F	157: 2	Lower ½	0.329	0.334	0.332
S96T003650F	157: 3	Lower ½	0.11	0.0731	0.09155[QC:c,e,f]
S96T004164F	157: 4	Subseg B	0.298	0.181	0.2395[QC:e]
S96T004165F		Subseg C	0.286	0.129	0.2075[QC:e]
S96T004343F	157: 5	Lower ½	0.0104	0.0092	0.0098
S96T004166F	157: 5A	Lower ½	0.0106	0.00951	0.010055
S96T003652F	157: 6	Lower ½	0.022	0.02	0.021[QC:c,f]
S96T004167F	157: 7	Subseg C	0.0031	< 0.0037	< 0.0034
S96T004168F		Subseg D	< 0.00203	< 0.00243	< 0.00223
Liquids			μCi/mL	μCi/mL	μCi/mL
S96T004133	157: 7	DL	< 0.00272	< 0.00449	< 0.003605
S96T003657	157: 8	DL	0.00735	0.00456	0.005955[QC:e]

B2.1.4.4 Physical Analyses. As required by the safety screening DQO, bulk density/specific gravity measurements were performed on the samples. No other physical tests were required or performed.

B2.1.4.4.1 Density/Specific Gravity. Density measurements were performed on the solids in the lower half of each segment and specific gravity measurements were performed on drainable liquid samples. Density measurements were performed using procedure LO-160-103, Rev. B0 and specific gravity measurements were performed using procedure LA-510-112, Rev. C-3.

The bulk density and specific gravity results are reported in Tables B2-32 and B2-33.

Table B2-32. Tank 241-BY-102 Analytical Results: Bulk Density.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
S96T004293	157: 1	Lower ½	1.25	N/R	1.25
S96T003632	157: 2	Lower ½	1.8	N/R	1.8
S96T003641	157: 3	Lower ½	1.33	N/R	1.33
S96T004124	157: 4	Subseg B	I.S.	N/R	---
S96T004125	157: 4	Subseg C	I.S.	N/R	---
S96T004340	157: 5	Lower ½	1.07	N/R	1.07
S96T004127	157: 5A	Lower ½	1.47	N/R	1.47
S96T003643	157: 6	Lower ½	1.86	N/R	1.86
S96T004130	157: 7	Subseg C	1.71	N/R	1.71
S96T004131		Subseg D	1.68	N/R	1.68

Notes:
I.S. = insufficient sample to perform analysis
N/R = not required

Table B2-33. Tank 241-BY-102 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			Unitless	Unitless	Unitless
S96T004133	157: 7	DL	1.46	1.455	1.4575
S96T003657	157: 8	DL	1.441	1.409	1.425

B2.1.4.5 Thermodynamic Analyses

B2.1.4.5.1 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. Nitrogen 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 DSC analyses were performed using procedure LA-514-113, Rev. C-1 on a Mettler[1] Model 20 differential scanning calorimeter or procedure LA-514-114, Rev. C-1 on a Perkin-Elmer[2] DSC 7 instrument.

The DSC results are presented in Table B2-34. Only the samples that exhibited exothermic behavior are displayed in the table; the results are shown on a wet weight basis. Nine of seventeen samples exhibited no exotherms. In the eight samples that exhibited exotherms, the mean exotherms ranged from 4.95 to 103.5 J/g. Dry weight basis values were calculated from the wet weight values by dividing by one minus the weight fraction water in the sample (determined from the TGA measurements). The dry weight conversions are shown in Table C1-2 in Appendix C. The dry weight values ranged from 9.6 to 141.5 J/g.

Table B2-34. Tank 241-BY-102 Analytical Results: Exotherm - Transition 1 (DSC).[1]

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Triplicate	Mean
Solids			J/g	J/g	J/g	J/g
S96T003633	157: 2	Lower ½	0.00	9.9	---	4.95
S96T003644	157: 3	Lower ½	14.1	0.00	---	7.05
S96T004145	157: 4	Subseg A	65.9	69	---	67.45
S96T004146		Subseg B	106.5	100.5	---	103.5
S96T004147		Subseg C	15.15	16.02	13.81	14.99
S96T004150	157: 7	Subseg A	21.4	18	---	19.7
S96T004152		Subseg C	29.57	36.82	---	33.195
S96T004153		Subseg D	0.00	114.51	---	28.63
			0.00	0.00	---	

Note:

[1]Wet weight basis results

[1]Trademark of Mettler Electronics, Anaheim, California.

[2]Trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, California.

B2.1.4.5.2 Thermogravimetric Analysis. Thermogravimetric analysis measures the mass of a sample while its temperature is increased at a constant rate. Nitrogen 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 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.

Tank 241-BY-102 samples were analyzed by TGA using either procedure LA-514-114, Rev. C-1 on a Perkin-Elmer™ TGA 7 instrument or procedure LA-560-112, Rev. B-1 on a Mettler™ TG 50 instrument. Table B2-35 shows the TGA percent water data for tank 241-BY-102. Average sample results ranged from 11.655 to 50.465 weight percent for the solids and 50.755 to 52.135 weight percent for the drainable liquids.

Table B2-35. Tank 241-BY-102 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			**wt%**	**wt%**	**wt%**
S96T004294	157: 1	Lower ½	11.89	11.42	11.655
S96T003633	157: 2	Lower ½	12.92	28.6	23.19[QC:e]
S96T003633		Lower ½	20.11	31.13	
S96T003644	157: 3	Lower ½	26.57	26.42	26.495
S96T004145	157: 4	Subseg A	23.59	30.6	27.095
S96T004146		Subseg B	28.7	24.88	26.79
S96T004147		Subseg C	19.83	20.46	20.145
S96T004341	157: 5	Lower ½	22.04	22.68	22.36
S96T004148	157: 5A	Upper ½	16.84	16.69	16.765
S96T004149		Lower ½	22.56	32.7	27.63[QC:e]
S96T003645	157: 6	Upper ½	49.02	51.46	50.24
S96T003646		Lower ½	50.22	50.71	50.465
S96T004150	157: 7	Subseg A	29.85	24.14	26.995
S96T004151		Subseg B	21.58	23.64	22.61
S96T004152		Subseg C	32.63	33.8	33.215
S96T004153		Subseg D	36.55	30.48	33.515

Table B2-35. Tank 241-BY-102 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			wt%	wt%	wt%
S96T004133	157: 7	DL	50.95	50.56	50.755
S96T003657	157: 8	DL	52.24	52.03	52.135

B2.1.4.6 Vapor Phase Measurements. Vapor phase flammability measurements were made prior to and during the 1996 core sampling event using a combustible gas meter. The combustible gas meter reports results as a percentage of the lower explosive limit (LEL). Because the National Fire Prevention Association defines the terms LEL and LFL identically, the two terms may be used interchangeably (National Fire Prevention Association 1995). The reported flammable gas result was zero percent of the LFL. In addition to flammability, vapor phase measurements for total organic carbon, oxygen, and ammonia were also made. The results of the vapor phase measurements are summarized in Table B2-36.

Table B2-36. Results of Vapor Phase Measurements of Tank 241-BY-102.

Measurement	Result	
	Riser 5	Riser 10A
Flammability	0 percent of LEL	0 percent of LEL
Total organic carbon	16 ppm	8 to 22.4 ppm
Oxygen	21%	20.9 to 21.1%
Ammonia	150 ppm	200 to 300 ppm

B2.2 NOVEMBER 1995 VAPOR SAMPLING

B2.2.1 Description of 1995 Vapor Sampling Event

Vapor sampling to support the vapor DQO (Osborne et al. 1995) was performed in tank 241-BY-102 on November 21, 1995. Vapor samples were removed from the tank headspace using the Vapor Sampling System, a truck-based sampling method that uses heated probes to obtain samples. Sampling devices, including eleven sorbent trains (for inorganic analytes) and five SUMMA[3] canisters (for permanent gases [CO_2, CO, CH_4, H_2, and N_2O] and non-methane hydrocarbons), were delivered to Pacific Northwest National Laboratory (PNNL) on November 29, 1995. A sorbent train consists of several connected sorbent traps. Of the eleven sorbent trains, eight were used to sample the headspace, while the remaining three were field blanks. Three of the five SUMMA™ canisters were used to sample the tank headspace, while the other two were filled with ambient air. Further detail regarding the sampling methodology and the sampling event itself can be found in *Headspace Vapor Characterization of Hanford Waste Tank 241-BY-102: Results from Samples Collected on 11/21/95* (Thomas et al. 1996).

B2.2.2 1995 Vapor Sample Handling and Analysis

Samples were received by PNNL for analysis at the Vapor Analytical Laboratory. The sorbent traps were used to measure the concentrations of NH_3, NO_2, NO, and H_2O. At PNNL, the traps were weighed and desorbed with the appropriate aqueous solutions (only weighing is performed for the water analysis). Ammonia was then evaluated by selective electrode (procedure PNL-ALO-226), and analyses for NO_2 and NO were performed by ion chromatography (procedure PNL-ALO-212). Sample results were blank-corrected. All samples were analyzed within 16 days after being collected. No deviations from standard procedures were noted. Results for the inorganic gases are presented in Section B2.2.3.

The SUMMA™ canisters were analyzed for permanent gases using gas chromatography/thermal conductivity detection (procedure PNL-TVP-05, Rev. 0). The analyses were performed on December 14, 1995, and the analytical results are provided in Section B2.2.3. Total non-methane hydrocarbons were analyzed in the canisters using cryogenic preconcentration followed by gas chromatography/flame ionization detection. This analysis was done according to procedure PNL-TVP-08, Rev. 0, which is similar to the U.S. Environmental Protection Agency method TO-12. Analyses were performed on January 5, 1996, and the results are also presented in Section B2.2.3.

B2.2.3 1995 Vapor Sampling Analytical Results Summary

The concentrations of the inorganic analytes, the permanent gases, and the total non-methane hydrocarbons were measured as described in Section B2.2.2. A summary of the analytical results is presented in Table B2-37. The raw analytical data can be found in Thomas et al. (1996). Quality control information is provided in Section B3.2.

[3]Trademark of Molectrics, Inc., Cleveland, Ohio

Table B2-37. Summary of 1995 Vapor Sampling Results.[1]

Category	Analyte	Average Vapor Concentration
Inorganic analytes	NH_3	175 ± 3 ppmv[2]
	NO_2	0.6 ± 0.2 ppmv[2]
	NO	0.3 ± 0.1 ppmv[2]
	H_2O	15.3 ± 0.6 mg/L[2]
Permanent gases	H_2	34 ppmv
	CO_2	24 ppmv
	CO	< 3 ppmv
	CH_4	< 4 ppmv
	N_2O	18 ppmv
Total non-methane hydrocarbons		19.87 mg/m^3

Notes:

[1]Thomas et al. (1996)

[2]Concentration uncertainty equals ± 1 standard deviation (absolute) for each set of samples.

