DOCUMENT RELEASE AND CHANGE FORM

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

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Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-112

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HNF-SD-WM-TI-707	05	EXPOSURE SCENARIOS AND UNIT FACTORS FOR THE HANFORD TANK WASTE PERFORMANCE ASSESSMENT
RPP-20110	02	STAGE 1 RETRIEVAL DATA REPORT FOR TANK 241-C-106
RPP-20577	01	STAGE II RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-106
RPP-22393	07	241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan
RPP-50910	00	SINGLE-SHELL TANK WASTE RETRIEVAL LIMIT OF TECHNOLOGY DEFINITION FOR MODIFIED SLUICING
RPP-52290	01	Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108
RPP-CALC-56856	00	Estimated Waste Volume Remaining in Single Shell Tank 241-C-112 after Hard Heel Retrieval
RPP-PLAN-55462	00	SINGLE-SHELL TANKS 241-C-111 AND 241-C-112 HARD HEEL RETRIEVAL TECHNOLOGY SELECTION
RPP-RPT-26475	01A	RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-203
RPP-RPT-29095	00	RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-202
RPP-RPT-30181	00B	RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-201
RPP-RPT-33060	00	RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-103
RPP-RPT-34062	00	RETRIEVAL DATA REPORT FOR SINGLE-SHELL TANK 241-C-204
RPP-RPT-42294	01	HANFORD WASTE MANAGEMENT AREA C SOIL CONTAMINATION INVENTORY ESTIMATES
RPP-RPT-43039	00	2009 AUTO-TCR FOR TANK 241-C-112
RPP-RPT-44139	03	Nuclear Waste Tank Retrieval Technology Review and Roadmap
RPP-RPT-52480	00	Retrieval Completion Report for Modified Sluicing of Tank 241-C-112
RPP-RPT-52516	00	Derivation of Best-Basis Inventory for Tank 241-C-112 as of April 26, 2012
RPP-RPT-52516	01	Derivation of Best-Basis Inventory for Tank 241-C-112 as of January 31, 2014
RPP-RPT-54072	00	Retrieval Data Report for Single-Shell Tank 241-C-104
RPP-RPT-54588	01	Tank 241-C-112 Hard Heel Retrieval Flowsheet for the Caustic Soak
RPP-RPT-54839	00	Evaluation of the Volumes in Tanks 241-C-101 and 241-AN-101 during Retrieval
RPP-RPT-55896	01	Retrieval Data Report for Single-Shell Tank 241-C-108
RPP-RPT-56900	00	Single-Shell Tank 241-C-112 Hard Heel Retrieval Completion Report

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RPP-56935, Rev. 1

Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-112

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Abstract: This Practicability Evaluation Request to Forego a Third Retrieval Technology documents that retrieval operations undertaken on single-shell tank 241-C-112 using modified sluicing with double-shell tank supernate and chemical retrieval (caustic/water dissolution) technologies have been completed to the limits of technology, and that further waste retrieval operation is not practicable. It is not certain that a technology can be developed that would be effective in removing the residual waste in tank 241-C-112. The additional exposure, time, and cost associated with developing and implementing an additional retrieval technology outweigh the risk reduction that might be achieved.

APPROVED
By marguerite washington at 10:17 am, Dec 18, 2014

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Dec 18, 2014
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Tank Operations Contractor (TOC) **RECORD OF REVISION**		(1) Document Number: RPP-56935	Page 1
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RPP-56935
Revision 1

Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-112

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EXECUTIVE SUMMARY

Single-shell tank 241-C-112 has been retrieved to a residual volume of ~1,700 ft^3 using modified sluicing with double-shell tank supernate and chemical retrieval (caustic/water dissolution) technologies deployed by a standard sluicer and an Extended Reach Sluicing System assembly. The U.S. Department of Energy has evaluated the practicability [as the term “practicable” is used in Appendix C, Part 1, of the Consent Decree in *State of Washington v. Department of Energy*, Case No. 08-5085-FVS (E.D. Wa. October 25, 2010)] of further retrieval using a third retrieval technology and determined the following.

- Based on the waste characteristics observed during the retrieval activities to date, no existing retrieval technology is likely to dissolve the residual waste material, or change the particles into a form that can be suspended and pumped, in order to achieve success in removing a significant portion of the remaining waste in tank 241-C-112. A new approach will need to be developed.

- Development and deployment of a new chemical retrieval process would likely remove some of the residual waste, but the likelihood of success cannot be predicted.

- The incremental reduction in inventory and risk is relatively small, even if the operation is successful. The determinations are based on residual waste composition estimates and not sample data.

- The deployment of an alternate retrieval technology would lead to an additional ~1,200 to 2,100 person-mrem of worker exposure.

- The minimum duration of additional process development and field activities would be between three and four years, because of the need to develop an alternate process/retrieval technology leading to significant delay in subsequent retrieval activities.

- The cost to develop and deploy an additional retrieval technology is likely between $12,150,000 and $19,000,000.

It is not certain that a technology can be developed that would be effective in removing the residual waste in tank 241-C-112. The additional exposure, time, and cost associated with developing and implementing an additional retrieval technology outweigh the risk reduction that might be achieved. Consequently, the U.S. Department of Energy believes that deployment of a third technology into tank 241-C-112 is not practicable.

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Abbreviations and Acronyms

BBI	Best-Basis Inventory
CCW	counter-clockwise
COC	constituent of concern
CW	clockwise
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
ERSS	Extended Reach Sluicing System
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HTWOS	Hanford Tank Waste Operations Simulator
ORP	(DOE) Office of River Protection
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	Revised Code of Washington
RWP	Radiological Work Permit
SST	single-shell tank
TCR	Tank Characterization Report
TOC	Tank Operating Contractor
TWINS	Tank Waste Information Network System
TWRWP	Tank Waste Retrieval Work Plan
WAC	Washington Administrative Code
WMA	Waste Management Area
WTP	waste treatment plant

PRACTICABILITY EVALUATION REQUEST TO FOREGO A THIRD RETRIEVAL TECHNOLOGY FOR TANK 241-C-112
Pursuant to Consent Decree in Case No. CV-08-5085-FVS
(*State of Washington v. Department of Energy* [E.D.Wa. October 25, 2010])

1.0 INTRODUCTION

This Practicability Evaluation Request to Forego a Third Retrieval Technology (also referred to herein as the Practicability Evaluation Request) documents that retrieval operations undertaken on single-shell tank (SST) 241-C-112 (C-112), using the modified sluicing with double-shell tank (DST) supernate and chemical retrieval (caustic/water dissolution) technologies, deployed by a standard sluicer and an Extended Reach Sluicing System (ERSS) assembly, were completed to the limits of technology, and that further retrieval is not practicable as that term is used in Appendix C, Part 1, of the Consent Decree in *State of Washington v. Department of Energy*, Case No. 08-5085-FVS (E.D. Wa. October 25, 2010) (hereinafter "Consent Decree"). The purpose of the Practicability Evaluation Request is to address whether it is practicable to continue waste retrieval operations using a third waste retrieval technology.

The waste in tank C-112 was retrieved as described in the Tank Waste Retrieval Work Plan (TWRWP; RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan*, Revision 7) that was submitted in accordance with Section IV-B of the Consent Decree. This Practicability Evaluation Request is the mechanism by which the U.S. Department of Energy (DOE) asserts that the retrieval technologies selected in the above-referenced TWRWP have reached their limits of technology, in compliance with the Consent Decree Section IV.B.5 requirements. Appendix C, Part 1 of the Consent Decree states that:

> *If the waste residual goal of 360 cubic feet is not achieved using the established two technologies, an additional retrieval technology established in a revised TWRWP shall be deployed to the "limits of technology;" provided that DOE may request that the State agree that DOE may forego implementing a third retrieval technology if DOE believes implementing such technology is not practicable under the criteria set forth above.*

Using the retrieval technologies established in the above-mentioned TWRWP (RPP-22393), DOE has retrieved tank C-112 to a residual volume of ~12,700 gal (~1,700 ft^3) (RPP-CALC-56856, *Estimated Waste Volume Remaining in Single-Shell Tank 241-C-112 After Hard Heel Retrieval*). The residual inventory evaluation used Hanford Tank Waste Operations Simulator (HTWOS) inventories scaled to the volume of waste remaining in an unretrieved tank to be consistent with the Waste Management Area (WMA) C performance assessment. The HTWOS model provided an approach to estimate residual inventories compared to estimates based on simple percentage and differentiates between soluble and insoluble constituents used in RPP-52290, *Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108*.

As set forth herein, DOE has conducted an analysis of the practicability of deploying the third technology that would otherwise be required by the terms of the Consent Decree and has determined that deploying any such technology in tank C-112 is not practicable.

The format and content of this Practicability Evaluation Request was developed collaboratively by the Washington State Department of Ecology (Ecology) and DOE-Office of River Protection (ORP) in a series of regular meetings between December 19, 2011 and March 6, 2012 and is documented in RPP-52290.

2.0 RETRIEVAL PROCESS DESCRIPTION AND CHRONOLOGY

2.1 PRE-RETRIEVAL CONDITION

Tank C-112 is a 530,000-gal SST that has been used to store radioactive waste since November 1946 (RPP-RPT-43039, *2009 Auto-TCR for Tank 241-C-112*). Figure 2-1 shows the tank C-112 plan view. In 1990 tank C-112 contained an estimated 104,000 gal (13,900 ft^3) of residual sludge waste after interim stabilization (HNF-SD-RE-TI-178, *Single-Shell Tank Leak Stabilization Record*).

Tank C-112 began receiving first-cycle decontamination waste from the 221-B Plant bismuth phosphate process via the tank 241-C-111 (C-111) cascade line. The first cascade transfer into tank C-112 was finished in April 1947. The tank remained static until the majority of the supernate was transferred to tank 241-B-106 in 1952.

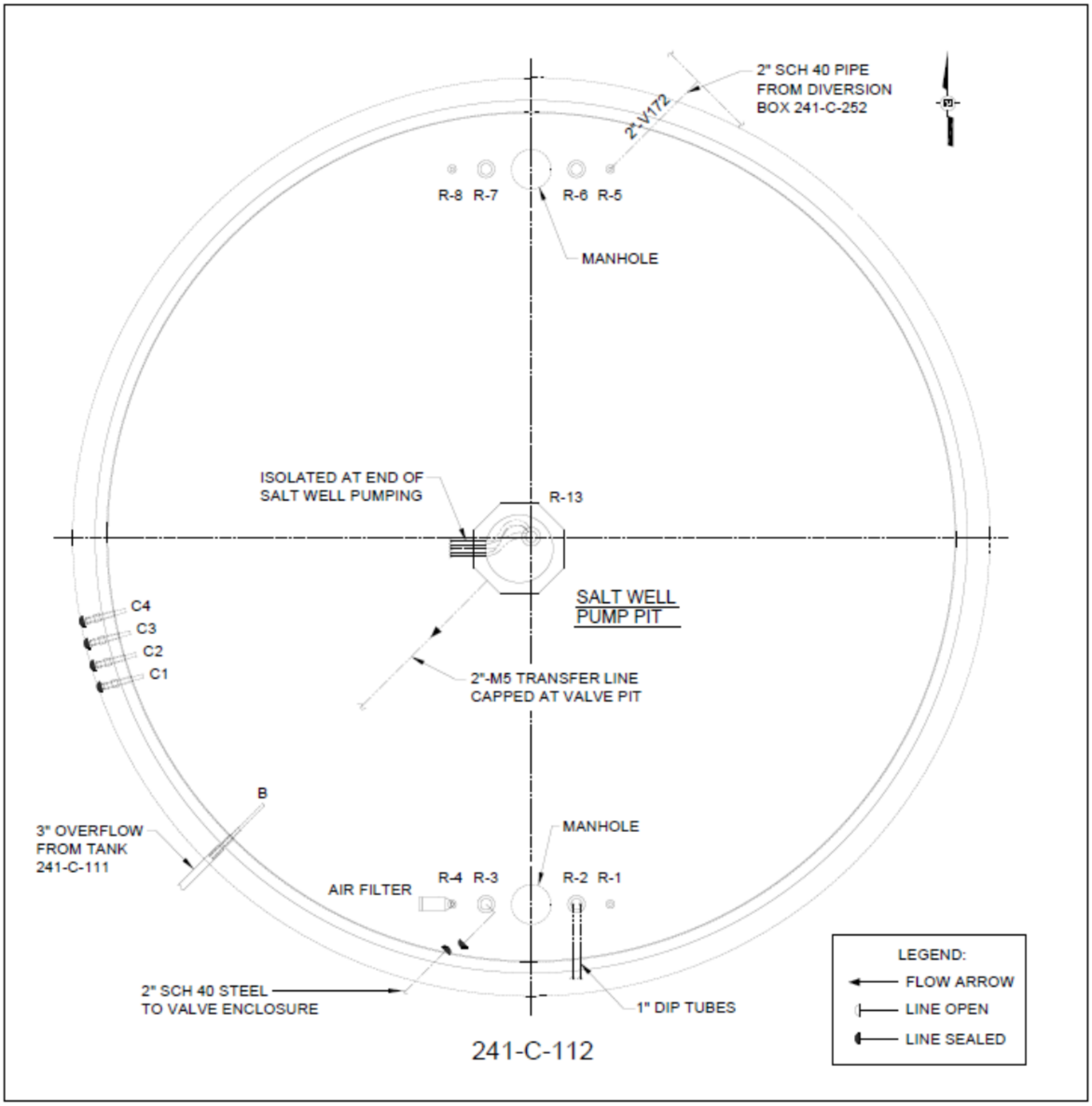
In 1953, tank C-112 received a cascade from tank C-111 and more supernate was transferred to tank 241-B-106. The tank received unscavenged uranium recovery waste from the uranium recovery process in 1954. In late 1955, tank C-112 began to be used for settling scavenged ferrocyanide waste. The scavenged supernate was decanted and sent to several cribs, and the ferrocyanide sludge was retained in the tank until the first quarter of 1958 when in-farm scavenging was completed.

Small transfers of flush water and cladding waste were received from 1958 through the second quarter of 1961. A small amount of waste from the strontium semiworks/hot semiworks was added to the tank in late 1961 and early 1962. In 1970 and 1975, B Plant ion-exchange waste from tank 241-C-110 (C-110) and drainage to C-301 catch tank was added to tank C-112. Tank C-112 was suspected of leaking and was emptied of pumpable liquid to tank 241-C-103 (C-103) in 1975 and 1976. Later surveillance could not confirm the suspected leak, and the tank is currently considered sound. Tank C-112 was removed from service in 1976, and the remaining supernate (4,000 gal) was sent to tank C-103. In 1983, 5,000 gal of waste (from saltwell pumping) was transferred to DST 241-AN-103 (RPP-RPT-43039).

Prior to starting retrieval of tank C-112, the chemical and radionuclide composition and inventory of the waste was documented in the Best-Basis Inventory (BBI) estimate and is based on the results of 1992 core samples (WHC-SD-WM-DP-026, *Single-Shell Tank Characterization Project and Safety Analysis Project Core 34, 35, and 36 Data Report Tank 241-C-112*) and process knowledge of the types of waste that were received at tank C-112 (RPP-RPT-43039).

During the tank C-112 retrieval process, the BBI estimate of waste remaining in the tank was updated (RPP-RPT-52516, *Derivation of Best-Basis Inventory for Tank 241-C-112 as of April 26, 2012*) based on waste retrieval transfers during modified sluicing operations from tank C-112 to tank 241-AN-101 (AN-101) from December 28, 2011 through April 18, 2012. This update provided a volume estimate of ~34,000 gal (4,490 ft^3) for the tank at the end of modified sluicing operations, and at the start of the caustic dissolution retrieval operations.

Figure 2-1. Tank 241-C-112 Plan View.



