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FOR THE

IDAHO NATIONAL LABORATORY

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INTEC Liquid Waste Management System

Attachment 2, Section C
Waste Characteristics

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ACRONYMS AND ABBREVIATIONS

ACMM	Analytical Chemistry Methods Manual
ALARA	as low as reasonably achievable
APHA	American Public Health Association
APS	Atmospheric Protection System
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CPP	Chemical Processing Plant
CRR	Carbon Reduction Reformer
DEQ	(Idaho) Department of Environmental Quality
DMR	Denitration and Mineralization Reformer
DOE	Department of Energy
DOT	Department of Transportation
DQO	data quality objective
dscm	dry standard cubic meter
EMCAP	Environmental Management Consolidated Audit Program
EPA	Environmental Protection Agency
ETS	Evaporator Tank System
FR	(WDS) Facility Representative
g	gram
GAC	granular activated carbon
gal	gallon
HEPA	high efficiency particulate air
hr	hour
HWMA	Hazardous Waste Management Act
HWN	hazardous waste number
IDAPA	Idaho Administrative Procedures Act

ILWMS	INTEC Liquid Waste Management System
INL	Idaho National Laboratory
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IWTU	Integrated Waste Treatment Unit
kg	kilogram
L	liter
lb	pound
LDR	Land Disposal Restriction
LET&D	Liquid Effluent Treatment and Disposal
mg	milligram
Mg	megagram
MSDS	Material Safety Data Sheet
NA	not applicable
NGLW	newly generated liquid waste
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NWCF	New Waste Calcining Facility
PEW	Process Equipment Waste
PEWE	Process Equipment Waste Evaporator
PK	process knowledge
ppm	parts per million
ppmw	parts per million weight
PWL	Process Waste Liquid
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RAL	Remote Analytical Laboratory
RCRA	Resource Conservation and Recovery Act

ROD	Record of Decision
SVOC	semi-volatile organic compound
TBP	Tributyl phosphate
TC	Toxicity Characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TFF	Tank Farm Facility
TOC	total organic carbon
TSS	total suspended solids
UHC	underlying hazardous constituent
VOC	volatile organic compound
VOG	vessel offgas
WAC	waste acceptance criteria
WAP	Waste Analysis Plan
WDDF	Waste Determination and Disposition Form
WGS	Waste Generator Services
WTS	waste technical specialist
µg	microgram

C. WASTE CHARACTERISTICS

This section has been prepared for the Idaho Nuclear Technology and Engineering Center (INTEC) Liquid Waste Management System (ILWMS) located at the Idaho National Laboratory (INL) Site. Four process codes are associated with the regulated hazardous waste management units in the ILWMS. The process codes are S01, container storage; S02, tank storage; T01, tank treatment; and X99, other miscellaneous treatment. The purpose of this section is to describe the process and rationale utilized by the Department of Energy (DOE), Idaho Operations Office-designated contractor to determine the physical and chemical characteristics of the wastes managed at these units. This section describes hazardous wastes and only the hazardous components of mixed wastes regulated by the Resource Conservation and Recovery Act (RCRA), Idaho Administrative Procedures Act (IDAPA), and the Code of Federal Regulations (CFR).

The ILWMS includes the Process Equipment Waste Evaporator (PEWE) system, the Liquid Effluent Treatment and Disposal (LET&D) facility, the Evaporator Tank System (ETS), and the Integrated Waste Treatment Unit (IWTU). The ILWMS includes tanks and ancillary equipment in Buildings CPP-604, CPP-649, CPP-659, CPP-1618, CPP-1696, and associated valve boxes.

Detailed descriptions of the PEWE, LET&D, ETS, and IWTU are provided in Attachment 1, Section D of this Permit. The regulated tanks and ancillary equipment associated with the ILWMS are listed below:

The regulated tanks and ancillary equipment specific to the PEWE system include:

- VES-WL-132, CPP-604 Evaporator Feed Sediment Tank (regulated under IDAPA as a storage/treatment tank)
- VES-WL-133, CPP-604 Evaporator Feed Collection Tank (regulated under IDAPA as a storage/treatment tank)
- VES-WL-102, CPP-604 Surge Tank for VES-WL-133 (regulated under IDAPA as a storage/treatment tank)
- VES-WL-109, CPP-604 Evaporator Head Tank (regulated under IDAPA as a storage tank).
- EVAP-WL-129, CPP-604 Evaporator Unit, including VES-WL-129, VES-WL-130, HE-WL-307, and HE-WL-308 (regulated under IDAPA as a miscellaneous unit with treatment/storage tanks)