B2.3 HISTORICAL SAMPLING EVENTS

Only one confirmed historical sampling event has been identified for tank 241-BY-102. A supernatant sample was taken in 1990 prior to the 1991 transfer of salt well liquor from tank 241-BY-102 to tank 241-AN-101. The sample was analyzed in duplicate. Results from the primary runs were attributed to sample R8081, and those from the duplicate were attributed to sample R8091. However, only one sample was actually removed from the tank. No other details regarding the event were available. Results from the 1990 sample are described in Table B2-38. The results were initially released in Edrington (1990). However, errors were found in the data, and a second internal letter (Edrington 1991) was released presenting the corrected data. Table B2-38 presents the corrected data only. These data have not been validated and should be used with caution.

Table B2-38. 1990 Supernatant Sample.[1] (3 sheets)

Waste Tank 241-BY-102 Composition of 241-BY-102 Waste				
Component	Lab Value			Lab Unit
	Sample #R8081	Sample #R8091	Average	
Physical Data				
Specific gravity	1.42	1.41	1.415	n/a
% H_2O	54	54	54	%
pH	13.4	13.4	13.4	n/a
Chemical Analysis				
Ag	85	<70	n/a	ppm
Al	26,500	29,600	28,000	ppm
As	1.76	0.07	---[2]	mg/L
Ba	37	27	32	ppm
Bi	450	420	440	ppm
Ca	20	26	23	ppm
Cd	<[3]	<[3]	n/a	ppm
Ce	1,200	1,000	1,100	ppm
CO_3	0.44	0.43	0.435	*M*
Cr	740	800	770	ppm
Cu	74	57	66	ppm
Fe	51	NR	n/a	ppm
Hg	<[3]	<[3]	n/a	ppm
K	5,900	6,200	6,000	ppm
La	130	NR	n/a	ppm
Li	NR	40	n/a	ppm
Mg	270	14	---[2]	ppm

Table B2-38. 1990 Supernatant Sample.[1] (3 sheets)

Waste Tank 241-BY-102 Composition of 241-BY-102 Waste				
Component	Lab Value			Lab Unit
	Sample #R8081	Sample #R8091	Average	
Chemical Analysis (Cont'd)				
Mn	7	NR	n/a	ppm
Mo	91	90	90	ppm
Na	1.82E+05	1.96E+05	1.89E+05	ppm
Ni	72	NR	n/a	ppm
NO_2	76,000	68,000	72,000	ppm
NO_3	1.80E+05	1.80E+05	1.80E+05	ppm
OH	2.7	2.6	2.65	*M*
Pb	730	<[3]	n/a	ppm
PO_4	<200	<200	<200	ppm
Se	0.12	0.31	0.22	mg/L
Si	480	360	420	ppm
SO_4	22,000	23,000	23,000	ppm
Sr	15	12	14	ppm
Ta	190	NR	n/a	ppm
Ti	51	NR	n/a	ppm
Zr	160	130	145	ppm
TOC	2.2	2.0	2.0	g/L carbon

Table B2-38. 1990 Supernatant Sample.[1] (3 sheets)

Waste Tank 241-BY-102 Composition of 241-BY-102 Waste				
	Lab Value			
Component	Sample #R8081	Sample #R8091	Average	Lab Unit
Radiological Analysis				
Total alpha	0.71	1.5	1.1	μCi/L
Total beta	3.40E+05	3.60E+05	3.50E+05	μCi/L
GEA - liquid	2.20E+05	2.10E+05	2.20E+05	μCi/L
$^{89/90}Sr$	420	490	460	μCi/L
^{99}Tc	460	220	340	μCi/L
$^{239/240}Pu$	<[3]	<[3]	n/a	μCi/L
^{241}Am	<[3]	<[3]	n/a	μCi/L

Notes:

[1]Edrington (1991)
[2]No averages reported on results that have large variations.
[3]Value less than detection limit for sample matrix.

Results were also available from "in-farm scavenging" laboratory studies conducted in 1955 (Sloat 1955). It is unclear if these studies are on actual waste samples from the tank. It is also under debate if the waste in tank 241-BY-102 in 1955 (MW) still remains in the tank. Agnew et al. (1996) predicts that 68 kL (18 kgal) of MW exists on the tank bottom. However, other records indicate differently. Unfortunately, the 1996 core sampling of the tank did not reach the lower portions of the waste. Results from the 1955 studies have therefore been presented in Table B2-39 because they may be the only characterization data for the MW.

Table B2-39. Summary of "In-Farm Scavenging" Laboratory Studies for Tank 241-BY-102 .[1]

Average Initial Composition						Scavenging Flowsheet		Final Concentration	
pH	^{137}Cs	^{90}Sr	PO_4^{3-}	SO_4^{2-}	Na^+	$Cs(NO_3)_2$	pH Adj.	^{137}Cs	^{90}Sr
---	μCi/mL	μCi/mL	*M*	*M*	*M*	*M*	---	μCi/mL	μCi/mL
9.4	0.044	3.12	0.13	0.21	1.4	0.01	No	0.053	0.99
						0.03	No	0.057	0.045

Notes:

Adj. = adjusted

[1]Sloat (1955)

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-BY-102. 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

Two cores of seven segments were originally expected from the sampling event. However, based on zipcord readings taken prior to sampling, core 157 was expected to contain eight segments, and core 159 was expected to contain four segments. For core 157, the full waste depth was not sampled because no solids were recovered from the eighth segment (although some drainable liquid was recovered). The drainable liquid recovered from this segment was most likely hydrostatic head fluid, as evidenced by the large bromide results (14,810 μg/mL). No other segment contamination from the hydrostatic head fluid was noted. High downforces were encountered during the acquisition of segment 5, which was stopped after only 20 cm (8 in.) of sample had been recovered. After the sampler was changed, 18 more cm (7 in.) from segment 5 were sampled and designated 5A. For core 159, only three segments were taken, because of high downforces during sampling.

None of these three segments actually contained waste. Because of all the problems encountered during sampling, two vertical profiles of the waste were not obtained as required by the SAP (Winkelman 1996).

B3.2 QUALITY CONTROL ASSESSMENT

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 QC tests were conducted on the 1996 core samples, allowing a full assessment regarding the accuracy and precision of the data. The SAP (Winkelman 1996) established the specific criteria for all analytes. Sample and duplicate pairs that had one or more QC results outside the specified criteria were identified by footnotes in the data summary tables. All QC evaluations performed on the 1995 vapor samples were within acceptable limits.

The standard and matrix spike recovery results provide an estimate of the accuracy of the analysis. If a standard or matrix spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. Sodium, total alpha, TIC, and TOC each had matrix spike results outside the established QC limits.

The analytical 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. Several of the ICP, IC, percent water, TIC, and TOC results had RPDs outside the QC limits. A number of RPDs were outside the established QC limits for the total alpha activity analysis. This may have been caused by sample heterogeneity and self-absorption by the solids left on the planchet after drying. Reruns were deemed unnecessary, because the sample results were far below the notification limit. Finally, only two total alpha activity samples exceeded the criterion for preparation blanks; thus, contamination was not a problem.

In summary, the vast majority of QC results were within the boundaries specified in the SAPs. The discrepancies mentioned here and footnoted in the data summary tables should not impact either the validity or the use of the data.

B3.3 DATA CONSISTENCY CHECKS

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Several comparisons were possible with the data set provided by the two core samples. Comparisons were made between 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 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 agreement between the two methods strengthens the credibility of both results, whereas a poor agreement brings the reliability of the data into question. All analytical mean results were taken from Table B3-4.

The analytical phosphorus mean of samples prepared by fusion digestion and analyzed by ICP was 9,500 μg/g, which represents total phosphorus. This amount of phosphorus converts to 29,100 μg/g of phosphate. The ICP result agrees well with the IC phosphate result of 27,000 μg/g, demonstrating that a majority of the phosphorus exists in a soluble form.

The analytical sulfur mean of samples prepared by ICP fusion digestion and analyzed by ICP was 17,300 μg/g, which represents total sulfur. This amount of sulfur converts to 51,900 μg/g of sulfate. The ICP result compared well to the IC sulfate mean result of 57,700 μg/g, demonstrating that the sulfur exists in a soluble form.

B3.3.2 Mass and Charge Balance

The principle 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.

Except sodium, all cations listed in Table B3-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. The anions listed in Table B3-2 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. Phosphate and sulfate, as determined by IC, were assumed to be completely water soluble and appear only in the anion mass and charge calculations. The concentrations of cationic species in Table B3-1, the anionic species in Table B3-2, and the percent water were ultimately used to calculate the mass balance.

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

$$\begin{aligned}\text{Mass balance} &= \text{Percent water} + 0.0001 \times \{\text{Total Analyte Concentration}\} \\ &= \text{Percent water} + 0.0001 \times \{Al(OH)_3 + SiO_2 + Na^+ + F^- + NO_3^- \\ &\quad + NO_2^- + PO_4^{3-} + SO_4^{2-} + CO_3^{2-} + C_2O_4^{2-} + C_2H_3O_2^-\}\end{aligned}$$

The total analyte concentrations from the above equation is 777,000 μg/g (wet weight). The mean weight percent water obtained from thermogravimetric analysis was 26.5 percent, or 265,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 104 percent (Table B3-3).

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 μeq/g basis.

Total cations (μeq/g) = $[Na^+]/23.0$ = 11,600 μeq/g

Total anions (μeq/g) = $[F^-]/19.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{3-}]/31.7 + [SO_4^{2-}]/48.0 + [CO_3^{2-}]/30.0 + [C_2H_3O_2^-]/59.0 + [C_2O_4^{2-}]/44.0$ = 10,100 μeq/g

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.15.

Table B3-1. Cation Mass and Charge Data.

Analyte	Concentration	Assumed Species	Concentration of Assumed Species	Charge
	μg/g		μg/g	μeq/g
Aluminum	41,600	$Al(OH)_3$	120,000	0
Silicon	4,350	SiO_2	9,300	0
Sodium	267,000	Na^+	267,000	11,600
Total			396,000	11,600

Table B3-2. Anion Mass and Charge Data.

Analyte	Concentration µg/g	Assumed Species	Concentration of Assumed Species µg/g	Charge µeq/g
Fluoride	18,000	F^-	18,000	947
Nitrate	95,000	NO_3^-	95,000	1,530
Nitrite	13,900	NO_2^-	13,900	302
Sulfate	57,700	SO_4^{2-}	57,700	1,200
Phosphate	27,000	PO_4^{3-}	27,000	853
Oxalate	19,300	$C_2O_4^{2-}$	19,300	439
TIC	27,800	CO_3^{2-}	139,000	4,630
TOC	4,360	$C_2H_3O_2^-$	10,700	181
Total			381,000	10,100

Table B3-3. Mass Balance Totals.

