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Tank Characterization Report for Single-Shell Tank T-102

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Executive Summary

Tank 241-T-102 (hereafter referred to as T-102) is a 530,000 gallon single-shell waste tank located in the 200 West T Tank farm at the Hanford Site. In 1993, two cores were taken from this tank and analysis of the cores was conducted by Battelle's 325-A Laboratory. Characterization of the waste in this tank was conducted to support Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-44-05 (see [8]).

Tank T-102 was constructed in 1943 and put into service in 1945 (see Table 1); it is the second tank in a cascade system with Tanks T-101 and T-103. During its process history, Tank T-102 received mostly Metal Waste (MW) from the Bismuth Phosphate Process and Coating Waste (CW) from the REDOX Process via the cascade from Tank T-101 and in transfers from Tank C-102. In 1956, the MW was removed from T-102 by pumping and sluicing[1]. This tank was declared inactive and retired from service in 1976 (see [9]). In 1981, intrusion prevention and stabilization measures were taken to isolate the waste in T-102. The tank presently contains approximately 121,100 liters (32,000 gallons) of liquid and sludge-like waste. Historically, there are no unreviewed safety issues associated with this tank and none were revealed after reviewing the data from the latest core sampling event in 1993.

Core 55 was taken from Riser 2 and Core 56 was taken from Riser 8 (see Figure 1). The core recoveries were poor (i.e., 65% for Core 55 and 10% for Core 56). The small amount of waste recovered from Core 56 was not large enough to permit any chemical analysis of that core; that material was archived for analysis at a later date. Hence, the results presented in this report come only from the analysis of Core 55, and the spatial variability (core to core variability) of the tank waste could not be estimated.

An extensive set of analytical measurements was performed on the core composites. The major constituents (>0.5 wt%) of the waste are water, aluminum, sodium, iron, and nitrate, ordered from the largest concentration to the smallest. The concentrations and inventories of these and other constituents are given in Table 2.

The results of the chemical analyses have been compared to the dangerous waste codes in the Washington Dangerous Waste Regulations (WAC 173-303). This assessment was conducted by comparing tank analyses against dangerous waste characteristics ("D" waste codes) and against state waste codes. The comparison did not include checking tank analyses against "U", "P", "F", or "K" waste codes, since application of these codes is dependent on the source of the waste and not on particular constituent concentrations. The results indicate that the waste in this tank is adequately described in the *Dangerous Waste Permit Application for the Single-Shell Tank System*; this permit is discussed in [6].

Table 1: Engineering Data Summary of Tank T-102

Tank Engineering Description		Tank Status	
Type:	Single Shell Tank	Watch List:	None
Construction:	1943-1944	Interim Stabilized:	3/81
In-Service:	1945	Intrusion Prevention:	8/81
Out of Service:	1976	Contents:	Non-Complexed Waste
Diameter:	23m (75 ft)	Integrity Category:	Sound
Operating Depth:	5.2m (17 ft)		
Nominal Capacity:	2,006,300 L (530,000 gal)		
Bottom Shape:	Dished		
Hanford Coordinates:	N43647.5, W78737.5		
Ventilation:	Passive		

[1] The process of administering a highly pressurized jet of water to the sludge bed in the bottom of the tank. Sluicing fluidizes the sludge into a slurry, allowing it to be pumped out of the tank.

Figure 1: Top View of Tank T-102

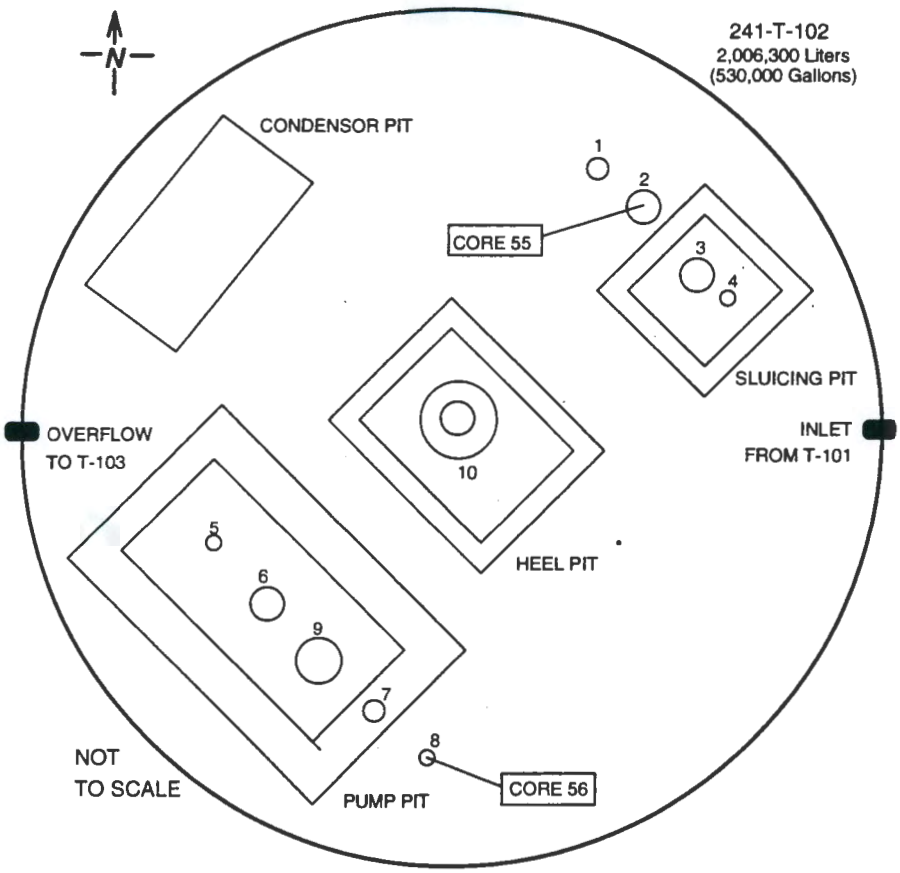

Table 2: Inventory Summary for Tank T-102

Physical Properties of Waste:			
Total Waste:	121,000 L (32,000 gal)	Supernate Volume:	49,210 L (13,000 gal)
Drainable Inter. Liquid:	0 L (0 gal)	Solids Density:	1.79 g/mL
Free Water:	10.3%	Liquid Density:	1.10 g/mL
Total Water:	33.2%	Temperature Average:	18.3 degrees C
pH:	9.82	Maximum Exotherm	No Exotherms
Heat Load:	2.47e+02 watts		
Chemical Properties of Waste*			
Aluminum:	2.03e+04 kg (15.80 wt%)	Nitrate:	2.25e+03 kg (1.75 wt%)
Sodium:	4.01e+03 kg (3.12 wt%)	Total Organic Carbon:	8.42e+01 kg (0.065 wt%)
Iron:	2.31e+03 kg (1.80 wt%)		
Radionuclides in the Waste			
Total Alpha Pu:	7.84e+00 Ci	Strontium-90:	3.06e+04 Ci
Cesium-137:	2.33e+03 Ci	Total Uranium	<9.09e+01 kg

* Inventory results are based on solids only. There were no liquid analyses.

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List of Terms

AA: atomic absorption

AEA: alpha energy analysis

ANOVA: analysis of variance

DNFSB: Defense Nuclear Facilities Safety Board

DOE: United States Department of Energy

DQO: data quality objective

DSC: differential scanning calorimetry

EPA: United States Environmental Protection Agency

FIC: Food Instrument Company

GC: gas chromatography

GEA: gamma energy analysis

HAS: Hanford Analytical Services

IC: ion chromatography

ICP: inductively coupled plasma atomic emission spectrometry

PNL: Pacific Northwest Laboratory

PUREX: Plutonium-Uranium Extraction Plant

QA: quality assurance

RPD: relative percent difference; For two samples, x_1 and x_2,

$RPD = \frac{|x_1 - x_2|}{(x_1 + x_2)/2} \times 100\%.$

RSD: relative standard deviation

$RSD = \frac{\sqrt{variance\ estimate}}{mean\ estimate} \times 100\%$

SAL: Shielded Analytical Laboratory

TGA: thermogravimetric analysis

TIC: total inorganic carbon

TOC: total organic carbon

Acknowledgements

It is appropriate to acknowledge individuals that made important contributions to this report. We appreciate the help of Chris Brevick (ICF Kaiser) and his staff in providing historical information on Tank T-102. Also, Todd Brown (Westinghouse Hanford Company) helped the authors of this report interpret the historical information available for this tank. We appreciate his contributions to our work as well.

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1 Introduction

Analysis was conducted on materials obtained from single-shell Tank T-102 to contribute toward the completion of what was previously Milestone M-10-06 (see [8]) of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, or TPA). The TPA has since been revised and tank waste characterization now supports Milestone M-44-05. This milestone directs Westinghouse Hanford Company to sample, analyze, and issue reports for twenty tanks. Samples were taken on Cores 55 and 56, but measurements were taken only on Core 55, since the small amount of waste recovered from Core 56 was not large enough to permit any chemical analysis for that core; that material was archived for analysis at a later date. The measurements taken on Core 55 were used to prepare inventory estimates and to support the following objectives:

1. Estimate both the concentration and total quantity of key analytes relating to safety issues, such as organics and radionuclides.
2. Provide input to risk-assessment-based decisions regarding disposal of the waste.
3. Measure physical properties, such as rheology, bulk density, and particle size.

These measurements and estimates are necessary for the design and fabrication of retrieval, pretreatment, and final waste disposal systems.

1.1 Purpose

The purpose of this report is to characterize the waste in Tank T-102. "Characterization" includes the determination of the physical, chemical (e.g., concentrations of elements and organic species), and radiological properties of the waste. These determinations are made using analytical results from T-102 core samples together with surveillance and historical information about the tank. The main objective of the characterization effort is to determine average waste properties.

This report also consolidates the available historical information regarding Tank T-102, arranges the analytical information from the recent core sampling in a useful format, and provides an interpretation of the data within the context of what is known about the tank.

1.2 Scope

The waste properties are determined from core samples, which were chemically and physically analyzed by the PNL Analytical Laboratory (325-A Laboratory). Additional relevant information on the waste has been compiled from historical sources. Types of historical information that are routinely checked include:

1. Past sampling events
2. Routine tank surveillance measurements
3. Tank transfer records

This historical information has been reviewed and compared with the laboratory data to help interpret the laboratory data more effectively. However, the characterization estimates presented in this report are derived from the laboratory data unless otherwise indicated. It is assumed that the laboratory data provides the most authoritative description of the tank waste.

Since T-102 was not a Watch List tank, relatively few segment-level measurements were requested. Also, it should be noted that since the tank contains only 121,100 liters (32,000 gallons) of waste, there could be at most one segment from which to take segment-level measurements. This sampling and analysis effort was intended to determine mean concentrations (by analyzing core composites) in order to meet process design characterization objectives for waste treatment. Process design generally requires knowledge of total inventories, but not of spatial variabilities in the waste composition. However, the uncertainty of the total inventories, which is dependent upon the spatial variabilities, is also needed for process design.

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2 Historical Tank Information

Since 1944, underground storage tanks in Hanford's 200 Areas have been used to store radioactive waste generated by the chemical processing plants and laboratories at the Hanford Site. A review of waste management operations records yield information about the various process waste types transferred into a tank. Based on the plant effluent stream compositions, transfer records, and the service life history of a tank, an assessment can be made of the expected waste inventory, its chemical and physical properties, and configuration of the waste in the tank.

The T tank farm is located in the 200 West Area and was constructed during 1943 and 1944 (see Hanford Site Tank Farms diagram for 200 West Area in Hanlon [9]). The T Tank farm is one of the original four tank farms (B, C, T and U) made up of single-shell tanks. There are 16 waste tanks in T farm. Four tanks (T-201 to T-204) have a nominal capacity of approximately 208,200 liters (208 m^3). The remaining twelve tanks (T-101 to T-112) have a capacity of approximately 2,006,300 liters (2020 m^3).

2.1 Tank Description

A top view diagram of Tank T-102 is presented in Appendix A. T-102 is one of the 12 large single-shell tanks with a capacity of approximately 2,006,300 liters. The tanks in each tank farm are connected in groups of three or four by pipelines, which permits waste to flow to succeeding tanks in the group. These groups of tanks are called cascades. Tank T-102 is the middle tank in a cascade that includes T-101 and T-103. Cascades served several functions in Hanford Site waste management operations. Cascaded tanks require fewer connections to be made during waste disposal; consequently, all three tanks were usable without having to connect the active waste transfer line directly to each individual tank. This handling method reduces the likelihood of personnel being exposed to the waste, and diminishes the chance of a loss of tank integrity due to overfilling. Another benefit of cascading was clarification of the wastes. In a cascade arrangement, most of the solids in the waste slurries routed to the tanks settle in the first tank (T-101), and the clarified liquids cascade on to the other tanks in the series (T-102 and T-103). Supernate from the final tank in the cascade series was sometimes routed to a disposal trench. Since most radionuclides are insoluble in alkaline media, this clarification process reduced the potential radiological contamination of the environment. T-102 currently contains approximately 121,100 liters of supernate and sludge type waste.

2.2 Process Knowledge and Sampling Data

Tank T-102 received two primary waste types from 1945 to 1973. The first type was Metal Waste (MW) from the Bismuth Phosphate Process (see Anderson [2]). This waste was generated during the uranium extraction part of the process. The MW contains approximately 90% of the original fission products activity and 1% of the uranium product. Since Metal Waste was removed in 1953 and the tank was sluiced[2] in 1956, it is unlikely that any MW remains in the tank. The second primary waste type received by T-102 was Coating Waste (CW) from a REDOX (reduction-oxidation) process. This waste was generated when aluminum-clad fuels were declad in a boiling solution of sodium nitrate. The coating waste is considered to be the principal waste remaining in the tank.

In later years of service (1971-1975), T-102 received smaller transfers of B-Plant Low-Level Waste, REDOX Waste, Evaporator Bottoms Waste, and Ion Exchange Waste. Most of these later transfers were dilute aqueous solutions.