- VES-WL-134, CPP-604 Process Condensate Surge Tank (regulated under IDAPA as a storage tank)
- EVAP-WL-161, CPP-604 Evaporator Unit, including VES-WL-161, VES-WL-162, HE-WL-300, and HE-WL-301 (regulated under IDAPA as a miscellaneous unit with treatment/storage tanks)
- VES-WL-131, CPP-604 Process Condensate Surge Tank (regulated under IDAPA as a storage tank)
- VES-WL-108, CPP-604 Process Offgas Condensate Knock Out Pot (regulated under IDAPA as a storage tank)
- VES-WL-111, CPP-604 Bottoms Collection Tank (regulated under IDAPA as a storage/treatment tank)
- VES-WL-101, CPP-604 Bottoms Collection Tank (regulated under IDAPA as a storage/treatment tank)
- VES-WM-100, VES-WM-101, and VES-WM-102, CPP-604 Tank Farm Tanks (regulated under IDAPA as storage/treatment tanks)
- VES-WL-135 (DVB-OGF-D5), VES-WL-136 (DVB-OGF-D8), VES-WL-137 (CPP-649), VES-WL-138, VES-WL-139, VES-WL-142, VES-WL-144 and VES-WL-150 (CPP-604), Process Waste Liquid Collection System (regulated under IDAPA as storage tanks)
- VES-WL-106, VES-WL-107, and VES-WL-163, CPP-604 Process Condensate Collection Tanks (regulated under IDAPA as treatment/storage tanks).

The regulated tanks and ancillary equipment specific to the LET&D facility are listed below:

- VES-WLK-197, CPP-1618 Acid Fractionator Waste Feed Head Tank (regulated under IDAPA as a storage tank)
- FRAC-WLL-170, CPP-1618 Acid Fractionator, including FRAC-WLL-170, HE-WLL-391, HE-WLL-396, HE-WLL-398, and VES-WLL-198 (regulated under IDAPA as a miscellaneous unit with treatment/storage tanks)
- FRAC-WLK-171, CPP-1618 Acid Fractionator, including FRAC-WLK-171, HE-WLK-392, HE-WLK-397, HE-WLK-399, and VES-WLK-199 (regulated under IDAPA as a miscellaneous unit with treatment/storage tanks)
- VES-WLL-195, CPP-1618 Acid Fractionator Bottoms Tank (regulated under IDAPA as a storage tank)
- VES-NCR-171, CPP-659 Annex LET&D Nitric Acid Recycle Tank (regulated under IDAPA as a storage tank)

- VES-NCR-173, CPP-659 Annex LET&D Nitric Acid Recycle Head Tank (regulated under IDAPA as a storage tank).

The regulated tanks and ancillary equipment specific to the ETS facility are listed below:

- VES-NCC-152, CPP-659 Constant Head Feed Tank (regulated under the IDAPA as a storage tank)
- EVAP-NCC-150, CPP-659 (which includes VES-NCC-150, HE-NCC-350, HE-NCC-351), (regulated under the IDAPA as a miscellaneous treatment (evaporation) unit with tank storage)
- VES-NCC-101, CPP-659 Blend Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-102, CPP-659 Hold Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-103, CPP-659 Hold Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-119, CPP-659 Fluoride Hot Sump Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-122, CPP-659 Non-Fluoride Hot Sump Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-108, CPP-659 Scrub Hold Tank (regulated under the IDAPA as a storage/treatment tank)
- VES-NCC-136, CPP-659 Vent Condenser Knockout Drum (regulated under the IDAPA as a storage tank)
- VES-NCC-116, CPP-659 Mist Collector (regulated under the IDAPA as a storage tank)

The regulated tanks and ancillary equipment specific to the IWTU facility are listed below:

- VES-SRC-131, Waste Feed Tank (regulated under IDAPA as a storage/treatment tank)
- VES-SRC-190 and -191, Product Receiver/Coolers (regulated under IDAPA as storage tanks)
- TK-SRE-196, Firewater Collection Tank (regulated under IDAPA as a storage tank)
- TK-SRH-141, Condensate Collection Tank (regulated under IDAPA as storage tank)
- Integrated Waste Treatment Unit (regulated under IDAPA as a miscellaneous treatment unit), which can be divided into the following two subsystems; 1) Sodium Bearing Waste (SBW) Treatment System, which manages the liquid and offgas phases of the process;

and 2) Product Transfer and Loadout System, which deals with solids management. The components of each of these subsystems are identified below:

- SBW Treatment System, includes VES-SRC-140 [Denitration and Mineralization Reformer (DMR)], F-SRC-153 (Process Gas Filter), VES-SRC-160 [Carbon Reduction Reformer (CRR)], COL-SRC-160 (Offgas Cooler), F-SRC-160 (Offgas Filter), BLO-SRH-260 A and B (Offgas Blowers), F-SRH-140 A, B, C, and D (Process HEPA Filters), F-SRH-141 A and B (Mercury Adsorbers), and BLO-SRH-240 A and B (Process Exhaust Blowers);

- Product Transfer and Loadout System, which includes AUG-SRC-440 (DMR Auger/Grinder), F-SRC-191 (Product Receiver Filter), VES-SRC-180 (Product Receiver Filter Product Pump), F-SRC-190 (Product Handling Vacuum Filter), and the Canister Filling Stations (3).

The PEWE system, LET&D facility, ETS, and IWTU are part of an overall liquid waste treatment train at the INTEC. The system is comprised of initial storage and accumulation tanks, followed by storage/transfer, and treatment tanks. The overall ILWMS reduces the volume of waste sent to the Tank Farm Facility (TFF) and treats the TFF waste converting it to a waste form suitable for shipment to an ultimate disposal facility. The nitric acid recovered by the LET&D is returned to the original process, where it reenters the primary stage of the treatment process. The reuse of nitric acid is consistent with both the RCRA regulations that encourage reuse, as well as principles of pollution prevention. Rather than continuing to purchase and use “new” nitric acid, the used acid is an effective substitute for commercial product, and ultimately results in less RCRA hazardous waste generation.

Process samples are taken from the New Waste Calcining Facility (NWCF) Tanks (VES-NCD-123, VES-NCD-129, VES-NCC-119, VES-NCC-122, VES-NCC-108, VES-NCC-101, VES-NCC-102, or VES-NCC-103) or F-SRH-141A/B, as necessary, to ensure optimum performance of the units. Process samples may also be taken at VES-WL-106, VES-WL-107, and VES-WL-163. Process samples are analyzed to ensure that the systems operate to minimize corrosion of the vessels and maintain system efficiency. If undesirable concentrations of process parameters are detected, then facility personnel may blend the waste with waste of lesser ionic concentration or add specifically identified commercial chemicals to make the waste more amenable to treatment. In some cases, recovered nitric acid may be added to tank systems to maintain acidity and promote the formation of a protective passivation layer to inhibit corrosion of the stainless steel.

C-1 CHEMICAL AND PHYSICAL ANALYSES: [IDAPA 58.01.05.012 and 008; 40 CFR §§ 270.14(b)(2) and 264.13(a)]

The INTEC units described in this permit are used to manage a variety of wastes generated from INL activities. Typical waste streams managed by the ILWMS include:

- Liquids generated incidental to conducting debris treatment, decontamination, and descaling activities on INL equipment, piping, and valves
- Concentrated evaporator bottoms
- Rain water and snow melt that infiltrate into sumps and other containment areas
- Water from radioactive fuel storage basins and pools
- Mop water and other cleaning liquids generated incidental to cleanup activities conducted in radiological areas
- Analytical residues, excess samples, and expired analytical standards generated by sampling and analytical laboratory activities
- Solutions from preventative maintenance and corrective maintenance leak tests on process piping and valves
- Newly generated liquid wastes (NGLW) resulting from normal operations and facility deactivation and decommissioning activities
- Aqueous service wastes, such as steam condensate
- ILWMS treatment residuals that may require further processing
- Other waste streams not currently identified that conform to the ILWMS waste acceptance criteria and process tolerance limits identified in Sections C-2(a)(1) and D-8(b)(5), respectively.