Totals	Concentrations µg/g	Charge µeq/g
Total from Table B3-1	396,000	11,600
Total from Table B3-2	381,000	10,100
Water %	265,000	0
Grand total	1,040,000	1,500

In summary, the above calculations yield reasonable (close to 1.00 for charge balance and 100 percent for mass balance) mass and charge balance values, indicating that the analytical results are generally self-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-BY-102. Due to poor waste recovery for core 159, the following evaluation was performed only on the analytical data from core 157. As a result, statistics for this tank can only give inferences for core 157 and not for the whole tank.

Two-sided 95 percent confidence intervals on the mean inventory were computed. The liquid sample data and solid sample data were analyzed separately. Liquid samples were only present in segments 7 and 8.

The upper and lower limits (UL and LL) to a two-sided 95 percent confidence interval for the mean are

$$\hat{\mu} \pm t_{(df,0.025)} \times \hat{\sigma}_{\hat{\mu}}.$$

In these equations, $\hat{\mu}$ is the estimate of the mean concentration, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean concentration, and $t_{(df,0.025)}$ is the quantile from Student's t distribution with *df* degrees of freedom for a two-sided 95 percent confidence interval.

The mean, $\hat{\mu}$, and the standard deviation, $\hat{\sigma}_{\hat{\mu}}$, were estimated using restricted maximum likelihood estimation (REML) methods. The degrees of freedom (*df*), for tank 241-BY-102, is the number of segments sampled minus one.

B3.4.1 Solid Segment and Liquid Segment Means

The statistics in this section were based on analytical data from the most recent sampling event for tank 241-BY-102. Analysis of variance (ANOVA) techniques were used to estimate the mean, and calculate confidence limits on the mean, for all analytes that had at least 50 percent of reported values above the detection limit. If at least 50 percent of the reported values were above the detection limit, all of the data were used in the computations. The detection limit was used as the value for nondetected results. No ANOVA estimates were computed for analytes with less than 50 percent detected values.

The results given below are ANOVA estimates based on the core segment data from core 157 of tank 241-BY-102. Mean concentration estimates, along with 95 percent confidence intervals on the mean, are given in Table B3-4 for the solid segment sample data and Table B3-5 for the liquid segment sample data. Because an actual concentration of less than zero is not possible, negative 95 percent confidence interval lower limits are reported as zero.

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Alpha[1]	μCi/g	0.0889	0.0436	7	0	0.192
% Water	%	26.5	3.91	7	17.3	35.8
ICP.f.Al	μg/g	41,600	25,700	7	0	1.02E+05
ICP.f.Sb[2]	μg/g	< 1,220	n/a	n/a	n/a	n/a
ICP.f.As[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Ba[2]	μg/g	< 1,010	n/a	n/a	n/a	n/a
ICP.f.Be[2]	μg/g	< 101	n/a	n/a	n/a	n/a
ICP.f.Bi[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.B[2]	μg/g	< 1,010	n/a	n/a	n/a	n/a
Bromide[2]	μg/g	< 854	n/a	n/a	n/a	n/a
ICP.f.Cd[2]	μg/g	< 101	n/a	n/a	n/a	n/a
ICP.f.Ca[2]	μg/g	< 2,110	n/a	n/a	n/a	n/a
ICP.f.Ce[2]	μg/g	< 2,300	n/a	n/a	n/a	n/a
Chloride[1]	μg/g	1,220	260	7	607	1,840
ICP.f.Cr	μg/g	1,870	305	7	1,150	2,600
ICP.f.Co[2]	μg/g	< 406	n/a	n/a	n/a	n/a
ICP.f.Cu[2]	μg/g	< 210	n/a	n/a	n/a	n/a
Fluoride	μg/g	18,000	5,710	7	4,460	31,500
ICP.f.Fe[2]	μg/g	< 1,860	n/a	n/a	n/a	n/a
ICP.f.La[2]	μg/g	< 1,010	n/a	n/a	n/a	n/a
ICP.f.Pb[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Li[2]	μg/g	< 203	n/a	n/a	n/a	n/a
ICP.f.Mg[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Mn[2]	μg/g	< 372	n/a	n/a	n/a	n/a
ICP.f.Mo[2]	μg/g	< 1,010	n/a	n/a	n/a	n/a
ICP.f.Nd[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Ni[1]	μg/g	4,820	1,300	7	1,740	7,900
Nitrate	μg/g	95,000	27,200	7	30,700	1.59E+05

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Nitrite[1]	μg/g	13,900	3,750	7	5,070	22,800
Oxalate[1]	μg/g	19,300	5,550	7	6,190	32,500
Phosphate	μg/g	27,000	7,890	7	8,310	45,600
ICP.f.P[2]	μg/g	< 9,500	n/a	n/a	n/a	n/a
ICP.f.Sm[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Se[2]	μg/g	< 2,030	n/a	n/a	n/a	n/a
ICP.f.Si[1]	μg/g	4,350	1,480	7	852	7,850
ICP.f.Ag[2]	μg/g	< 203	n/a	n/a	n/a	n/a
ICP.f.Na	μg/g	2.67E+05	25,500	7	2.07E+05	3.27E+05
ICP.f.Sr[2]	μg/g	< 203	n/a	n/a	n/a	n/a
Sulfate	μg/g	57,700	14,200	7	24,200	91,300
ICP.f.S[1]	μg/g	17,300	3,550	7	8,940	25,700
ICP.f.Tl[2]	μg/g	< 4,060	n/a	n/a	n/a	n/a
ICP.f.Ti[2]	μg/g	< 203	n/a	n/a	n/a	n/a
TIC	μg/g	27,800	4,530	7	17,100	38,500
TOC	μg/g	4,360	749	7	2,590	6,130
ICP.f.U[2]	μg/g	< 10,100	n/a	n/a	n/a	n/a
ICP.f.V[2]	μg/g	< 1,010	n/a	n/a	n/a	n/a
ICP.f.Zn[2]	μg/g	< 396	n/a	n/a	n/a	n/a
ICP.f.Zr[2]	μg/g	< 203	n/a	n/a	n/a	n/a

Notes:

df = degrees of freedom
LL = lower limit
UL = upper limit

[1]Some "less-than" values are in the analytical results.

[2]More than 50 percent of the analytical results were less-than values; therefore, confidence intervals were not computed.

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Alpha[1]	µCi/mL	0.00478	0.00117	1	0	0.0197
% Water	%	51.5	0.69	1	42.7	60.2
Al	µg/mL	50,800	5,800	1	0	1.24E+05
Sb[2]	µg/mL	< 36.1	n/a	n/a	n/a	n/a
As[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
Ba[2]	µg/mL	< 30.1	n/a	n/a	n/a	n/a
Be[2]	µg/mL	< 3	n/a	n/a	n/a	n/a
Bi[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
B[2]	µg/mL	< 30.1	n/a	n/a	n/a	n/a
Bromide[1]	µg/mL	7,730	7,080	1	0	97,700
Cd[2]	µg/mL	< 3	n/a	n/a	n/a	n/a
Ca[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
Ce[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
Chloride	µg/mL	14,900	1,780	1	0	37,500
Cr	µg/mL	1,020	796	1	0	11,100
Co[2]	µg/mL	< 12	n/a	n/a	n/a	n/a
Cu[2]	µg/mL	< 6.01	n/a	n/a	n/a	n/a
Fluoride[2]	µg/mL	< 99.9	n/a	n/a	n/a	n/a
Fe[1]	µg/mL	50	19.9	1	0	303
La[2]	µg/mL	< 30.1	n/a	n/a	n/a	n/a
Pb	µg/mL	106	6.67	1	21	191
Li[2]	µg/mL	< 6.01	n/a	n/a	n/a	n/a
Mg[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
Mn[2]	µg/mL	< 6.01	n/a	n/a	n/a	n/a
Mo	µg/mL	51.2	63	1	0	131
Nd[2]	µg/mL	< 60.1	n/a	n/a	n/a	n/a
Ni[2]	µg/mL	< 12	n/a	n/a	n/a	n/a
Nitrate	µg/mL	1.75E+05	26,600	1	0	5.12E+05

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Nitrite	μg/mL	79,800	4,000	1	29,000	1.31E+05
Oxalate[1]	μg/mL	854	307	1	0	4,750
Phosphate	μg/mL	5,340	2,720	1	0	39,900
P	μg/mL	911	285	1	0	4,530
Sm[2]	μg/mL	< 60.1	n/a	n/a	n/a	n/a
Se[2]	μg/mL	< 60.1	n/a	n/a	n/a	n/a
Si	μg/mL	183	61	1	0	958
Ag	μg/mL	17.1	0.586	1	9.62	24.5
Na	μg/mL	2.40E+05	6,300	1	1.59E+05	3.20E+05
Sr[2]	μg/mL	< 6.01	n/a	n/a	n/a	n/a
Sulfate	μg/mL	10,900	4,280	1	0	65,400
S	μg/mL	1,360	392	1	0	6,350
Tl[2]	μg/mL	< 120	n/a	n/a	n/a	n/a
Ti[2]	μg/mL	< 6.01	n/a	n/a	n/a	n/a
TIC	μg/mL	2,460	915	1	0	14,100
TOC	μg/mL	1,800	245	1	0	4,910
U[2]	μg/mL	< 300	n/a	n/a	n/a	n/a
V[2]	μg/mL	< 30.1	n/a	n/a	n/a	n/a
Zn	μg/mL	25.9	7.8	1	0	125
Zr[2]	μg/mL	< 6.01	n/a	n/a	n/a	n/a
SpG	---	1.44	0.0162	1	1.24	1.65

Notes:

[1]Some less-than values are in the analytical results.

[2]More than 50 percent of the analytical results were less-than values; therefore, confidence intervals were not computed.

B3.4.2 Analysis of Variance Models

A statistical model is needed to account for the spatial and measurement variability in $\hat{\sigma}_{\hat{\mu}}$. This cannot be done using an ordinary standard deviation of the data (Snedecor and Cochran 1980).

The statistical model fit to the liquid segment sample data is

$$Y_{ij} = \mu + S_i + A_{ij},$$

$$i=1,\ldots,a,\ j= 1,\ldots,n_i,$$

where

Y_{ij}	=	laboratory results from the j^{th} duplicate from the i^{th} segment in the tank
μ	=	the grand mean
S_i	=	the effect of the i^{th} segment
A_{ij}	=	the effect of the j^{th} analytical result from the i^{th} segment
a	=	the number of segments
n_i	=	the number of analytical results from the i^{th} location.

The variable S_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(S)$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$ and $\sigma^2(A)$ were obtained using REML techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using the statistical analysis package S-PLUS (Statistical Sciences 1993).

The statistical model fit to the solid segment sample data is

$$Y_{ijk} = \mu + S_i + L_{ij} + A_{ijk},$$

$$i=1,\ldots,a,\ j= 1,\ldots,b_i,\ n=1,\ldots n_{ij},$$

where

Y_{ijk}	=	laboratory results from the k^{th} duplicate from the j^{th} location in the i^{th} segment
μ	=	the grand mean
S_i	=	the effect of the i^{th} segment
L_{ij}	=	the effect of the j^{th} location from the i^{th} segment
A_{ijk}	=	the effect of the k^{th} analytical result from the j^{th} location from the i^{th} segment
a	=	the number of segments
b_i	=	the number of locations in the i^{th} segment
n_{ij}	=	the number of analytical results from the j^{th} location from the i^{th} segment.