The estimated composition of the waste in Tank T-102, based on historical data and records, is reported in Table 3. Composition estimates from three sources are reported in Table 3. The estimates in the second column are derived from the Track Radioactive Components Model (TRAC — see [11]), which is based on tank transfer records and process history. The algorithm employed in TRAC tends to bias the sodium and nitrate contents high. The TRAC results in Table 3 are the total waste results from Reference [11]. The waste volume from Reference [9] was used to convert the TRAC results from moles to moles/L. The estimates in the third column of Table 3 are from two previous T-102 sampling events. The radionuclides results are

[2] Sluicing is the process of administering a highly pressurized jet of water to the sludge bed in the bottom of the tank in order to fluidize the sludge into a slurry, allowing it to be pumped out of the tank.

from a 1973 sampling event performed to help identify possible leaks, and the other results are from a 1974 sampling event to determine if the waste in Tank T-102 was suitable as feed to the 242-S Evaporator. The third set of historical estimates were derived by Los Alamos National laboratories (LANL) and are based on tank transfer records and the process history of the tank [1]. The LANL solid and liquid waste estimates reported are REDOX Coating Waste estimates from 1952 to 1960 (CWR 52-60). The LANL estimates and the 1973-1974 sampling results are compared with the 1993 core sampling results in Section 6.

Table 3: Historical Composition Estimates of T-102 Content

Constituent	TRAC	Sampling 73/74	LANL Solids	LANL Liquids
	(M)	(M)	(M)	(M)
Aluminum	0.044	0.214	6.048	1.64
Bismuth	0.000	NA	0.000	0.000
Carbonate	0.033	0.176	0.000	0.000
Chromium	0.000	NA	0.000	0.000
Fluoride	0.025	0.046	0.000	0.000
Hydroxide	0.05	0.474	20.346	0.000
Iron	0.001	NA	0.000	0.000
Lead	0.000	NA	0.000	0.000
Manganese	0.000	NA	0.000	0.000
Nitrate	0.33	2.18	0.555	0.820
Nitrite	0.017	0.722	0.971	1.440
Phosphate	0.008	0.012	0.000	0.000
Potassium	0.004	NA	0.000	0.000
Silicate	0.002	NA	0.144	0.020
Sodium	0.413	4.12	2.914	3.930
Sulfate	0.008	0.102	0.000	0.000
Uranium	NA	NA	0.180	0.004
	(μCi/g)	(μCi/g)	(μCi/g)	(μCi/g)
Americium-241	0.013	NA	NA	NA
Carbon-14	0.006	NA	NA	NA
Cesium-137	3.127	164.516	1.404	NA
Plutonium	NA	NA	1.837	NA
Strontium-90	0.313	5.46	14.62	NA
Technetium-99	0.006	NA	NA	NA
	(g/mL)	(g/mL)	(g/mL)	(g/mL)
Density	1.80	1.24	1.714	1.26
	(%)	(%)	(%)	(%)
Weight percent solids	NA	26.33	NA	NA

NA: Not Applicable

2.3 Surveillance Data

Each of the 177 underground tanks at the Hanford Site is routinely monitored for supernate levels, solid waste levels, dry well status and temperature readings. A monthly surveillance report (see [9]) lists the results of this monitoring and the status of each tank (e.g., watch lists, leak status, unusual events).

2.3.1 Solid and Liquid Waste Levels

Figure 2 shows the supernate and solids waste levels within Tank T-102 from 1945 to the present[3]. Supernate and sludge levels were taken on a quarterly basis as part of the overall surveillance effort in the tank farms. Zero on the vertical scale is at the knuckle bottom of the tank and the dish bottom is 30.48 cm (1 ft) below that, at -30.48 cm (-12 inches). The sludge level in the tank is indicated by the shaded area and the supernate level is indicated by the thick line above the shaded area.

For Tank T-102, the early waste level records were not always available on a quarterly basis (see Anderson [2]). During these times, it was necessary to estimate the changing surface levels based on best engineering judgement.

Tank T-102 began receiving overflow from Tank T-101 in September 1945, and began to overflow into Tank T-103 in November of the same year. From 1945 to 1952, existing records did not distinguish between liquid and solid waste phases — only the total volume was measured. It is assumed that the solid waste heel in the tank was negligible and that the total volume is actually the volume of the liquid waste. However, it should be noted that sluicing occurred in 1956, and measurements recorded after the sluicing are of most importance to the characterization of the tank.

In the second quarter of 1952, measurements for both the liquid and solid waste are registered (2,006,000 liters and 0 liters, respectively). This is the first known documentation distinguishing between the liquid and solid waste levels. In the third and fourth quarters, however, no data can be found for the solid waste.

In 1953, there is one recording (third quarter) for solid waste and two recordings (second and third quarters) for liquid waste. The MW was removed from T-102 in December of 1953, at which time the tank was declared empty. Since no waste was received until 1955, there are no data registered for 1954.

In 1955, the MW recorded is for the liquid level only. However, a small amount of sludge (solid waste) remained in the bottom of the tank.

In 1956, the supernate in T-102 was pumped to TX-115 and sluicing was initiated. As noted earlier, this implies that all of the MW was removed from the tank.

In 1957, CW was added to the tank.

From 1958 to 1964, no data was registered in Anderson [2], with the exception of one recording of liquid CW in the second quarter of 1961. Also, no solid waste is recorded until the fourth quarter of 1969. It is assumed that solids from CW settled to the bottom of the tank to form a waste heel.

After 1964, consistent records were kept through 1980. In 1965, T-102 received CW from Tank C-102 (approximately 1,685,000 liters). In 1969, approximately 1,881,000 liters of CW were pumped out to Tank T-103. In 1972, 1,851,000 liters of mixed waste were received from Tank T-101. In 1974, 1,798,000 liters of mixed waste were pumped from Tank T-102 into Tank S-110.

In the second quarter of 1976, Tank T-102 was removed from service.

2.4 Temperature Readings

Tank T-102 dome space temperature readings were taken from 1976 to 1981. These temperature readings were taken from a thermocouple tree installed in one of the tank's risers. There are no temperature readings from 1981 to the present because the thermocouple tree was removed in 1981. These readings were usually take on a monthly or quarterly basis.

The temperature data over this time period ranged from -3.33 to 34.44 degrees C, with a mean and standard deviation of 18 and 6 degrees C, respectively. The latest temperature reading available for the tank was from February 1981, and was 20 degrees C. The temperature readings seem to vary somewhat randomly about the mean over this time period, and the data is too limited to observe any differences attributable to seasonality. The heat load analysis (reported in Section 5) determined that the amount of heat produced in the tank is the equivalent of approximately three ordinary 100-watt light bulbs. From this determination, coupled with an examination of the temperature readings, it is concluded that the heat generation levels in Tank T-102 are not high enough to warrant concern about high heat evolution.

[3] The tank level diagram, Figure 2, was obtained from ICF-Kaiser in August, 1994. The diagram is labeled PRELIMINARY since additional historical information is expected in the near future to update it. Updates will also be made as revisions to the report. The references contained in Figure 2 are [2], [5], [9], [17]. and [18]

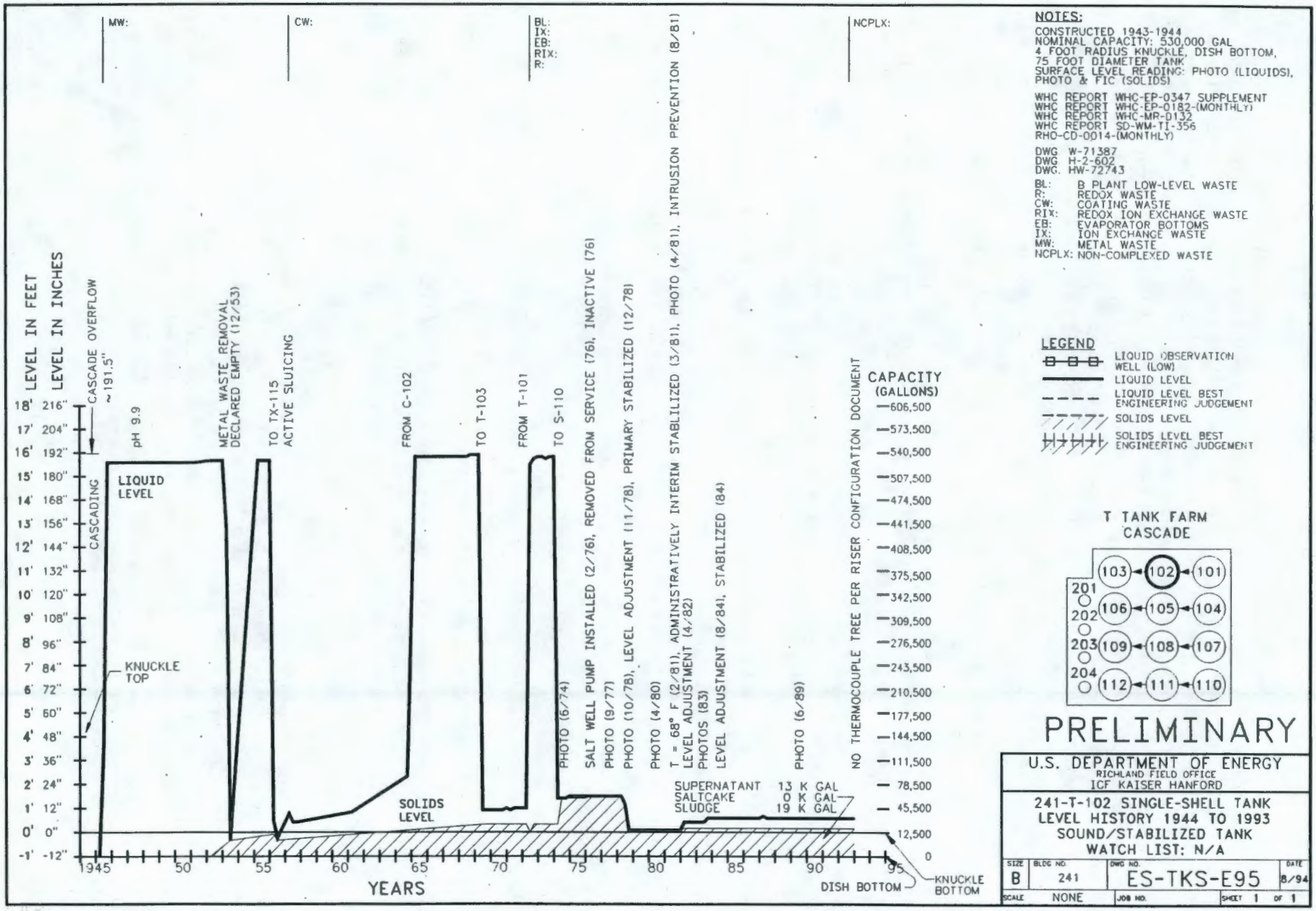

Figure 2: Tank Waste-level Summary for T-102

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2.5 Tank Status

Tank T-102 is not presently on any Watch List and has no unreviewed safety issues associated with it that can be determined from present historical data.

Intrusion prevention measures were taken on Tank T-102 in August 1981, meaning that all access to the tank not required for long-term surveillance has been sealed in a way that provides at least one barrier to the inadvertent addition of liquid. The tank has a total inventory of 121,100 liters. Level readings were taken using a Food Instrument Corporation gauge. The gauge is currently out of compliance with operational documentation (see Hanlon [9]). T-102 was declared administratively interim stabilized in 1981, since the stabilization data for the tank was not available at the time (see Hanlon [9]). However, present surveillance data shows T-102 does not meet current interim stabilization criteria (less than 19,000 liters of supernate) since there are 49,210 liters of supernate in the tank.

Tank T-102 is currently classified as a sound (non-leaking) tank.

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3 Tank Sampling Overview

This section describes the latest Tank T-102 core sampling event (1993). For this sampling event, details are given about the core sampling equipment, the sampling process, the location of samples taken from the tank, the sample recoveries, and the transfer of the core samples to the 325-A Laboratory.

3.1 Core Sampling Event

The high-level radioactive waste tanks in the 200 East and West Area Tank Farms on the Hanford Site are underground storage tanks with a minimum of 6 feet of soil cover. Because these tanks are underground, access to the waste is limited to existing risers, as illustrated in Figure 5 in Appendix A. The underground storage tanks are sampled with specialized core sampling equipment that is capable of acquiring waste samples through the risers. This equipment is also designed to protect operators and the environment from excessive radiation exposure and contamination. The core sampling equipment is mounted on a truck. The truck is positioned over the desired riser, and a drill string containing the sampler is lowered through the riser into the tank. The truck is equipped with a rotating platform so that the sample can be taken from the tank and the sampler can be remotely placed in a liner and then a shipping cask. These remote operations reduce the amount of manual handling of the full sampler, and reduce the radiation dose to which personnel are exposed.

Two types of core sampling methods (push mode and rotary mode) are currently used. The push mode method is limited to soft waste materials, while the rotary mode method is used on harder waste types. Rotary mode sampling requires more time for assembly at the sampling site, and safety concerns have been raised about this mode of operation (e.g., generation of heat at the drill bit and potential ignition of the waste). These safety concerns have been addressed [12], but push mode sampling is generally preferred whenever possible because of the safety factor provided by this system.

Both the push and the rotary mode samplers are constructed of stainless steel. The push mode samplers used to sample Tank T-102 are 102 cm (40 in.) long and 3.2 cm (1.25 in.) in diameter, and capture a cylindrical sample 48 cm (19 in.) long and 2.2 cm (7/8 in.) in diameter. The volume of this sample is 187 mL. Once the sampler is lowered through the drill string to the appropriate depth, a piston inside the cylindrical sample reservoir is held stationary as the sampler is pushed through the waste. The 5.08 cm (2 in.) diameter drill string is fitted with a blunt drill bit which cuts the waste and directs it into the sampler. Tank stratification is maintained in the sample, since the sample is not pulled or poured into the sampler. The sample is captured by a rotary valve which closes when the sampler has been pushed 48 cm (19 in.). The closed sampler is extracted from the drill string and another sampler is inserted. The drill string is then lowered another 48 cm (19 in.) to capture the next segment of waste. A complete core sample consists of as many 48 cm (19 in.) segments as are needed to sample the depth of the waste in the tank.