Radionuclides that contribute the majority of the activity for wastes managed in the ILWMS include Y-90, Sr-90, Cs-137, Ba-137m, Pu-238, Sm-151, Pu-241, Pm-147, Eu-155, Eu-154, Pu-239, Am-241, Co-60, Ni-63, Cs-134, Sb-125, H-3, Pu-240, Tc-99, Cd-113m, Te-125m, Pa-233, Np-237, Eu-152, Zr-93, Cm-244, Fe-55, Nb-93m, Nb-94, Ru-106, Rh-106, Cs-135, U-234, Ce-144, and Pr-144. The units that comprise the ILWMS are capable of handling high-level, transuranic, and low-level radioactive wastes. Activities of typical wastes range from <20 nCi/g to 50,000 nCi/g. The exposure rates associated with these process solutions routinely exceed 100 mrem/hr and can pose a potentially serious hazard to workers at the INL if appropriate protective measures such as time, distance, and shielding are not applied. As a result the INL is requesting the use of alternate handling and sampling techniques as proposed in this permit.

Before being received into the ILWMS, wastes undergo RCRA characterization in accordance with IDAPA 58.01.05.006 (40 CFR § 262.11). The characterization is based on process knowledge and/or analytical data. Due to the radiological nature of wastes managed in the ILWMS, characterization and the assignment of Environmental Protection Agency (EPA) hazardous waste numbers (HWNs) occur through the use of acceptable knowledge, which involves both process knowledge (PK) and/or chemical/physical testing of the waste. Listed HWNs are applied based on knowledge of the processes. *A Regulatory Analysis and Reassessment of U.S. Environmental Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System*, INEEL/EXT-98-01213, Rev. 1, February 1999 identifies the listed HWNs associated with the INTEC liquid waste system. Characteristic HWNs may be applied by testing the waste according to the methods set forth in Subpart C of 40 CFR Part 261, or according to an equivalent method approved by the Director of the Idaho Department of Environmental Quality, or by applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.

The RCRA Part A Permit for the PEWE, LET&D, ETS, and IWTU lists 28 EPA HWNs. Of the 28 HWNs identified, 5 are listed HWNs and 23 are characteristic HWNs. Units that comprise the ILWMS manage land disposal restricted waste liquids that exhibit the characteristics of corrosivity and toxicity, and contain one or more listed constituents.

Although the feed solutions to the PEWE, LET&D, ETS, and IWTU do not exhibit the characteristic of ignitability, the EPA HWN D001 is identified on the Part A since small quantities of low total organic carbon (TOC) ignitables may enter the system. Sampling and analysis has demonstrated that when these small quantities of ignitable waste are aggregated with other wastes to facilitate treatment, the characteristic of ignitability is lost. However, the HWN D001 is tracked through the ILWMS to account for these ignitable materials and any underlying hazardous constituents (UHCs) to ensure proper cradle-to-grave management of mixed and hazardous wastes.

C-1a Waste in Containers: [IDAPA 58.01.05.008; 40 CFR §§ 264.172 and 264.177(a)]

The containerized waste produced and stored in the IWTU Vault Loading Area and Vault Storage Area is a sodium carbonate-based granular solid treatment product. In general, the IWTU treats acidic, aqueous liquid wastes that contain small quantities of organics and heavy metals (exhibit the characteristic of toxicity) and/or contain listed hazardous waste constituents identified on the Part A permit application for this permit. The IWTU stores the treatment product prior to shipment to an ultimate disposal facility. The IWTU removes the organic constituents and mercury during the treatment of the TFF waste. The treatment product exhibits the characteristic of toxicity for metals and retains the

listed hazardous waste numbers. The canisters are designed and constructed of materials that are compatible with the sodium carbonate-based granular solid for storage, shipment, and ultimate disposal off-Site. The treatment waste will not be added to unwashed canisters that may have previously contained incompatible waste or material.

C-1b Waste in Tank Systems: [IDAPA 58.01.05.008; 40 CFR §§ 264.191(b)(2) and 264.192(a)(2)]

The wastes managed in the ILWMS tank systems described in this permit are all very similar in composition. In general, the ILWMS treats and stores acidic, aqueous liquid wastes that contain small quantities of heavy metals and organics (exhibit the characteristic of toxicity) and/or contain listed hazardous waste constituents identified on the Part A permit application for this permit. These wastes are generated from a variety of INL activities including building and equipment decontamination, debris and liquid waste treatment, and research and development. A brief description of each of the tank systems, and typical wastes managed, is detailed below. Specific characterization information regarding the waste to be treated in the IWTU is presented in Appendix C-1 and Appendix C-2. A more detailed description of each tank system is provided in Attachment 1, Section D, "Process Information," of this permit.