The variables S_i and L_{ij} are assumed to be random effects. These variables and A_{ijk} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$ were also obtained using REML techniques. The statistical results were obtained using statistical analysis package S-PLUS (Statistical Sciences 1993).

B3.4.3 Inventory

The total inventory of each analyte from the solid layer can be calculated using an average density of 1.50 g/mL and a waste volume of 1,050 kL (277 kgal). The calculation is performed by multiplying the concentration estimates given in Table B3-4 by the density and the waste volume, and then dividing by 1,000. The total alpha inventory can be calculated similarly, although dividing by 1,000 is not performed. Inventories for the solids are presented in Table B3-6. The liquid inventory can be calculated in a similar manner by using the drainable liquid volume of 42 kL (11 kgal). The mean result in Table B3-5 is multiplied by the waste volume and then divided by 1,000,000. The total alpha inventory is multiplied by the waste volume and then divided by 1,000. The liquid inventories are presented in Table B3-7.

Table B3-6. Analytical-Based Inventory for Solid Segment Sample Data for Tank 241-BY-102. (2 sheets)

Analyte	Inventory (kg)	LL (kg)	UL (kg)
Alpha	140 (Ci)	0 (Ci)	302 (Ci)
Water	4.17E+05	2.72E+05	5.63E+05
ICP.f.Al	65,400	0	1.61E+05
ICP.f.Sb	< 1,910	n/a	n/a
ICP.f.As	< 3,190	n/a	n/a
ICP.f.Ba	< 1,590	n/a	n/a
ICP.f.Be	< 159	n/a	n/a
ICP.f.Bi	< 3,190	n/a	n/a
ICP.f.B	< 1,590	n/a	n/a
Bromide	< 1,340	n/a	n/a
ICP.f.Cd	< 159	n/a	n/a
ICP.f.Ca	< 3,320	n/a	n/a
ICP.f.Ce	< 3,190	n/a	n/a
Chloride	1,920	955	2,890
ICP.f.Cr	2,950	1,810	4,080
ICP.f.Co	< 638	n/a	n/a
ICP.f.Cu	< 331	n/a	n/a
Fluoride	28,300	7,020	49,500
ICP.f.Fe	< 2,920	n/a	n/a
ICP.f.La	< 1,590	n/a	n/a
ICP.f.Pb	< 3,190	n/a	n/a
ICP.f.Li	< 319	n/a	n/a
ICP.f.Mg	< 3,190	n/a	n/a
ICP.f.Mn	< 585	n/a	n/a
ICP.f.Mo	< 1,590	n/a	n/a
ICP.f.Nd	< 3,190	n/a	n/a

Table B3-6. Analytical-Based Inventory for Solid Segment Sample Data for Tank 241-BY-102. (2 sheets)

Analyte	Inventory (kg)	LL (kg)	UL (kg)
ICP.f.Ni	< 7,580	2,740	12,400
Nitrate	1.49E+05	48,200	2.51E+05
Nitrite	21,900	7,970	35,800
Oxalate	30,400	9,720	51,000
Phosphate	42,400	13,100	71,700
ICP.f.P	< 14,900	n/a	n/a
ICP.f.Sm	< 3,190	n/a	n/a
ICP.f.Se	< 3,190	n/a	n/a
ICP.f.Si	6,850	1,340	12,400
ICP.f.Ag	< 319	n/a	n/a
ICP.f.Na	4.20E+05	3.25E+05	5.14E+05
ICP.f.Sr	< 319	n/a	n/a
Sulfate	90,800	38,000	1.44E+05
ICP.f.S	27,200	14,100	40,400
ICP.f.Tl	< 6,380	n/a	n/a
ICP.f.Ti	< 319	n/a	n/a
TIC	43,800	26,900	60,600
TOC	6,860	4,070	9,640
ICP.f.U	< 15,900	n/a	n/a
ICP.f.V	< 1,590	n/a	n/a
ICP.f.Zn	< 622	n/a	n/a
ICP.f.Zr	< 319	n/a	n/a

Table B3-7. Analytical-Based Inventory for Liquid Segment Sample Data for Tank 241-BY-102. (2 sheets)

Analyte	Inventory (kg)	LL (kg)	UL (kg)
Alpha	0.199	0 (Ci)	0.821 (Ci)
% Water	31,100	25,800	36,400
Al	2,110	0	5,180
Sb	< 1.50	n/a	n/a
As	< 2.50	n/a	n/a
Ba	< 1.25	n/a	n/a
Be	< 0.125	n/a	n/a
Bi	< 2.50	n/a	n/a
B	< 1.25	n/a	n/a
Bromide	322	0	4,070
Cd	< 0.125	n/a	n/a
Ca	< 2.50	n/a	n/a
Ce	< 2.50	n/a	n/a
Chloride	621	0	1,560
Cr	42.4	0	464
Co	< 0.500	n/a	n/a
Cu	< 0.250	n/a	n/a
Fluoride	< 4.16	n/a	n/a
Fe	2.08	0	12.6
La	< 1.25	n/a	n/a
Pb	4.40	0.875	7.94
Li	< 0.250	n/a	n/a
Mg	< 2.50	n/a	n/a
Mn	< 0.250	n/a	n/a
Mo	2.13	0	5.46
Nd	< 2.50	n/a	n/a

Table B3-7. Analytical-Based Inventory for Liquid Segment Sample Data for Tank 241-BY-102. (2 sheets)

Analyte	Inventory (kg)	LL (kg)	UL (kg)
Ni	< 0.500	n/a	n/a
Nitrate	7,270	0	21,300
Nitrite	3,320	1,210	5,440
Oxalate	35.5	0	198
Phosphate	222	0	1,660
P	37.9	0	188
Sm	< 2.50	n/a	n/a
Se	< 2.50	n/a	n/a
Si	7.62	0	39.9
Ag	0.711	0.401	1.02
Na	9,970	6,640	13,300
Sr	< 0.250	n/a	n/a
Sulfate	454	0	2,720
S	56.7	0	264
Tl	< 5.00	n/a	n/a
Ti	< 0.250	n/a	n/a
TIC	102	0	587
TOC	74.9	0	205
U	< 12.5	n/a	n/a
V	< 1.25	n/a	n/a
Zn	1.08	0	5.20
Zr	< 0.250	n/a	n/a

B4.0 APPENDIX B REFERENCES

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

In Appendix C, the results of statistical analyses and other numerical manipulations required for the applicable DQOs are described. These analyses for the safety screening and organic DQOs are presented in this appendix as described below. No statistical analyses were needed for the vapor DQO.

- **Section C1**: Statistics for Safety Screening DQO
- **Section C2**: Statistics for Organic DQO
- **Section C3**: 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-BY-102. All data in this section are from the final laboratory data package for the 1996 core sampling event for tank 241-BY-102 (Fritts 1996).

Confidence intervals were computed for each sample number from the analytical data. The sample numbers and confidence intervals are provided in Table C1-1 for DSC and Table C1-2 for total alpha.

The upper limit 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 percent confidence interval.

For the tank 241-BY-102 data (per sample number), *df* equals the number of observations minus one, i.e., the *df* equals 1.

The limit for plutonium is 1 g/L assuming that all the plutonium is ^{239}Pu. This translates to a total alpha limit of 61.5 μCi/mL for liquid samples. Because the maximum bulk density sampled was 1.86 g/mL, the limit for the solid segment samples was 33.1 μCi/g.

The upper limit of the 95 percent confidence interval for each sample number based on total alpha data is listed in Table C1-1. Each confidence interval can be used to make the following statement: "If the upper limit is less than 33.1 μCi/g (61.5 μCi/mL for drainable liquid), then one would reject the null hypothesis that the total alpha is greater than or equal to 33.1 μCi/g (61.5 μCi/mL for drainable liquid) at the 0.05 level of significance." All upper limits were well below the DQO thresholds. Therefore, the available analytical results indicate that criticality is not an issue for this tank.

The upper limit of the 95 percent confidence interval for each sample number based on DSC data is listed in Table C1-2. Each confidence interval can be used to make the following statement: "If the upper limit is less than 480 J/g, then one would reject the null hypothesis that DSC is greater than or equal to 480 J/g at the 0.05 level of significance." All upper limits were well below the DQO thresholds. Therefore, the available analytical results indicate that energetics are not an issue for this tank.

Table C1-1. 95 Percent Confidence Interval Upper Limits for Total Alpha for Tank 241-BY-102 (Units are μCi/g, or μCi/mL for Drainable Liquid).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T003635	Core 157, Segment 2, Lower Half	0.332	0.003	0.347
S96T003650	Core 157, Segment 3, Lower Half	0.092	0.018	0.208
S96T003652	Core 157, Segment 6, Lower Half	0.021	0.001	0.027
S96T003657	Core 157, Segment 8, Drainable Liquid	0.006	0.001	0.015
S96T004133[1,2]	Core 157, Segment 7, Drainable Liquid	0.004	0.001	0.009
S96T004164	Core 157, Segment 4, Qtr Segment B	0.240	0.059	0.609
S96T004165	Core 157, Segment 4, Qtr Segment C	0.208	0.079	0.703
S96T004166	Core 157, Segment 5A, Lower Half	0.010	0.001	0.013
S96T004167[2]	Core 157, Segment 7, Qtr Segment C	0.003	3.00E-04	0.005
S96T004168[1,2]	Core 157, Segment 7, Qtr Segment D	0.002	2.00E-04	0.003
S96T004295	Core 157, Segment 1, Lower Half	0.019	0.002	0.035
S96T004343	Core 157, Segment 5, Lower Half	0.010	0.001	0.014

Notes:

[1]Sample result is below the detection limit.
[2]Duplicate result is below the detection limit.

Table C1-2. 95 Percent Confidence Interval Upper Limits for DSC for Tank 241-BY-102 (Units are J/g-Dry).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T003633	Core 157, Segment 2, Lower Half	6.5	6.5	47.2
S96T003644	Core 157, Segment 3, Lower Half	9.6	9.6	70.2
S96T003645	Core 157, Segment 6, Upper Half	0	0	0
S96T003646	Core 157, Segment 6, Lower Half	0	0	0
S96T003657	Core 157, Segment 8, Drainable Liquid	0	0	0
S96T004133	Core 157, Segment 7, Drainable Liquid	0	0	0
S96T004145	Core 157, Segment 4, Qtr Segment A	92.6	2.2	106.1
S96T004146	Core 157, Segment 4, Qtr Segment B	141.5	4.5	169.9
S96T004147	Core 157, Segment 4, Qtr Segment C	19.6	0.6	23
S96T004148	Core 157, Segment 5A, Upper Half	0	0	0
S96T004149	Core 157, Segment 5A, Lower Half	0	0	0
S96T004150	Core 157, Segment 7, Qtr Segment A	27	2.3	41.5
S96T004151	Core 157, Segment 7, Qtr Segment B	0	0	0
S96T004152	Core 157, Segment 7, Qtr Segment C	49.7	5.4	83.8
S96T004153	Core 157, Segment 7, Qtr Segment D	43	43	144.2
S96T004294	Core 157, Segment 1, Lower Half	0	0	0
S96T004341	Core 157, Segment 5, Lower Half	0	0	0

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. In this appendix, one-sided confidence limits supporting the organic DQO are calculated for tank 241-BY-102. All data considered in this section are taken from the final laboratory data package for the 1996 core sampling event (Fritts 1996).