After a segment is captured by the sampler, it is sealed within a stainless steel liner and placed in a shipping cask. The casks are transported to the analytical laboratory for sample identification, storage and extrusion prior to analysis.

Tank T-102 was sampled in March 1993. Using the push mode method, Core 55 was taken through Riser 2 and Core 56 was taken through Riser 8. The locations of the risers are shown in Figure 5 in Appendix A.

The sampling casks containing the core samples were sent to the PNL 325-A Laboratory for extrusion and analysis on April 1, 1993. One sample cask was found to be empty. The cask containing Core 55 had been accidentally sent to SX Tank Farm, but was later retrieved by the 325-A Building Laboratory on May 4, 1993. As can be seen, the chain of custody was broken (see Reference [7]). Although this irregularity probably does not have substantial implications for the analytical results (some analytical results could be unsuitable for certain purposes) and interpretation, they do warrant concern with regard to conduct of operations and safety. However, the chain of custody for the sample was re-established, the double-containment strategy employed in the handling of the samples was successful in preventing any excessive radiological exposure to personnel, and no material escaped confinement. Further investigation and refinement of the sampling process, procedures, and sampler design is in progress.

The objective of core sampling is to recover a representative sample of sufficient volume for analytical tests. The core recovery for both T-102 cores was relatively poor. Core 55 had a core recovery of 65% and

Core 56 had a recovery of approximately 10%. Due to the small amount of waste recovered in the Core 56 sample, no chemical analyses were performed on it. This material was archived for analysis at a later date. The core recoveries, volumes and masses of the samples are given in Table 4. Core 55 was used for analysis and split lengthwise across the extrusion tray. One side of the sample was used for rheological analysis and the other side for the remaining analyses. The laboratory analysis of Core 55 commenced in May 1993.

Table 4: Actual Percent Recovery in Tank T-102

	Core 55 (Riser 2)	Core 56 (Riser 8)
% Recovery	65%	10%
Mass	80.59 g	8.42 g
Volume	45 mL	4 mL

3.2 Additional Tank Sampling

No other sampling information is available for Tank T-102.

4 Sample Handling and Analytical Scheme

The sample handling, sample preparation and types of analysis performed on the Core 55 subsamples are described in this section.

4.1 Waste Description

The two cores sampled from Tank T-102, Core 55 and Core 56, had recoveries of 65% and 10% of the expected volume, respectively. Minimal drainable liquid (less than 10 mL) was associated with the Core 55 sample; this drainable liquid was not separated from the solids.

Of the 12.7 cm (5 in.) of waste obtained from Core 55, the top 5.08 cm (2 in.) were dry and crumbly. This 5.08-cm (2-in.) portion of the sample was brown with streaks of white. The next 5.08 cm (2 in.) were a white sticky sludge with brown streaks. The bottom 2.54 cm (1 in.) of the segment had a similar consistency to the top 5.08 cm (2 in.) — dry and crumbly — but the entire sample was brown. During homogenization of Core 55, dark specks were observed. After further investigation, the dark specks were determined to have magnetic properties, which were probably shavings or filings from equipment that was discarded into the tank. Since it is assumed that the obtained sample is representative of the tank content and that the waste in the tank is uniformly distributed, it is expected that the amount of drainable liquid found in the sample would be proportionally equal to the amount of drainable liquid observed in the tank. It is known that the 121,100 liters (32,000 gallons) of waste in the tank contains approximately 49,200 liters (13,000 gallons) of supernate (or 40%) and the 80-gram Core 55 sample contains approximately 13 grams (9.85 mL) of drainable liquid (or 16%). From this information, the Core 55 sample did not appear to provide an adequate representation of this tank's contents. From a study of a photographic collage (see Figure 6 in Appendix A) of the tank's interior (constructed by ICF Kaiser Hanford), it was concluded that the spatial variability in the waste, and the locations of the risers (which were at the edges of the tank, while most of the drainable liquid was located near the center), were the major contributors to the inadequacy of the sample.

No drainable liquid was observed in the 8-gram sample of Core 56, which was brown with a dry granular texture. This limited sample precluded any analysis of physical or rheological properties, and was archived without any homogenization. As a result, only one core composite, Core 55, was prepared for chemical and radiological analysis.

4.2 Holding Time Considerations

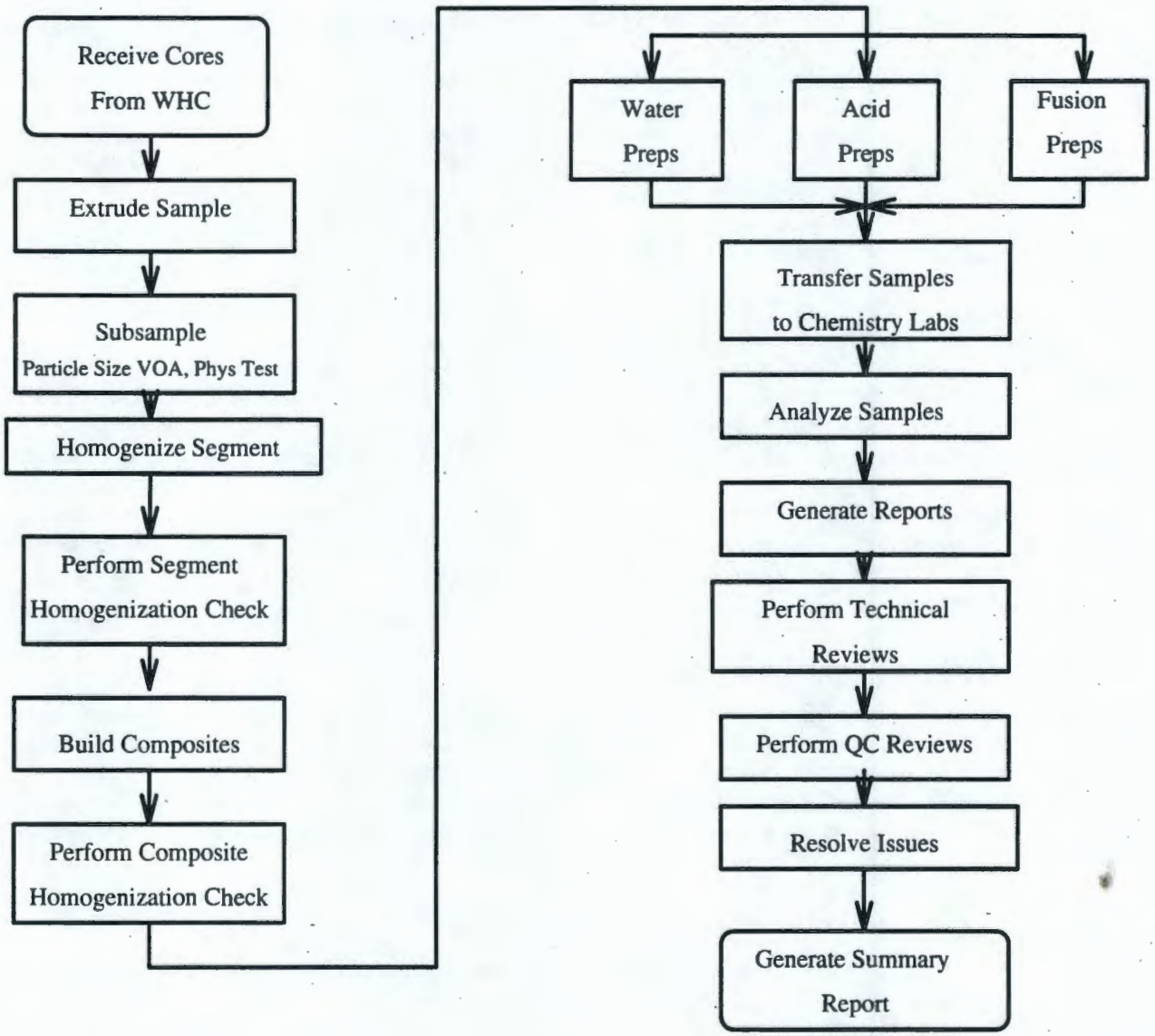
Regulatory analyses have limits imposed between the time a sample is recovered and the time of analysis (hold time limitations). Analysis of samples within the hold time limitations helps to ensure the data quality. The samples were received on April 1, 1993, and analysis commenced in May 1993, which does not meet holding time limits [6]. However, since holding times mostly affect organic analyses, and this tank contains few organic constituents, the implications for data quality and interpretation of the data are considered negligible.

4.3 Sample Preparation and Analytical Methods

Most analytical procedures require a sample preparation process prior to analysis. Figure 3 is a flowchart of the steps taken by the 325-A Laboratory to analyze tank core samples. The T-102 core samples were obtained from WHC tank farms personnel and extruded at PNL's Hot Cell Facility, the 325-A Laboratory. A videotape was taken of the extrusion process. The extruded sample of Core 55 was split lengthwise along the extrusion tray. One side of the sample was used for rheological analysis, while the other was used for the remaining analyses. Prior to homogenization of the Core 55 composite sample, two subsamples were taken for particle size and thermal analysis. The remaining 26 grams of Core 55 composite were homogenized by hand. Mechanical mixing was not used because too much of the sample would have been lost in the mixing procedure.

Table 5 lists the sample preparation and analytical methods. The "preferred methods" given in Table 5 were those methods expected to yield the most representative analytical results, and used to perform the waste inventory calculations. Reference [19] was used to determine the preferred method for each analyte measured on the samples. After the samples were physically and chemically analyzed, laboratory core reports were generated and reviewed. After the review process was finished and various issues resolved, a final summary report was issued [7].

Figure 3: Data Collection and Preparation



4.4 Sample Homogeneity

One side of Core 55 was used to prepare a homogenized sample. Except for rheology and physical properties, no unhomogenized samples were analyzed. The homogenized sample was prepared for analysis by potassium hydroxide fusion, and submitted to the laboratory for gamma energy analysis (GEA), inductively coupled plasma analysis (ICP), and total alpha analysis.

Table 5: Sample Preparation and Analytical Methods Used on Tank T-102 Samples

Analyte	Sample Prep.	Preferred Method	Analyte	Sample Prep.	Preferred Method
Aluminum	A,F,W	ICP:A	Antimony	A,F,W	ICP:A
Arsenic	A,F,W	ICP:A	Barium	A,F,W	ICP:A
Bismuth	A,F,W	ICP:F	Beryllium	A,F,W	ICP:A
Boron	A,F,W	ICP:A	Cadmium	A,F,W	ICP:A
Calcium	A,F,W	ICP:A	Cerium	A,F,W	ICP:A
Chromium	A,F,W	ICP:A	Cobalt	A,F,W	ICP:A
Copper	A,F,W	ICP:A	Dysprosium	A,F,W	ICP:A
Europium	A,F,W	ICP:A	Gadolinium	A,F,W	ICP:A
Iron	A,F,W	ICP:F	Lanthanum	A,F,W	ICP:A
Lead	A,F,W	ICP:A	Lithium	A,F,W	ICP:A
Magnesium	A,F,W	ICP:A	Manganese	A,F,W	ICP:A
Molybdenum	A,F,W	ICP:A	Neodymium	A,F,W	ICP:A
Nickel	A,F,W	ICP:A	Palladium	A,F,W	ICP:A
Phosphorus	A,F,W	ICP:F	Potassium	A,F,W	ICP:A
Rhodium	A,F,W	ICP:A	Ruthenium	A,F,W	ICP:A
Selenium	A,F,W	ICP:A	Silicon	A,F,W	ICP:F
Silver	A,F,W	ICP:A	Sodium	A,F,W	ICP:F
Strontium	A,F,W	ICP:A	Tellurium	A,F,W	ICP:A
Thallium	A,F,W	ICP:A	Thorium	A,F,W	ICP:A
Tin	A,F,W	ICP:A	Titanium	A,F,W	ICP:A
Tungsten	A,F,W	ICP:A	Vanadium	A,F,W	ICP:A
Yttrium	A,F,W	ICP:A	Zinc	A,F,W	ICP:A
Zirconium	A,F,W	ICP:A	Chloride	W	IC:W
Cyanide	W	IC:W	Fluoride	W	IC:W
Nitrate	W	IC:W	Nitrite	W	IC:W
Phosphate	W	IC:W	Sulfate	W	IC:W
Ammonia	W	ISE:W	Mercury	A	CVAA:A
Curium-243/244	F	Alpha Radchem:F	Gross alpha	F	Alpha Radchem:F
Neptunium-237	F	Alpha Radchem:F	Plutonium-238	F	Alpha Radchem:F
Plutonium-239/240	F	Alpha Radchem:F	Total alpha	F,W	Alpha Radchem:F
Gross beta	F,W	Beta Radchem:F	Strontium-90	F	Beta Radchem:F
Technetium-99	F	Beta Radchem:F	Americium-241	A,F,W	GEA:F
Cerium-144	A,F,W	GEA:F	Cesium-134	A,F,W	GEA:F
Cesium-137	A,F,W	GEA:F	Cobalt-60	A,F,W	GEA:F
Europium-154	A,F,W	GEA:F	Europium-155	A,F,W	GEA:F
Potassium-40	A,F,W	GEA:F	Uranium	F	Laser Fluorimetry:F
Plutonium-239	F	Mass Spectrometry:F	Plutonium-240	F	Mass Spectrometry:F
Plutonium-241	F	Mass Spectrometry:F	Plutonium-242	F	Mass Spectrometry:F
Uranium-234	F	Mass Spectrometry:F	Uranium-235	F	Mass Spectrometry:F
Uranium-236	F	Mass Spectrometry:F	Uranium-238	F	Mass Spectrometry:F
Tritium	W	Liq Scintillation:W	Carbon-14		Liq Scintillation:W
Nickel-59	A	Liq Scintillation:A	Nickel-63	A	Beta Radchem:F
TOC	D,W	Persulfate Oxidation:D	Hex. Chromium	W	Calorimetric:W
Total carbon	D,W	Persulfate Oxidation:W	TIC	D,W	Persulfate Oxidation:W
SVOA		GC/Mass Spectrometry	VOA		GC/Mass Spectrometry

A: Acid Dig., CVAA:Cold Vapor Atomic Absorption, D: Direct Analysis,
F: KOH/Ni Fusion, ISE: Ion Specific Electrode
SVOA: Semi-Volatile Organics Analysis, VOA: Volatile Organics Analysis
W: Water Digestion

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5 Analytical Results and Waste Inventory

There were 2,033 analytical measurements on Core 55 that were used in the statistical and chemical analyses discussed in this report. As noted in Section 3, no analytical measurements were made on Core 56 due to the small amount of sample recovered. Since Core 55 is comprised of one segment, the composite and segment level data are the same. Approximately 41% of the analytical measurements were taken for quality control reasons. Homogenization tests account for 230 of the analytical measurements in the set of data.