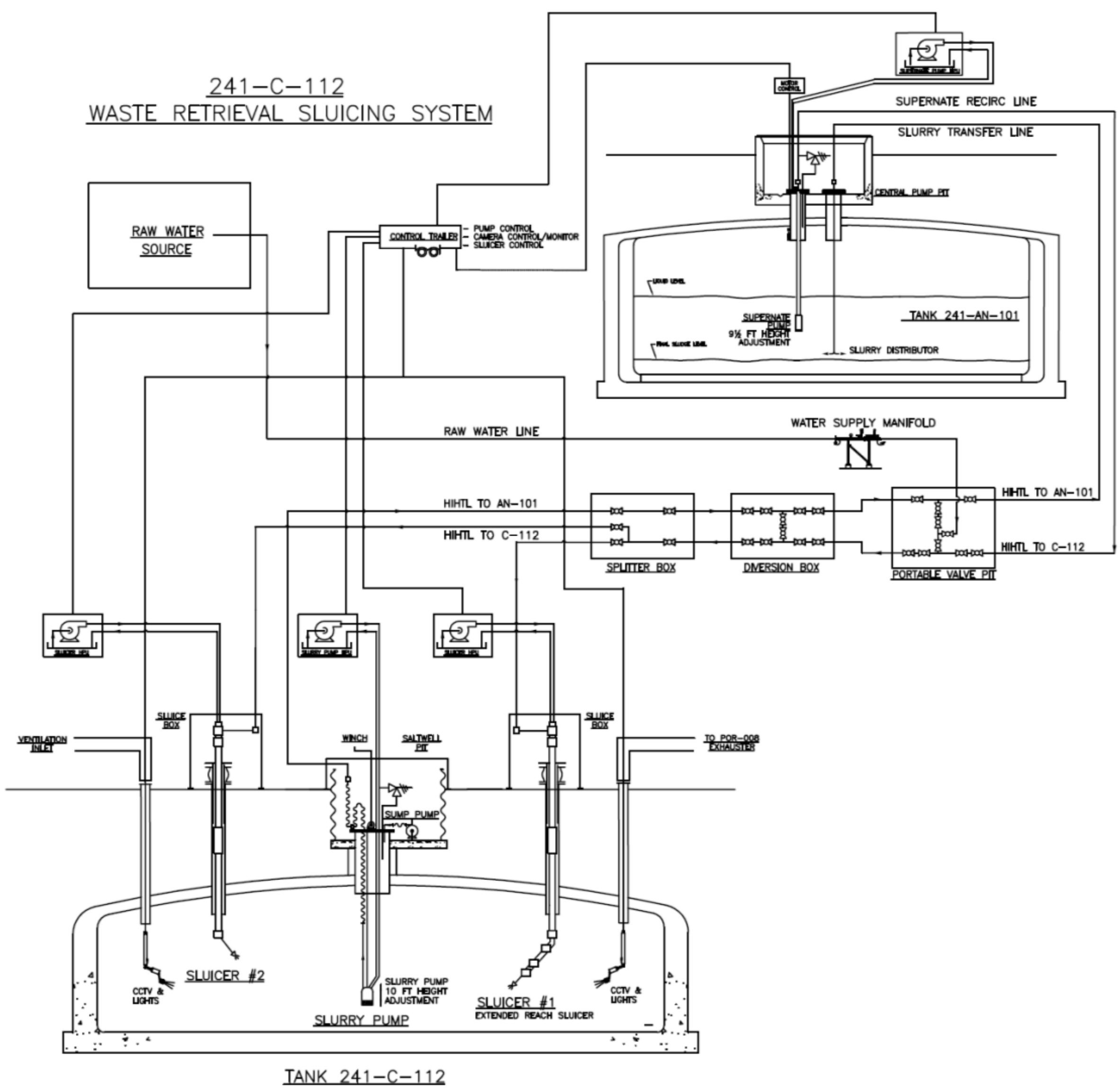
Source: RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan*.

Modified sluicing with DST supernate was the first retrieval technology selected and employed in tank C-112, as described (and approved by Ecology) in RPP-22393. Chemical retrieval (caustic/water dissolution) was identified as the second technology as described (and approved by Ecology) in Revision 7 of RPP-22393.

2.2 RETRIEVAL SYSTEM AND PROCESS DESCRIPTIONS

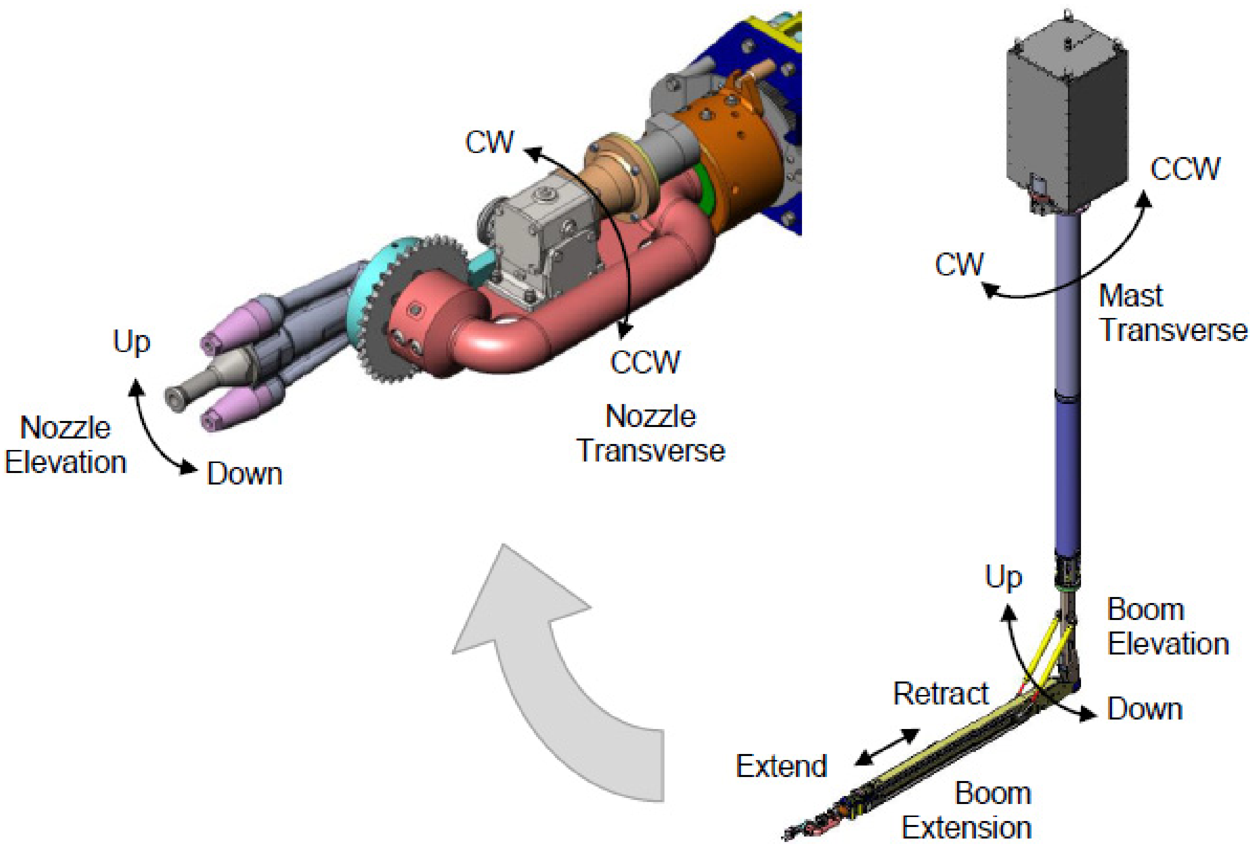
The sluicing system in tank C-112 consisted of two sluicers and a variable speed hydraulically powered slurry pump. The sluicers were installed on opposite sides of the tank and the slurry pump was located in the center of the tank. Sluicer #1, in riser 7 (Figure 2-1, R-7), was comprised of an ERSS with the ability to extend up to ~27 ft into the tank and deploy the sluicer nozzle closer to the waste. Sluicer #2, in riser 2 (Figure 2-1, R-2), was a fixed height sluicer located near the top of the tank, similar to the sluicers used in previous tank retrievals. The slurry pump had a 10-ft adjustment range and could be extended to the bottom of the tank. Video cameras were installed to support sluicing. The pumps, cameras, and hydraulic sluicers were controlled from a control trailer. Figure 2-2 provides an overview of the sluicing system.

Figure 2-2. Tank 241-C-112 Modified Sluicing System Overview.



The ERSS deployed in tank C-112 is depicted in Figure 2-3. Sluicing operations were conducted more or less continuously except when pumping down the liquid in tank C-112 at the end of each operating period. Typically, one sluicer was used at a time. Sluicer operation was alternated based on the location of visible remaining solids. A remotely controlled valve in the portable valve pit was used to control the flow to the sluicers. The liquid flow through the operating sluicer was maintained at ~90 gpm to 120 gpm. Valves were used to direct the supernate, slurry, and flush water flows to and from tank C-112.

Figure 2-3. Extended Reach Sluicing System.



CCW = counter-clockwise CW = clockwise

The slurry pump in tank C-112 has a hydraulic pump unit. The pressure on the hydraulic pump unit was used to control the flow rate on the slurry pump in tank C-112. Instrumentation enabled operators to monitor pump speed (flow of the slurry stream) and the sluicing (supernate) stream(s). Temperature and liquid level was monitored in tank AN-101.

The tank AN-101 adjustable height supernatant pump was used to pump supernate to the sluicers in tank C-112. The pump inlet could be adjusted from 175 in. to 287 in. above tank bottom. The elevation of the pump inlet was maintained at ~6 ft above the bottom of the distributor to minimize carryover of solids from the slurry stream into the sluicing stream.

A slurry distributor in tank AN-101 distributes the sludge as it is received from tank C-112. The height of the slurry distributor could be adjusted from 77 in. to 317 in. above tank bottom.

Connections were provided to flush the slurry and supernatant lines with water. Water, at times, was directed at the waste in tank C-112 via the sluicers when needed to mobilize or rinse the solids. To prevent siphoning of waste from tank AN-101 back to tank C-112, air bleed holes were drilled in the slurry distributor pipe and in a jumper in the supernatant pump line.

Most of the soft, readily suspended fine particles were retrieved from the tank during bulk retrieval using modified sluicing. Most of the waste that remained was a hard material that was resistant to retrieval using un-heated water and supernate.

The second technology deployed at tank C-112 was chemical retrieval. As noted in the TWRWP (RPP-22393), "chemical retrieval" is a category of retrieval process, and the specific steps for each chemical retrieval process in a given tank are specified in the process control plan. In the case of tank C-112, the chemical retrieval process included addition of caustic solution and of water, as described below, and is refered to as "chemical retrieval (caustic/water dissolution)".

Caustic (50 wt% sodium hydroxide, NaOH) was added via a drop leg into tank C-112 to react with gibbsite [aluminum trihydroxide, $Al(OH)_3$] to form sodium aluminate [$NaAl(OH)_4$]. This reaction is called "metathesis." The resulting sodium aluminate would dissolve when water was added. The caustic was recirculated for a period of time to react with the waste solids. After recirculation, the caustic solution was transferred to tank AN-101, and then a sluicing campaign was performed using supernate from tank AN-101 as the sluicing medium. Following sluicing, hot water was added to dissolve the sodium aluminate from the metathesis, as well as other soluble chemicals in the waste. The liquid was pumped out, and caustic was again used to dissolve any remaining gibbsite. A final rinse of the waste fines with water concluded the hard heel retrieval process. A sampling sleeve, installed in riser 3 (adjacent to the sluicer), was used to collect samples during the tank C-112 hard heel retrieval to monitor the dissolution process.

During the hard heel retrieval operation, it was observed that the softer, finer sludges were mobilized and removed from the tank, leaving denser and larger-size waste. It was recognized that different components would be removed during different phases of the process. The intent of the chemical retrieval (caustic/water dissolution) process was to break up the large-sized waste and remove the resulting smaller particles by suspending them in supernatant liquid during sluicing.

2.3 RETRIEVAL OPERATIONS SUMMARY

A summary of the chronology of tank C-112 modified sluicing operations is shown in Table 2-1. Modified sluicing operations were performed during 58 operating days (112 shifts) starting on December 28, 2011 and ending on April 18, 2012. The waste in tank C-112 consisted of a soft brown sludge that, if accessible, could be readily mobilized by the sluicers and pumped from the tank. The soft waste was overlaid with a hard waste surface that appeared to be several inches in thickness. Sluicing had to penetrate the hard waste to access the softer waste below. Once the softer waste was accessed, the retrieval progressed at a relatively slow, but steady rate for most of the retrieval period.

Figure 2-4 shows the modified sluicing retrieval system performance (volume of waste retrieved as a function of the volume of slurry, i.e., solids plus recycled tank AN-101 supernate, transferred from tank C-112 to tank AN-101). The volume of waste retrieved is estimated from the increase in the waste volume in tank AN-101 after accounting for water additions.

Table 2-1. Chronological Summary of Modified Sluicing Retrieval Operations. (2 sheets)

Date(s)	Description
December 28 to 30, 2011	Performed 3 days (5 shifts) of retrieval operations. Operations began at 8:00 PM on December 28, 2011 using the standard sluicer. The waste surface was observed to be hard and the standard sluicer had little or no effect on the waste. Use of the Extended Reach Sluicing System (ERSS) began on December 29; it was able to make a small hole in the hard waste and also appeared to have abraded the surface of the waste in places. Leaking of hydraulic fluid from the ERSS was observed the next day and sluicing operations were switched back to the standard sluicer. 13,800 gal of tank 241-AN-101 supernate was pumped into tank 241-C-112 (C-112) at the end of operations on December 30 to soak the waste in an attempt to soften the hard surface.
December 31, 2011 to January 17, 2012	Performed 8 days (14 shifts) of retrieval operations. After four days of soaking, the supernate was pumped out on January 3, 2012 at the start of the day's operations. The waste surface remained hard and difficult to sluice. The ERSS was used to create holes and cracks in the waste surface and to break up the hard waste. The softer waste below was retrieved using both sluicers. The slurry pump was lowered as waste was retrieved. Troubleshooting of the ERSS hydraulic leak was performed between January 4 and 11. The leak was found to be coming from the lines for the control of the nozzle positioning functions. To minimize leakage, an administrative restriction was placed on the use of those nozzle functions on January 13.
January 18 to 29, 2012	Performed 1 day (2 shifts) of retrieval operations. Weather and weather-related equipment problems impacted retrieval operations during this period. Non-essential work was curtailed on January 18, 19, and 20 because of bad weather conditions. Cold temperatures and high winds affected tank ventilation systems.
January 30 to February 26, 2012	Performed 16 days (33 shifts) of retrieval operations. Work continued on breaking up the waste surface with the ERSS and retrieving waste. The slurry pump was lowered every few days as the retrieval progressed. By February 24, the pump had been lowered to within a few inches of the tank bottom. The solids concentration in the slurry averaged about 3.9 vol% during this period. On February 1, the hydraulic lines to the nozzle functions of the ERSS were disconnected to minimize leakage; they were reconnected as needed to reposition the nozzle.
February 27 to March 29, 2012	Performed 18 days (34 shifts) of retrieval operations. On February 27, in an attempt to lower the slurry pump to the bottom of the tank, the pump was raised and the area beneath the pump sluiced to clear away solids. However, additional solids accumulated in the area and the pump could only be lowered to about 10 in. from the tank bottom. Retrieval operations continued, using the ERSS most of the time. The solids concentration in the slurry averaged about 1.6 vol% during this time.
March 30 to April 8, 2012	Performed 5 days (10 shifts) of retrieval operations. Sluicing continued with the ERSS. The solids concentration in the slurry averaged about 0.8 vol%. On April 6, the slurry pump was lowered several inches.

Table 2-1. Chronological Summary of Modified Sluicing Retrieval Operations. (2 sheets)

Date(s)	Description
April 9 to 18, 2012	Performed 7 days (14 shifts) of retrieval operations. The retrieval performance appeared to have decreased during the period between March 30 and April 6; in anticipation of approaching the limit of technology, more frequent pump-downs of tank C-112 were performed with material balance measurements recorded immediately after the pump-downs. The pump-downs were also done more completely and consistently in order to get better retrieval performance estimates. The solids concentration in the slurry averaged about 0.8 vol% during this period. Retrieval performance of less than 0.6 vol% was observed between April 14 and 17 and retrieval operations ceased on April 18. The ending slurry pump elevation was about 3 in. from the bottom of the tank.