Confidence intervals were computed for each sample number from the analytical data. The sample numbers and confidence intervals are provided in Table C2-1 for percent water and Table C2-2 for TOC.

For percent water, the lower limit 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 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 percent confidence interval.

For the tank 241-BY-102 data (per sample number), *df* equals the number of observations minus one, i.e., the *df* equals 1.

The lower limit of the 95 percent confidence interval for each sample number based on percent water data is listed in Table C2-1. Each confidence interval can be used to make the following statement: "If the lower limit is greater than 17 percent, then one would reject the null hypothesis that the percent water is less than or equal to 17 percent at the 0.05 level of significance." All upper limits were well below the DQO thresholds. Therefore, the available analytical results indicate that organics are not an issue for this tank.

The upper limit of the 95 percent confidence interval for each sample number based on TOC data is listed in Table C2-2. Each confidence interval can be used to make the following statement: "If the upper limit is less than 30,000 μg/g, then one would reject the null hypothesis that TOC is greater than or equal to 30,000 μg/g at the 0.05 level of significance."

Table C2-1. 95 Percent Confidence Interval Lower Limits for Weight Percent Water for Tank 241-BY-102 (Units are in wt%). (2 sheets)

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	LL
S96T003633	Core 157, Segment 2, Lower Half	23.19	4.16	13.41
S96T003644	Core 157, Segment 3, Lower Half	26.50	0.08	26.02
S96T003645	Core 157, Segment 6, Upper Half	50.24	1.22	42.54
S96T003646	Core 157, Segment 6, Lower Half	50.47	0.25	48.92

Table C2-1. 95 Percent Confidence Interval Lower Limits for Weight Percent Water for Tank 241-BY-102 (Units are in wt%). (2 sheets)

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	LL
S96T003657	Core 157, Segment 8, Drainable Liquid	52.14	0.11	51.47
S96T004133	Core 157, Segment 7, Drainable Liquid	50.76	0.20	49.52
S96T004145	Core 157, Segment 4, Qtr Segment A	27.10	3.51	4.96
S96T004146	Core 157, Segment 4, Qtr Segment B	26.79	1.91	14.73
S96T004147	Core 157, Segment 4, Qtr Segment C	20.15	0.32	18.16
S96T004148	Core 157, Segment 5A, Upper Half	16.77	0.08	16.29
S96T004149	Core 157, Segment 5A, Lower Half	27.63	5.07	0
S96T004150	Core 157, Segment 7, Qtr Segment A	27.00	2.86	8.97
S96T004151	Core 157, Segment 7, Qtr Segment B	22.61	1.03	16.11
S96T004152	Core 157, Segment 7, Qtr Segment C	33.22	0.59	29.52
S96T004153	Core 157, Segment 7, Qtr Segment D	33.52	3.04	14.35
S96T004294	Core 157, Segment 1, Lower Half	11.66	0.24	10.17
S96T004341	Core 157, Segment 5, Lower Half	22.36	0.32	20.34

Table C2-2. 95 Percent Confidence Interval Lower Limits for TOC for Tank 241-BY-102 (Units are in μg/g Dry Weight). (2 sheets)

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T003633	Core 157, Segment 2, Lower Half	8,189	1,223	11,761
S96T003644	Core 157, Segment 3, Lower Half	13,024	1,127	16,316
S96T003645	Core 157, Segment 6, Upper Half	7,064	111	7,762
S96T003646	Core 157, Segment 6, Lower Half	8,486	333	9,458
S96T003657	Core 157, Segment 8, Drainable Liquid	2,987	7	3,034
S96T004133	Core 157, Segment 7, Drainable Liquid	2,163	35	2,382
S96T004145	Core 157, Segment 4, Qtr Segment A	5,994	1,199	9,496

Table C2-2. 95 Percent Confidence Interval Lower Limits for TOC for Tank 241-BY-102 (Units are in μg/g Dry Weight). (2 sheets)

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T004146	Core 157, Segment 4, Qtr Segment B	14,206	546	17,656
S96T004147	Core 157, Segment 4, Qtr Segment C	2,761	507	5,964
S96T004148	Core 157, Segment 5A, Upper Half	8,224	102	8,868
S96T004149	Core 157, Segment 5A, Lower Half	2,008	277	2,817
S96T004150	Core 157, Segment 7, Qtr Segment A	3,911	158	4,905
S96T004151	Core 157, Segment 7, Qtr Segment B	1,383	39	1,627
S96T004152	Core 157, Segment 7, Qtr Segment C	8,123	621	12,047
S96T004153	Core 157, Segment 7, Qtr Segment D	3,911	30	4,101
S96T004294	Core 157, Segment 1, Lower Half	929	84	1,458
S96T004341	Core 157, Segment 5, Lower Half	4,766	477	7,775

C3.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BY-102

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BY-102

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 information for tank 241-BY-102 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 CHEMICAL INVENTORY SOURCES

Available waste (chemical) information for tank 241-BY-102 include the following:

- Data from a push-mode core sample that was collected in 1996. See Appendix B for data.
- The inventory estimate for this tank (Agnew et al. 1996) generated from the Hanford Defined Waste model (HDW) developed at Los Alamos National Laboratory.
- Tank Characterization Report (TCR) data from other tanks identified historically as having the same BY saltcake (BYSltCk) waste type.

A list of references used in this evaluation is provided at the end of this Appendix (Section D5.0).

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Sampling-based inventories (see Appendix B), derived from the analytical concentration data from the core samples, and the HDW model inventories are compared in Tables D2-1 and D2-2. Table D2-1 compares nonradioactive components on a kilogram (kg) basis, and Table D2-2 compares the radioactive components on a total curie basis. The HDW model document (Agnew et al. 1996) provides tank content estimates in terms of component concentrations and inventories.

Sampling-based inventories listed in the TCR were calculated by multiplying the mean concentration of an analyte by the current waste mass, derived using the current tank volume and the mean density of the waste. However, the sample data are based on a single incomplete core sample (a full profile of the waste was not obtained). The tank is reported to contain 1,050 kL (277 kgal) of saltcake waste (Hanlon 1996) and the mean density is reported to be 1.50 g/mL (Appendix B).

The HDW estimate is based on the 1994 waste levels and does not take into account the 1995 stabilization effort. The estimate includes supernatant and some interstitial liquids that were removed from the tank during stabilization. The HDW model inventory is based on a waste volume of 1,291 kL (341 kgal) and a density of 1.62 g/mL. The waste in the HDW model is partitioned in this manner: 1,180 kL (312 kgal) BY saltcake, 42 kL (11 kgal) from an unspecified source (assigned as an unknown), and 68 kL (18 kgal) metal waste sludge.

The sampling-based inventory was developed by assuming that the last 48.3 cm (19 in.) of waste at the tank bottom had the same mean concentrations as did the rest of the tank. It is possible that a small layer of TBP sludge remains at in the bottom of this tank, but no firm documentation is available to support this assumption. The assumption used for this assessment is that there is no sludge layer at the bottom of the tank. Only a sample taken at the bottom of the tank can indicate if this is correct.

Table D2-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-BY-102. (2 sheets)

Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)	Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)
Al	65,500	69,600	Ni	7,580	942
Ag	<319	NR	NO_2	25,200	97,000
Bi	<3,190	229	NO_3	156,000	475,000
Ca	3,320	3,720	OH	NR	202,000
Ce	<3,190	NR	oxalate	30,400	0.3
Cd	<159	NR	Pb	<3,190	1,400
Cl	2,540	5,500	P as PO_4	45,800	10,500
Co	<638	NR	Sb	<1,910	NR
Cr	2,990	3,170	Si	6,860	2,640
Cu	<331	NR	S as SO_4	91,200	23,000

Table D2-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-BY-102. (2 sheets)

Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)	Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)
F[3]	28,300	1,380	Sr	<319	0.38
Fe	2,920	1,520	TIC	43,800	8,800
Hg	NR	8.64	TOC	6,940	9,200
K	NR	1,800	U_{total}	<15,900	39,500
La	<1,590	0.55	Zn	622	NR
Mg	<3,190	NR	Zr	<319	32.9
Mn	585	218	H_2O (wt%)	29.9	38.3
Mo	<1,590	NR	density (kg/L)	1.50	1.62
Na	430,000	351,000			
NH_4	NR	215			

Notes:

NR = not reported

[1]Appendix B
[2]Agnew et al. (1996)
[3]Fluoride based on water soluble portion only.

Table D2-2. Sampling and HDW Predicted Inventory Estimates for Radioactive Components in Tank 241-B-102.

Analyte	Sampling[1] inventory estimate (Ci)	HDW[2] inventory estimate (Ci)	Analyte	Sampling[1] inventory estimate (Ci)	HDW[2] inventory estimate (Ci)
^{90}Sr	NR	1.56E+05	$^{239/240}Pu$	NR	207
^{137}Cs	NR	2.61E+05			

Notes:

[1]Appendix B
[2]Agnew et al. (1996)

D3.0 COMPONENT INVENTORY EVALUATION

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

D3.1 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

The reported waste types in tank 241-BY-102 are as follows. (See Appendix A for a detailed summary of the waste transfer history.)

Agnew et al. (1996): MW, UNK, BYSltCk
Hill et al. (1995): TBP, EB-ITS, CW, 1C

1C = First cycle decontamination waste from the bismuth phosphate process
BYSltCk = BY Saltcake (same as EB-ITS)
CW = Coating waste from the bismuth phosphate process
EB-ITS = Evaporator bottoms from in-tank solidification
MW = Metal waste from the bismuth phosphate process
TBP = Tributyl phosphate or uranium recovery process supernatants
UNK = Unknown

As addressed in Section D2.0 Agnew et al. (1996) estimates volumes for these waste types before salt well pumping and Hanlon (1996) estimates volumes after the pumping. The Hanlon waste volume estimate of 1,050 kL (277 kgal) is used in this assessment.