The core composite data was used to determine mean concentrations and hence to estimate the waste inventory of Tank T-102. The associated uncertainties of the mean concentration and waste inventory were not estimated. This is due to the absence of spatial variability estimates, which are usually the largest component of variability in the mean uncertainty estimate calculation. The spatial variability (i.e., core-to-core variability) cannot be estimated, since there is data available for only one core. A summary of the results from the statistical analysis for the one core is given in this section. The complete results are contained in Appendix B.

5.1 Chemical Analyses and Radiological Determinations

Since analytical data was available only for Core 55, the mean concentration was estimated using the arithmetic mean of all of the analytical results for each constituent. An estimate of the analytical variability in the data was obtained. However, these variance estimates should not be used as uncertainty estimates for the estimated mean concentrations.

Analytical results that were below the detection limits were replaced with the detection limit values for the calculation of mean concentrations. The analytical variability estimate was not calculated if more than 75% of the results were below the detection limit for a given constituent.

Table 6 gives a summary of the analytical results from Core 55. The table contains the following information for each chemical and radiological constituent:

1. Constituent name and preferred analytical method
2. Estimated mean concentration
3. Units of the mean concentration
4. Estimated inventory
5. Units of the inventory.

The inventory was calculated using a solids density of 1.79 g/mL and the solids volume of 71,790 liters. The inventory results are for the solids portion of the waste only. This is because there were no supernate samples available to analyze and hence no supernate composition information. Approximately 40% of the waste volume is made up of supernate based on the surveillance data (see Reference [9]). Because of this, the total waste inventory is expected to be somewhat different than the results presented in Table 6. However, the major constituents in the tank (other than water) should not be substantially affected by this constraint and therefore the solids inventories for these constituents should be similar to the total inventory. However, concentrations based on total inventories may change if water is included. Mean concentration and inventory estimates with a less than sign (<) in front of them indicate that all of the analytical results used to calculate that estimate are detection limits (i.e., the estimate should be considered an upper bound).

Table 6: Summary of the Composite Level Results for Anions, Metals, Organics and Radionuclides

Analyte	Analytical Method: Sample Preparation	Mean Concentration	Total Inventory
	Anions		
		(μg/g)	(kg)
Chloride	IC:W	1.50e+02	1.93e+01
Cyanide	CN:W	4.15e+00	5.33e-01
Fluoride	IC:W	1.10e+02	1.41e+01
Nitrate	IC:W	1.75e+04	2.25e+03
Nitrite	IC:W	4.00e+03	5.14e+02
Phosphate	IC:W	5.65e+02	7.26e+01
Phosphate	ICP:F	1.09e+04	1.40e+03
Sulfate	IC:W	7.85e+02	1.01e+02
	Cations		
		(μg/g)	(kg)
Aluminum	ICP:A	1.58e+05	2.03e+04
Ammonia	ISE:W	2.70e+01	3.47e+00
Antimony	ICP:A	5.22e+02	6.71e+01
Arsenic	ICP:A	5.31e+02	6.82e+01
Barium	ICP:A	1.06e+02	1.36e+01
Beryllium	ICP:A	<5.99e+01	<7.70e+00
Bismuth	ICP:F	<1.67e+04	<2.15e+03
Boron	ICP:A	1.84e+02	2.36e+01
Cadmium	ICP:A	1.28e+01	1.64e+00
Calcium	ICP:A	6.28e+02	8.07e+01
Cerium	ICP:A	<1.20e+03	<1.54e+02
Chromium	ICP:A	7.59e+02	9.75e+01
Cobalt	ICP:A	1.11e+02	1.43e+01
Copper	ICP:A	1.70e+01	2.18e+00
Dysprosium	ICP:A	<5.99e+02	<7.70e+01
Europium	ICP:A	<2.40e+03	<3.08e+02
Gadolinium	ICP:A	<5.99e+03	<7.70e+02
Hexavalent Chromium	Calorimetric:W	7.43e+02	9.55e+01
Iron	ICP:F	1.80e+04	2.31e+03
Lanthanum	ICP:A	<5.99e+02	<7.70e+01
Lead	ICP:A	4.22e+02	5.42e+01
Lithium	ICP:A	<3.60e+02	<4.63e+01
Magnesium	ICP:A	1.05e+03	1.35e+02
Manganese	ICP:A	7.97e+02	1.02e+02
Mercury	CVAA:A	6.25e+00	8.03e-01
Molybdenum	ICP:A	<3.60e+02	<4.63e+01
Neodymium	ICP:F	3.66e+03	4.00e+01
Nickel	ICP:A	7.30e+01	9.38e+00
Palladium	ICP:A	<3.60e+03	<4.63e+02
Phosphorus	ICP:F	3.55e+03	4.56e+02
Potassium	ICP:A	<1.20e+04	<1.54e+03
Rhodium	ICP:A	<3.60e+03	<4.63e+02
Ruthenium	ICP:A	<2.40e+03	<3.08e+02
Selenium	ICP:A	1.03e+03	1.32e+02
Silicon	ICP:F	3.84e+03	4.93e+02

Table 6: Summary of the Composite Level Results for Anions, Metals, Organics and Radionuclides

Analyte	Analytical Method: Sample Preparation	Mean Concentration	Total Inventory
Silver	ICP:A	1.85e+01	2.38e+00
Sodium	ICP:F	3.12e+04	4.01e+03
Strontium	ICP:A	1.80e+01	2.31e+00
Tellurium	ICP:A	<5.99e+03	<7.70e+02
Thallium	ICP:A	<5.99e+03	<7.70e+02
Tin	ICP:A	<1.20e+04	<1.54e+03
Titanium	ICP:A	1.05e+01	1.35e+00
Thorium	ICP:A	9.59e+03	1.23e+03
Tungsten	ICP:A	<2.40e+03	<3.08e+02
Uranium	Laser Fluorimetry:F	<7.07e+02	<9.09e+01
Vanadium	ICP:A	<1.20e+02	<1.54e+01
Yttrium	ICP:A	1.03e+02	1.32e+01
Zinc	ICP:A	1.12e+02	1.44e+01
Zirconium	ICP:A	4.18e+01	5.37e+00
Organics			
		(μg/g)	(kg)
Total carbon	Persulfate Oxidation:W	4.06e+03	5.22e+02
Total inorganic carbon	Persulfate Oxidation:W	3.46e+03	4.45e+02
Total organic carbon	Persulfate Oxidation:W	6.55e+02	8.42e+01
Radionuclides			
		(μCi/g)	(Ci)
Americium-241	GEA:F	1.59e-01	2.04e+01
Carbon-14	Liquid Scintillation:W	4.60e-02	5.91e+00
Cesium-134	GEA:F	<9.00e-03	<1.16e+00
Cesium-137	GEA:F	1.81e+01	2.33e+03
Cerium-144	GEA:F	9.60e-02	1.23e+01
Cobalt-60	GEA:F	2.70e-02	3.47e+00
Curium-243/244	Alpha Radchem:F	1.00e-03	1.00e-03
Europium-152	GEA:F	<7.00e-03	<9.00e-01
Europium-154	GEA:F	3.30e-01	4.24e+01
Europium-155	GEA:F	3.66e-01	4.70e+01
Gross alpha	Alpha Radchem:F	2.28e-01	2.93e+01
Gross beta	Beta Radchem:F	4.88e+02	6.27e+04
Neptunium-237	Alpha Radchem:F	1.00e-03	1.29e-01
Plutonium-238	Alpha Radchem:F	6.00e-03	7.71e-01
Plutonium-239/240	Alpha Radchem:F	5.50e-02	7.07e+00
Potassium-40	GEA:F	1.30e-02	1.67e+00
Ruthenium-103	GEA:F	<6.38e-01	<8.20e+01
Ruthenium-106	GEA:F	<1.12e-01	<1.44e+01
Strontium-90	Beta Radchem:F	2.38e+02	3.06e+04
Technetium-99	Beta Radchem:F	1.80e-02	2.31e+00
Thorium-228	GEA:F	<2.20e-02	<2.83e+00
Total alpha Pu*	Alpha Radchem:F	6.10e-02	7.84e+00
Tritium	Liquid Scintillation:W	7.00e-03	9.00e-01
		(%)	(Ci)
Uranium-234	Mass Spectrometry:F	6.00e-03	NA
Uranium-235	Mass Spectrometry:F	6.98e-01	NA

Table 6: Summary of the Composite Level Results for Anions, Metals, Organics and Radionuclides

Analyte	Analytical Method: Sample Preparation	Mean Concentration	Total Inventory
Uranium-236	Mass Spectrometry:F	1.30e-02	NA
Uranium-238	Mass Spectrometry:F	9.93e+01	NA

* Total alpha emitted from Pu-238, Pu-239, Pu-240, Pu-241

Appendix B contains the following statistical results for all constituent and analytical method combinations:

1. Constituent name and analytical method
2. Estimated mean concentration
3. Estimated analytical variability presented as a relative standard deviation (RSD)
4. Units of the mean concentration
5. Number of analytical results used in the above calculations
6. Number of analytical results used in the above calculations that were below the detection limits.

5.2 Physical Measurements

Measurements of the following physical characteristics were taken: weight percent solids, weight percent oxides, particle size, sample density, centrifuged supernate density, solids density and settling behavior. These measurements are necessary for the design and fabrication of retrieval, pretreatment, and final waste disposal systems. General physical assays were obtained on unhomogenized aliquots from Core 55. Particle size, shear strength, and settling behavior were also determined on unhomogenized aliquots from Core 55. Since shear strength is easily susceptible to changes such as time lapse or temperature, and the holding time was exceeded, the measurement for shear strength is a qualified estimate (estimated using best judgement). Table 7 shows the averages of the available physical measurements. A preferable set of measurements would include complete segment-level data on more than one core, so that both horizontal and vertical variability could be adequately assessed. As noted earlier in this section, analytical results are available only for Core 55.

Table 7: Summary of Physical Measurements

Property	Mean	RSD (%)	Mean Units
Centrifuged solids density:Physical Properties	1.80e+00	NA	g/mL
Centrifuged supernate density:Physical Properties	1.10e+00	NA	g/mL
Density:Physical Properties	1.79e+00	31	g/mL
pH Measurement:pH:W	9.82e+00	NA	NA
Settled solids:Physical Properties	4.13e+01	123	vol%
Volume percent centrifuged solids:Physical Properties	9.60e+01	NA	vol%
Weight percent centrifuged solids:Physical Properties	9.70e+01	NA	wt%
Weight percent oxides:Physical Properties	6.57e+01	NA	wt%
Percent water: Thermogravimetric Analysis	3.32e+01	NA	%
Weight percent solids:Percent Solid	8.97e+01	16	wt%
Weight percent solids:Physical Properties	7.23e+01	NA	wt%

The relative standard deviation (RSD) reported in this table is a measure of the analytical variability in the data. The RSD is not an estimate of the uncertainty about the tank mean estimate.

5.2.1 Energetics

Thermal measurements were made on unhomogenized materials from Core 55 and are summarized in Table 8. No exotherms were found up to 500 degrees C.

Table 8: Core 55 Thermal Measurements

	DSC			TGA	
Transition	Enthalpy (cal/g)	Onset (degrees C)	Range (degrees C)	Range (degrees C)	Mass Loss (%)
1	2.45	76	70-111	30-190	1.5
2	319	255	190-380	190-370	24.4
3	NA	NA	NA	370-545	7.3

However, the thermal analysis did identify three endotherms in the waste occurring at 76, 255, and 410 degrees C, respectively. The first endotherm had an enthalpy of 2.45 cal/wet gram of sample, and a temperature range between 70 and 111 degrees C. Its temperature range suggests the loss of free water. Free water is determined from the weight percent solids assay (100 - weight percent solids). Total water for the sample matrix is determined from the mass loss in the TGA. The second endotherm had a temperature range between 190 and 380 degrees C, with an enthalpy averaging 319 calories per gram of sample. This endotherm and its associated mass loss is probably due to the decomposition of aluminum hydroxide to aluminum oxide and water. This supposition is based on several observations. First, the aluminum content of the waste in this tank is relatively high and historically, it is known that coating waste contains high amounts of aluminum hydroxide. Next, the endotherms relating to the two higher temperatures correspond reasonably well with the temperature ranges and magnitudes for this reaction. Finally, the mass loss associated with this temperature range (190 to 380 degrees C) is close to what would be expected for aluminum hydroxide. The third endotherm was observed but unquantified because it exceeded the limitations of the instrument.

5.2.2 Particle Size Analysis

Two Core 55 samples were analyzed for particle size distribution. The samples were observed to be very light in color with a fine, dry, powdery texture. The samples were suspended in 50% glycerol solution to moisten and suspend the particles. The samples were well dispersed and no large or agglomerated particles were observed. Table 9 describes the particle sizes, which ranged between .5 and 150 micrometers.

5.2.3 pH Measurement

The pH of the water leach of the Core 55 composite was measured according to Reference [13]. The pH was measured as 9.80 and 9.83 for the sample and duplicate results, respectively.

5.2.4 Weight Percent Solids and Weight Percent Oxides

Samples were placed into preweighed vials, weighed and allowed to air-dry overnight to remove free liquid and prevent splattering in the oven. The samples were then transferred to a muffle furnace or drying oven at 105 degrees C where they were dried for 24 hours. The dried samples were removed from the oven, placed in a desiccator to cool to room temperature, reweighed, and the weight percent total solids was calculated.