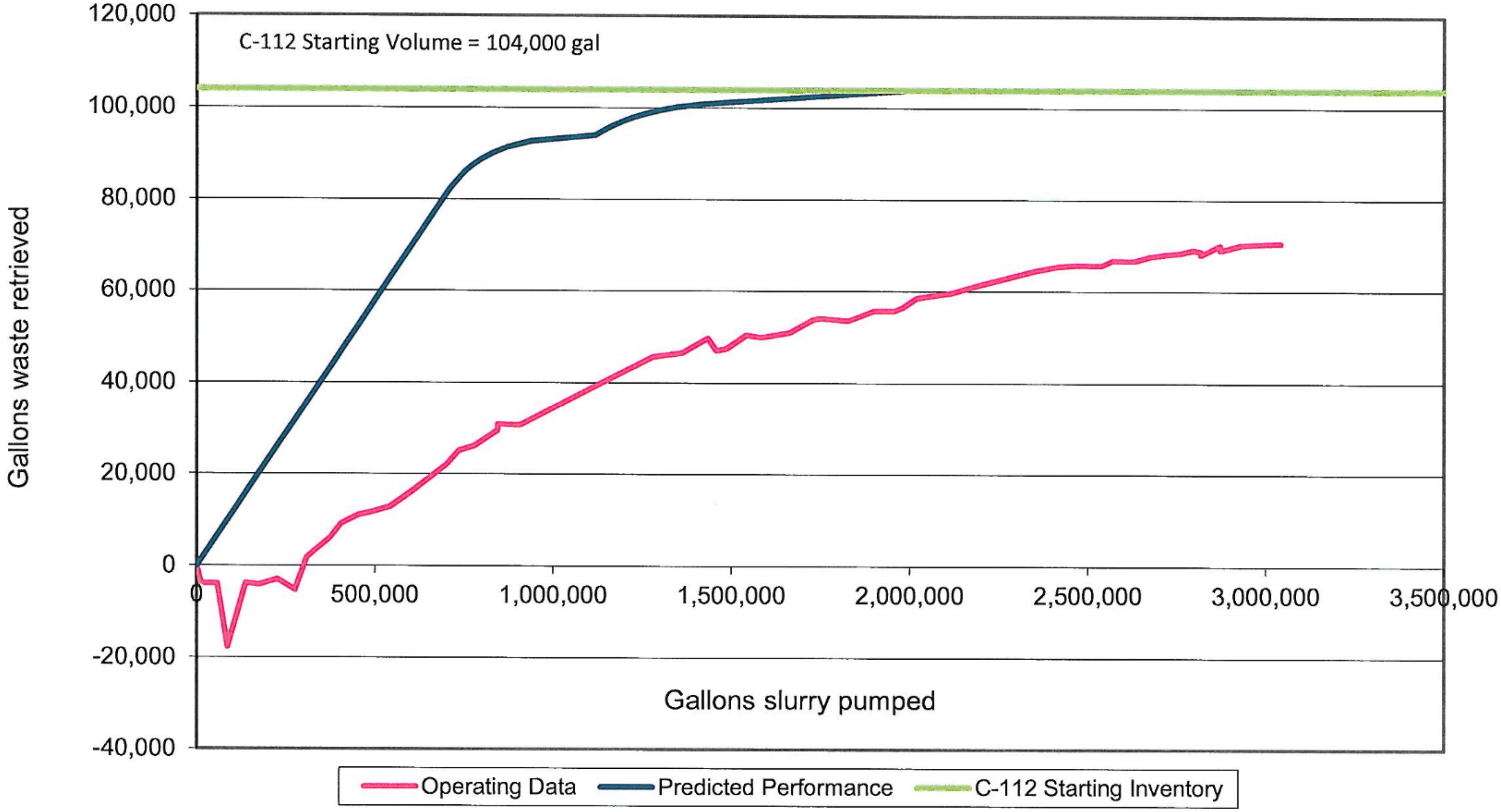
This running volume balance does not entirely distinguish between liquids and solids and does not account for solids dissolution or liquid evaporation.

As the volume of waste material received by tank AN-101 approaches the starting waste volume of tank C-112, the estimate of the volume remaining in tank C-112 using the arithmetic difference between these two volumes becomes increasingly sensitive to uncertainties in the starting waste volume estimate and cumulative measurement uncertainties. The running volume balance and other information was used to generate an estimate of the actual volume of waste retrieved during the modified sluicing of tank C-112. The final estimate of waste volume retrieved is greater than the apparent volume based on operating data. This observation is consistent with results from other tanks. An assessment done of two methods used to track progress during the retrieval of tank 241-C-101 (C-101) to tank AN-101 (RPP-RPT-54839, *Evaluation of the Volumes in Tanks 241-C-101 and 241-AN-101 during Retrieval*) determined that volume is not conserved during retrieval, due to factors that include uncertainties in the initial volume, the initial waste porosity, the dissolution of solids during waste transfers and the evaporation of liquids during the retrieval and waste transfer process.

It should be noted that for most tanks that have been retrieved by modified sluicing, the rate of waste retrieval is initially high and begins to fall off as the easily retrieved sludge is removed and heavier and larger waste remains. However, this was not the case with tank C-112 retrieval. As shown by the slope of the line in Figure 2-4, the retrieval rate for tank C-112 remained relatively constant throughout the retrieval, being only slightly higher in the first ~1.5 million gal of slurry pumped than in the second.

At the end of sluicing operations, an estimated 70,400 gal (9,410 ft^3) or 67.7% of the initial waste volume had been retrieved and ~34,000 gal (4,490 ft^3) remained in tank C-112.

Figure 2-4. Tank 241-C-112 Sluicing Waste Retrieval Progress.



The hard heel retrieval operation (chemical retrieval) started with caustic pre-conditioning followed by sluicing with supernate. This approach was determined to be the best method for retrieving the remaining heel solids in tank C-112 (RPP-PLAN-55462, *Single-Shell Tanks 241-C-111 and 241-C-112 Hard Heel Retrieval Technology Selection*). The first step was to add ~12,000 gal of caustic (19.4 M NaOH). The caustic was introduced to the tank through a drop leg. Mixing was achieved using the slurry pump to circulate the caustic while alternating flow through the ERSS and standard sluicer. The liquid was pumped out to tank AN-101 at the end of the first processing step (Table 2-2).

The second step involved modified sluicing of the solids that remained in tank C-112 following the caustic pre-conditioning. Sluicing was performed with either the ERSS or the standard sluicer, depending on the location of the visible solids, using supernate from tank AN-101. When sluicing no longer appeared effective in removing more solids, the liquid level in the tank was reduced as much as possible.

Hot water was added to dissolve the sodium fluoride phosphate, sodium aluminate, and sodium phosphate compounds that were present in significant quantities, and to remove other compounds as well such as the insoluble oxides of uranium, iron, and bismuth; fluorapatite; and sodium aluminosilicate. The hot water was recirculated and pumped out to tank AN-101.

A second caustic dissolution cycle began with the addition of another ~12,000 gal of 19.4 M NaOH through a drop leg. The caustic was recirculated using the ERSS and standard sluicer as before. Following recirculation, the liquid was pumped from tank C-112 to tank AN-101. Sluicing with supernate was repeated to remove any additional waste particles that were small enough to be suspended. Tank C-112 residual liquid level was then reduced to the minimum achievable by the slurry pump (RPP-RPT-56900, *Single-Shell Tank 241-C-112 Hard Heel Retrieval Completion Report*).

The use of caustic and the ERSS/standard sluicing operations resulted in the breakup of only some of the large pieces of solids in the tank. The ERSS was only effective at breaking up the large waste pieces at close range and required that the solids be sluiced to be close to the ERSS nozzle. Because large pieces of solids were not easily moved with the sluicers, a relatively small volume of solid waste was removed during sluicing. Waste particles the size of sand and larger could not be suspended and pumped out of the tank.

Volume displacement measurements and tank video scans were performed during the transfer of the added water from tank C-112 to tank AN-101 on January 28, 2014. Three water washes of the waste in tank C-112 were performed following the pump-out of the liquid used in the volume displacement measurement.

Table 2-2. Chronological Summary of Chemical Retrieval (Caustic/Water Dissolution) Operations.

Date(s)	Description
November 18 to 19, 2013	Three truckloads of 50 wt% caustic (~12,000 gal) were added to tank 241-C-112 (C-112), followed by water line flushes to initiate caustic pre-conditioning process.
November 19 to December 3, 2013	Caustic re-circulation was performed for 9 days (15 shifts) for a total of 109 hours and 35 minutes. Sluicer # 2 was initially used to direct the caustic at the waste heel material, followed by sluicer # 1 (Extended Reach Sluicing System [ERSS]) in the later shifts. A sample was taken from the recirculating caustic at the end of this time.
December 11 to 12, 2013	The caustic that had been circulated in the tank was pumped out to tank 241-AN-101 (AN-101) while being diluted with tank AN-101 supernate. Much of the solids in the center of the tank had a mud-like appearance, while large chunks of waste still remain in other parts of the tank.
December 18 to 31, 2013	Sluicing of the solids with supernate continued, using either sluicer # 1 or # 2, for a cumulative sluicing time of 119 hours. Operations were cycled between the two sluicers in an attempt to move more fines into the slurry pump suction. There was limited success in breaking up the large chunks of solid material. The mud like waste material proved to be just a shallow overlay of more monolithic type of solids.
December 31, 2013 to January 3, 2014	Hot water dissolution was performed in two batches, the first on December 31 and the second on January 3. Recirculation was performed for 3 additional operating days, followed by pump-out.
January 6 to 7, 2014	A second caustic addition was performed using three truckloads of 50 wt% caustic (~12,000 gal) followed by water line flushes.
January 8 to 21, 2014	Caustic recirculation continued for 10 operating days. Three samples were taken during this period to monitor the caustic reaction with the waste and showed that the caustic was not being consumed as calculated (RPP-RPT-54588, *Tank 241-C-112 Hard Heel Retrieval Flowsheet for the Caustic Soak)*. Pump-downs of tank C-112 were performed with material balance measurements recorded immediately after the pump-downs.
January 23, 2014	Transferred caustic from tank C-112 to tank AN-101.
January 23 to 28, 2014	Sluicing with supernate was performed over 4 operating shifts to recover any fines which may have been left by the caustic cleaning.
January 28, 2014	Volume displacement was performed to assess extent of retrieval. The displacement evaluation used supernate plus ~8,000 gal of water added to tank C-112 to ensure most of the solids were covered.
January 29, 2014	First water flush of ~8,300 gal was added to tank C-112 and recirculated for 4 hours. Tank C-112 was then pumped out.
January 30, 2014	Second water flush of ~8,500 gal was added to tank C-112 and recirculated for 7 hours. Tank C-112 was then pumped out.
January 31, 2014	Third and final waste flush of ~6,800 gal of water added to tank C-112, recirculated for 4 hours, and pumped from the tank completing the retrieval campaign. The transfer line was flushed after the last transfer.

2.4 PROCESS EFFECTIVENESS AND ENHANCEMENTS

Tank C-112 used a combination modified sluicing system, equipped with one ERSS and one standard sluicer, to retrieve the tank waste. The ERSS is different from a standard sluicer in that it has a boom, as well as a mast, which can be used to place the sluicer nozzle closer to the waste and increase the effectiveness of sluicing in breaking up solid waste in the tank (see Figure 2-3).

The ERSS boom is designed to extend and retract with a range of 15 to 28 ft and elevate approximately 90° along the vertical. The mast rotates ±180°, providing a side-to-side motion to the boom. These operations can be manipulated to bring the nozzle much closer to the waste in the tank than is possible with the fixed-elevation standard sluicer. The nozzle on the ERSS is capable of continuous rotation 360° in both the elevation and transverse functions.

The standard sluicer had little effect on the hard waste surface in tank C-112. However, the ERSS did break up some of the hard waste and was able to move some of the large solid pieces. The ERSS did clear away some of the solids on the adjacent stiffener ring but did not break up the removed waste that simply fell to the floor of the tank. Even with the ERSS, the waste was difficult to break up.

During the operation (on January 15) the ERSS hung up on one of the tank stiffener rings and the ERSS nozzle was bent. Because of the damage, movement of the ERSS nozzle was constrained to the transverse and elevation directions. This constraint did not prevent the ERSS from reaching any waste areas, but in some cases required additional positioning of the remaining joints to reach a specific waste area.

A concentrated caustic soak of the hard solids in tank C-112 was also performed in an attempt to soften the hard waste surface. The caustic soak appeared to have no effect on the waste surface. The waste was found to remain congealed and not break down into finer particles or dissolve so portions of the waste could be suspended and carried with the fluid. The density differences (mass) of the particulate waste were too great for the slurry to keep such material suspended and mobilized to enable the pump to transfer the waste. The waste solids, even small, could not remain suspended in the waste liquid and would settle, remaining in the tank.

Attempts were made to spray the tank wall and stiffener rings. However, while reduction in the waste was observed in the areas adjacent to the ERSS, not much waste was observed to be removed from the walls and stiffener rings. It is unlikely that the use of additional sluicers would have any impact on the effectiveness of removing waste that is on the walls and breaking up the waste on the stiffener rings.

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3.0 LIMIT OF RETRIEVAL TECHNOLOGY

Appendix C, Part 1 of the Consent Decree states that:

> *For each tank or group of tanks, the TWRWP shall establish two retrieval technologies that shall be deployed to each of their "limits of technology" in an effort to obtain a waste residue goal of 360 cubic feet of waste or less for each tank.*

During the development of the outline for this Practicability Evaluation Request to Forego a Third Technology for tank C-112, DOE-ORP and Ecology jointly decided that information demonstrating that the first two retrieval technologies had met their respective limits of technology was necessary to evaluate the practicability of deploying a third technology. This information is provided below.

Appendix C, Part 1 of the Consent Decree defines "limits of technology" as follows:

> *The "limits of technology" means that the recovery rate of that retrieval technology for that tank is, or has become, limited to such an extent that it extends the retrieval duration to the point at which continued operation of the retrieval technology is not practicable, with the consideration of practicability to include matters such as risk reduction, facilitating tank closures, costs, the potential for exacerbating leaks, worker safety, and the overall impact on the tank waste retrieval and treatment mission.*

The DOE-ORP has deployed two technologies to this point at tank C-112: modified sluicing and chemical retrieval (caustic/water dissolution). Modified sluicing operations started on December 28, 2011 with an initial waste volume of 104,000 gal (~13,900 ft^3). At least 91,250 gal (~12,200 ft^3) of waste were removed by the first and second retrieval technologies, leaving ~12,700 gal (~1,700 ft^3) per RPP-CALC-56856. The residual waste solids volume estimate is based on process status determinations. It will be superseded by a more accurate estimate when post-retrieval measurements are completed. The estimate of ~1,700 ft^3 is ~1,340 ft^3 above the retrieval goal of 360 ft^3 per the Consent Decree.

The waste in tank C-112 was retrieved as described in the TWRWP, RPP-22393. Discussion of the limit of technology for each of the deployed retrieval methods is included in RPP-22393, and is summarized below.

3.1 LIMIT OF TECHNOLOGY FOR MODIFIED SLUICING

According to RPP-50910, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing*, meeting the following two criteria constitutes reaching the "limit of technology" for retrieval of waste from a Hanford Site SST using modified sluicing with only DST supernate or water as the sluicing medium.

1) *The concentration of SST waste in the retrieved slurry sent to the DST is within or bracketing a 0 to 0.6 vol. percent range for three operating periods. Bracketing refers to two successive data points, one of which is below 0 and the next near or above 0.6, which average less than 0.6 vol. percent. An operating period is a period over which retrieval performance is measured. An operating period is normally one operating day, but as a minimum must be greater than or equal to 8 hours in duration and consist of at least 10 kgal of slurry transferred from the SST.*

2) *The The U. S. Department of Energy (DOE), Office of River Protection (ORP) and the Tank Operating Contractor (TOC) have provided documentation to the State of Washington Department of Ecology (Ecology) that demonstrates that all reasonable efforts were attempted to enhance effectiveness of the installed modified sluicing retrieval system in order to increase waste removal from all quadrants of the tank under consideration.*

Modified sluicing was performed from December 28, 2011 to April 18, 2012 in tank C-112.

Figure 2-4 shows the sluicing retrieval system performance (volume of waste retrieved as a function of the volume of slurry, i.e., solids plus recycled tank AN-101 supernate, transferred from tank C-112 to tank AN-101).

Table 3-1 shows the retrieval efficiency for the last eight days of retrieval sluicing operations, during which tank pump-downs were performed more completely and more often to provide consistent estimates of retrieval efficiency. Table 3-1 shows that early on April 18, 2012 the requirements of the limit of technology definition were met following three consecutive operating periods. The concentration of solids in the slurry for the three operating periods was 0.2 vol%, 0.5 vol%, and 0.3 vol%. Thus the first criterion of RPP-50910 was met for modified sluicing retrieval operations.