New Waste Calcining Facility (NWCF) Tanks
(VES-NCD-123, VES-NCD-129, VES-NCC-119, and VES-NCC-122)

VES-NCD-123, the Decon Holdup Tank, and VES-NCD-129, the Decon Collection Tank, are located in CPP-659 and support decontamination facility activities. These tanks primarily collect acidic, aqueous decontamination solutions from debris treatment, including high efficiency particulate air (HEPA) filter leaching activities, and equipment decontamination. These tanks are described in detail in the Hazardous Waste Management Act (HWMA)/RCRA Storage and Treatment Permit for the INTEC, Volume 18, October 2004.

Tanks VES-NCC-119, the Fluoride Hot Sump Tank, and VES-NCC-122, the Non-Fluoride Hot Sump Tank, are also located in CPP-659 and support operation of the Evaporator Tank System (ETS) as well as NWCF decontamination activities. During operation of the ETS, evaporator bottoms are routed to VES-NCC-119. Condensed evaporator overheads are collected in VES-NCC-122. These tanks also receive acidic, aqueous liquid decontamination solutions generated in the NWCF as a result of equipment repair or preventive maintenance. Wastes collected in VES-NCC-119 are usually transferred to the TFF. If the fluoride concentration is determined to be below the corrosive limit, or can be blended with other wastes to conform to tolerance limits, or can be complexed to alleviate corrosion concerns, then the solution may be transferred to the PEWE system. Wastes collected in VES-NCC-122 are typically sent to the PEWE for volume reduction.

Process Waste Liquid (PWL) System
(VES-WL-135, VES-WL-136, VES-WL-137, VES-WL-138, VES-WL-139, VES-WL-142, VES-WL-144, and VES-WL-150)

The PWL tanks are located in CPP-604, CPP-649, and associated valve boxes. The PWL system receives condensate from the Atmospheric Protection System (APS) and the Main Stack Sump as well as waste solutions from CPP-604/-605 floor sumps or drains, and sampler drains. These aqueous solutions are typically generated on an irregular basis and are transferred directly to the PEWE Feed Sediment/Feed Tanks, VES-WL-132 or VES-WL-133.

Sumps SU-WL-140, -143, -145, -146, -147 and -148 do not contain tanks. These sumps are not used routinely. The exclusive purpose of these sumps is to contain liquids during immediate responses to discharges of hazardous wastes.

Sump SU-WL-140 is located in the South Cell of the Rare Gas Plant (RGP). The RGP is no longer active. Therefore, there are no sources of waste that would be collected in this sump.

Sump SU-WL-143 is located in the RGP Pump Pit. Since the RGP is no longer active, there are no sources of waste that would be collected in this sump.

Sump SU-WL-148 is located at the INTEC main stack. In the event of equipment failure, condensate from the main stack could collect in this sump.

Sumps SU-WL-145 and SU-WL-146 are part of the secondary containment and leak detection system in the PEWE Condensate Collection Cell.

Sump SU-WL-147 is part of the secondary containment and leak detection system in the PEWE EVAP-WL-161 Cell.

CPP-604 Tank Farm Tanks (VES-WM-100, VES-WM-101, and VES-WM-102)

VES-WM-100, VES-WM-101, and VES-WM-102 typically provide storage capacity for PEWE bottoms. If necessary, these tanks can also be used to store PEWE feed solutions by routing liquids through valve box C-40.

Evaporator Feed Sediment Tank (VES-WL-132)

VES-WL-132 may receive waste from the tank systems previously described in this section as inputs to the ILWMS. In addition, VES-WL-132 may receive snow melt or other liquids from TFF sumps and valve boxes, basin water from CPP-666, or waste from other INL facilities.