For determination of weight percent oxides, the samples were placed into preweighed crucibles, weighed and allowed to air-dry overnight to remove free liquid and prevent splattering in the oven. The samples were then transferred to a muffle furnace at between 1000 degrees C and 1050 degrees C for 30 minutes. The calcined samples were removed from the oven, placed in a desiccator to cool to room temperature, reweighed, and the weight percent oxides was calculated (see Reference [7]).

Table 9: Particle Size Distribution of T-102 Samples

Description	Volume Density Basis Diameter (micrometers)	Number Density Basis Diameter (micrometers)
Mean Particle Size	35	0.93
Median Particle Size	36	2.35
Lower Diameter Boundary (which encompasses 90% of the particles)	10	< 4
Upper Diameter Boundary (which encompasses 90% of the particles)	60	N/A

5.3 Heat Load Analysis

The waste in Tank T-102 is radioactive, and consequently generates some heat through radioactive decay. The most significant radioactive contributors in the waste are strontium-90 and cesium-137, contributing approximately 38,100 and 2,900 Curies, respectively. Table 10 summarizes the power produced by the radionuclides in the waste. Based on the heat load calculations, about 270 watts of heat are produced in the tank — equivalent to about three ordinary 100-watt light bulbs. The heat load calculations indicate that there is no significant heat production due to the decay of radioactive isotopes in the tank.

Table 10: Radionuclide Inventory and Projected Heat Load

	TotalCi	*watts/Ci*	*watts*
Americium-241	2.54e+01	3.28e-02	8.34e-01
Cesium-137	2.90e+03	4.72e-03	1.37e+01
Cobalt-60	4.32e+00	1.54e-02	6.65e-02
Curium-243/244	1.60e-01	3.44e-02	5.50e-03
Europium-154	5.28e+01	9.03e-03	4.76e-01
Europium-155	5.85e+01	7.27e-04	4.25e-02
Neptunium-237	1.60e-01	2.38e-02	3.81e-03
Plutonium-238	9.59e-01	3.33e-02	3.19e-02
Plutonium-239/240	8.79e+00	3.06e-02	2.69e-01
Strontium-90	3.81e+04	6.67e-03	2.54e+02
Technetium-99	2.88e+00	5.00e-04	1.44e-03
Tritium	1.12e+00	2.61e-01	2.92e-01
Uranium-234	4.16e-02	2.83e-02	1.18e-03
Uranuim-235	1.76e-02	2.71e-02	4.77e-04
Uranium-236	1.60e-03	2.57e-02	4.11e-05
Uranium-238	3.84e-02	2.49e-02	9.56e-04
Total Heat Load			2.70e+02

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6 Interpretation of Analytical Results

As noted in previous sections, the 1993 core sample recoveries from Tank T-102 were poor, and only Core 55 was analyzed in the laboratory. The analyses on this single core had to be limited due to the small amount of sample available. For this reason, only limited interpretations can be made from the analytical results. To obtain more realistic inventory estimates and associated uncertainty estimates, additional core samples from T-102 would be required.

This section compares the analytical results to the sets of historical estimates discussed in Section 2. Some general chemical and radiological interpretations are also presented.

6.1 Historical and Core Sampling Result Comparisons

Given the limits noted above, a comparison of the T-102 historical estimates (from Section 2) to T-102 core sampling results is important. If reasonable agreement is found between the historical and core sampling results, the limits placed on the interpretation of analytical results may be relaxed to a certain extent.

Table 11 compares historical data to the 1993 core sampling results. The second and third columns in Table 11 present LANL (solid waste estimates) and 1973/1974 sampling results, respectively. These are the same results presented in Table 3, except that the units have been converted from molarity to concentration (μg/g) for the anions and cations. Columns 2 and 3 of Table 11 are compared to column 4 (average of the core sampling results) to assess the level of agreement between the historical estimates and the core sampling results. For simplicity, only the three most significant digits are reported in columns 2, 3 and 4 of Table 11.

The last two columns in Table 11 present the relative percent errors (RPE) for the LANL and 1973/1974 sampling estimates. Based on the RPEs, there is reasonable agreement ($\pm$ 50%) between the LANL estimates and the core sampling results for four of the major constituents (aluminum, nitrate, sodium, and strontium-90) in Tank T-102.

The 1973/1974 sampling estimates do not compare as well with the core sampling results. This is not surprising, given that the T-102 waste state was very different in 1973/1974 than it was in 1993 when T-102 was core sampled. When the tank was sampled in 1973/1974, the tank was filled to capacity with dilute aqueous waste. A few months after this sampling, the dilute aqueous waste was pumped out of the tank, leaving behind some residual solids on top of a waste heel of REDOX (reduction-oxidation) coating waste. The difference in the tank waste in 1973/1974 and in 1993 is also evidenced in the weight percent solid differences from the two sampling events (i.e., 26% in 1974 and 90% in 1993).

It is also interesting to note that the concentration of anions in the 1993 core samples is much lower than in the 1973/1974 samples (particularly nitrite and nitrate). It is hypothesized that the water soluble anions were leached out of the solids by the dilute aqueous waste that was later pumped out of the tank. This accounts for the differences in the anion concentration levels between the 1973/1974 sampling and the 1993 sampling of Tank T-102.

6.2 Chemical and Radiological Interpretations

The solubility of the phosphate in Tank T-102 waste can be determined by comparing the ion chromatography analysis (IC) results for phosphate to the inductively coupled plasma analysis (ICP) results for phosphorus. Table 12 contains phosphate solubility calculated two ways. The first way is to calculate the phosphorus as phosphate (using the ICP fusion analytical results) and compare that to the IC phosphate results. The second way is to compare the ICP water leach phosphorus results to the ICP fusion phosphorus results.

The phosphate in Tank T-102 waste is almost entirely in the insoluble form, based on the two solubility calculations (i.e., 5.2% and 11.6%) in Table 12.

Table 13 contains a check on the internal consistency of the radiological determinations for the T-102 samples. Most of the alpha activity in the waste is from americium-241. The gross alpha estimate is compared to the sum of americium-241 and plutonium-239/240 estimates. These two quantities are very comparable, with a relative percent difference of 6%. The gross beta estimate is compared to two times the strontium-90 estimate plus the cesium-137 estimate. Most of the beta activity is from strontium-90. These two quantities

Table 11: Comparison of Historical and Core Sampling Estimates

Constituent	Historical LANL	Historical Sampling 73/74	Composite Estimates	RPE* LANL	RPE* Sampling 73/74
	(μg/g)	(μg/g)	(μg/g)		
Aluminum	9.52e+04	4.66e+03	1.58e+05	-3.98e+01	-9.71e+01
Bismuth	0.00e+00	NA	1.67e+04	-1.00e+02	NA
Chromium	0.00e+00	NA	7.59e+02	-1.00e+02	NA
Fluoride	0.00e+00	7.02e+02	1.10e+02	-1.00e+02	5.38e+02
Iron	0.00e+00	NA	1.80e+04	-1.00e+02	NA
Lead	0.00e+00	NA	4.22e+02	-1.00e+02	NA
Manganese	0.00e+00	NA	7.97e+02	-1.00e+02	NA
Nitrate	2.01e+04	1.09e+05	1.75e+04	1.46e+01	5.23e+02
Nitrite	2.60e+04	2.68e+04	4.00e+03	5.51e+02	5.70e+02
Phosphate	0.00e+00	9.04e+02	5.65e+02	-1.00e+02	5.99e+01
Potassium	0.00e+00	NA	1.30e-02	-1.00e+02	NA
Sodium	3.91e+04	7.64e+04	3.12e+04	2.53e+01	1.45e+02
Sulfate	0.00e+00	7.90e+03	7.85e+02	-1.00e+02	9.07e+02
Uranium	2.55e+04	NA	6.00e-03	4.25e+08	NA
	(μCi/g)	(μCi/g)	(μCi/g)		
Cesium-137	1.40e+00	1.65e+02	1.81e+01	-9.22e+01	8.09e+02
Plutonium	1.84e+00	NA	6.10e-02	2.91e+03	NA
Strontium-90	1.46e+01	5.46e+00	1.80e+01	-1.88e+01	-6.97e+01
	(g/mL)	(g/mL)	(g/mL)		
Density	1.714	1.24e+00	1.32e+00	2.98e-01	-6.06e+00
	(%)	(%)	(%)		
Weight percent solids	NA	2.63e+01	8.97e+01	NA	-7.05e+01

* Relative Percent Error = (Hist. Est. - Comp. Est)/(Comp. Est.) $\times$ 100
NA: Not available or not analyzed

Table 12: Phosphate Solubility

Calculation	Phosphate Solubility
$\frac{IC{:}W\ PO_4^{3-}\ result}{ICP{:}F\ P\ result\ as\ PO_4^{3-}} = \frac{565}{10879} \times 100$	5.2%
$\frac{ICP{:}W\ P\ result}{ICP{:}F\ P\ result} = \frac{413}{3550} \times 100$	11.6%

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are also very comparable, with a RPD of 1%. It should be noted that the quantities used in Table 12 and Table 13 were taken from Tables 6 and 23.

Table 13: Alpha and Beta Energy Checks

Calculation	Gross Alpha or Beta	RPD
Total Alpha		
$^{241}Am + {}^{239/240}Pu = 0.214\ \mu Ci/g$	$0.228\ \mu Ci/g$	6%
Total Beta		
$2(^{90}Sr) + {}^{137}Cs = 494\ \mu Ci/g$	$488\ \mu Ci/g$	1%

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7 Quantitative and Statistical Quality Assurance Tests

This section contains a summary of the various quality assurance tests and measurements applied to the T-102 analytical results. These tests and measurements include the mass balance, homogenization tests, spike recoveries, and method blanks.

7.1 Mass Balance

The mass balance is a validation calculation designed to compare the results of the metals, anions, and laboratory moisture measurements for consistency with each other. The mass balance was completed for the Core 55 analytical results. The best estimate of core contents (Table 6) for the metals, anions, postulated hydroxides and postulated oxides are summed in order to postulate the amount of water present in the tank. The postulated water content is then compared to the measured water content for agreement.

Since two very important laboratory measurements were not made, oxygen and complexed hydroxide, assumptions are made to account for them. The postulated oxide and hydroxide species are listed in Tables 14 and 15 for the anions and cations, respectively. It should be noted that to select these species, specific assumptions had to be made pertaining to the formulas of the oxides and hydroxides that exist in Tank T-102. Different assumptions could lead to significantly different results.

Table 14: Anion Mass Contribution

Measured Concentration Anion		Postulated Component		Postulated Oxide*
	(μg/g)		(μg/g)	(μg/g)
Chloride	150	Cl^-	150	
Fluoride	110	F^-	110	
Nitrate	17,500	NO_3^-	17,500	
Nitrite	4,000	NO_2^-	4,000	
Phosphate	10,900	PO_4^{3-}	10,900	
Silicon	3,840	SiO_3^{2-}	10,422	6,582
Sulfate	785	SO_4^{2-}	785	
Sum	37,285		43,867	6,582

* Not measured as an anion

Table 16 summarizes the mass balance from Tables 14 and 15. The mass of the anions, cations, postulated hydroxides and postulated oxides are summed and the total is subtracted from 1,000,000 to get the estimated water. The total water estimated from the mass balance is 376,857 μg/g, as compared to 332,000 μg/g, which is the total water measured by Thermal Gravimetric Analysis (TGA). The relative percent difference between these two results is approximately 13%. This mass balance accounted for approximately 95.5% of the total mass of the core sample.

7.2 Homogenization Tests

Two aliquots were taken from the top and bottom of the Core 55 composite and prepared for analysis in the laboratory using KOH fusion. There was no statistical difference in the results for aliquots taken at the top of the composite and aliquots taken at the bottom (at the 90% confidence level). The primary reason that no statistical difference was observed is attributed to the large analytical variability (i.e., lack of agreement between duplicate results). This large analytical variability was probably due to local heterogeneity in the samples rather than to instrument variability. The logic behind this last statement is that dark particles were observed in the primarily white homogenized composite sample. It is possible that the particle size distribution between aliquots is a contributing factor to the variability. The presence of dark particles made it likely that aliquots taken very near each other could have large differences in analyte concentrations.

Table 15: Metals (Cations) Mass Contribution

Measured Concentration		Postulated Components		Postulated	
				Oxide	Hydroxide
	(μg/g)		(μg/g)	(μg/g)	(μg/g)
Aluminum	158,113	$Al(OH)_3$	456,946		298,833
Antimony	522	Sb_2O_5	693	171	
Arsenic	2,670	As_2O_5	4,090	1,420	
Cadmium	13	CdO	15	2	
Calcium	1,670	CaO	2,334	664	
Chromium	949	CrO_3	1,824	875	
Iron	17,973	$Fe(OH)_2$	28,936		10,963
Lead	2,630	PbO	2,830	200	
Magnesium	1,052	MgO	1,744	692	
Manganese	973	MnO_2	1,539	566	
Neodymium	3,660	Nd_2O_3	4,260	600	
Potassium	12,000	KOH	17,100		5,100
Selenium	1,033	SeO_3	1,660	627	
Sodium	31,157	$NaOH$	54,206		23,049
Strontium	167	SrO	197	30	
Uranium	707	$UO_2(OH)_2$	903	95	101
Total	235,289		579,277	5,942	338,046

Table 16: Summary of Core 55 Mass Balance

Source	Mass μg/g
Sum of cations	235,289
Sum of anions	37,285
Sum cations hydroxide	338,046
Sum cations oxide	5,942
Sum anions oxide	6,582
Subtotal	623,143
Estimated H_2O from mass balance	376,857
Measured Total H_2O from TGA*	332,000
Relative Percent Difference (H_2O)	13%
Estimated total for matrix (Subtotal and TGA)	955,143
Percent Difference (Total)	-4.5%

* Thermal Gravimetric Analysis

A proposal was made to improve the homogenization by reducing particle size through a grinding process. Unfortunately, there was an insufficient amount of sample material to run another set of homogenization tests to check the effects of the grinding process.