A sludge layer may or may not exist at the bottom of tank 241-BY-102. During 1954, the tank was sluiced, and it was declared empty in June 1954 (Rodenhizer 1987). However, the HDW assumes that none of the MW solids were removed during the sluicing and attributes 68 kL (18 kgal) of the waste volume to MW sludge. There is also a possibility that TBP supernatants transferred to the tank after it was sluiced, depositing sludge in the tank (Agnew et al. 1995). Because the sampling did not extend to the bottom 48.3 cm (19 in.) of the tank, none of these positions can be verified. This assessment does not assume a sludge layer in tank 241-BY-102.

D3.2 ASSUMPTIONS USED

The following sections provide an engineering evaluation of tank 241-BY-102 contents. For this evaluation, the following assumptions and observations were made:

- Total waste mass is calculated using the sampling-based measured density and the tank volume listed in Hanlon (1996) (1,050 kL [277 kgal]). The different volume and density used in the HDW model will provide an intrinsic 28 percent relative percent difference, and may bias the HDW results generally higher, if the analytical concentrations from the two methods are relatively close. The waste types that contribute to the total volume are also different in each case as described in Section D2.0. As a result, the two inventory estimates are not made on the same basis.

- Only the BYSltCk waste stream contributed to solids formation.

- No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion purposes are factored into this evaluation.

D3.3 BASIS FOR CALCULATIONS USED IN THIS EVALUATION

Table D3-1 summarizes the engineering evaluation approach used on tank 241-BY-102.

Table D3-1 Assessment Methodology Used For Tank 241-BY-102

Type of Waste	How Calculated	Check Method
Supernatant	No supernatant predicted	n/a
Saltcake Vol. = 1,048 kL (277 kgal)	Used the sample-based inventory, which was calculated by multiplying the average tank analyte concentration by the total mass of the waste in tank 241-BY-102. The density used was the average measured density (1.50 g/mL).	Used sample-based concentrations for three other 241-BY tanks, multiplied by saltcake total mass in tank 241-BY-102. The density used was the average density of the tanks for which the concentrations were derived (1.71 g/mL).
Sludge	No sludge predicted.	n/a

BY saltcake (BYSltCk), the abbreviation used by Agnew et al. (1996), denotes salt waste supernatants that are evaporated and concentrated using in-tank heaters. In-tank solidification (ITS) campaigns were performed in the BY Tank Farm from 1964 through 1976. Waste supernatants that were evaporated originated primarily from the $BiPO_4$ process operations in B Plant. Heaters were placed in tanks 241-BY-101, 241-BY-102, and 241-BY-112. Certain BY tanks were designated as feed tanks. Concentrates from the heated tanks were transferred to other tanks in the BY tank farm and some BX tank farm tanks where they cooled and crystallized (Agnew et al. 1995).

A defined waste comparison for BYSltCk is provided in Agnew et al. (1996). Because of the complicated waste supernatant transfer history of feed to the ITS campaign and the lack of a flowsheet basis for the waste, it is difficult to perform an independent assessment to estimate a saltcake composition that can be compared to the model-based BYSltCk composition. However, samples from BY tank farm tanks other than tank 241-BY-102 that contain BYSltCk have been analyzed and the results have been reported. The analytical results for these tanks were evaluated at the core segment level and the BYSltCk was identified. Table D3-2 summarizes the compositions of saltcake from tank 241-BY-105, 241-BY-106, and 241-BY-110 based on the segment-level analysis reported, respectively, in Simpson et al. (1996a), Bell et al. (1996), and Simpson et al. (1996b). For comparison, the waste component concentrations for tank 241-BY-102 and the BYSltCk defined waste composition from Agnew et al. (1996) are also shown in Table D3-2.

As indicated in Table D3-2, the concentrations of major waste components such as sodium, aluminum, nitrate, fluoride, and sulfate vary among the three comparison tanks (tanks 241-BY-105, 241-BY-106, and 241-BY-110) by no more than a factor of about three. However, the variation among tanks for minor components is much higher.

Note that the iron, chromium, nickel, silicon, fluoride, phosphate, and sulfate concentrations in the tank 241-BY-102 samples are significantly higher than the corresponding average concentrations of those components in the three BY farm comparison tanks. The high sulfate and phosphate concentrations in tank 241-BY-102 are apparently compensated by lower nitrate concentrations. Some of the apparent anomalies for tank 241-BY-102 likely result from the use of tank 241-BY-102 as the ITS unit 1 (ITS-1). This tank contained the heater itself, whereas several of the other BY farm tanks received evaporated supernatant from tank 241-BY-102. In particular, components with slightly lower solubilities would likely concentrate and precipitate from solution and collect on or near the caked surface of the ITS unit in tank 241-BY-102.

The average analytical-based composition from tanks 241-BY-105, 241-BY-106, and 241-BY-110 compare more favorably with the HDW model BYSltCk composition than the tank 241-BY-102 composition does.

Table D3-2. Concentrations of Components in BY Tank Farm Saltcake Samples. (3 sheets)

Analyte	Component Concentration (µg/g)					
	BY-105	BY-106	BY-110	Average Concentration	BY-102[1]	HDW Avg.[2] BYSltCK
Non-radioactive components						
Al	18,400	20,400	14,100	17,633	41,600	35,783
Bi	55.6	NR	NR	55.6	< 2,030	116.2
B	NR	113	92.3	103	< 1,010	NR
Cd	6.54	8.25	21.1	12.0	< 101	NR
Ca	216	308	400	308	< 2,100	1817.9
Chloride	897	2,060	2,250	1,736	1,220	2,784.3
Cr	321	855	2,900	1,359	1,870	1,628.7
Co	8.75	NR	NR	8.75	< 406	NR
Cu	7.57	NR	NR	7.57	< 210	NR
Fluoride	4,100	5,130	5,420	4,883	18,000	699.5

Table D3-2. Concentrations of Components in BY Tank Farm Saltcake Samples. (3 sheets)

Analyte	Component Concentration (µg/g)					
	BY-105	BY-106	BY-110	Average Concentration	BY-102[1]	HDW Avg.[2] BYSltCK
Non-radioactive components (Cont'd)						
Fe	476	215	924	538	1,860	554.4
Pb	50.3	64.5	130	82	< 2,030	726.1
Mn	54.8	9.57	52.8	39.1	372	110.4
Ni	75.9	47.9	193	106	4,820	489.7
Nitrate	4.91E+05	3.29E+05	1.84E+05	3.35E+05	95,000	2.46E+05
Nitrite	9,410	32,100	30,600	24,037	13,900	49,532
Oxalate	11,300	8,990	13,600	11,297	19,300	0.15
Phosphate	4,890	5,270	14,200	8,120	27,000	4,023.3
P	1,010	1,032	4,650	2,231	< 9,500	NR
K	712	2,470	1,930	1,704	NR	910.8
Si	180	184	451	272	4,350	1,359.2
Na	1.98E+05	2.03E+05	2.37E+05	2.13E+05	2.67E+05	1.76E+05
Sr	88.3	44.4	58.1	64	< 203	0.19
Sulfate	10,600	11,300	18,400	13,433	57,700	11,357
S	3,140	3,280	5,950	4,123	17,300	NR
TIC	NR	7,359	31,800	19,580	27,800	3,720.6
TOC	3,250	2,500	5,920	3,890	4,360	NR
U	261	164.2	697	374	< 10,100	3,793
Zn	36.8	164.2	32.8	77.9	< 396	NR
Zr	5.23	6.28	14.4	8.64	< 203	16.7
Density (g/mL)	NR	1.71	NR	1.71	1.50	1.62
wt% H_2O	16.1	25.5	23.2	21.6	NR	37.4

Table D3-2. Concentrations of Components in BY Tank Farm Saltcake Samples. (3 sheets)

Analyte	Component Concentration (μCi/g)					
	BY-105	BY-106	BY-110	Average Concentration	BY-102[1]	HDW Avg.[2] BYSltCK
Radionuclides						
^{137}Cs	NR	106	60	83.0	NR	133.2
^{90}Sr	NR	< 4.26	22.5	22.5	NR	80.3
$^{239/240}Pu$	NR	NR	0.0192	0.0192	NR	0.107
Total Alpha	0.0168	< 0.00945	0.0434	0.0301	NR	NR
Total Beta	NR	< 80.2	NR	NR	NR	NR

Note:
[1]From Appendix B.
[2]Agnew et al. (1996).

D3.4 ESTIMATED COMPONENT INVENTORIES

Estimated chemical inventories for tank 241-BY-102 are summarized in Table D3-3. Shown are the sample-based inventory and the inventory estimated by the HDW model. Also shown is the predicted (engineering evaluation) inventory based on the average analytical values for the three BY farm comparison tanks. Comments and observations are provided in the following text.

Tanks 241-BY-112 and tank 241-BY-102 were the designated tanks in the BY tank farm for the ITS systems. Tank 241-BY-101 had an ITS unit for a short time; this was upgraded and transferred to tank 241-BY-102. Because of its configuration (i.e., a heater in one tank and subsequent tanks connected in series for cooling the concentrated supernatant), the ITS system caused a different mix of analytes to settle in tank 241-BY-102. For example, there is significantly less nitrate and nitrite in tank 241-BY-102 than in the other BY tanks. There is also more calcium, manganese, nickel, silicon, sulfate, phosphate, fluoride, and iron than in the BY saltcake in the three comparison tanks (see Section D3.3). At this time, there is no way to acurately predict the saltcake analytical values through an engineering assessment, other than by using analytical data from other tanks containing BYSltCk. However, because tank 241-BY-102 was the evaporator tank for the ITS system, prediction as to what is in tank 241-BY-102 by using the other BY tanks as a basis is less accurate.

Table D3-3. Comparison of Selected Component Inventory Estimates for Tank 241-BY-102 Waste.

Component	Engineering Assessment (kg)[1]	Sample-based (kg)	HDW estimate (kg)
Bi	100	<3,190	229
Ca	555	3,320	3,720
Cl	3,130	2,540	5,500
K	3,070	NR	1,800
La	NR	<1,590	0.55
NO_3	6.03E+05	1.56E+05	4.75E+05
NO_2	43,300	25,200	97,000
Mn	70	585	218
Ni	190	7,580	942
Oxalate	20,300	30,400	0.3
Pb	147	<3,190	1,400
Si	489	6,860	2,640
SO_4	24,200	91,200	23,000
Sr	115	<319	0.38
Cr	2,450	2,990	3,170
PO_4	14,600	45,800	10,500
F	8,790	28,300	1,380
Al	31,800	67,500	69,600
Fe	969	2,920	1,520
TIC	35,300	43,800	8,800
TOC	7,000	6,940	9,200
U	674	<15,900	39,500
Zr	15.6	<319	32.9
Na	3.83E+05	4.30E+05	3.51E+05
H_2O (percent)	21.6	29.9	38.3

Note:

[1]Based on average concentrations for components in tanks 241-BY-105, 241-BY-106, and 241-BY-110.

The HDW model does not properly represent the decreased solubilities for components in tank 241-BY-102 (e.g., phosphate, sulfate, and fluoride) that are normally quite soluble in other tanks containing BYSltCk. The increased temperatures and rapid boil-off in tank 241-BY-102 likely resulted in a concentration and precipitation of these components. The concentrated supernatants were transferred to other BY farm tanks for cooling and further precipitation of the more soluble components.