VES-WL-132 functions as a settling basin for solids that would otherwise settle out in the Evaporator Feed Collection Tank, VES-WL-133. When the feed stream enters VES-WL-132, it encounters a baffle-and-weir system. The solids settle out of the solution as it flows under the baffle and over the weir. Since the cessation of fuel processing activities in the early 1990's, solids are no longer considered a problem in the feed solutions. However, in the unlikely event that VES-WL-132 was to completely fill, solids would be carried over into VES-WL-133. As VES-WL-132 approached its capacity, solids would be detected as a result of plugging in the vessel's instrument lines. VES-WL-132 would then be immediately bypassed, diverting feed solutions directly to VES-WL-133. Once full of solids, VES-WL-132 is designed to be remotely removed/replaced. The full sediment tank will be managed as a RCRA solid waste and disposed in accordance with all applicable regulations. However, if the solids content in PEWE feed remains low, the INL may elect not to install a new feed sediment tank.

Evaporator Feed Collection Tank (VES-WL-133)

VES-WL-133 receives waste from all the sources previously identified in this section as inputs to the ILWMS. Waste from several of these inputs may be blended to promote optimum operability of the unit. VES-WL-133 serves both evaporators, EVAP-WL-129 and EVAP-WL-161. Wastes are transferred from VES-WL-133 to either the Evaporator Head Tank, VES-WL-109, or directly to EVAP-WL-129.

Surge Tank for VES-WL-133 (VES-WL-102)

The current function of this tank is to provide surge capacity for VES-WL-133.

Evaporator Head Tank (VES-WL-109)

VES-WL-109 provides a constant head for feed solution to evaporator EVAP-WL-161. Feed is pumped to this tank from the Evaporator Feed Collection Tanks, VES-WL-133 or VES-WL-102. VES-WL-109 has an overflow that returns to either VES-WL-133 or VES-WL-102.

Process Condensate Surge Tank (VES-WL-134)

VES-WL-134 collects acidic condensate from evaporator EVAP-WL-129 overheads. VES-WL-134 provides the capability for the evaporators to be operated in series. For series operation, EVAP-WL-129 is operated until VES-WL-134 is full. This tank then provides feed for EVAP-WL-161.

VES-WL-134 may also be used to store concentrated acidic LET&D bottoms for reuse in other INTEC operations.

Process Condensate Surge Tank (VES-WL-131)

VES-WL-131 collects acidic condensate from evaporator EVAP-WL-129 and/or EVAP-WL-161 overheads. When full, the contents of this tank are transferred to one of the Process Condensate Collection Tanks, VES-WL-106, VES-WL-107, or VES-WL-163.

Process Condensate Collection Tanks (VES-WL-106, VES-WL-107, and VES-WL-163)

VES-WL-106, VES-WL-107, and VES-WL-163 store acidic condensate from Process Condensate Surge Tank, VES-WL-131. This aqueous condensate may be either re-fed to the PEWE or transferred to the LET&D facility for recovery of nitric acid.

Bottoms Collection Tanks (VES-WL-101 and VES-WL-111)

VES-WL-101 and VES-WL-111 primarily collect concentrated acidic PEWE evaporator bottoms from EVAP-WL-129 and EVAP-WL-161. Valve box C-40 allows transfers between these tanks and other facilities including the TFF, ETS, and CPP-659.

Process Condensate Knock Out Pot (VES-WL-108)

The function of the Process Condensate Knock-Out Pot is to remove entrained acidic condensate remaining in the vessel offgas (VOG) for the PEWE process condensate collection and surge tanks. From this point, PEWE condensate VOG passes to the plant VOG system. Any liquid removed drains back to VES-WL-131 or VES-WL-133.

Acid Fractionator Waste Feed Head Tank (VES-WLK-197)

VES-WLK-197 receives PEWE acidic condensate from the CPP-604 Process Condensate Collection Tanks, VES-WL-106, VES-WL-107, and VES-WL-163. This vessel acts as the feed tank to LET&D fractionators, FRAC-WLL-170 and FRAC-WLK-171.

Acid Fractionator Bottoms Tank (VES-WLL-195)

VES-WLL-195 collects concentrated acidic LET&D bottoms from fractionators FRAC-WLL-170 and FRAC-WLK-171. These bottoms are primarily comprised of concentrated nitric acid (10-13 molar) solution.

Nitric Acid Recycle Tank (VES-NCR-171)

VES-NCR-171 stores the concentrated nitric acid recovered by the LET&D facility. This acid may be used elsewhere at the INTEC for decontamination or waste treatment.

Nitric Acid Recycle Head Tank (VES-NCR-173)

VES-NCR-173 acts as a constant head feed tank for transfers of LET&D recovered nitric acid to other INTEC processes. Concentrated nitric acid is airlifted from the Nitric Acid Recycle Tank, VES-NCR-171, to VES-NCR-173 for this purpose.