The second criterion associated with the limit of technology definition from RPP-50910 requires a demonstration that all reasonable attempts were made to enhance the effectiveness of the installed modified sluicing system in order to increase waste removal from all quadrants of the tank under consideration. By the end of modified sluicing in tank C-112, the hard waste surface, which had been largely uniform at the start of retrieval, had been broken up by the ERSS. Cracks in the surface of the hard waste or large chunks of the hard waste were present in all areas of the tank bottom. To the extent practicable, waste had been sluiced out from under the hard waste. Waste levels were lowest on the north side of the tank where the ERSS was located, and higher on the south side where the standard sluicer was located. In an attempt to soften the hard waste surface, ~13,800 gal of supernate from tank AN-101 was pumped into tank C-112 on the third day of operations and allowed to stand for four days, but no change in the hard waste was observed. Given the location and form of the residual waste, no further actions using the installed modified sluicing system were considered likely to remove the remaining waste. Additional sluicing would not change the waste particles into a form that could be suspended and pumped out of the tank.

Table 3-1. Waste Retrieval Efficiency for April 9 to 18, 2012.

<table>
<tr><th>Operating Period Start</th><th>Operating Period End</th><th>Waste Retrieved, gal</th><th>Slurry Pumped, gal</th><th>Solids in Slurry, vol%</th></tr>
<tr><td>4/9/12,10:10 AM</td><td>4/9/12, 7:55 PM</td><td>522</td><td>44,949</td><td>1.2</td></tr>
<tr><td>4/9/12, 7:55 PM</td><td>4/10/12, 5:20 AM</td><td>303</td><td>39,327</td><td>0.8</td></tr>
<tr><td>4/10/12, 5:20 AM</td><td>4/10/12, 3:15 PM</td><td>605</td><td>36,041</td><td>1.7</td></tr>
<tr><td>4/11/12, 11:05 AM</td><td>4/11/12, 5:02 PM</td><td>-302</td><td>22,103</td><td rowspan="3">1.3</td></tr>
<tr><td>4/12/12, 10:09 AM</td><td>4/12/12, 10:33 AM</td><td>-742</td><td>0</td></tr>
<tr><td>4/13/12, 9:37 AM</td><td>4/13/12, 9:25 PM</td><td>2,007</td><td>53,828</td></tr>
<tr><td>4/13/12, 9:25 PM</td><td>4/13/12, 10:11 PM</td><td>-1,018</td><td>1,398</td><td rowspan="2">0.2</td></tr>
<tr><td>4/16/12, 10:53 AM</td><td>4/16/12, 9:59 PM</td><td>1,128</td><td>56,655</td></tr>
<tr><td>4/17/12, 9:56 AM</td><td>4/17/12, 7:15 PM</td><td>220</td><td>45,478</td><td>0.5</td></tr>
<tr><td>4/17/12, 7:15 PM</td><td>4/18/12, 5:30 AM</td><td>110</td><td>43,879</td><td>0.3</td></tr>
<tr><td>4/18/12, 5:30 AM</td><td>4/18/12, 3:00 PM</td><td>0</td><td>24,034</td><td>0.0</td></tr>
</table>

Note:
Operations on April 18, 2012 between 5:30 AM and 3:00 PM were not used for the determination that the limit of technology had been reached. The duration does not meet the minimum 8-hr operating period requirement because although the operating period officially ended with the application of administrative locks on the retrieval pumps at 3:00 PM, the decision to cease sluicing had been made earlier in the day.

Source: RPP-RPT-52480, *Retrieval Completion Report for Modified Sluicing of Tank 241-C-112*.

Per the Consent Decree, the limits of technology should consider risk reduction, facilitating tank closures, worker safety, overall impact on mission and costs.

- The modified sluicing had effectively removed the bulk of the sludge, and little or no additional waste could be retrieved by continued deployment, resulting in little or no additional reduction of risk.

- Continued modified sluicing would result in continued exposure to workers. Although retrieval operations are controlled from a control trailer, multiple field activities (exhauster filter changes, valve line-ups, field measurements and monitoring, etc.) are required to support the retrieval operations, resulting in continued exposure.

- Continued modified sluicing would increase schedule duration, with the potential to affect other retrieval activities and therefore the overall retrieval and treatment mission.

- Continued modified sluicing would incur costs without an associated risk reduction.

As a result, DOE-ORP concluded that modified sluicing had been deployed to the limit of technology.

3.2 LIMIT OF TECHNOLOGY FOR CHEMICAL RETRIEVAL (CAUSTIC/WATER DISSOLUTION)

Caustic pre-conditioning was performed as described in Section 2.3. At the end of caustic recirculation, a sample of the caustic solution (including any dissolved waste materials) was obtained. The sample dated December 3, 2013 in Table 3-2 shows the results of that sample analysis. The predicted values of analytes in Table 3-2 show the expected concentrations if the reaction had proceeded as expected (based on observations in previous deployments of caustic dissolution, and on the predicted waste composition). Both sodium (Na) and hydroxide (OH) concentrations in the recirculating liquid were higher than had been predicted. This result indicates that less of the caustic than expected had reacted with the waste. This result suggested that that waste composition was different than predicted, including chemical forms that do not react as readily with caustic. Sluicing was performed to removed all the waste materials that had been broken up into small enough particles. Opportunistic hot water dissolution was also performed to remove any materials that were more soluble in water than in caustic.

Table 3-2. Process Solution Sample Results.

Sample Date	Measured	Predicted	Measured	Predicted*	Measured	Predicted*
	Al (M)		Na (M)		OH (M)	
December 3, 2013	0.64	0.53	10.1	6.4	7.7	4.2
January 8, 2014	NA	NA	NA	NA	17.5	NA
January 14, 2014	0.99	0.02	13.2	13.2	10.6	13.2
January 20, 2014	1.37	0.02	12.04	13.2	9.62	13.2

*Predicted values are derived from RPP-RPT-54588, *Tank 241-C-112 Hard Heel Retrieval Flowsheet for the Caustic Soak*, Appendix C.

Following the sluicing, water dissolution, and pump-down of liquids in the tank, the second cycle of caustic dissolution proceeded. The first sample taken after caustic addition (Table 3-2, January 8, 2014) showed the expected high concentration of hydroxide (OH, 17.5M). The second sample taken six days later showed that the reaction of the caustic with waste materials was proceeding, because the caustic was being consumed in the reaction (that is, the concentration of hydroxide had dropped to 10.6M). More of the caustic had reacted than had been predicted, based on the results of the December 3 sample, indicating that the caustic dissolution step was having some effect on the waste material. The results for aluminum (Al) in Table 3-2 show that some of the aluminum compounds were reacting and releasing aluminum into solution, as desired.

The sample taken on January 20, 2014, after an additional six days of caustic recirculation, showed that the reaction had dropped off dramatically. During that time, the hydroxide concentration only dropped from 10.6M to 9.62M. The amount of caustic added had been more than enough to continue reacting, if there had been any waste material that would react with caustic. Thus, it was concluded that the caustic dissolution step had reached its limit.

While the sample results clearly indicated that the reaction of aluminum with the caustic had taken place (Table 3-2), the video and material balance did not show significant change in the waste in tank C-112. To make sure that all the waste that could be retrieved was retrieved, a final four-day sluicing campaign was performed. The first sluicing period showed about 1,900 gal of waste retrieved, consistent with dissolving the products of the caustic dissolution process and pumping them from the tank. The subsequent three sluicing periods showed very limited effectiveness with a net retrieval of only 220 gal in over 180,000 gal of supernate pumped for an average retrieval rate of 0.1%, indicating that the limits of the technology had been met. A volume displacement was done as part of the final sluicing to estimate the final waste remaining in the bottom of the tank. The estimated final volume in the tank at the end of sluicing was 12,700 gal (see RPP-CALC-56856). The final hot water flushes may have reduced the residual waste volume further, but a better volume estimate is not currently available.

All reasonable efforts to enhance the effectiveness of the caustic/water dissolution process were made. Toward the end of retrieval operations, ERSS nozzles were positioned to move waste solids from the north side of the tank toward the opposite sluicer. Additional sluicing and washing of the tank walls and stiffener rings following caustic recirculation was attempted to remove adhered waste. Visual observations of this attempt showed no significant removal of the adhered waste.

Per the Consent Decree, the limits of technology should consider the effect of additional deployment on risk reduction, worker safety, facilitating tank closures,and the overall impact on mission and costs.

- The caustic/water dissolution retrieval had broken up the waste heel and allowed some additional waste retrieval, but was not changing the remaining waste to a form that could be suspended and pumped. Hence it had reached the point where little or no additional waste could be retrieved by continued deployment, resulting in little or no additional reduction of risk.

- Continued caustic/water dissolution retrieval would result in continued exposure to workers. Although retrieval operations are controlled from a control trailer, multiple field activities (exhauster filter changes, valve line-ups, field measurements and monitoring, etc.) are required to support the retrieval operations, resulting in continued exposure.

- Continued caustic/water dissolution retrieval would increase schedule duration and delay other retrieval activities. Specifically, continued operation of tank C-112 caustic dissolution would delay completion of tank C-111 retrieval construction and operations of tank C-111 second and third retrieval technologies, and would also delay initiation of the the first and second retrieval technologies in tank 241-C-102. Delayed retrieval would result in delays to closure of the 241-C Tank Farm (C Farm) tanks.

- Continued caustic/water dissolution would increase the amount of caustic and hot water added to tank C-112 and transferred into the DST system. This increase would lead to more waste transfer operations in the DST system, more evaporator operations, and limitations on DST space that would further limit future retrieval activities.

- Continued caustic/water dissolution retrieval would incur costs without an associated reduction of risk.

As a result, DOE-ORP concluded that chemical retrieval (caustic/water dissolution) had been deployed to the limit of technology.

3.3 LIMIT OF TECHNOLOGY CONCLUSION

As described in Sections 3.1 and 3.2, both the modified sluicing and chemical retrieval (caustic/water dissolution) technologies were performed in tank C-112 to the point where further operation of the combined technologies would not reduce risk significantly, while continuing to cause exposure to workers, increase costs, and delay the initiation or completion of other retrieval activities. Consequently, DOE-ORP concluded that the modified sluicing and chemical retrieval (caustic/water dissolution) steps had reached the limits of technology.

4.0 SUMMARY OF VOLUME AND DESCRIPTION OF RESIDUAL WASTE

4.1 ESTIMATE OF WASTE VOLUME REMOVED

The estimated waste volume removed from tank C-112 in the two retrieval phases is estimated to be 91,250 gal (~12,200 ft^3).

4.2 ESTIMATE OF RESIDUAL WASTE VOLUME REMAINING

As described in RPP-CALC-56856, the estimated volume remaining in tank C-112 is 12,700 gal (1,700 ft^3). The volume estimate was based on video observations and liquid displacement measurements taken during the transfer of liquid from tank C-112 to tank AN-101.

4.3 DESCRIPTION OF RESIDUAL WASTE REMAINING

Figure 4-1 is a panorama view from videos taken after retrieval operations were complete. Most of the large waste piles seen in the background are comprised of larger chunks of waste material. A pool of liquid remains in the center, below the pump intake level. The waste on the stiffener rings and walls appears to be the same as at the conclusion of tank C-112 sluicing and reported in RPP-CALC-56856.

The waste remaining in the tank includes a pool of liquid in the center of the tank. Waste solids covers almost all of the tank bottom. The most noticeable piles are in the southwest and southeast quadrants of the tank. Lower solids piles are located on the north and northwest areas of the knuckle. Figure 4-2 is another panorama view of tank C-112 from videos showing the waste accumulations about the end of the tank and pile on the southeast side of the tank.

Based on observations during retrieval, much of the waste remaining on the tank floor has been broken into particles about the size of sand. These particles were too large or too dense to be suspended in liquid in order to pump them out of the tank.

Figure 4-1. Waste Remaining After Retrieval.

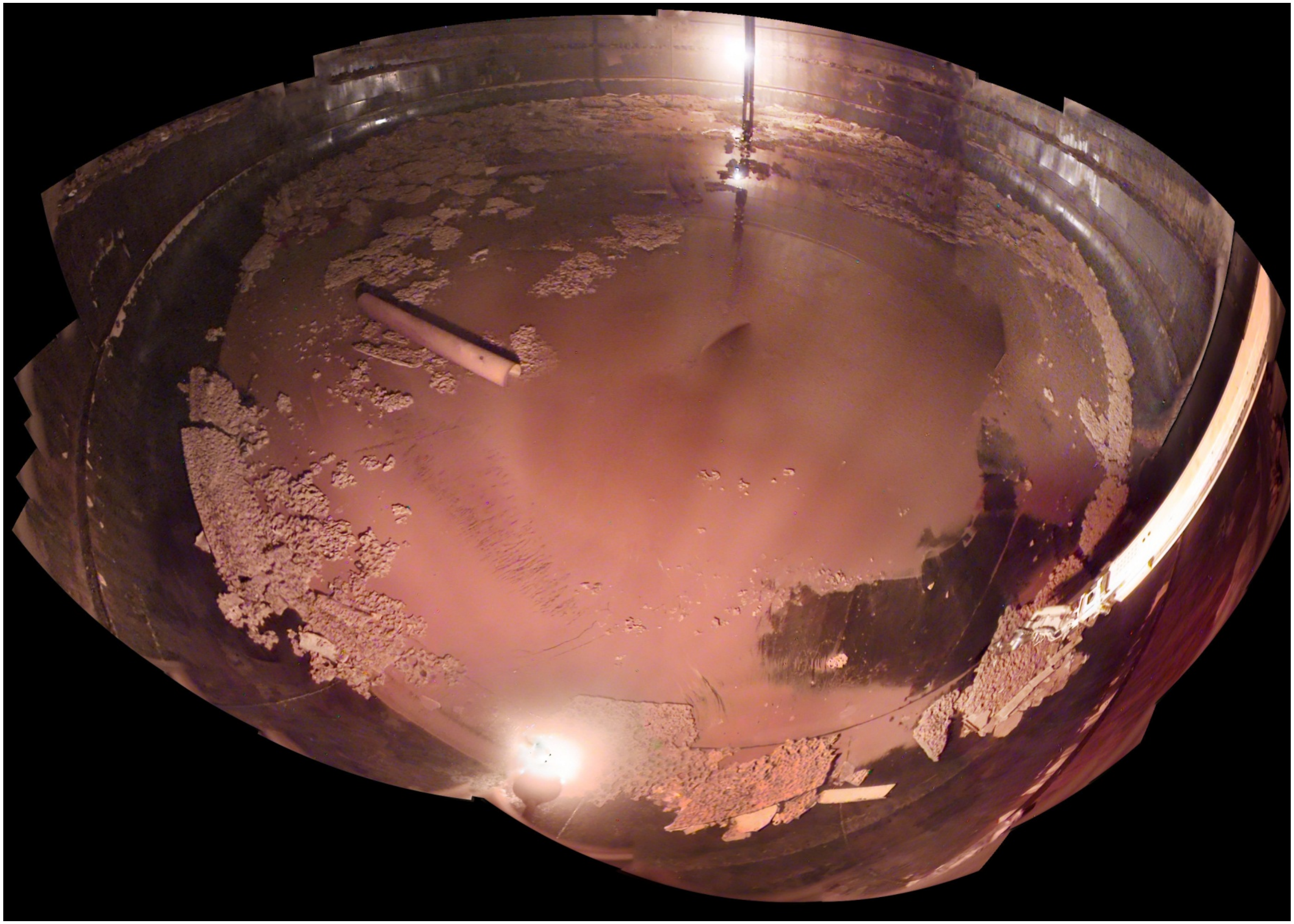
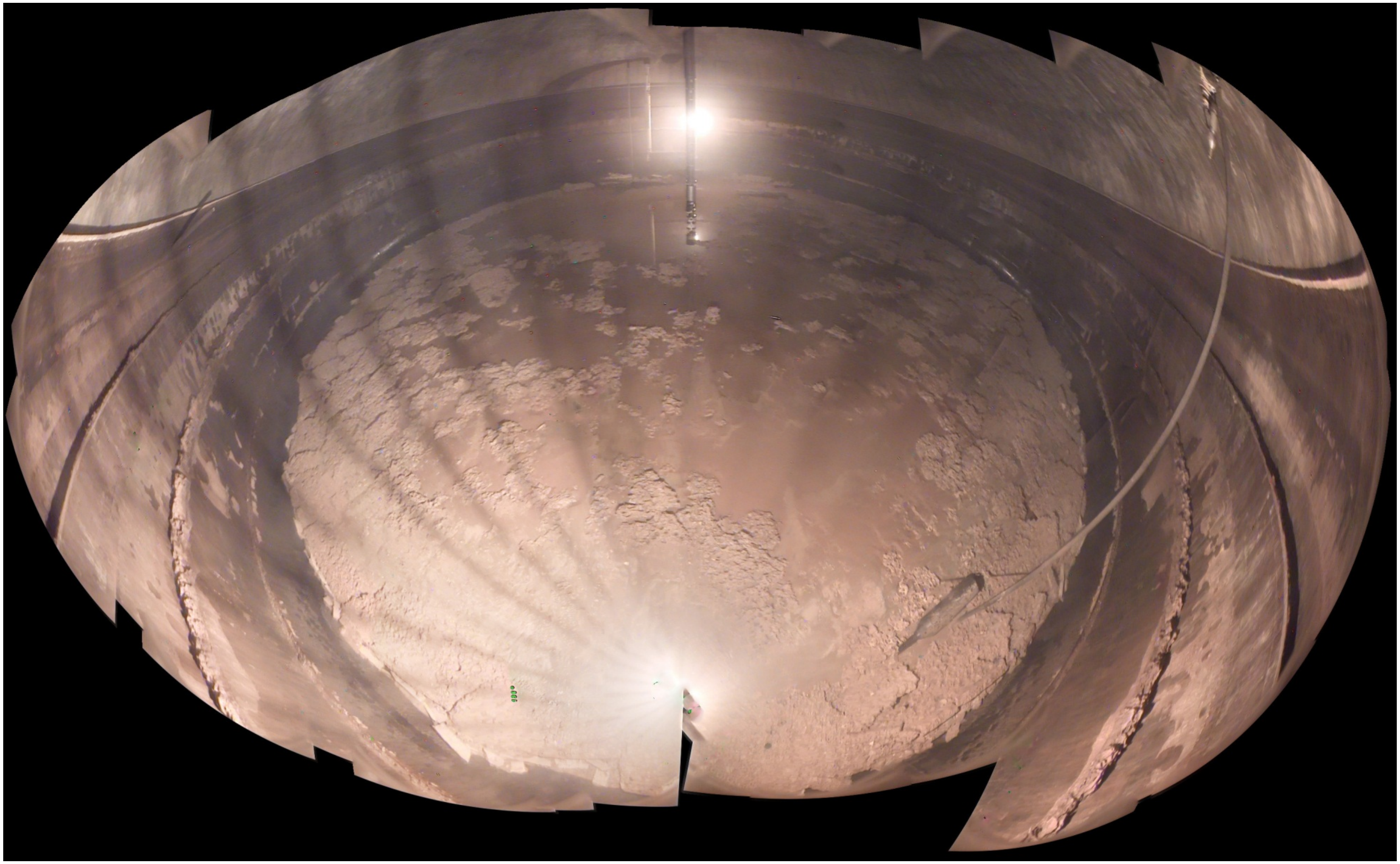