7.3 Evaluation of Spikes and Blanks

Spikes and blanks are regularly run in the laboratory to determine whether or not the analysis procedures are producing unbiased measurements. If the results for the blanks are too high, or if the spike recoveries deviate substantially from 100% (± 25%), then the associated measurements are either re-run or flagged in the data base. The control thresholds for this QA evaluation are based on the ground water standards contained in the Resource Conservation and Recovery Act (RCRA), and are not necessarily the most relevant standards to apply to these measurements.

In this section, we present an overview of the blank and spike measurements. These measurements provide a good indication of laboratory performance, but we have not attempted to apply the RCRA standards rigorously to this data. For the analysis presented in other parts of this report, all data, including QA flagged data, has been used. There was also no attempt to correct any of the data for high blanks or low spike recovery.

7.3.1 QA Flags

Hanford Analytical Services (HAS) reviewed all data and assigned quality assurance flags to the results. Of the 2,033 measurements (see Section 5) in the data set, HAS classified about 10% as unusable or "estimate only" (a QA flag of J or Q). All these measurements were used in the analyses. About 38% of the measurements were below the detection limit (i.e., the analyte was not found in the samples). For these data, the detection limit was substituted for the measured value.

In order to perform the analyses presented in this report, all data were used and none of the HAS-flagged data were deleted. Table 17 provides a list of the defined HAS flags, while Table 18 summarizes the amount of flagged data in the data set. From the tables, one can see that much of the data has been flagged as below detection limit (U and UJ); this is not a QA problem. The "Q" flag in Table 18 indicates that the result is close to the detection limit (i.e., above the detection limit but below the quantification limit).

From Table 18, one can see that approximately 15% of all ICP-Fusion and ICP-Acid measurements above the detection limit have a Q flag. Since ICP is the major measurement method for most elements, there would be a large problem for data interpretation if all Q-flagged measurements were deleted from the data set.

7.3.2 Blanks

Method blanks were run for each duplicate pair of samples for the ICP analytical method. In all but three cases, the amount of the analyte measured in the blank was less than the method detection limit. The three cases were from the ICP analysis on the acid-digested Core 55 composite sample. The three constituents and their associated blank-to-measurement ratios were boron (126%), calcium (49%), and sodium (2%). Boron and calcium had low concentrations and therefore their associated blank measurements do not warrant concern about contamination. Sodium did have a high concentration but its blank measurement was only 2%. Since the analytical RSD was 10%, any contribution to the uncertainty from the blank is likely overwhelmed by the analytical variability, and therefore, does not warrant action.

7.3.3 Spikes

Spike recovery percentages are generally between 75% and 125%. Figure 4 and Table 19 provide concise summaries of the percent recoveries. As one can see from Table 19, 13 spikes were outside the acceptable range, and they are listed in Table 20.

Even though most of the recoveries are within the desired 75-125%, one should consider whether this information should be used to correct for biases. For several important measurement methods (e.g., ICP),

Figure 4: Box-plots of Recovery Percentages

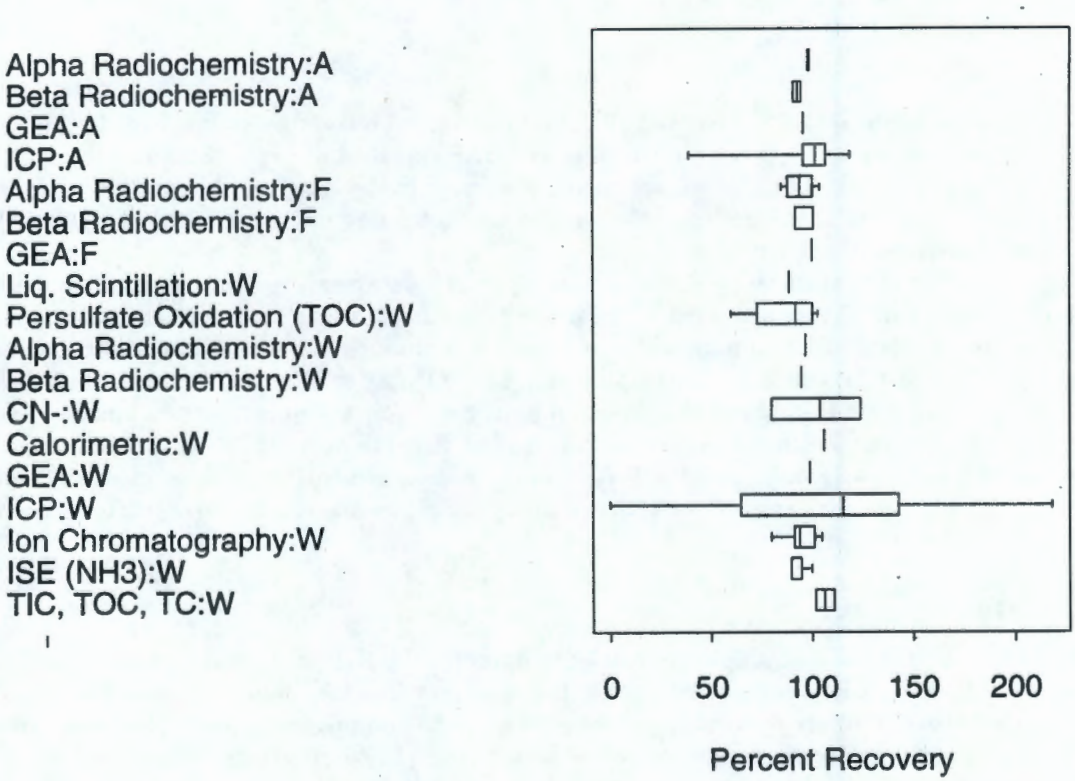

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Table 17: QA flag Description

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

the results are consistently above or below 100% recovery. This consistency in the recoveries indicates that a bias may exist in these measurements. The variability in the recovery percentages is surprisingly small for several analysis methods.

Table 18: Summary of QA flags on sample and duplicate measurements

Analysis Method	None	J	N	Q	R	U	UJ
Alpha Radiochemistry:A	4	0	0	0	0	4	0
Beta Radiochemistry:A	7	0	0	0	0	1	0
GEA:A	10	0	0	0	0	61	0
ICP:A	440	0	5	77	1	167	0
CVAA (Hg):A	2	1	0	0	0	1	0
DSC:D	16	0	0	0	0	0	0
Alpha Radiochemistry:F	21	0	0	0	0	3	0
Beta Radiochemistry:F	10	0	0	0	0	2	0
GEA:F	25	0	0	0	0	48	0
ICP:F	33	0	0	98	2	307	0
Laser Fluorimetry:F	3	0	0	0	0	2	0
Mass Spectroscopy:F	8	0	0	0	0	0	0
Liq. Scintillation:W	9	0	0	0	0	0	0
Percent Solids:D	8	0	0	0	0	0	0
Persulfate Oxidation (TOC):W	9	6	0	0	0	0	0
Physical Properties	40	0	0	0	0	0	0
TGA:D	18	0	0	0	0	0	0
Alpha Radiochemistry:W	3	0	0	0	0	1	0
Beta Radiochemistry:W	4	0	0	0	0	0	0
CN-:W	6	1	0	0	0	0	0
Calorimetric:W	2	1	0	0	0	1	0
GEA:W	11	0	0	0	0	26	0
Hydroxide:W	0	0	0	0	0	0	0
ICP:W	214	0	2	23	6	215	0
IC:W	26	8	0	0	0	10	4
ISE (NH3):W	4	0	0	0	0	0	1
TIC, TOC, TC:W	7	3	0	0	0	0	0
pH:W	3	2	0	0	0	0	0
Total Flags	943	22	7	198	9	849	5

Table 19: Summary of Spike Recoveries (75-125% Range)

Analytical Method	Inside	Outside
Alpha Radiochemistry:A	2	0
Beta Radiochemistry:A	2	0
GEA:A	1	0
ICP:A	32	1
CVAA (Hg):A	0	0
DSC:D	0	0
Alpha Radiochemistry:F	4	0
Beta Radiochemistry:F	3	0
GEA:F	1	0
ICP:F	0	0
Laser Fluorimetry:F	0	0
Mass Spectroscopy:F	0	0
Liq. Scintillation:W	1	0
Percent Solids:D	0	0
Persulfate Oxidation (TOC):D	3	1
Physical Properties	0	0
TGA:D	0	0
Alpha Radiochemistry:W	1	0
Beta Radiochemistry:W	1	0
CN-:W	3	0
Calorimetric:W	1	0
GEA:W	1	0
Hydroxide:W	0	0
ICP:W	5	11
IC:W	12	0
ISE (NH3):W	4	0
TIC, TOC, TC:W	2	0
pH:W	0	0

Table 20: Spike Recoveries below 75% and above 125%

Sample ID	Method Name	Constituent	result	Result Type
93-08755-J	Persulfate Oxidation (TOC):W	Total organic carbon	60%	SPIKE RECOVERY
93-08755c1	ICP:W	Aluminum	1010%	SPIKE RECOVERY
93-08755c1	ICP:W	Iron	34%	SPIKE RECOVERY
93-08755c1	ICP:W	Lead	143%	SPIKE RECOVERY
93-08755c1	ICP:W	Manganese	4869%	SPIKE RECOVERY
93-08755c1	ICP:W	Nickel	131%	SPIKE RECOVERY
93-08755c1	ICP:W	Silicon	206%	SPIKE RECOVERY
93-08755c1	ICP:W	Uranium	171%	SPIKE RECOVERY
93-08755c1	ICP:W	Vanadium	65%	SPIKE RECOVERY
93-08755c1	ICP:W	Zirconium	0%	SPIKE RECOVERY
93-08755c1	ICP:W	Bismuth	0%	SPIKE RECOVERY
93-08755c1	ICP:W	Calcium	218%	SPIKE RECOVERY
93-08755a1	ICP:A	Silicon	39%	SPIKE RECOVERY

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8 Conclusions and Recommendations

This section contains the major conclusions drawn from the analysis of T-102 sampling data and historical records. Some recommendations for future T-102 characterization activities are also given.

The waste in Tank T-102, before the sluicing of 1956, was made up primarily of metal waste (MW) from the bismuth phosphate process and aluminum coating waste (CW). The MW waste contained approximately 90% of the original fission products activity and 1% of the uranium product. Since no MW has been added since the 1956 sluicing, it is believed that no MW currently exists in Tank T-102. The CW was generated in the process which removed aluminum cladding from irradiated fuel rods using a boiling solution of sodium nitrate, and is expected to have high concentrations of aluminum, sodium, and nitrate. Excluding water, the analytes found in highest concentration (>10,000 ppm) in T-102 samples were aluminum, sodium, iron, and nitrate. The high concentrations of aluminum, sodium, and nitrate are assumed to be due to the CW.

The T-102 waste inventory estimates are based entirely on the analytical results from Core 55. As noted in earlier sections, the sample recovery for Core 55 was relatively poor (i.e., 65%). The inventory estimates should therefore be viewed with caution. Additional core samples or updated historical estimates (e.g., LANL tank layer model estimates) could possibly be used to improve the waste inventory estimates for Tank T-102. More specifically, it is recommended that additional sampling be performed through a riser near the tank's center, if and when such a riser becomes available for sampling, so that a more representative sample may be procured. From inspection of the photographic collage of this tank (see Figure 6 in Appendix A), spatial variability within the tank is not considered to be well represented by the current set of core samples. The proposed new sample, together with the Core 55 sample and the small amount of information available from the Core 56 sample, would combine to substantially strengthen the current knowledge of Tank T-102's contents and waste configuration.

Uncertainties in the waste inventory estimates for Tank T-102 could not be addressed with the analytical results available. To obtain uncertainty estimates, additional core samples must be taken from the tank.

The T-102 core sampling results were compared to two sets of historical estimates (i.e., LANL and the 1973/1974 sampling event). There was relatively good agreement between the LANL estimates and the core sampling estimates for the major constituents found in the tank. Due to vast differences in the waste conditions in T-102 at the different sampling times, there was poor agreement between the 1973/1974 sampling results and the 1993 core sampling results.

The QA tests show mixed results as to the usability of the analytical data from the T-102 core samples. The mass/charge balance shows relatively good agreement between postulated and measured results. The homogenization tests, however, indicate that there was a high level of local heterogeneity in the Core 55 composite sample, which could bias the analytical results obtained from this sample. Based on the analysis of blanks measurements, there was no significant sample contamination. The majority of the spike recoveries are within the 100% ± 25% acceptable range; however, some analytical methods had spike recoveries that were consistently above or below 100%.

T-102 is not on any of the watch lists (e.g., ferrocyanide or flammable gas), and therefore has no safety issues that need to be addressed.

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9 References

[1] Agnew SF, 1994. "Hanford Defined Wastes: Chemical and Radionuclide Compositions," LAUR-94-2657, Los Alamos National Laboratory, Los Alamos, NM.

[2] Anderson JD, 1990. "A History of the 200 Area Tank Farms," WHC-MR-0132, Westinghouse Hanford Company, Richland WA.

[3] Babad H, 1994. "Tank Safety Screening Data Quality Objective," WHC-SD-WM-SP-004, Westinghouse Hanford Company, Richland WA.

[4] Bell KE, 1993. "Tank Waste Remediation System Tank Waste Characterization Plan," WHC-SD-WM-PLN-047, Rev. 1, Westinghouse Hanford Company, Richland WA.

[5] Borsheim, GL, Kirch, NW, "Summary of Single-Shell Waste Tank Stability," WHC-EP-0347, May 1992, Westinghouse Hanford Company, Richland WA.

[6] De Lorenzo, DS, Rutherford JH, Smith DJ, Hiller DB, Johnson KW, and Simpson BC, 1994. "Tank Characterization Reference Guide," WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, WA.

[7] Giamberardini, KK, 1993. "PNL 325 Laboratories Single Shell Tank Waste Characterization, Tank T-102," WHC-SD-WM-DP-052, Addendum 1, Rev. 0 , Westinghouse Hanford Company, Richland WA.

[8] "Hanford Federal Facility Agreement and Consent Order," as amended 1994. Washington State Department of Ecology, United States Environmental Protection Agency, and the United States Department of Energy, Olympia WA.

[9] Hanlon BM, 1993. "Tank Farm Surveillance and Waste Status Summary Report for November 1993," WHC-EP-0182-68, Westinghouse Hanford Company, Richland WA.