Blend Tank (VES-NCC-101)

VES-NCC-101 receives waste from VES-NCC-102, VES-NCC-103, VES-NCC-119, VES-NCC-122, VES-NCD-123, VES-NCD-129, PEWE, and the TFF and acts as the feed tank for the ETS. Feed for the IWTU is also stored in this tank prior to transfer to VES-NCC-102 or VES-NCC-103. Chemical adjustments to the feed can be accomplished here.

Hold Tank (VES-NCC-102)

VES-NCC-102 receives waste from VES-NCC-101, VES-NCC-103, VES-NCC-119, VES-NCC-122, VES-NCD-123, VES-NCD -129, PEWE, and the TFF. This tank also provides feed surge capacity for the ETS. Feed for the IWTU is also transferred through this tank. Chemical adjustments to the feed can be accomplished here.

Hold Tank (VES-NCC-103)

VES-NCC-103 receives waste from VES-NCC-101, VES-NCC-102, VES-NCC-119, VES-NCC-122, VES-NCD-123, VES-NCD-129, PEWE, and the TFF. This tank also provides feed surge capacity for the ETS. Feed for the IWTU is also transferred through this tank. Chemical adjustments to the feed can be accomplished here.

Scrub Hold Tank (VES-NCC-108)

VES-NCC-108 collects the condensate from the Vent Condenser Knockout Drum, VES-NCC-136.

Vent Condenser Knockout Drum (VES-NCC-136)

The function of VES-NCC-136 is to remove entrained condensate remaining in the offgas. Any liquid removed drains to VES-NCC-108.

Mist Collector (VES-NCC-116)

The function of VES-NCC-116 is to remove entrained condensate remaining in the offgas. Any liquid removed drains to VES-NCC-119.

Constant Head Feed Tank (VES-NCC-152)

VES-NCC-152 provides a constant head for feed solution to evaporator VES-NCC-150. Feed is airlifted to this tank from the Blend Tank, VES-NCC-101.

Waste Feed Tank (VES-SRC-131)

VES-SRC-131 provides feed solution to the DMR (VES-SRC-140). Feed is transferred to VES-NCC-101, VES-NCC-102 and VES-NCC-103 and then to the Waste Feed Tank.

Product Receiver/Cooler (VES-SRC-190 and 191)

VES-SRC-190 and 191 receives solid treatment product from the DMR and CRR, and fines collected in the Process Gas Filter, Offgas Filter, Product Handling Vacuum Filter, and Product Receiver Filter Product Pump, where they are cooled prior to being transferred to storage/shipping canisters.

Fire Water Collection Tank (TK-SRE-196)

TK-SRE-196 is provided to collect fire water resulting from a fire in the IWTU Building Ventilation HEPA Filters, Process HEPA Filters, or Mercury Adsorbers. Any fire water collected in this tank will be analyzed and transferred to suitable containment for treatment or disposal.

Condensate Collection Tank (TK-SRH-141)

TK-SRH-141 is provided to collect condensate from the IWTU stack and off-gas sampling equipment. The collected liquid is transferred to the waste feed tank and fed to the IWTU process.

C-1g Waste in Miscellaneous Treatment Units: [IDAPA 58.01.05.012; 40 CFR §270.23]

The miscellaneous treatment units covered by this Part B permit include the PEW evaporators, EVAP-WL-129 and EVAP-WL-161, the LET&D facility fractionators, FRAC-WLL-170 and FRAC-WLK-171, the ETS, EVAP-NCC-150, IWTU steam reformers, VES-SRC-140 and VES-SRC-160, and associated ancillary equipment including the Product Transfer Loadout System.

As noted previously in Section C-1b, the ILWMS is part of an overall liquid waste treatment train. Aqueous liquids generated from INL decontamination, waste treatment, and other activities are processed in the PEWE and ETS to reduce the volume of mixed waste sent to the TFF for storage. The LET&D facility further reduces this volume by recovering approximately 99% of the nitric acid contained in condensed PEWE overheads. This nitric acid is then used elsewhere on-Site for treatment and decontamination activities in lieu of purchasing commercial grade nitric acid, effectively minimizing the quantity of waste generated from INL activities. The final component(s) of the ILWMS treatment train is the IWTU. PEWE and ETS bottoms currently stored in the TFF, and NGLW will be treated by the IWTU. A brief description of each of the miscellaneous treatment units and typical wastes managed are detailed below. A more detailed description of each miscellaneous treatment unit is provided in Attachment 1, Section D, "Process Information," of this permit.