Figure 4-2. Waste Remaining After Retrieval – Waste Pile on Southeast Side.



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5.0 IMPRACTICABILITY OF THIRD RETRIEVAL TECHNOLOGY

5.1 RATIONALE FOR THIRD RETRIEVAL TECHNOLOGY SELECTION

5.1.1 Candidate Retrieval Technologies

The candidate technologies for hard heel waste retrieval were reviewed and documented in RPP-RPT-44139, *Nuclear Waste Tank Retrieval Technology Review and Roadmap*. The lists of potential technologies were developed based on three relevant categories of tanks and waste:

1. Sound tanks vs. assumed leaking tank
2. Tanks with sludge waste vs. saltcake waste
3. Tanks with limited vs. extensive in-tank congestion (e.g., air-lift circulators).

Tank C-112 is designated a sound tank with residual sludge waste and limited in-tank congestion. The first two technologies deployed at tank C-112 were modified sluicing with an ERSS and chemical retrieval (caustic/water dissolution). After modified sluicing alone reached its limit of technology, caustic dissolution was deployed to break up remaining waste to the limits of the technology. This included washing down the tank walls. At that point, caustic/water dissolution also reached its limits of technology. The candidate retrieval technologies for the residual waste retrieval for tank C-112 are shown in Table 5-1. Limitations, capabilities and current availability associated with each technology listed are also shown.

5.1.2 Evaluation of Technologies for Consideration in Tank 241-C-112

Section 4.3 describes the waste remaining in tank C-112 after completion of the modified sluicing and caustic/water dissolution processes. The candidate retrieval technologies identified in Table 5-1 were evaluated for their ability to retrieve the tank C-112 residual waste using a process similar to that used in the selection of the second retrieval technology for deployment in tank C-112 (RPP-PLAN-55462), and taking into account the observed effectiveness of the technologies deployed to date. The evaluation also considered the continued use of the existing ERSS and/or modified sluicing system in combination with a third technology. The candidate technologies were evaluated to determine their potential for success.

The evaluation of a potential third technology considered the category of "chemical retrieval" processes. As noted in the TWRWP (RPP-22393), each chemical retrieval process is defined in the process control plan, based on tank historical data or samples of the waste to be retrieved. Although the caustic/water dissolution process had been deployed to the limit of technology, other chemical retrieval processes were considered for the remaining waste. To be successful, a different chemical retrieval process would need to use chemicals that react with the remaining sand-sized particles so that they dissolve or become suspended in liquid in order to be pumped.

Table 5-1. Candidate Retrieval Technologies for Tank 241-C-112.

Candidate Technology	Limitations/Capabilities	Technology Availability
Chemical retrieval – hot water dissolution	Water dissolution applies when water soluble chemicals exist – limited applicability in removal of additional sludge without use of significant volume of water; would cause major impacts on available tank space	Technology available to deploy; was opportunistically used during the caustic/water operations with limited success.
New Chemical Retrieval Technology: Alternate dissolution media (e.g., acid) modified sluicing – new risers/ additional sluicers	No existing technology – development of a new chemical retrieval method is uncertain, and may involve operational limitations that cannot yet be identified	Technology must be developed and is not readily available to deploy
Enhanced modified sluicing – used with in-tank vehicle such as a FoldTrack®*	Can move loose residuals to central location, may provide additional mechanical breakup of large chunks of waste, deployment riser availability could be a limitation	An updated FoldTrack® has been developed and deployed in tank 241-C-110. Additional units not available at this time and may require development and modification in design to address issues identified during tank C-110 waste retrieval operations. Delaying deployment for 3-5 years.
Enhanced modified sluicing – used with high-pressure water; two ERSS units.	May provide additional breakup of large chunks	High-pressure water has been deployed with the ERSS in tank 241-C-101 and will be deployed in tank C-111. Additional ERSS units will require system design and could take 2-3 years to deploy.
Mobile Arm Retrieval System – sluice mode	Requires a 47-in. central riser for deployment	Being redesigned for 42-in. riser deployment – installation of new risers in a tank is also an option. The only available unit is being used for tank 241-C-107 retrieval and is not designed for use in additional tanks. A Mobile Arm Retrieval System unit is not available at this time and no additional units are in development or being fabricated.
Mobile Arm Retrieval System – vacuum mode	Requires a 47-in. central riser for deployment	Still in the development and testing process. The only available unit will be used in tank 241-C-105 retrieval and it is also not designed for use in additional tanks. A Mobile Arm Retrieval System unit is not available at this time and no additional units are in development or being fabricated.

*The FoldTrack® Mobile Retrieval Tool is manufactured by Non Entry Systems Ltd., UK Patent Application No: 0718573.9.

Chemical Retrieval – Hot Water Dissolution

In tank C-112, the second technology (caustic/water dissolution) used a multi-step process comprised of a caustic soak, hot water dissolution, followed by another caustic strike. In addition, hot water was used during the post-retrieval waste rinses. The post-retrieval rinses that used more than 25,000 gal of water only appeared to reduce the remaining waste volume by ~1,000 gal. The use of additional hot water may enhance solubility of some of the waste components, but is unlikely to retrieve a significant portion of the remaining waste. Based on the limited additional waste recovery with supplemental water additions (including hot water), residual sludge waste does not appear highly soluble in water. Additional sluicing with hot water is unlikely to achieve the goal of less than 360 ft^3 (based on the recovery rates observed during the three hot water washes at the conclusion of the second retrieval technology), and would likely require the use of several hundred thousand gallons of water to get the most out of the waste retrieval effort. The addition of those volumes of water to the DST system would have a major impact on available tank space, as well as significantly increased costs to evaporate the water from the waste. Hot water dissolution is not a viable candidate for a third retrieval technology.

New Chemical Retrieval Technology

A new chemical retrieval technology using alternate dissolution media (such as acid) would need to be developed based on the chemical and physical characteristics of the residual waste. Sampling and analysis of the residual waste would require 9 to 12 months prior to beginning process development. A new chemical retrieval flowsheet would need to be developed, based on samples of the waste residual. Any chemical additions have to be evaluated for impact on waste chemistry (waste compatibility) to ensure that the DST that receives the waste remains within specifications required for tank safety and integrity. Any chemical additions also need to be evaluated for potential impact on the waste treatment plant (WTP). It is not possible to estimate the likelihood of identifying a chemical retrieval process that would be safe and effective for the residual waste in tank C-112. If such a process can be developed, the probable time for development and deployment is three years or more based on projections of timelines required to develop and implement similar technologies in the past.

If a new chemical retrieval technology is developed, it would probably be deployed with a modified sluicing system and/or ERSS. However, given the history of equipment operating life, it is likely that replacement of one or more the ERSS, standard sluicer, slurry pump and/or other system components would be required to deploy the new retrieval technology. A new chemical retrieval technology has the potential to be a viable retrieval technology, but there is a very high uncertainty associated with its development.

Enhanced Modified Sluicing Combined with In-Tank Vehicle

Mechanical waste reduction using Enhanced Modified Sluicing combined with an in-tank vehicle, such as the FoldTrack®[1], was considered. Mechanical forces associated with this combination of technologies have the potential to break up some of the remaining waste chunks. Based on observation of the FoldTrack® performance in tank C-110, breakup of the larger chunks of waste using the FoldTrack® did not lead to the amount of additional waste recovery that would be needed for tank C-112. The mechanical breakup still left the waste particles too large for mobilization with the slurry pump. The sand-sized particles in C-112 would not be further reduced by use of the FoldTrack®. Use of the FoldTrack® system in tank C-110 as a back-stop during sluicing to help keep waste particles suspended in the liquid near the slurry pump intake to facilitate slurry removal did provide some additional recovery. However, using

[1] The FoldTrack® Mobile Retrieval Tool is manufactured by Non Entry Systems Ltd., UK Patent Application No: 0718573.9.

the FoldTrack® as a back-stop to the pump inlet would likely suspend only a small fraction of the smallest remaining particles. Additional mechanical size reduction of the residual waste may not lead to significant additional waste retrieval. Also, deployment of an in-tank vehicle will not have any impact on waste remaining on tank walls and stiffener rings.

Based on lessons learned from the deployment of the FoldTrack® in tank C-110, a number of design changes are required to improve FoldTrack® operation; such as managing the connecting control hose. The hose formed pools and pockets of waste and on many occations constrained FoldTrack® movement. Furthermore, the original FoldTrack® design is no longer available; the design is proprietary and the previous manufacturer is no longer operating. It is estimated that three to five years would be required to develop, demonstrate, design and construct a system for tank C-112. It is not viable to use an in-tank vehicle, such as the FoldTrack®, because of the low probability for success in retrieving additional waste.

Enhanced Modified Sluicing Combined with High-Pressure Water

Mechanical waste reduction using high-pressure water deployed by the ERSS system was considered. High-pressure water was deployed with the ERSS in tank C-101, where it was effective in reducing large areas of solids to smaller chunks of waste. However, the chunks could not be reduced to the point where the waste particles were small enough to be mobilized with the slurry pump. Attempts were made to spray the tank walls and stiffener rings with high-pressure water in tank C-101. The liquid was able to reach the waste on the walls and stiffener rings, but no measurable reduction was observed.

It may be possible to deploy high-pressure water with the installed ERSS in tank C-112. However, damage incurred during operation of the second retrieval technology may require that the ERSS be replaced before high-pressure water could be deployed. Replacement of one or both of the currently installed sluicing systems in tank C-112 would take two to three years. Given the low probability for success in retrieving additional waste, use of high-pressure water is not viable.

Mobile Arm Retrieval System

It is not clear that a mobile arm retrieval system would provide much more retrieval capability than the ERSS and caustic retrieval that were already deployed in tank C-112. The mobile arm retrieval system (both the vacuum system and the high-pressure water) would reach more areas of the wall and stiffener rings. However, the ERSS and caustic dissolution had little success retrieving waste from those areas, even when the nozzle was close to the waste surface (in some cases chunks of waste were removed from the stiffener ring to be deposited in their entirety on the tank floor). Deployment of a mobile arm system requires a central 47-in. riser. Installation of a central 47-in. riser requires cutting a hole in the concrete dome of the tank. This activity requires ~12 months of design and field work, and by its nature results in significant worker dose. The deployment of this technology would greatly extend the duration of the retrieval process, without any anticipated increase in retrieval yield. Thus, it was not considered viable.

Conclusion of Technology Evaluation

None of the existing retrieval technologies is a viable candidate as an immediately available third technology in tank C-112. None of the existing retrieval technologies have a reasonable expectation of successful retrieval of much additional waste. The use of a new chemical retrieval using another chemical agent is the most viable choice for a third retrieval technology. However, the time frame of such a development and the actual effectiveness of such a chemical process is uncertain. Further discussion of the viability of chemical retrieval technologies is provided in Sections 5.2, 5.3, and 5.4.

5.2 PROCESS DESCRIPTION OVERVIEW FOR CANDIDATE TECHNOLOGY

Given the factors considered in Section 5.1, chemical retrieval using another chemical agent is the most viable choice for a third retrieval technology.

Chemical retrieval methods generally involve the batch additions of a chemical solution into the tank. The residual waste in tank C-112 likely contains high concentration of insoluble compounds needing to be identified by residual waste sampling. Chemical dissolution systems add concentrated chemical solutions to the tank to modify the insoluble chemical compounds. The reactions will likely occur slowly and may take time to reach equilibrium with the waste. The resultant solubilized waste will dilute in water and in dilute caustic solutions.

Retrieval through chemical dissolution uses the following process:

- Add chemical solution to the tank
- Mix the waste and chemical solution, usually through recirculation of the chemical solution
- Wait for the combined waste and chemical solution to fully react, to be determined during chemical process development testing
- Retrieve the solution with conventional slurry pumping or an alternate pump system suitable for removal of liquid volumes.

Infrastructure requirements for any chemical addition system include a chemical receipt and delivery system, a drop leg (in a riser) for initial addition of the chemical into the tank, one or more sluicers to circulate the solution for purposes of contacting all waste surfaces (the existing ERSS and slurry pump can provide this function), a waste transfer pump to transfer the waste solution/dissolved waste to the DST system, and a flow meter inside a containment box to monitor pump flow rates and protect the slurry pump from damage. All these required systems are already in place in the modified sluicing system in tank C-112, but equipment will likely need replacement by the time a process is developed. Additional infrastructure requirements for chemical addition are minimal.

5.3 PERFORMANCE ASSUMPTIONS

A -new chemical retrieval technology was identified as the only approach with the potential to break up the consolidated waste piles and reduce large chunks to finer material that could be mobilized or dissolved and retrieved. The chemicals would need to react with the sand-sized particles so that they dissolve or become suspended in liquid in order to be pumped. The effectiveness of the chemical retrieval process is uncertain and it is not possible to predict the actual effectiveness of such a process without further characterization of the waste. For purposes of this evaluation, it is assumed that chemical retrieval could used to mobilize and remove between as little as 0 and as much as 100% of the waste piles, chunks and fines remaining on the tank floor. The distributon of final liquid pool near the central pump pit is a function of the pump intake configuration, so additional reduction of this pool is unlikely.

Tank C-112 caustic/water dissolution experience has shown little success with reducing the material left on the tank walls and stiffener rings. For purposes of this evaluation, it is assumed that dissolution new chemical retrieval process in tank C-112 could remove up to 50% of the remaining waste on the tank walls and stiffener rings.

The estimated total residual volume at the end of the second retrieval technology deployment was ~12,700 gal (1,700 ft^3) per RPP-CALC-56856, comprised of ~320 gal (~43 ft^3) associated with the waste adhering to the wall and stiffener rings and the remaining waste at the bottom of the tank. The estimate of the waste volume was based on video observations and liquid displacement measurements taken during the transfer of liquid from tank C-112 to tank AN-101.

Table 5-2 estimates the potential range of waste retrieval that could be achieved using a new chemical retrieval process, based on the waste location (most of the waste is on the south side of the tank). The waste on the bottom of the tank includes a pool of liquid that is below the intake for the slurry pump, and thus may not be retrievable by any method.