[10] DOE 1994, Hanford Environmental Information System (HEIS), Volume 8, Tank Characterization Data (TCD) Subject Area, DOE/RL-93-24-8.

[11] Jungfleisch FM and Simpson BC, 1993. "A Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980," SD-WM-TI-057, Rev 0-A, Westinghouse Hanford Company, Richland WA.

[12] Keller, CM, 1993. "Core Drill Operating Envelope Test Report," WHC-SD-WM-ER-123,Westinghouse Hanford Company, Richland WA.

[13] "Measurement of pH in Aqueous Solutions," Pacific Northwest Laboratory Technical Procedure PNL-ALO-225.

[14] "Particle Size Distribution By Laser Scanning (Time of Transition)," Pacific Northwest Laboratory Technical Procedure PNL-ALO-530, Rev. 0.

[15] "Percent Solids Determination of Soils/Sludges/Solids," Pacific Northwest Laboratory Technical Procedure PNL-ALO-504.

[16] "Physical Rheological Properties," Pacific Northwest Laboratory Technical Procedure PNL-ALO-501.

[17] RHO, 1981. "Waste Status Summary Report for October 1981," RHO-CD-0014, Rockwell Hanford Operations, Richland WA.

[18] Welty RK, 1988, "Waste Storage Tank Status and Leak Detection Criteria," SD-WM-TI-356, Rev. 0, September 1988, Westinghouse Hanford Company, Richland WA.

[19] Winters WI, 1991, "Evaluation of SST Data," Internal Memo 28200-91-055, July 30, Westinghouse Hanford Company, Richland WA

[20] Winters WI, Jensen L, Sasaki LM, Weiss RL, Keller JF, Schmidt AJ, and Woodruff MG, 1990. "Waste Characterization Plan for Hanford Site Single-Shell Tanks," WHC-EP-0210, Rev 1, Westinghouse Hanford Company, Richland WA.

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A Tank Engineering Data and Waste Summary

Figure 5: Top View of Tank T-102

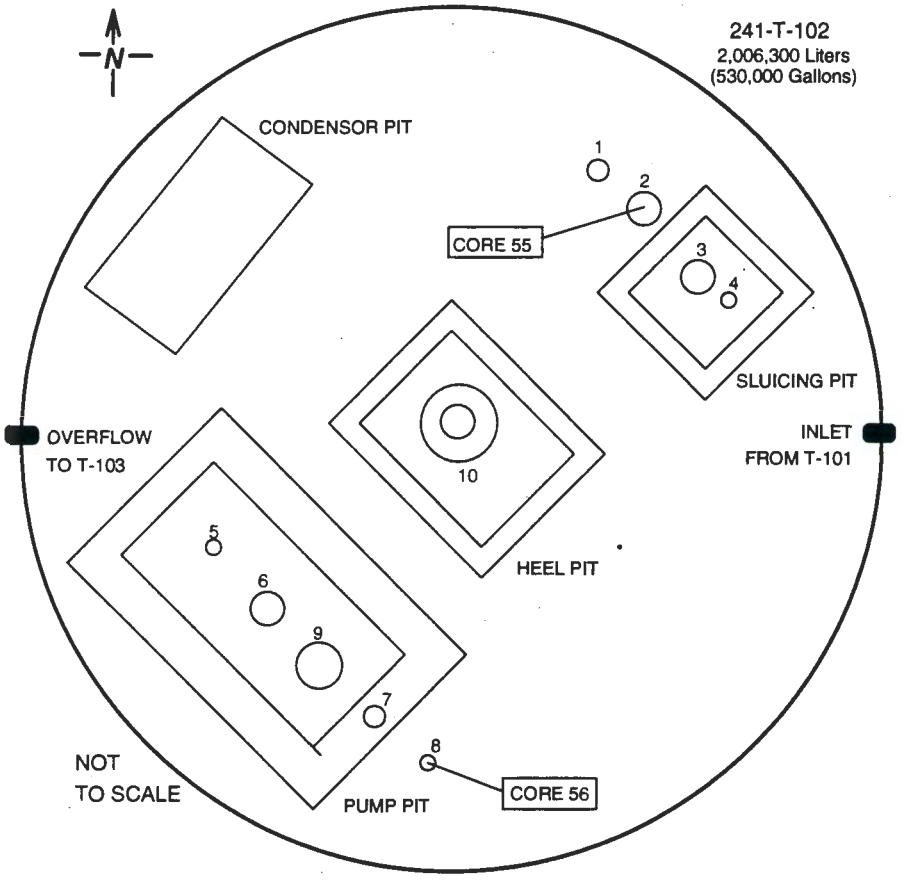

Table 21: Engineering Data Summary of Tank T-102

Tank Engineering Description		Tank Status	
Type:	Single Shell Tank	Watch List:	None
Construction:	1943-1944	Interim Stabilized:	3/81
In-Service:	1945	Intrusion Prevention:	8/81
Out of Service:	1976	Contents:	Non-Complexed Waste
Diameter:	23m (75 ft)	Integrity Category:	Sound
Operating Depth:	5.2m (17 ft)		
Nominal Capacity:	2,006,300 L (530,000 gal)		
Bottom Shape:	Dished		
Hanford Coordinates:	N43647.5, W78737.5		
Ventilation:	Passive		

Table 22: Inventory Summary of Tank T-102

Physical Properties of Waste:			
Total Waste:	121,000 L (32,000 gal)	Supernate Volume:	49,210 L (13,000 gal)
Drainable Inter. Liquid:	0 L (0 gal)	Solids Density:	1.79 g/mL
Free Water:	10.3%	Liquid Density:	1.10 g/mL
Total Water:	33.2%	Temperature Average:	18.3 degrees C
pH:	9.82	Maximum Exotherm	No Exotherms
Heat Load:	2.47e+02 watts		
Chemical Properties of Waste*			
Aluminum:	2.03e+04 kg (15.80 wt%)	Nitrate:	2.25e+03 kg (1.75 wt%)
Sodium:	4.01e+03 kg (3.12 wt%)	Total Organic Carbon:	8.42e+01 kg (0.065 wt%)
Iron:	2.31e+03 kg (1.80 wt%)		
Radionuclides in the Waste			
Total Alpha Pu:	7.84e+00 Ci	Strontium-90:	3.06e+04 Ci
Cesium-137:	2.33e+03 Ci	Total Uranium	<9.09e+01 kg

* Inventory results are based on solids only. There were no liquid analyses.

241-T-102

Photo date: 6-28-89

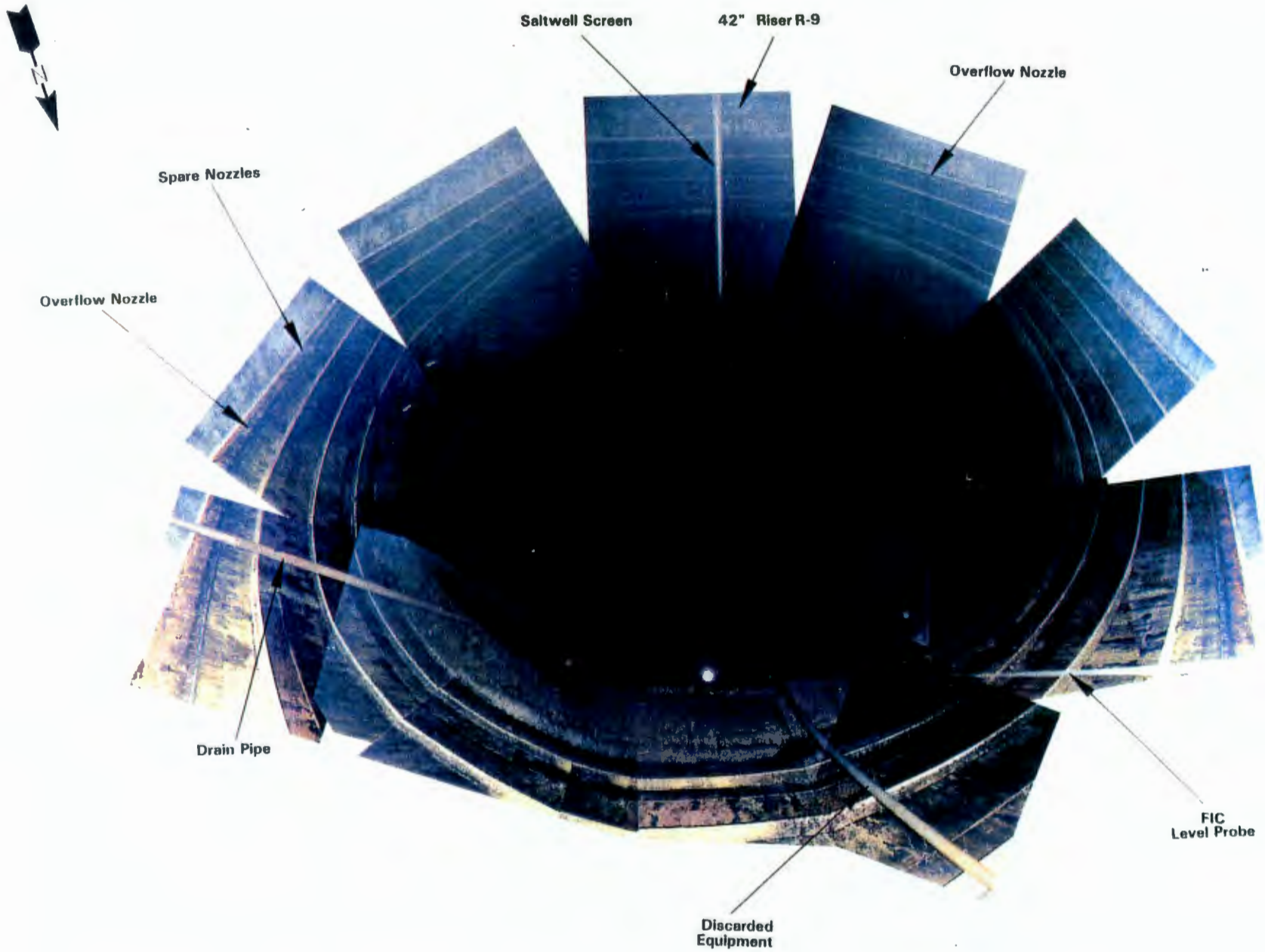

Figure 6: Photo Collage of Tank T-102 Interior

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B Composite Estimates and Variability Summary

This Appendix contains the results of the statistical analysis of Core 55 from the 1993 core sampling of Tank T-102. The table below contains the following fields:

1. Constituent name and analytical method
2. Estimated mean concentration
3. Estimated analytical variability presented as a relative standard deviation (RSD)
4. Units of the mean concentration
5. Number of analytical results used in the calculations
6. Number of analytical results used in the calculations that were below the detection limits (<DL).

Table 23: Tank Concentrations from Composite Samples

Constituent	Analytical Method/ Sample Preparation	Mean Concentration $\hat{\mu}$	Analytical RSD(%)	Obs. #	Obs. <DL
		Anions			
		(μg/g)			
Chloride	IC:W	1.50e+02	115	4	2
Cyanide	CN:W	4.15e+00	9	2	0
Fluoride	IC:W	1.10e+02	115	4	0
Nitrate	IC:W	1.75e+04	116	4	2
Nitrite	IC:W	4.00e+03	115	4	2
Phosphate	IC:W	5.65e+02	115	4	2
Sulfate	IC:W	7.85e+02	115	4	0
		Metals			
		(μg/g)			
Aluminum	ICP:A	1.58e+05	8	4	0
Aluminum	ICP:F	3.02e+05	4	4	0
Aluminum	ICP:W	7.92e+02	19	4	0
Ammonia	ISE:W	2.70e+01	NA	1	1
Antimony	ICP:A	5.22e+02	106	4	2
Antimony	ICP:F	1.67e+03	NA	4	4
Antimony	ICP:W	3.03e+02	NA	4	4
Arsenic	ICP:A	5.31e+02	134	4	1
Arsenic	ICP:F	2.67e+03	77	4	2
Arsenic	ICP:W	4.85e+02	77	4	0
Barium	ICP:A	1.06e+02	102	4	2
Barium	ICP:F	<3.34e+02	NA	4	4
Barium	ICP:W	<6.07e+01	NA	4	4
Beryllium	ICP:A	<5.99e+01	NA	4	4
Beryllium	ICP:F	<1.67e+02	NA	4	4
Beryllium	ICP:W	<3.03e+01	NA	4	4
Bismuth	ICP:A	5.99e+03	NA	4	4
Bismuth	ICP:F	1.67e+04	NA	4	4
Bismuth	ICP:W	3.03e+03	NA	4	4
Boron	ICP:A	1.84e+02	16	4	0
Boron	ICP:F	7.34e+02	60	4	2
Boron	ICP:W	<1.21e+02	NA	4	4