Because of the unique history of tank 241-BY-102 as an ITS evaporator tank, it is judged that the analytical data from the 1996 core sample best represents the component concentrations for this tank. With the exception of tank 241-BY-112, other tanks in the BY farm received concentrated supernatants from the ITS evaporator tanks. The waste in these receiver tanks exhibit markedly different concentrations of certain components.

Tank 241-BY-112, which also contained an ITS unit, was sampled in 1996. When the analytical results become available, these will be examined to determine if similar differences in component concentrations exist between tank 241-BY-112 and the concentrated supernatant receiver tanks.

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

An evaluation of available chemical information for tank 241-BY-102 was performed that included:

- Data from a push-mode 1996 core sample (Appendix B)
- An inventory estimate generated by the HDW model (Agnew et al. 1996)
- Evaluation of the BYSltCk data from other BY Tank Farm tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-102. For the following reasons, the sampling-based inventory was chosen as the best basis for those analytes for which sampling-based analytical values were available:

- The sample-based inventory analytical concentrations compared favorably to those of other BY tanks. There were, however, the noted exceptions because this tank was the evaporator tank for the ITS-1 unit.
- No methodology is available to fully predict BYSltCk from process flowsheet or historical records
- Waste transfer records are not complete and not always accurate

For those few analytes for which no values could be calculated from the sample-based inventory, the engineering evaluation data or the HDW model values were used. These values are less reliable than the values for which sample data are available.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-102. When the sample-based inventory had a high less-than value or was not measured, the engineering assessment-based values were used (if available). Results for radionuclides were not available for the sample-based inventory. The HDW model was used only where no other data were available. The best-basis inventory for tank 241-BY-102 is presented in Tables D4-1 and D4-2.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)	Comment
Al	67,500	S	---
Bi	100	E	Used average concentration from other tanks in BY Farm.
Ca	3,320	S	---
Cl	2,540	S	---
TIC as CO_3	2.19E+05	S	---
Cr	2,990	S	---
F	28,300	S	---
Fe	2,920	S	---
Hg	8.6	M	---
K	3,070	E	Used average concentration from other tanks in BY Farm
La	0.55	M	---
Mn	585	S	---
Na	4.30E+05	S	---
Ni	7,580	S	---
NO_2	25,200	S	---
NO_3	1.56E+05	S	---
OH	NR	---	---
Pb	147	E	Used average concentration from other tanks in BY Farm
P as PO_4	45,800	S	---
Si	6,860	S	---

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)	Comment
S as SO_4	91,200	S	---
Sr	115	E	Used average concentration from other tanks in BY Farm
TOC	6,940	S	---
U_{TOTAL}	674	E	Used average concentration from other BY tanks. May be low, the sample was < 15,900 kg.
Zr	15.6	E	Used average concentration from other tanks in BY Farm

Notes:

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

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997).

Analyte	Total inventory (Ci)	Basis (S, M, or E)	Comment
^{90}Sr	40,500	E	HDW estimate was 1.59E+05
^{90}Y	40,500	E	Based on Sr
^{137}Cs	1.50E+05	E	HDW estimate was 2.61E+05
^{137m}Ba	1.42E+05	E	Based on Cs
^{239}Pu	34.6	E	HDW estimate was 207

Notes:

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

D5.0 APPENDIX D REFERENCES

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Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Bell, K. E., J. Franklin, J. Stroup, J. L. Huckaby, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-106*, WHC-SD-WM-ER-616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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

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

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corp., Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., J. G. Field, and L. M. Sasaki, 1996a, *Tank Characterization Report for Single-Shell Tank 241-BY-105*, WHC-SD-WM-ER-598, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., R. D. Cromar, R. D. Schreiber, 1996b, *Tank Characterization Report for Single-Shell Tank 241-BY-110*, WHC-SD-WM-ER-591, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-BY-102

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-BY-102

Appendix E provides a bibliography of information that supports the characterization of tank 241-BY-102. 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-BY-102 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 - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of tank 241-BY-102
- IIb. Sampling of BY saltcake waste type

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories using both 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, or set of references, 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

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

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

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

- Document describes a system of sorting single-shell tanks into groups based on the major waste types contained in each tank.

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

- Document describes a model for estimating tank waste inventories using process knowledge, radioactive decay estimates using ORIGEN, and assumptions about waste types, solubility, and constraints.

Remund, K. M., C. M. Anderson, and B. C. Simpson, 1995, *Hanford Single-Shell Tank Grouping Study*, PNL-10749, Pacific Northwest Laboratory, Richland, Washington.

- Document provides groupings of single-shell tanks by their waste contents and compares these with the sort on radioactive waste type and tank layer models.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, General Electric, Richland, Washington.

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

Ib. Fill History/Waste Transfer Records

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1996, *Waste Status and Transaction Record Summary for the Northeast Quadrant of the Hanford 200 Area*, WHC-SD-WM-TI-615, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains spreadsheets depicting all known tank additions/transfers.

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

- Document contains tank fill histories and primary campaign/waste type information up to 1981.

Autrey, D. R., 1978, *Summary of Saltwell Pumping Status for the Period Ending April 30, 1978*, (internal memo 60410-78-092 to J. W. Bailey, May 17), Rockwell Hanford Operations, Richland, Washington.

- Letter provides a month-end summary of saltwell pumping activities for April 1978. Information includes the following for each tank pumped: volume of liquid pumped during the month, total volume pumped, volume of interstitial liquid remaining, and receiver tank.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document describes sluicing processes, equipment, and facilities; provides information on the sluicing of specific tanks (including tank 241-BY-102), and provides information on the properties of the wastes.

Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

- Document shows riser location in relation to tank aerial view as well as a description of each riser and its contents.

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

- Document gives an assessment of riser locations for each tank; however, not all tanks are included/completed. Also included is an estimate of the risers available for sampling.

Reich, F. R., 1996, *BY Tank Farm Waste Inventory and Transfer Data for ITS-2 Operation During January to June 1972*, WHC-SD-WM-DP-206, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides copies of daily "ITS-2 Inventory and Pumping" data sheets showing pumping activity and liquid level changes.

Reich, F. R., 1996, *Operating Data to In-Tank Solidification ITS-2 for January 1 to October 10, 1974*, WHC-SD-WM-DP-207, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides copies of "Profile Temperatures in ITS-2 Bottoms Tanks" data sheets.

Reich, F. R., 1996, *Waste Temperature Profiles in ITS-2 BY Tanks for October to December 1974*, WHC-SD-WM-DP-208, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides copies of "Profile Temperatures in ITS-2 Bottoms Tanks" data sheets.

Reich, F. R., 1996, *BY Tank Farm Waste Inventory and Transfer Data for ITS-2 Operation During January to December 1971*, WHC-SD-WM-DP-209, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides copies of daily "ITS-2 Inventory and Pumping" data sheets showing pumping activity and liquid level changes.

Swaney, S. L., 1993, *Waste Level Discrepancies Between Manual Level Readings and Current Waste Inventory for Single-Shell Tanks*, (internal letter 7C242-93-038 to G. T. Frater, December 10), Westinghouse Hanford Company, Richland, Washington.

- Letter explains observed discrepancies between manual tape waste level readings and estimated waste inventories for single-shell tanks.

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

- Document provides thermocouple location and status information for double- and single-shell tanks.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides leak detection information for all single- and double-shell tanks. Liquid level, liquid observation well, and drywell readings are included.

Id. Sample Planning/Tank Prioritization

Brown, T. M., S. J. Eberlein, J. W. Hunt, T. J. Kunthara, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Document establishes an approach to determine the priority for tank sampling and characterization and identifies high priority tanks for sampling.

Stanton, G. A., 1996, *Baseline Sampling Schedule, Change 96-04*, (internal letter 75610-96-11 to Distribution, August 22), Westinghouse Hanford Company, Richland, Washington.

- Letter provides a tank waste sampling schedule through fiscal year 2002 and lists samples taken since 1994.

Tranbarger, R. K., 1990, *SST Liquid Sample Analysis Criteria for FY91*, (Don't Say It - Write It [DSI] to R. S. Edrington, August 1), Westinghouse Hanford Company, Richland, Washington.

- Informal correspondence provides list of analyses to be performed on liquid grab samples from tank 241-BY-102 and other single-shell tanks. This was superseded by informal correspondence from D. E. Deaton to R. S. Edrington on August 6, 1990.

Deaton, D. E., 1990, (DSI to R. S. Edrington, August 6), Westinghouse Hanford Company, Richland, Washington.

- Informal correspondence provides a revised list of analyses to be performed on liquid grab samples from tank 241-BY-102 and other single-shell tanks. This supersedes informal correspondence from R. K. Tranbarger to R. S. Edrington on August 1, 1990.

Mulkey, C. H., 1996, *Single-Shell Tank System Waste Analysis Plan*, WHC-EP-0356, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document is the waste analysis plan for single-shell tanks as required by Washington Administrative Code 173-303 and 40 Code of Federal Regulations Part 265.

Winkelman, W. D., 1996, *Tank 241-BY-102 Tank Characterization Plan*, WHC-SD-WM-TP-446, Rev. 2, Lockheed Martin Hanford Corporation, Richland, Washington.

- Document discusses all relevant DQOs and how their requirements will be met for tank 241-BY-102.

Winkelman, W. D., 1996, *Tank 241-BY-102 Push Mode Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-094, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains detailed sampling and analysis scheme for core samples to be taken from tank 241-BY-102 to address applicable DQOs.

Winkelman, W. D., J. W. Hunt, and L. J. Fergestrom, 1996, *Fiscal Year 1997 Tank Waste Analysis Plan*, WHC-SD-WM-PLN-120, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

- Document contains *Hanford Federal Facility Agreement and Consent Order* requirement-driven TWRS characterization program information and a list of tanks addressed in fiscal year 1997.

Ie. Data Quality Objectives/Customers of Characterization Data

Cash, R. J., 1996, *Scope Increase of "Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue," Rev. 2*, (internal letter 79300-96-029 to S. J. Eberlein, July 12), Westinghouse Hanford Company, Richland, Washington.

- Letter adds tank 241-BY-102 and three other single-shell tanks to the list of tanks to be analyzed in accordance with the Organic DQO. Tank 241-BY-102 is added because it would not meet preliminary safety criteria for Organic Watch List tanks if the tank liquid were drained.

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

- DQO used to determine if tanks are under safe operating conditions.

Osborne, J. W., J. L. Huckaby, E. R. Hewitt, C. M. Anderson, D. D. Mahlum, B. A. Pulsipher, and J. Y. Young, 1995, *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tank headspaces contain potentially flammable levels of gases and vapors and or if there is a potential for worker hazards associated with the toxicity of constituents in any vapor emissions from the tanks.