Table 5-2. Potential Waste Removal Using Chemical Retrieval, Based on Waste Location and Configuration.

Waste Location and Configuration	Estimated Residual	Potential to Remove	Estimated Range of Volume to Remove	Estimated Range of Final Residual Volume
Waste on the Bottom of Tank	12,400 gal	0 – 100%	0 – 12,400 gal	0 – 12,400 gal
Tank Walls and Stiffener Rings	320 gal	0 – 50%	0 – 160 gal	160 – 320 gal
Estimated Total	12,700 gal (1,700 ft^3)		0 – 12,560 gal (0 – 1,680 ft^3)	160 – 12,560 Total gal (43 – 1,680 ft^3)

Deployment of a new chemical retrieval process in combination with the existing ERSS or standard sluicer may not remove any of the residual waste. In the best case, it may have the potential to remove up to 12,560 gal or 1,680 ft^3 of waste from the tank, leaving as little as ~160 gal or ~43 ft^3 of waste behind based on the waste location. This best case estimate does not include the remaining liquid pool that is below the slurry pump intake.

5.4 ESTIMATED VOLUME AND INVENTORY REDUCTION

For purposes of this Practicability Evaluation Request, Ecology and DOE-ORP have agreed that risk reduction would be evaluated by the reduction of inventories for certain key constituents of concern (COCs).[2] The key selected COCs identified in those discussions for the groundwater pathway were ^{99}Tc, total uranium, actinides, chromium, nitrates, and nitrites. Key COCs identified in those discussions for the direct contact pathway were ^{90}Sr, ^{137}Cs, and actinides. Hazardous components listed (chromium, nitrates, and nitrites) are regulated by Ecology under the *Resource Conservation and Recovery Act of 1976* (RCRA),[3] and the radionuclides (total uranium, ^{99}Tc, ^{90}Sr, ^{137}Cs, and actinides) are regulated by DOE under its authority under the *Atomic Energy Act of 1954*, as amended. For completeness, this Practicability Evaluation Request addresses both hazardous components and radionuclides[4].

The agreed-to list of COCs was evaluated to determine what inventory reduction could be achieved by deployment of a third technology. The actual volume that could be retrieved by a third technology is not known. Therefore, for purposes of further evaluation, calculations are performed to determine the potential inventory reduction if 10,000 gal (~1,340 ft^3) of waste is removed, bringing the residual total to less than 360 ft^3.

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[2] See EDMC 1213413, *Meeting Notes: Risk Reduction for Retrieval Completion Certification per the Consent Decree* (December 20, 2011).

[3] The Environmental Protection Agency has authorized the State of Washington to enforce its Hazardous Waste Management Act (*Revised Code of Washington* [RCW] 70.105, "Hazardous Waste Management"), as implemented by *Washington Administrative Code* 173-303, "Dangerous Waste Regulations," in lieu of the Federal RCRA program. Citation omitted.

[4] The DOE's inclusion of information about radionuclides in this evaluation is for informational purposes only and not for the purposes of regulation, and does not confer regulatory authority to Ecology under RCRA or RCW 70.105 over radionuclides regulated under the *Atomic Energy Act of 1954*.

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6.0 EVALUATION OF PRACTICABILITY

6.1 EVALUATION OF INVENTORY AND IMPACT REDUCTION

The COCs included in this Practicability Evaluation Request can be divided into two groups. The first group contains constituents that could impact groundwater, while the second group contains radionuclides that if brought to the surface could provide significant radiological dose to the individuals that brought them to the surface. Previous analyses for tank residuals (retrieval data reports for tanks C-103 (RPP-RPT-33060, *Retrieval Data Report for Single-Shell Tank 241-C-103*), 241-C-104 (C-104) (RPP-RPT-54072, *Retrieval Data Report for Single-Shell Tank 241-C-104*), 241-C-106 (C-106) (RPP-20577, *Stage II Retrieval Data Report for Single-Shell Tank 241-C-106* and RPP-20110, *Stage I Retrieval Data Report for Single-Shell Tank 241-C-106*), and 241-C-108 (C-108) (RPP-RPT-55896, *Retrieval Data Report for Single-Shell Tank 241-C-108*), and the 241-C-200 tanks (RPP-RPT-30181, *Retrieval Data Report for Single-Shell Tank 241-C-201*; RPP-RPT-29095, *Retrieval Data Report for Single-Shell Tank 241-C-202*; RPP-RPT-26475, *Retrieval Data Report for Single-Shell Tank 241-C-203*; and RPP-RPT-34062, *Retrieval Data Report for Single-Shell Tank 241-C-204*) have shown these to be nitrate, nitrite, chromium (regulated under *Washington Administrative Code* [WAC] 173-303, "Dangerous Waste Regulations"), ^{99}Tc, and uranium (regulated under the *Atomic Energy Act of 1954*) for the groundwater group; and ^{90}Sr, ^{137}Cs, and the actinides for radiological dose, all of which are regulated under the *Atomic Energy Act of 1954*.

In addition to the analyses in the retrieval data reports, RPP-RPT-42294, *Hanford Waste Management Area C Soil Contamination Inventory Estimates* (Appendix D, p. D-1/D-2) compared the concentration of non-radiological contaminants found in tank residuals against concentration levels of COCs in soil derived from the methodology given in WAC 173-340, "Model Toxics Control Act – Cleanup," section 173-340-747, "Deriving Soil Concentrations for Groundwater Protection." The comparison given in RPP-RPT-42294 has also shown that uranium, nitrite, chromium (conservatively assumed to be hexavalent) and nitrate could potentially adversely impact groundwater.

6.1.1 Basis for Inventory Reduction Estimate

The estimated inventory of waste in tank C-112 before retrieval was 104,000 gal according to RPP-RPT-43039. The 104,000-gal initial volume estimate assumed that the waste surface within tank C-112 was a flat surface with a level equal to the manual tape measurement.

During waste retrieval, different chemical constituents are removed at different rates depending on their physical and chemical form and solubility. The HTWOS models the expected waste retrieval using "wash factors" to account for the differences in physical and chemical form, and solubility. The WMA C performance assessment will use HTWOS inventories scaled to the volume of waste remaining in an unretrieved tank. As such, the HTWOS model provides a rigorous approach to estimate residual inventories compared to estimates based on simple percentage and differentiates between soluble and insoluble constituents. The HTWOS was used to estimate the inventory of COCs expected to remain in tank C-112 if the tank were retrieved to

360 ft^3. This inventory estimate for a volume of 360 ft^3 is scaled linearly to estimate the current inventory (at 1,700 ft^3) and the inventory that would be removed if a third technology retrieved an additional 1,340 ft^3. Table 6-1 shows the starting inventory, the inventory estimated by HTWOS for a final volume of 360 ft^3, and the current estimated inventory.

Table 6-1. Volume/Inventory of Constituents of Concern Remaining in Tank 241-C-112 at the End of Each Retrieval Technology.

Parameter	Units	Inventory at Start of Retrieval	Inventory after Two Retrieval Technology	Estimated Inventory that May Be Removed Using a Third Technology	Estimated Inventory after Third Technology
		Best-Basis Inventory[1]	Linear Extrapolation[2]		HTWOS Inventory
Volume	ft^3	13,903	1,700	1,340	360
Volume	gal	104,000	12,700	10,000	2,693
Contaminants Related to Groundwater Regulated under *Resource Conservation and Recovery Act of 1976*					
Chromium	kg	187	8.7	6.8	1.84
Nitrate	kg	42,000	1,156	911	245
Nitrite	kg	24,600	821	647	174
Contaminants Related to Groundwater Regulated under *Atomic Energy Act of 1954*					
Uranium	kg	20,800	3,167	2,496	671
Tc-99	Ci	54.2	3.4	2.7	0.72
Contaminants Related to Radiological Dose Regulated under *Atomic Energy Act of 1954*					
Sr-90	Ci	468,000	81,411	64,163	17,248
Cs-137	Ci	208,000	31,010	24,440	6,570
Actinides	Ci	533	80	63	17

HTWOS = Hanford Tank Waste Operations Simulator

[1] Initial Best-Basis Inventory based on RPP-RPT-43039, *2009 Auto-TCR for Tank 241-C-112*; April 1, 2004.
[2] Ratio from HTWOS Inventory.

6.1.2 Inventory Removed following Deployment of Retrieval Technologies at Tank 241-C-112

Table 6-1 provides the estimated volumes/inventories (all radionuclides have been decayed to January 1, 2008) remaining in tank C-112 for the following: 1) prior to retrieval operation, 2) after first and second retrieval technologies and 3) with an assumption that the third technology would reduce the volume to 360 ft^3. The basis for inventory estimates, given in Table 6-1, is as follows.

- **Inventory at Start of Retrieval:** RPP-RPT-43039 provides the BBI.

- **Inventory after Two Retrieval Technology:** The HTWOS output for a volume of 360 ft^3 was extrapolated linearly to a volume of 1,700 ft^3.

- **Estimated Inventory that May Be Removed Using a Third Technology:** The difference between the HTWOS output at 360 ft^3 and the linear extrapolation of 1,700 ft^3 was calculated. This approach simply assumes that a third technology would retrieve the waste to the Consent Decree goal of 360 ft^3.

- **Estimated Inventory after Third Technology:** All COCs are calculated using the HTWOS model output for a volume of 360 ft^3.

Table 6-1 and Figure 6-1 provide the volume/inventory of constituents remaining in the tank after the deployment of the first and second retrieval technologies. Deploying a third retrieval technology would reduce the inventory of these analytes by a small fraction of what has already been retrieved during the modified sluicing and caustic dissolution waste removal actions.

6.1.3 Comparison of Residual Waste after First and Second Retrieval Technology against Previously Retrieved Waste Management Area C Tanks

To date in the Waste Management Area (WMA) C, six 100-series tanks (C-101, C-103, C-104, C-106, C-108 and 241-C-109) and all four 200-series tanks have been retrieved. Tanks C-101, C-106, and C-108 did not meet the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989) retrieval goal of 360 ft^3, while tanks C-103, C-104, and 241-C-109 bettered the HFFACO goal. All of the 200-series tanks met the HFFACO goal of 30 ft^3. The waste inventory was obtained from the associated tank BBI estimate (Tank Waste Information Network System [TWINS], Queried 09/09/2013, [Best-Basis Inventory, Best-Basis Calculation Detail], http://twins.pnl.gov/twinsdata/forms/datamenu.htm).

Table 6-2a compares the amount of inventory remaining in tank C-112 after modified sluicing and caustic dissolution against the maximum inventory found in the other retrieved tanks in WMA C. Table 6-2b compares the amount of inventory remaining in tank C-112 after modified sluicing and caustic dissolution against the sum of the inventory of each constituent for other retrieved tanks.

6.1.4 Comparison of Third Technology against Previously Retrieved Waste Management Area C Tanks

Table 6-3a compares the amount of inventory removed to reach the Consent Decree goal of 360 ft^3 using a third technology in tank C-112 against the maximum inventory found in the other retrieved tanks in WMA C, while Table 6-3b compares the amount of inventory assumed to be removed using a third technology to reach 360 ft^3 against the sum of the inventory of each constituent for all other retrieved tanks. These comparisons assume that the deployment of the third technology will reach the retrieval goal of 360 ft^3.

Figure 6-1. Bar Charts Showing Volume and Inventory for Constituents of Concern Remaining in the Tank after the Deployment of Each Retrieval Technology.

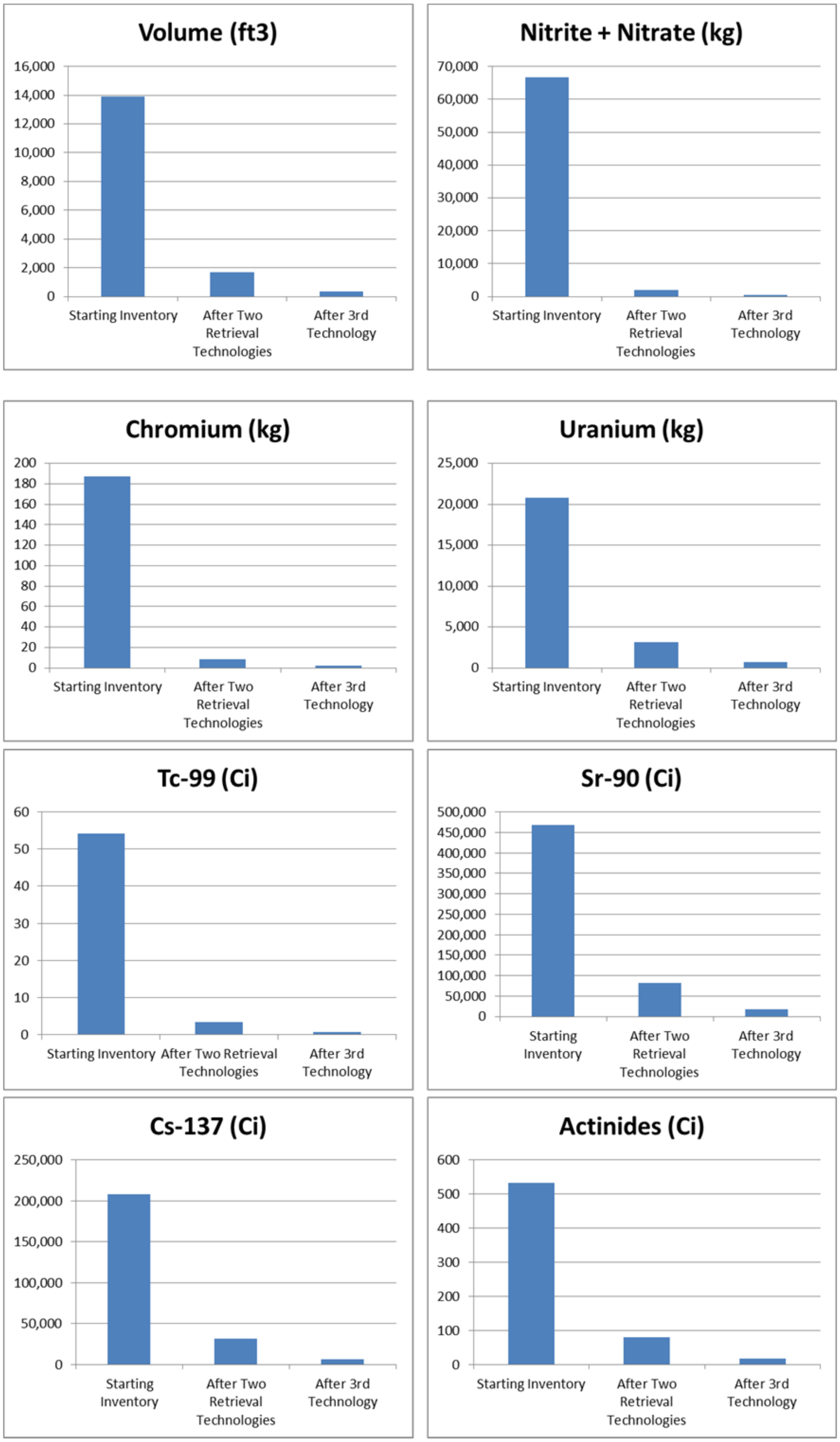

Table 6-2a. Comparison of Tank 241-C-112 Residual Volume and Inventory after Two Retrieval Technologies against Maximum Volume and Residual Inventories Found in Waste Management Area C Retrieved Tanks.

Para-meter	Units	C-112* after Two Retrie-val Techno-logies	Max. of Tanks C-108, C-106, C-103, C-200s	
			Max of WMA C Residual Inventory	After Two Retrieval Technologies / Max Inv. × 100 (%)
Contaminants Related to Groundwater Impacts				
Volume	ft^3	1,700	660	258%
Regulated under RCRA				
Chromium	kg	8.7	12	73%
Nitrate	kg	1,156	180	642%
Nitrite	kg	821	78	1,053%
Regulated under *Atomic Energy Act of 1954*				
Uranium	kg	3,167	330	960%
Tc-99	Ci	3.4	0.17	2,000%
Contaminants Related to Radiological Dose				
Sr-90	Ci	81,411	60,000	136%
Cs-137	Ci	31,010	1,300	2,385%
Actinides	Ci	80	120	67%

Table 6-2b. Comparison of Tank 241-C-112 Residual Volume and Inventory after Two Retrieval Technologies against Sum of Volume and Residual Inventories for Waste Management Area C Retrieved Tanks.