Table 23: Tank Concentrations from Composite Samples

Constituent	Analytical Method/ Sample Preparation	Mean Concentration $\hat{\mu}$	Analytical RSD(%)	Obs. #	Obs. <DL
Cadmium	ICP:A	1.28e+01	16	4	0
Cadmium	ICP:F	5.92e+02	68	4	0
Cadmium	ICP:W	<3.03e+01	NA	4	4
Calcium	ICP:A	6.28e+02	9	4	0
Calcium	ICP:F	1.76e+03	67	4	2
Calcium	ICP:W	2.59e+02	109	4	2
Cerium	ICP:A	<1.20e+03	NA	4	4
Cerium	ICP:F	<3.34e+03	NA	4	4
Cerium	ICP:W	<6.07e+02	NA	4	4
Chromium	ICP:A	7.59e+02	3	4	0
Chromium	ICP:F	9.49e+02	20	4	2
Chromium	ICP:W	7.72e+02	1	4	0
Cobalt	ICP:A	1.11e+02	94	4	3
Cobalt	ICP:F	<3.34e+02	NA	4	4
Cobalt	ICP:W	<6.07e+01	NA	4	4
Copper	ICP:A	1.70e+01	21	4	0
Copper	ICP:F	1.68e+02	76	4	2
Copper	ICP:W	<3.03e+01	NA	4	4
Dysprosium	ICP:A	<5.99e+02	NA	4	4
Dysprosium	ICP:F	<1.67e+03	NA	4	4
Dysprosium	ICP:W	<3.03e+02	NA	4	4
Europium	ICP:A	<2.40e+03	NA	4	4
Europium	ICP:F	<6.67e+03	NA	4	4
Europium	ICP:W	<1.21e+03	NA	4	4
Gadolinium	ICP:A	<5.99e+03	NA	4	4
Gadolinium	ICP:F	<1.67e+04	NA	4	4
Gadolinium	ICP:W	<3.03e+03	NA	4	4
Hexavalent Chromium	Calorimetric:W	7.43e+02	0	2	0
Iron	ICP:A	2.02e+04	4	4	0
Iron	ICP:F	1.80e+04	11	4	0
Iron	ICP:W	8.25e+01	57	4	0
Lanthanum	ICP:A	<5.99e+02	NA	4	4
Lanthanum	ICP:F	<1.67e+03	NA	4	4
Lanthanum	ICP:W	<3.03e+02	NA	4	4
Lead	ICP:A	4.22e+02	10	4	0
Lead	ICP:F	2.63e+03	31	4	2
Lead	ICP:W	<3.64e+02	NA	4	4
Lithium	ICP:A	<3.60e+02	NA	4	4
Lithium	ICP:F	<1.00e+03	NA	4	4
Lithium	ICP:W	<1.82e+02	NA	4	4
Magnesium	ICP:A	1.05e+03	104	4	2
Magnesium	ICP:F	<3.34e+03	NA	4	4
Magnesium	ICP:W	<6.07e+02	NA	4	4
Manganese	ICP:A	7.97e+02	5	4	0
Manganese	ICP:F	9.73e+02	7	4	0
Manganese	ICP:W	1.87e+01	115	4	1
Mercury	CVAA:A	6.25e+00	33	2	0
Molybdenum	ICP:A	<3.60e+02	NA	4	4
Molybdenum	ICP:F	<1.00e+03	NA	4	4

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Table 23: Tank Concentrations from Composite Samples

Constituent	Analytical Method/ Sample Preparation	Mean Concentration $\hat{\mu}$	Analytical RSD(%)	Obs. #	Obs. <DL
Molybdenum	ICP:W	1.55e+02	110	4	2
Neodymium	ICP:A	3.11e+02	16	4	0
Neodymium	ICP:F	3.66e+03	68	4	0
Neodymium	ICP:W	<3.03e+02	NA	4	4
Nickel	ICP:A	7.30e+01	9	4	0
Nickel	ICP:W	<1.82e+02	NA	4	4
Palladium	ICP:A	<3.60e+03	NA	4	4
Palladium	ICP:F	<1.00e+04	NA	4	4
Palladium	ICP:W	<1.82e+03	NA	4	4
Phosphorus	ICP:A	5.98e+02	6	4	0
Phosphorus	ICP:F	3.55e+03	66	4	2
Phosphorus	ICP:W	4.13e+02	2	4	0
Potassium	ICP:A	<1.20e+04	NA	4	4
Potassium	ICP:W	<6.07e+03	NA	4	4
Rhodium	ICP:A	<3.60e+03	NA	4	4
Rhodium	ICP:F	<1.00e+04	NA	4	4
Rhodium	ICP:W	<1.82e+03	NA	4	4
Ruthenium	ICP:A	<2.40e+03	NA	4	4
Ruthenium	ICP:F	<6.67e+03	NA	4	4
Ruthenium	ICP:W	<1.21e+03	NA	4	4
Selenium	ICP:A	1.03e+03	108	4	2
Selenium	ICP:F	<3.34e+03	NA	4	4
Selenium	ICP:W	<6.07e+02	NA	4	4
Silicon	ICP:A	8.66e+02	4	4	0
Silicon	ICP:F	3.84e+03	19	4	2
Silicon	ICP:W	4.27e+02	103	4	2
Silver	ICP:A	1.85e+01	14	4	0
Silver	ICP:F	6.71e+02	97	4	2
Silver	ICP:W	<6.07e+01	NA	4	4
Sodium	ICP:A	2.80e+04	3	4	0
Sodium	ICP:F	3.12e+04	10	4	0
Sodium	ICP:W	2.88e+04	2	4	0
Strontium	ICP:A	1.80e+01	5	4	0
Strontium	ICP:F	<1.67e+02	NA	4	4
Strontium	ICP:W	<3.03e+01	NA	4	4
Tellurium	ICP:A	<5.99e+03	NA	4	4
Tellurium	ICP:F	<1.67e+04	NA	4	4
Tellurium	ICP:W	<3.03e+03	NA	4	4
Thallium	ICP:A	<5.99e+03	NA	4	4
Thallium	ICP:F	<1.67e+04	NA	4	4
Thallium	ICP:W	<3.03e+03	NA	4	4
Thorium	ICP:A	<9.59e+03	NA	4	4
Thorium	ICP:F	<2.67e+04	NA	4	4
Thorium	ICP:W	<4.85e+03	NA	4	4
Tin	ICP:A	<1.20e+04	NA	4	4
Tin	ICP:F	<3.34e+04	NA	4	4
Tin	ICP:W	<6.07e+03	NA	4	4
Titanium	ICP:A	1.05e+01	12	4	0
Titanium	ICP:F	1.69e+02	74	4	2

Table 23: Tank Concentrations from Composite Samples

Constituent	Analytical Method/ Sample Preparation	Mean Concentration $\hat{\mu}$	Analytical RSD(%)	Obs. #	Obs. <DL
Titanium	ICP:W	<3.03e+01	NA	4	4
Tungsten	ICP:A	<2.40e+03	NA	4	4
Tungsten	ICP:F	<6.67e+03	NA	4	4
Tungsten	ICP:W	<1.21e+03	NA	4	4
Uranium	ICP:A	<2.40e+04	NA	4	4
Uranium	ICP:F	<6.67e+04	NA	4	4
Uranium	ICP:W	<1.21e+04	NA	4	4
Uranium	Laser Fluorimetry:F	7.07e+02	5	2	0
Vanadium	ICP:A	<1.20e+02	NA	4	4
Vanadium	ICP:F	<3.34e+02	NA	4	4
Vanadium	ICP:W	<6.07e+01	NA	4	4
Yttrium	ICP:A	1.03e+02	109	4	2
Yttrium	ICP:F	<3.34e+02	NA	4	4
Yttrium	ICP:W	<6.07e+01	NA	4	4
Zinc	ICP:A	1.12e+02	14	4	0
Zinc	ICP:F	9.57e+02	21	4	2
Zinc	ICP:W	<1.21e+02	NA	4	4
Zirconium	ICP:A	4.18e+01	5	4	0
Zirconium	ICP:F	<3.34e+02	NA	4	4
Zirconium	ICP:W	<6.07e+01	NA	4	4
Organics					
		(μg/g)			
Total carbon	Persulfate Oxidation:D	1.54e+03	116	4	0
Total carbon	Persulfate Oxidation:W	4.06e+03	3	2	0
Total inorganic carbon	Persulfate Oxidation:D	1.24e+03	116	4	0
Total inorganic carbon	Persulfate Oxidation:W	3.46e+03	2	2	0
Total organic carbon	Persulfate Oxidation:D	4.03e+02	87	3	0
Total organic carbon	Persulfate Oxidation:W	6.55e+02	1	2	0
Radionuclides					
		(μCi/g)			
Americium-241	Alpha Radchem:F	2.56e-01	7	2	0
Americium-241	GEA:A	0.00e+00	NA	6	6
Americium-241	GEA:F	1.59e-01	58	4	0
Americium-241	GEA:W	1.00e-02	60	2	0
Carbon-14	Liquid Scintillation:W	4.60e-02	9	2	0
Cerium-144	GEA:A	0.00e+00	NA	6	6
Cerium-144	GEA:F	<9.60e-02	41	4	4
Cerium-144	GEA:W	<4.20e-02	NA	2	2
Cesium-134	GEA:A	0.00e+00	NA	6	6
Cesium-134	GEA:F	<9.00e-03	NA	4	4
Cesium-134	GEA:W	<4.00e-03	NA	2	2
Cesium-137	GEA:A	1.00e-03	100	6	3
Cesium-137	GEA:F	1.81e+01	87	4	0
Cesium-137	GEA:W	2.64e+01	1	2	0
Cobalt-60	GEA:A	0.00e+00	NA	6	6
Cobalt-60	GEA:F	2.70e-02	30	4	0
Cobalt-60	GEA:W	1.00e-03	0	2	1
Curium-243/244	Alpha Radchem:F	1.00e-03	0	2	0

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Table 23: Tank Concentrations from Composite Samples

Constituent	Analytical Method/ Sample Preparation	Mean Concentration $\hat{\mu}$	Analytical RSD(%)	Obs. #	Obs. <DL
Europium-152	GEA:A	0.00e+00	NA	6	4
Europium-152	GEA:F	<7.00e-03	29	4	4
Europium-152	GEA:W	<1.00e-03	100	2	2
Europium-154	GEA:A	0.00e+00	NA	6	4
Europium-154	GEA:F	3.30e-01	56	4	0
Europium-154	GEA:W	1.50e-02	33	2	0
Europium-155	GEA:A	0.00e+00	NA	6	4
Europium-155	GEA:F	3.66e-01	56	4	0
Europium-155	GEA:W	1.60e-02	19	2	0
Gross alpha	Alpha Radchem:A	0.00e+00	NA	6	4
Gross alpha	Alpha Radchem:F	2.28e-01	1	2	0
Gross alpha	Alpha Radchem:W	6.00e-03	17	2	0
Gross beta	Beta Radchem:A	1.50e-02	153	6	1
Gross beta	Beta Radchem:F	4.88e+02	0	2	0
Gross beta	Beta Radchem:W	3.74e+01	8	2	0
Neptunium-237	Alpha Radchem:F	1.00e-03	0	2	0
Plutonium-238	Alpha Radchem:F	6.00e-03	17	2	0
Plutonium-239/240	Alpha Radchem:F	5.50e-02	11	2	0
Potassium-40	GEA:A	0.00e+00	NA	6	6
Potassium-40	GEA:F	<1.30e-02	NA	4	4
Potassium-40	GEA:W	<2.00e-03	50	2	2
Ruthenium-103	GEA:A	0.00e+00	NA	5	5
Ruthenium-103	GEA:F	<6.38e-01	NA	4	4
Ruthenium-103	GEA:W	<3.75e-01	2	2	2
Ruthenium-106	GEA:A	0.00e+00	NA	6	6
Ruthenium-106	GEA:F	<1.12e-01	NA	4	4
Ruthenium-106	GEA:W	<5.50e-02	0	2	2
Strontium-90	Beta Radchem:F	2.38e+02	11	2	0
Technetium-99	Beta Radchem:F	1.80e-02	6	2	0
Thorium-228	GEA:A	0.00e+00	NA	5	5
Thorium-228	GEA:F	<2.20e-02	NA	4	4
Thorium-228	GEA:W	<1.10e-02	0	2	2
Total alpha*	Alpha Radchem:F	6.10e-02	11	2	0
Tritium	Liquid Scintillation:W	7.00e-03	14	2	0
		(%)			
Uranium-234	Mass Spectrometry:F	6.00e-03	17	2	0
Uranium-235	Mass Spectrometry:F	6.98e-01	2	2	0
Uranium-236	Mass Spectrometry:F	1.30e-02	0	2	0
Uranium-238	Mass Spectrometry:F	9.93e+01	0	2	0

* Total alpha emitted from Pu-238, Pu-239, Pu-240, Pu-241

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C Raw Data Set Summary

This appendix describes the format of the T-102 data set used to produce the results discussed in this report. The data set contains chemical measurements made by the 325-A Laboratory on T-102 core samples. The data were originally downloaded from the Tank Characterization Database (TCD). The following changes were made to the data set in preparation for the various statistical analyses:

1. The *KOH* fusion ICP analyses for nickel and potassium were removed from the data set.
2. Only 17 of the original 40 TCD fields remain in the data set.
3. Any sample result that was below the detection limit was replaced with the detection limit value, if it was available.

An electronic ASCII copy of the T-102 data set is available upon request. This data set does not include any of the quality assurance data (i.e., matrix spikes and method blanks). The T-102 data set is 2,033 records in length. Table 24 describes the contents of each field. Reference [10] contains more information on the format of the data in the TCD.

Table 24: Description of T-102 Data Set Fields

Field	Description
1	Core Number
2	Segment or Composite Number
3	Analytical Method Name
4	Phase of the Waste Sample (i.e. Solid or Liquid)
5	Sample Location (TOP and BOTTOM are homogenization samples and TOTAL is the standard sample)
6	Sample ID Number (Assigned by the 325-A Laboratory)
7	Dilution Factor
8	Sample Batch Number
9	Table and Page Number in the Validation Report that contain the sample results
10	Constituent name
11	Measured Sample Result
12	Result Type (e.g., Primary Result, Duplicate Result)
13	Result Units
14	Detection Limit
15	Detection Limit Units
16	Data Quality Flags assigned by Hanford Analytical Services
17	Field indicating if a result is above the detection limit (T = above DL, F = below DL)

Table 25 contains an example of three records from a dataset similar to the T-102 dataset.

Table 25: Example of Three Records from a Raw Data Set

Field 1	Field 2	Field 3	Field 4	Field 5
Field 6	Field 7	Field 8	Field 9	Field 10
Field 11	Field 12	Field 13	Field 14	Field 15
Field 16	Field 17			
core26	3	Extraction Organic (VOA)	S	TOTAL
BLANK	1.0		PG.145	Tetrachloroethane
3.800000e+06	PRIMARY_RESULT	UG/G	NA	
UDR	F			
core26	3	Acid Digestion ICP	S	TOP
9203238A	10.0	21	Pg 67, Table 2-2e	Tellurium
2.087700e+02	DUPLICATE_RESULT	UG/G	208.77000	UG/G
U	F			
core27	Comp1	Fusion ICP	S	BOTTOM
9210669H1B	2.0	49	Pg 353, Table 2-1b	Tellurium
4.293200e+02	DUPLICATE_RESULT	UG/G	429.32000	UG/G
U	F			

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