Turner, D. A., H. Babad, L. L. Buckley, and J. E. Meacham, 1995, *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue*, WHC-SD-WM-DQO-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to categorize organic tanks as "safe," "conditionally safe," or "unsafe" based on fuel and moisture concentrations and to support resolution of the safety issue.

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of Tank 241-BY-102

Bechtold, D. B., 1991, *Total Cyanide Results for Tank Farm Supernates*, (DSI to R. J. Cash, March 13, 1991), Westinghouse Hanford Company, Richland, Washington.

- Informal correspondence reports pH and cyanide analysis results for liquid grab samples from tank 241-BY-102 and other single-shell tanks.

Edrington, R. S., 1990, *BY and C Tank Farm Supernate Sample Analyses*, (internal letter 16220-PCL-117 to R. K. Tranbarger, November 20), Westinghouse Hanford Company, Richland, Washington.

- Letter provides results of the analysis of grab samples from tank 241-BY-102 and other single-shell tanks.

Edrington, R. S., 1991, *BY and C Tank Farm Supernate Sample Analyses (Revision of 1622-PCL90-117)*, (internal letter 28110-PCL91-048 to R. K. Tranbarger, June 3), Westinghouse Hanford Company, Richland, Washington.

- Letter provides corrections to the sample results reported in the previous reference (Edrington 1990).

Edrington, R. S., 1991, *Cooling Curves for BY and C Tank Farm Liquid Samples*, (internal letter 28110-PCL91-014 to R. K. Tranbarger, February 15), Westinghouse Hanford Company, Richland, Washington.

- Letter provides cooling curve data for grab samples from tank 241-BY-102 and other single-shell tanks.

Fritts, L. L., 1996, *Tank 241-BY-102, Cores 157 and 159, Analytical Results for the 45 Day Report*, WHC-SD-WM-DP-196, Rev. 0, Rust Federal Services of Hanford, Inc., Richland, Washington.

- Document contains the results of sample analysis of core samples obtained from tank 241-BY-102 during 1996. Analyses in support of the safety screening DQO are presented (total alpha, bulk density, DSC, and TGA).

Fritts, L. L., 1996, *Tank 241-BY-102, Cores 157 and 159, Analytical Results for the Final Report*, WHC-SD-WM-DP-196, Rev. 1, Rust Federal Services of Hanford, Inc., Richland, Washington.

- Document contains the results of sample analysis for core samples obtained from tank 241-BY-102 during 1996. Analytical results presented include ICP, IC, TIC, and TOC.

Thomas, B. L., J. C. Evans, K. H. Pool, K. B. Olsen, J. S. Fruchter, K. L. Silvers, 1996, *Tank Vapor Characterization Project, Headspace Vapor Characterization of Hanford Waste Tank 241-BY-102: Results from Samples Collected on 11/21/95*, PNNL-11164, Pacific Northwest National Laboratory, Richland, Washington.

- Document contains the results of analysis of vapor samples taken from the headspace of tank 241-BY-102. Results are reported for ammonia, nitrogen dioxide, nitric oxide, water vapor, carbon dioxide, carbon monoxide, methane, hydrogen, nitrous oxide, and total non-methane hydrocarbons.

WHC, 1990, *Sample Status Report for R 8081*, (computer printout, October 19), Laboratory Customer Computer System, Westinghouse Hanford Company, Richland, Washington.

- Computer printout of sample analysis results for an aliquot (sample R 8081) of liquid grab sample R 8039 taken from tank 241-BY-102. Samples R 8081 and R 8091 are sample and duplicate.

WHC, 1990, *Sample Status Report for R 8091*, (computer printout, October 19), Laboratory Customer Computer System, Westinghouse Hanford Company, Richland, Washington.

- Computer printout of sample analysis results for an aliquot (sample R 8091) of liquid grab sample R 8039 taken from tank 241-BY-102. Samples R 8081 and R 8091 are sample and duplicate.

WHC, 1991, *Sample Status Report for R 8786*, (computer printout, March 8), Laboratory Customer Computer System, Westinghouse Hanford Company, Richland, Washington.

- Computer printout of sample analysis results for liquid grab sample R 8786 from tank 241-BY-102; only cyanide and sample appearance are reported.

WHC, 1991, *Sample Status Report for R 8824*, (computer printout, May 31), Laboratory Customer Computer System, Westinghouse Hanford Company, Richland, Washington.

- Computer printout of sample analysis results for liquid grab sample R 8824 from tank 241-BY-102; only pH, $^{239/240}$Pu, ^{241}Am, and sample appearance are reported.

Winkelman, W. D., 1996, *Safety Screening/Immediate Notification for Tank 241-BY-102,* (internal letter 79400-96-165 to J. N. Appel and Distribution, August 30), Westinghouse Hanford Company, Richland, Washington.

- Letter documents the completion of primary safety screening analyses and indicates that no notification limits were exceeded.

IIb. Sampling of BY Saltcake Waste Type

Benar, C. J., J. G. Field, and L. C. Amato, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-104*, WHC-SD-WM-ER-608, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains characterization data for the waste in tank 241-BY-104, which includes BY saltcake.

Bell, K. E., J. Franklin, J. Stroup, J. L. Huckaby, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-106*, WHC-SD-WM-ER-616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains characterization data for the waste in tank 241-BY-106, which includes BY saltcake.

Buckingham, J. S., 1972, *Exothermic Reactions in ITS Feed Solutions*, (Internal Memorandum to D. J. Larkin, March 17), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains differential thermal analysis results and gas chromatography results for ITS feed.

Metz, W. P., 1972, *Nitric Acid Neutralization and Concentration of ITS Feed*, (Internal Memorandum to J. S. Buckingham, June 2), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains a general chemical analysis of ITS feed.

Simpson, B. C., R. D. Cromar, and R. D. Schreiber, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-110*, WHC-SD-WM-ER-591, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains characterization data for the waste in tank 241-BY-110, which includes BY saltcake.

Simpson, B. C., J. G. Field, and L. M. Sasaki, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-105*, WHC-SD-WM-ER-598, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains characterization data for the waste in tank 241-BY-105, which includes BY saltcake.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories using both Campaign and Analytical Information

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains waste type summaries, primary chemical compound and analyte, radionuclide estimates for sludge, supernatant, and solids.

Agnew, S. F., 1996, *Errata for Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document provides corrections to TLM graphs and tank inventory estimates and provides other minor corrections to the original document.

Agnew, S. F., R. A. Corbin, J. Boyer, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, B. L. Young, R. Anema, and C. Ungerecht, 1996, *History of Organic Carbon in Hanford HLW Tanks: HDW Model Rev. 3*, LA-UR-96-989, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document attempts to account for the disposition of soluble organics and provides estimates of TOC content for each tank.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 - 1975*, ARH-CD-601B, Atlantic Richfield Hanford Company, Richland, Washington.

- Document contains major components for waste types and some assumptions. Purchase records are used to estimate chemical inventories.

Allen, G. K., 1975, *Hanford Liquid Waste Inventory as of September 30, 1974*, ARH-CD-229, Atlantic Richfield Company, Richland, Washington.

- Document contains major components for waste types and some assumptions.

Dodd, R. A., 1994, *Waste Compatibility Assessment of Tank 241-BY-102 and Tank 241-BY-109 Waste With Waste Contained in Tank 241-AN-101 Via DCRT 244-BX*, (internal letter 7CF10-039-094 to R. Ni, October 14), Westinghouse Hanford Company, Richland, Washington.

- Letter assesses the compatibility of wastes to be transferred from single-shell tanks 241-BY-102 and 241-BY-109 to double-shell tank storage in support of tank stabilization activities. Letter provides justification for making the waste transfers.

Grigsby, J. M., 1992, *Ferrocyanide Waste Tank Hazard Assessment Interim Report*, WHC-SD-WM-RPT-032, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- This document includes an estimate of the ferrocyanide concentration and inventory for tank 241-BY-102 and other single-shell tanks derived from a model.

Klem, M. J., 1988, *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944 - 1980)*, WHC-EP-0172, Westinghouse Hanford Company, Richland, Washington.

- Document provides a list of chemicals used in production facilities and support operations that sent wastes to the single-shell tanks. List is based on chemical process flowsheets, essential materials consumption records, letters, reports, and other historical data.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single and Double Shell Tanks*, (Internal Memorandum 74A20-96-30 to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

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

Shelton, L. W., 1995, *Chemical and Radionuclide Inventory for Single and Double Shell Tanks*, (Internal Memorandum 75520-96-007 to R. M. Orme, August 8), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains an tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Radionuclide Inventories for Single and Double Shell Tanks*, (Internal Memorandum 71320-96-002 to F. M. Cooney, February 14), Westinghouse Hanford Company, Richland, Washington.

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

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains a global inventory based on process knowledge and radioactive decay estimates using ORIGEN2. Plutonium and uranium waste contributions are taken at 1 percent of the amount used in processes. Also compares information on ^{99}Tc from both ORIGEN 2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1996, *Tank Waste Source Term Inventory Validation, Vol I, II, and III*, WHC-SD-WM-ER-400, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document contains a quick reference to sampling information in spreadsheet or graphical form for 24 chemicals and 11 radionuclides for all the tanks.

Brevick, C. H., L. A. Gaddis, A. C. Walsh, 1994, *Supporting Document for the Northeast Quadrant Historical Tank Content Estimate Report for BY Tank Farm*, WHC-SD-WM-ER-312, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains summary information for tanks in the BY Tank Farm as well as appendixes containing more detailed information including tank waste level history, tank temperature history, cascade and drywell charts, riser information, in-tank photo collages, and tank layer model bar chart and spreadsheet.

Brevick, C. H., R. L. Newell, and J. W. Funk, 1996, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-349, Rev. 1A, Westinghouse Hanford Company, Richland, Washington.

- Document contains summary information for tanks in B, BX, and BY Tank Farms as well as in-tank photo collages and inventory estimates.

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

- This document, updated monthly, contains a summary of: tank waste volumes, Watch List tanks, occurrences, tank integrity information, equipment readings, tank location, leak volumes, and other miscellaneous tank information.

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Document contains in-tank photos and summaries of the tank description, leak detection system, and tank status.

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

- Document gives an assessment of the relative dryness of tank wastes.

Sloat, R. J., 1955, *"In-Farm Scavenging" Operating Procedures and Control Data*, General Electric, Richland, Washington.

- Document contains tank 241-BY-102 waste composition and summary of in-farm scavenging laboratory studies.

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.

- Document provides an estimate of radionuclide and chemical concentrations for each single-shell tank using sampling data and TRAC model estimates.

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DISTRIBUTION SHEET

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Distribution	Data Assessment and Interpretation	Date 03/12/97
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Pacific Northwest National Laboratory					
A. F. Noonan	K9-91	X			
Rust Federal Services of Hanford, Inc.					
C. T. Narquis	T6-16	X			
SGN Eurisys Services Corp.					
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