Para-meter	Units	C-112* after Two Retrieval Techno-logies	Sum of Tanks C-108 + C-106 + C-103 + C-200s	
			Sum of WMA C Residual Inventory	After Two Retrieval Technologies / Residual Inv. × 100 (%)
Contaminants Related to Groundwater Impacts				
Volume	ft^3	1,700	1,440	118%
Regulated under RCRA				
Chromium	kg	8.7	33.8	26%
Nitrate	kg	1,156	222	521%
Nitrite	kg	821	122	673%
Regulated under *Atomic Energy Act of 1954*				
Uranium	kg	3,167	850	373%
Tc-99	Ci	3.4	0.229	1,485%
Contaminants Related to Radiological Dose				
Sr-90	Ci	81,411	75,700	108%
Cs-137	Ci	31,010	2,340	1,325%
Actinides	Ci	80	211	38%

* RPP-RPT-43039, *2009 Auto-TCR for Tank 241-C-112*.

RCRA = *Resource Conservation and Recovery Act of 1976*

WMA = Waste Management Area

Following Table 6-3a-b is Figure 6-2, which is a series of bar charts showing a comparison of the maximum found between each tank, the sum of what is currently left behind in the retrieved tanks, and what could be removed if a third technology could reduce the volume to 360 ft^3. Figure 6-2 clearly shows that the third technology would substantially further reduce the inventory of residual waste. Note that the expected inventory values in tank residuals come from ORP-11242, *River Protection Project System Plan* (a HFFACO primary document under Milestone M-062-40). It must be added that these inventory numbers are based on bounding volumes and compositions, and actuals are likely to be significantly less than those presented herein. Furthermore, the percentage removed when compared against the sum of residuals for all retrieved tanks will continue to become smaller as more tanks are retrieved.

Table 6-3a. Comparison of Volume and Inventory Potentially Removed by Third Technology against Maximum Volume and Inventory for Waste Management Area C Retrieved Tanks.

Parameter	Units	Removed by 3rd Tech.*	Maximum of Tanks C-108, C-106, C-103, and C-200s: Max of WMA C Residual Inventory	After 3rd Tech / Max Inv. × 100 (%)
Contaminants Related to Groundwater Impacts				
Volume	ft^3	1,340	660	203%
Regulated under RCRA				
Chromium	kg	6.8	12	57%
Nitrate	kg	911	180	506%
Nitrite	kg	647	78	830%
Regulated under *Atomic Energy Act of 1954*				
Uranium	kg	2,496	330	756%
Tc-99	Ci	2.7	0.17	1,576%
Contaminants Related to Radiological Dose				
Sr-90	Ci	64,163	60,000	107%
Cs-137	Ci	24,440	1,300	1,880%
Actinides	Ci	63	120	53%

Table 6-3b. Comparison of Volume and Inventory Potentially Removed by Third Technology against Sum of Residual Volumes and Inventory for Waste Management Area C Retrieved Tanks.

Parameter	Units	Removed by 3rd Tech.*	Sum of Tanks C-108, C-106, C-103, and C-200s: Sum of WMA C Residual Inventory	After 3rd Tech / Residual Inv. × 100 (%)
Contaminants Related to Groundwater Impacts				
Volume	ft^3	1,340	1,440	93%
Regulated under RCRA				
Chromium	kg	6.8	33.8	20%
Nitrate	kg	911	222	411%
Nitrite	kg	647	122	531%
Regulated under *Atomic Energy Act of 1954*				
Uranium	kg	2,496	850	294%
Tc-99	Ci	2.7	0.229	1,170%
Contaminants Related to Radiological Dose				
Sr-90	Ci	64,163	75,700	85%
Cs-137	Ci	24,440	2,340	1,044%
Actinides	Ci	63	211	30%

* All constituents of concern used a linear extrapolation based on volume reduction.

RCRA = *Resource Conservation and Recovery Act of 1976* WMA = Waste Management Area

6.1.5 Facilitating Waste Management Area C Closure

To understand the relative impact of using a third technology to meet the Consent Decree goal of 360 ft^3 on closure, Table 6-4 provides a comparison between the inventory of COCs that might be removed by a third technology in tank C-112 and the inventory that is expected to be left in all WMA C tanks at closure (expected inventory values in tank residuals come from ORP-11242). The inventory values for WMA C (C Farm) in that document were decayed to January 1, 2043.

Figure 6-2. Charts Showing Volume and Inventory of Constituents of Concern Potentially Removed for the Third Technology Compared against the Maximum of the Sum of the Volume and Inventory of Constituents of Concern Remaining in the Waste Management Area C Retrieved Tanks.

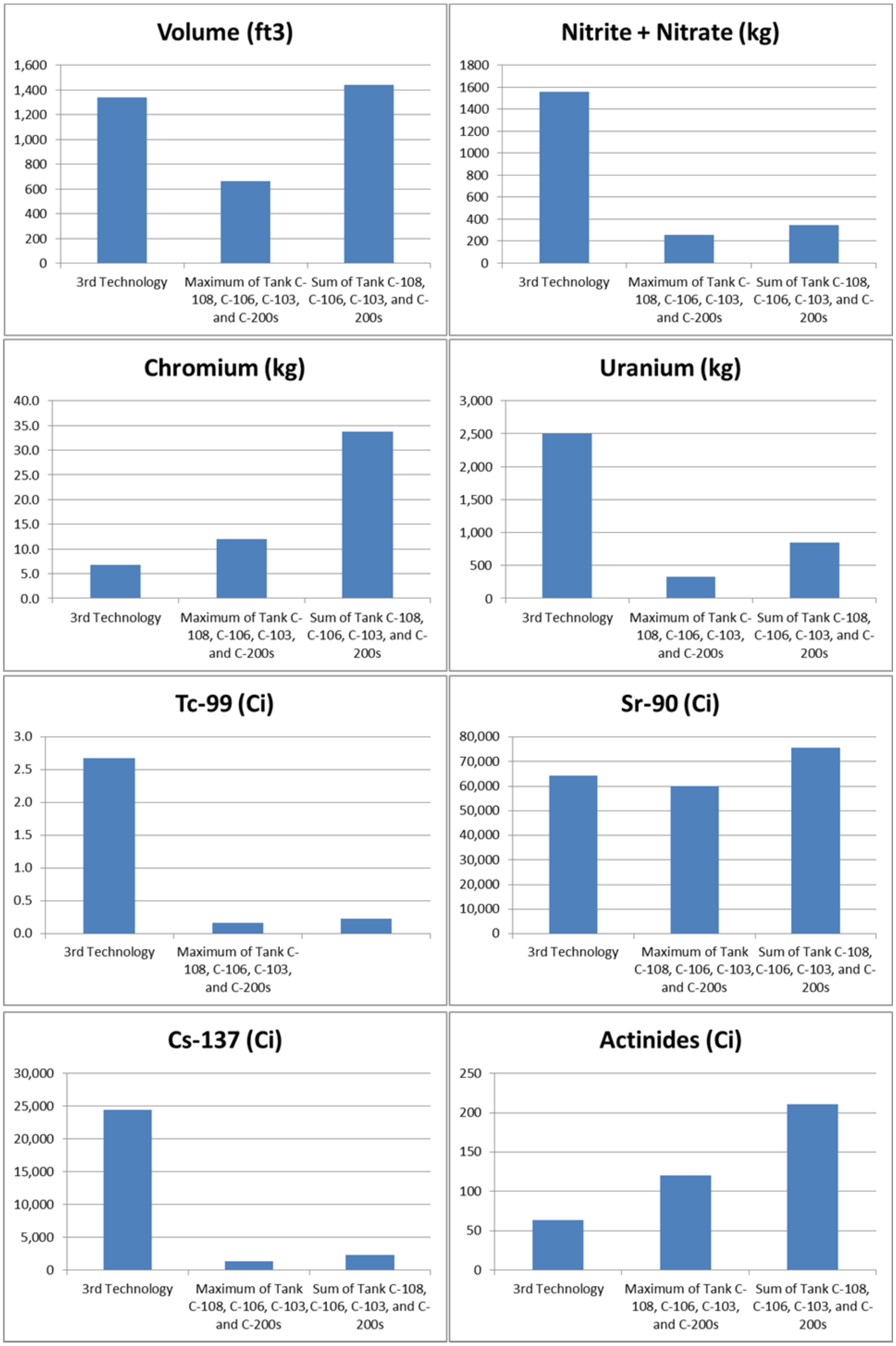

Table 6-4. Residual Volume/Material Removed Per Retrieval Technology.

Parameter	Units	241-C-112 3rd Technology Removes (at 360 ft^3)*	All 241-C Farm Tanks Residual Inventory at Closure	
			Inventory	3rd Techology Potential Removed Inventory/ 241-C Farm Tank Residual Inventory × 100 (%)
Contaminants Related to Groundwater Impacts Regulated under *Resource Conservation and Recovery Act of 1976*				
Chromium	kg	6.8	160	4.3%
Nitrate	kg	911	2,200	41%
Nitrite	kg	647	130	498%
Contaminants Related to Groundwater Impacts Regulated under *Atomic Energy Act of 1954*				
Uranium	kg	2,496	5,700	44%
Tc-99	Ci	2.7	2.4	113%
Contaminants Related to Radiological Dose Regulated under *Atomic Energy Act of 1954*				
Sr-90	Ci	64,163	280,000	23%
Cs-137	Ci	24,440	25,000	98%
Actinides	Ci	63	1,400	4.5%

* The inventory removed by the third technology was estimated by linear extrapolation based on volume using Hanford Tank Waste Operations Simulator inventory.

For the majority of the COCs, the amount of their inventory that might be removed from the successful deployment of a third technology is a significant fraction of the total projected inventory at closure, recognizing that the BBI inventory used in the determination is an engineered estimate. This may lead to the conclusion that the deployment of a third technology could remove these contaminants and substantially improve the resulting impact of WMA C after closure. However, the calculations shown in Table 6-4 assume that a third retrieval technology reduces the tank C-112 waste residual volume to not more than 360 ft^3. As discussed in Section 5, there is no candidate retrieval technology likely to achieve that target. The contaminants that have higher projected inventory at closure are nitrite, ^{99}Tc, and uranium. The potential future impacts of these contaminants are discussed below.

6.1.6 Potential Future Impact of Residual Waste – Groundwater Impacts

For comparison purposes, an estimate of the potential future impact of the contaminants related to radiological dose regulated under the *Atomic Energy Act of 1954* (uranium, ^{99}Tc, ^{90}Sr, ^{137}Cs and actinides) was generated.

The potential impacts to human health posed by the residual waste in tank C-112 were evaluated using the methodology documented in DOE/ORP-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*. The SST performance assessment methodology represents the current approach being used to support the assessment of long-term impacts to human health from tank residuals.

The impacts from existing residual wastes considering COCs for the groundwater pathway were evaluated with a variety of performance metrics. The concentration of COCs at the WMA C fenceline is the maximum modeled concentration for a constituent, and this concentration was estimated using cross-sectional modeling of vadose zone and groundwater flow and transport. For example, the concentration at the fenceline for ^{99}Tc for the existing inventory estimate is estimated at ~14 pCi/L. The ^{99}Tc concentration level that is equivalent to the 4 mrem/year drinking water standard is 900 pCi/L.

Table 6-5 shows estimated WMA C fenceline concentrations ^{99}Tc and ^{14}C inventories, Federal maximum concentration levels, incremental lifetime cancer risk, and the drinking water dose associated with residual waste left after the use of the second retrieval technology (1,700 ft^3) and the hypothetical third technology (360 ft^3). The groundwater incremental lifetime cancer risks and radiological dose for drinking water are evaluated for radiological analytes using the residual waste inventories and exposure scenarios. Estimated concentration levels for the selected analytes showed that the impact estimated for residual waste left in tank C-112 are one to four orders of magnitude below the performance objectives identified for the groundwater pathway.

Table 6-6 shows estimated nitrate and nitrite inventory, fenceline concentrations, Federal maximum concentration levels, and hazard quotients associated with residual waste left after the use of the second retrieval technology and the hypothetical third technology. Estimated residual inventories were linearly extrapolated based on HTWOS inventory.

Owing to its affinity to be sorbed on Hanford sediments, uranium in residual inventory from tank C-112 does not arrive in groundwater at the WMA C fenceline within the period of analysis, 10,000 years.

After the second retrieval technology, estimated residual waste concentrations for nitrate and nitrate are three to four orders of magnitude below the performance objective of 1.0. The hypothetical third technology estimated residual waste concentrations for nitrate and nitrate to be three and four orders of magnitude below their respective maximum concentration levels, and estimated hazard three to five orders of magnitude below the performance objective of 1.0.

6.1.7 Potential Future Impact of Residual Waste – Inadvertent Intruder Impact

The evaluation of potential future impacts of residual wastes that was considered in this practicability study was the inadvertent intruder dose for the suburban gardener scenario. This scenario was selected for two reasons:

1) Of all evaluated inadvertent intruder scenarios, this scenario produced the highest future exposure, and thus can be considered a worst-case scenario

2) This scenario did not require modeling of contaminant movement through the soil, and therefore has fewer sources of uncertainty than other scenarios.

Table 6-5. Estimated Incremental Lifetime Cancer Risk and Groundwater Concentrations at Peak Year for Technetium-99 and Carbon-14 to Residual Inventories in Single-Shell Tank 241-C-112 Based on Hanford Tank Waste Operations Simulator Inventory.

Analyte	Inventory (Ci)	Waste Management Area C Fenceline Concentration (pCi/L)[a]	Federal Maximum Concentration Level (pCi/L)	Groundwater Incremental Lifetime Cancer Risk[b]		Radiological Dose - Beta/Photon (mrem/yr) Drinking Water Only Scenario[b]
				Industrial	Residential	
After Second Retrieval Technology (1,700 cubic feet)						
C-14	1.08E-01	1.67E-01	2,000	1.29E-09	9.35E-09	3.33E-04
Tc-99	3.41E+00	1.36E+01	900	1.88E-07	4.57E-06	6.06E-02
Hanford Tank Waste Operations Simulator Inventory (360 cubic feet)						
C-14	2.29E-02	3.53E-02	2,000	2.74E-10	1.98E-09	7.06E-05
Tc-99	7.23E-01	2.89E+00	900	3.98E-08	9.69E-07	1.28E-02
Removed by Third Technology (estimated 1,340 cubic feet)						
C-14	8.52E-02	1.31E-01	2,000	1.02E-09	7.37E-09	2.63E-04
Tc-99	2.69E+00	1.07E+01	900	1.48E-07	3.60E-06	4.77E-02
Performance Objective[c]				**1-0E-6 to 1.0E-4[d]**	**1-0E-6 to 1.0E-4[d]**	**4[e]**

[a] Based on the Hanford Tank Waste Operations Simulator inventory, the simulation estimates that peak concentrations for ^{14}C and ^{99}Tc will arrive at the Waste Management Area C fenceline at year 9,781 and 10,481, respectively.

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

[c] Performance objectives apply to all contaminants for the entire waste management area.

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

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

The suburban gardener exposure scenario for the Hanford Site assumes that a well is drilled through the tank at a future date, bringing drill cuttings containing contaminated material to the surface. The drill cuttings are distributed on the soil surface, thereby allowing an individual living at the site to become chronically exposed over a lifetime. The exposure routes into the individual include ingestion, dust inhalation, external radiation, and produce from a garden containing the drill cuttings. The produce from the garden accounts for 25% of the individual's total produce consumption. This exposure scenario is described in HNF-SD-WM-TI-707, *Exposure Scenarios and Unit Factors for the Hanford Tank Waste Performance Assessment*.

Table 6-7 shows the estimated dose that would be expected from the residual waste prior to retrieval, after two retrieval technologies, and at the Consent Decree (360 ft^3), and the reduction in dose that would be anticipated if a third technology reduced the residual volume to 360 ft^3.

Dose for residuals is estimated between the assumed end of the 100-year institutional control period and 1,000 years post-closure.

Table 6-6. Hazard Quotient and Groundwater Concentrations at Peak Year for Nitrate and Nitrite Related to Residual Inventories in Single-Shell Tank 241-C-112 Based on Hanford Tank Waste Operations Simulator Inventory.

Analyte	Inventory (kg)	Waste Management Area C Fenceline Concentration (µg/L)[a]	Federal Maximum Concentration Level (µg/L)	Hazard Quotient	
				WAC 173-340 Groundwater Method B[b]	WAC 173-340 Groundwater Method C[b]
After Second Retrieval Technology (1,700 cubic feet)					
Nitrate	1.16E+03	4.75E+00	45,000	1.85E-04	8.48E-05
Nitrite	8.21E+02	3.37E+00	3,300	2.11E-03	9.63E-04
Hanford Tank Waste Operations Simulator Inventory (360 cubic feet)					
Nitrate	2.45E+02	1.01E+00	45,000	3.93E-05	1.80E-05
Nitrite	1.74E+02	7.14E-01	3,300	4.46E-04	2.04E-04
Removed by Third Technology (estimated 1,340 cubic feet)					
Nitrate	9.11E+02	3.74E+00	45,000	1.46E-04	6.68E-05
Nitrite	6.47E+02	2.66E+00	3,300	1.66E-03	7.59E-04
Performance Objective				**1.0[c]**	**1.0[c]**

Reference: *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup."

[a] Based on the Hanford Tank Waste Operations Simulator inventory, the simulation estimates that peak concentrations for nitrate and nitrite will arrive at the Waste Management Area C fenceline at year 10481.

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

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

After two retrieval technologies, a maximum exposure dose of 7,620 mrem/year is estimated 100 years post-closure. At the Consent Decree volume (360 ft^3), a maximum exposure dose of 1,610 mrem/year is estimated 100 years post-closure. An estimated reduction in dose of 6,000 mrem/year is anticipated if a third technology was used. The maximum dose after two retrieval technologies, at 360 ft^3, and the dose reduction anticipated by a third technology is estimated to decrease below the 100 mrem/year performance objective for chronic intruder exposure between 200 and 300 years post-closure.

Table 6-7. Potential Future Impact of Residual Waste in Tank 241-C-112.

Inadvertent Intruder Dose[1] (mrem/year) for the Suburban Gardener

Years After Closure:	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**
Calendar Year:	**2132**	**2232**	**2332**	**2432**	**2532**	**2632**	**2732**	**2832**	**2932**	**3032**
Prior to Retrieval (13,903 ft^3)	6.23E+04[2]	5.54E+03	6.28E+02	1.87E+02	1.36E+02	1.20E+02	1.09E+02	9.96E+01	9.18E+01	8.50E+01
After two retrieval technologies (1,700 ft^3)	7.62E+03	6.78E+02	7.68E+01	2.29E+01	1.66E+01	1.47E+01	1.33E+01	1.22E+01	1.12E+01	1.04E+01
Consent Decree[3] Goal (360 ft^3)	1.61E+03	1.44E+02	1.63E+01	4.85E+00	3.52E+00	3.11E+00	2.82E+00	2.58E+00	2.38E+00	2.20E+00
Removed by Third Technology[4] (estimated 1,340 ft^3)	6.00E+03	5.34E+02	6.06E+01	1.81E+01	1.31E+01	1.16E+01	1.05E+01	9.60E+00	8.84E+00	8.20E+00

[1] Performance Objective = 100 mrem/year; starting decay date = January 1, 2008.
[2] Values listed in red are results above the performance objective.
[3] Consent Decree in *State of Washington v. Department of Energy*, Case No. CV-08-5085-FVS (E.D. Wa. October 25, 2010).
[4] Assumes that a third retrieval technology can be developed and deployed to reduce the residual waste volume to 360 ft^3.

Although a number of other exposure scenarios were evaluated, including those that involved groundwater contamination, all other inadvertent intruder scenarios (i.e., acute exposure from the well driller inadvertent intruder scenario, commercial farmer inadvertent intruder scenarios) and chronic dose from an all-pathways farmer scenario resulted in doses that are all below their respective performance objectives (i.e., 500 mrem for acute inadvertent intruder exposure, 100 mrem/year for chronic intruder exposure, and 25 mrem/year for chronic exposure to all environmental pathways) within 100 and 200 years post-closure.

6.1.8 Conclusions on Potential Future Impacts

The future impacts on groundwater of the residual waste in tank C-112 were evaluated, using standard groundwater measures. The estimated residual inventory after the first and second retrieval technologies results in an impact that is well below standards. While additional retrieval will likely further reduce the future impact, the additional risk reduction may not be significant.

The future impact from inadvertent intrusion with the residual waste was evaluated using standard performance measures. The estimated dose from residual waste inventory after the first and second retrieval technologies exceeds the chronic exposure standard of 100 mrem/yr in the most conservative inadvertent intrusion scenario at 200 years post-closure. If a third technology could be deployed to reduce the residual waste to 360 ft^3, the residual inventory would still exceed the same chronic exposure standard. Although continued retrieval would result in some additional inventory reduction, other measures (such as a robust closure cap) will be required to address potential inadvertent intrusion impacts.

6.2 EVALUATION OF IMPACTS TO WORKER SAFETY FROM THIRD RETRIEVAL TECHNOLOGY

This criterion assesses the actual and potential impact to worker safety during deployment of a third retrieval technology. All work is performed with safety as the first priority. However, due to the nature of the work, radiological exposure cannot reasonably be avoided.

6.2.1 Evaluation of Exposure That Could Be Incurred During Chemical Dissolution

The exposure that would be received during a new chemical retrieval process at tank C-112 was estimated using the actual exposure during caustic dissolution at tank C-112 and equipment replacement at tank C-112. Estimated exposures were developed using the total person-dose associated with Radiological Work Permits (RWPs) specific to the work.

Caustic dissolution operations for tank C-112 occurred from November 2013 through January 2014. Operations were performed under RWP CO-200, Pumping. With the exception of the last few days of January, all operations under this RWP were associated with tank C-112 caustic dissolution. Exposures incurred were 238 person-mrem in November 2013, 484 person-mrem in December 2013, and 521 person-mrem in January 2014, for a total of 1,243 person-mrem.

Another potential source of exposure during a chemical retrieval campaign at tank C-112 would be realized if any of the existing retrieval equipment had to be replaced. Replacement of the ERSS, standard sluicer, or slurry pump in tank C-112 are all possible (and likely) scenarios. The exposure expected from removal and installation of failed equipment (sluicer, ERSS, or pump) in tank C-112 is estimated using the previous removal, disposal and installation of a sluicer in tank C-112, riser R-7, and replacement of the slurry pump in tank 241-C-107 (C-107). Sluicer removal was performed under RWP CO-788 at 62 person-mrem. Sluicer disposal was performed under RWP-CO-802 at 723 person mrem. Sluicer installation was performed under RWP CO-797 at 20 person-mrem. Replacement of the slurry pump in tank C-107 incurred more than 250 person-rmem under RWP CO-787, and disposal of the slurry pump incurred an additional 204 person-mrem under RWP CO-807. Thus, an additional equivalent exposure (more than 900 person-rem for sluicer removal, disposal, and installation, more than 450 person-mrem for slurry pump replacement) would be incurred for each piece of equipment requiring replacement.

The total exposure for deploying chemical retrieval in tank C-112 would range from 1,200 to 2,100 person-mrem or more, depending on the need to replace failed equipment.

6.3 EVALUATION OF MISSION IMPACT FROM DEPLOYING THIRD RETRIEVAL TECHNOLOGY

This criterion assesses the potential for the deployment of a third retrieval technology to impact the WTP, impact overall schedule, and impact continuing retrieval of other tanks or other mission priorities.

6.3.1 Retrieval Schedule Impacts

The best-case schedule for deploying a chemical dissolution process (to be defined through laboratory testing) at tank C-112 assumes that the existing sluicers (the ERSS and the standard sluicer) as well as the slurry pump continue to operate for the duration of the chemical dissolution process. Deployment of a chemical dissolution process will require sampling and analysis (9 to 12 months), process development and testing (9 to 15 months), development of procedures, training, safety analysis and potential safety basis updated (12 months). Once the process is well defined, some equipment design and construction (if required) could take place in parallel with the final procedure and training activities.

The best-case schedule assumes that existing equipment will not require replacement. That assumption may not be valid, and all existing equipment would need to be evaluated to determine if replacement is warranted. Once all processes and equipment are in place, a period of two to six months is assumed to perform the chemical retrieval process cycle.

However, the overall process development, preparation and deployment is anticipated to take three to four years. A better estimate cannot be developed without more definition of the process itself.

6.3.2 Impacts to Achieving Consent Decree Milestones

Deployment of a third technology in tank C-112 cannot be completed prior to the Consent Decree Milestone B-1 date of September 30, 2014. The third technology would most likely be deployed after retrieval of the other C Farm tanks. Activities are underway to begin retrieval of waste from tanks in the 241-A and 241-AX Tank Farms, in support Consent Decree Milestones B-3 and B-4. Future retrieval of additional waste from tank C-112 has the potential to impact these activities due to the need to coordinate retrieval equipment, receiver DST configurations, and personnel.

6.3.3 Impacts to Waste Treatment Plant

The most promising third technology, chemical dissolution, will add to the chemical load to be processed by the WTP. Chemical dissolution will require the addition of an unspecified amount of chemicals, including both the chemicals needed for the retrieval process and any additional chemicals required to keep the DST receiver tank chemistry within specification. Any added chemicals will increase the inventory requiring treatment in the WTP, and some chemicals have the potential to require new treatment processes.

The overall outcome of deployment of a third retrieval technology in tank C-112 cannot be determined until the chemical retrieval process is defined.

6.4 EVALUATION OF POTENTIAL FOR EXACERBATING LEAKS

Tank C-112 is currently classified as sound. The potential for exacerbating leaks was not considered further in this practicability evaluation.

6.5 ROUGH ORDER OF MAGNITUDE COST ESTIMATE FOR DEPLOYING THIRD RETRIEVAL TECHNOLOGY

A cost estimate for deployment of a third technology in tank C-112 has been developed and is provided in Table 6-7. It does not include the cost for replacement of a pump or ERSS or incorporation of a new ERSS to replace the standard sluicer, should that be necessary. The estimate is developed using the caustic dissolution cost basis, plus assumed development costs for the new technology. The estimate assumes that additional waste analysis is required to develop and test the third technology. The estimate also assumes that additional waste sampling and analysis is required during the operation of the third technology. Waste sampling at the end of retrieval, development of a retrieval data report, and any activities associated with closure are excluded from this estimate.

Combined with the estimate in Table 6-8, this leads to an expected cost of approximately $12,150,000, assuming that no pump or ERSS replacement is required.

In addition to the costs associated with the chemical retrieval operation, the waste slurry pump may need to be replaced in order to complete operation of the third retrieval technology. A cost estimate for an SST slurry pump replacement is provided in Table 6-9. Should it be necessary to replace an ERSS, the cost (based on actual cost for the tank C-112 ERSS placement) will be more than $2,000,000.

Table 6-8. Cost Estimate Basis for New Technology Development, Installation, and Operation, Using Tank 241-C-112 Second Technology Cost Estimate.

Activity	Fully Burdened Cost
Labor costs	$6,250,000
Materials	$1,680,000
Contracts	$1,790,000
Overhead costs	$2,430,000
Total	$12,150,000

Table 6-9. Cost to Replace a Slurry Pump.

Activity	Fully Burdened Cost
Labor costs	$536,000
Materials	$677,000
Contracts	$2,175,000
Overhead costs	$1,560,000
Total	**$4,948,000**

The likely total cost estimate to deploy chemical dissolution in tank C-112 is at least approximately $12,150,000. Should the ERSS, standard sluicer or slurry pump require replacement, the cost will increase to greater than $19,000,000.

7.0 CONCLUSIONS

Modified sluicing and chemical retrieval (caustic/water dissolution) processes removed the waste in tank C-112 to a residual volume of ~1,700 ft^3. Based on the waste characteristics observed during the retrieval activities to date, no existing retrieval technology is likely to achieve success in removing a significant portion of the remaining waste in tank C-112. A new approach will need to be developed. It is possible that a new chemical retrieval process could be developed and used to remove a portion of the remaining waste by altering its chemical form so that it would be dissolved or suspended in liquid to be pumped. Chemical retrieval could enable most of the residual waste piles to be broken up into smaller pieces for subsequent retrieval by an additional sluicing step, but must first be proven viable through laboratory and process testing. It may be less successful in removing waste from the walls and stiffener rings.

- Development and deployment of a new chemical retrieval process would likely remove some of the residual waste, but the likelihood of success cannot be predicted.
- The reduction in inventory and the incremental reduction in risk is relatively small, even if the operation is successful. The determinations are based on residual waste composition estimates and not sample data.
- The deployment of chemical retrieval would lead to an additional ~1,200 to 2,100 person-mrem of worker exposure, excluding any work/laboratory technician exposure during process testing activities.
- The minimum duration of additional process development and field activities would be between three and four years, because of the need to develop an alternate process/retrieval technology leading to significant delay in subsequent retrieval activities.
- The cost to develop and deploy an additional retrieval technology is likely between $12,150,000 and $19,000,000.

It is not certain that a technology that would be effective in removing the residual waste in tank C-112 can be developed. The additional exposure, time, and cost associated with developing and implementing an additional retrieval technology outweigh the risk reduction that might be achieved. Consequently, the U.S. Department of Energy believes that deployment of a third technology into tank 241-C-112 is not practicable.

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INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-112	Information Category: ☐ Abstract ☐ Journal Article ☐ Summary ☐ Internet ☐ Visual Aid ☐ Software ☐ Full Paper ☐ Report ☑ Other WMA C Closure WIR Evaluation Reference
Publish to OSTI? ☐ Yes ☑ No	
Trademark/Copyright "Right to Use" Information or Permission Documentation	Yes ☐ NA ☑
Document Number: RPP-56935 Revision 1	Date: December 2014
Author: Darling, David (Dave) B	

Part II: External/Public Presentation Information

Conference Name:	
Sponsoring Organization(s): Rebecca Blackwell	
Date of Conference:	Conference Location:
Will Material be Handed Out? ☐ Yes ☑ No	Will Information be Published? ☐ Yes ☑ No *(If Yes, attach copy of Conference format instructions/guidance.)*

Part III: WRPS Document Originator Checklist

Description	*Yes*	*N/A*	*Print/Sign/Date*
Information Product meets requirements in TFC-BSM-AD-C-01?	☐	☑	
Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	☐	☑	
If product contains pictures, safety review completed?	☐	☑	

Part IV: WRPS Internal Review

Function	*Organization*	*Date*	*Print Name/Signature/Date*
Subject Matter Expert	WRPS		Darling, David (Dave) B Approved via att. IDMS data file.
Responsible Manager	WRPS		Levitt, Marc T Approved via att. IDMS data file.
Other:			

Part V: IRM Clearance Services Review

Description	*Yes*	*No*	*Print Name/Signature*
Document Contains Classified Information?	☐	☑	If Answer is "Yes," ADC Approval Required Print Name/Signature/Date
Document Contains Information Restricted by DOE Operational Security Guidelines?	☐	☑	Reviewer Signature: Print Name/Signature/Date
Document is Subject to Release Restrictions? *If the answer is "Yes," please mark category at right and describe limitation or responsible organization below:*	☐	☑	Document contains: ☐ Applied Technology ☐ Protected CRADA ☐ Personal/Private ☐ Export Controlled ☐ Proprietary ☐ Procurement – Sensitive ☐ Patentable Info. ☐ OUO ☐ Predecisional Info. ☐ UCNI ☐ Restricted by Operational Security Guidelines ☐ Other (Specify)
Additional Comments from Information Clearance Specialist Review?	☐	☑	Information Clearance Specialist Approval APPROVED *By S. Natalie Molina at 12:23 pm, Jan 06, 2025* Print Name/Signature/Date

When IRM Clearance Review is Complete – Return to WRPS Originator for Final Signature Routing (Part VI)

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part VI: Final Review and Approvals

Description	*Approved for Release* Yes	N/A	*Print Name/Signature*
WRPS External Affairs	☐	☑	Henderson, Destry J Approved via att. IDMS data file.
WRPS Office of Chief Counsel	☐	☑	Kneese, Kyle C Approved via att. IDMS data file.
DOE – ORP Public Affairs/Communications	☐	☑	Millikin, Emily J Approved via att. IDMS data file.
Other:	☐	☐	
Other:	☐	☐	

Comments Required for WRPS-Indicate Purpose of Document:

Reference for WMA C Closure WIR Evaluation that will be put into Hanford Administrative Record.

APPROVED
By S. Natalie Molina at 12:28 pm, Jan 06, 2025

Approved for Public Release; Further Dissemination Unlimited

Information Release Station

Was/Is Information Product Approved for Release? ☑ Yes ☐ No

If Yes, what is the Level of Releaser? ☑ Public/Unrestricted ☐ Other (Specify) ______

Date Information Product Stamped/Marked for Release: 01/06/2025

Was/Is Information Product Transferred to OSTI? ☐ Yes ☑ No

Forward Copies of Completed Form to WRPS Originator

This XML file does not appear to have any style information associated with it. The document tree is shown below.


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    Information Clearance </comments>
  </task>
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