Process Equipment Waste Evaporator Unit (EVAP-WL-129, includes VES-WL-129, VES-WL-130, HE-WL-307 and HE-WL-308)

The function of EVAP-WL-129 is to reduce the volume of waste sent to the TFF. The evaporator is composed of a flash column, VES-WL-129, a mist eliminator, VES-WL-130, a reboiler, HE-WL-307, and a condenser, HE-WL-308. Feed pumps draw waste from the Evaporator Feed Collection Tank, VES-WL-133, and transfer the waste to the evaporator. The evaporator uses steam to heat the feed in a reboiler. This feed is circulated from the reboiler through the flash column, where vapor is separated from the liquid. Liquid drops to the bottom of the flash column and is recycled back to the reboiler. Constituents of the feed that have a lower boiling point than the system temperature produce a vapor. Any constituents with a higher boiling point remain in the liquid and are recirculated through the evaporator.

The vapor phase rises in the flash column, encounters a baffle, and then passes through a coarse wire mesh to remove entrained liquid droplets from the vapor. The vapor continues through the mist eliminator, which contains a fine wire mesh to remove additional entrained liquid droplets (light constituents and water). Finally, the vapor flows through a condenser where acidic vapor is condensed and collected in VES-WL-131. Any non-condensable vapor is routed to the plant VOG system.

Process Equipment Waste Evaporator Unit (EVAP-WL-161, includes VES-WL-161, VES-WL-162, HE-WL-300 and HE-WL-301)

EVAP-WL-161 is similar to EVAP-WL-129 in both design and operation. One minor difference is that EVAP-WL-161 is gravity fed from an Evaporator Head Tank, VES-WL-109, rather than receiving waste directly from feed pumps. Evaporator EVAP-WL-161 is composed of a flash column, VES-WL-161, a separator, VES-WL-162, a reboiler, HE-WL-300, and a condenser, HE-WL-301. The operation of this evaporator is virtually identical to that described above for EVAP-WL-129.

LET&D Acid Fractionator (FRAC-WLL-170, includes HE-WLL-398, HE-WLL-396, and VES-WLL-198)

The LET&D treatment process reduces the volume of liquid waste by fractionating condensed acidic PEW evaporator overheads into saturated steam/offgas and acid. The fractionators separate the waste solution into water (overheads) and nitric acid (bottoms). Fractionator FRAC-WLL-170 includes a reboiler, HE-WLL-398, a condenser, HE-WLL-396, and a liquid separator, VES-WLL-198. The feed is heated to its boiling point by introducing steam to the reboiler. The vapor from the boiling liquid rises through several stacked sieve trays (perforated plates) in FRAC-WLL-170. The sieve trays installed in the fractionator column mix the vapors and liquid. As the descending liquid contacts the rising vapor on each tray, nitric acid condenses and remains in solution. Due to its higher boiling point, the nitric acid collects in the bottom of the fractionator, while water, with a lower boiling point, is discharged as steam.

The saturated steam offgas generated from the fractionation process is drawn through the condenser, where it is partially condensed, producing a reflux stream and steam offgas. This mixture then flows through a liquid separator where the reflux is removed and returned to the top of the acid fractionator. The reflux flows downward, providing liquid for the upper trays. The remaining steam flows through the separator, passes through a superheater and HEPA filters, and is exhausted to the atmosphere via the INTEC Main Stack.

LET&D Acid Fractionator (FRAC-WLK-171, includes HE-WLK-399, HE-WLK-397, and VES-WLK-199)

Fractionator FRAC-WLK-171 is identical in design and operation to FRAC-WLL-170. FRAC-WLK-171 includes a reboiler, HE-WLK-399, a condenser, HE-WLK-397, and a liquid separator, VES-WLK-199.

Evaporator Tank System Unit (VES-NCC-150, HE-NCC-350, and HE-NCC-351)

The function of the ETS is to reduce the volume of waste sent to and stored in the TFF. The evaporator is composed of a flash column, VES-NCC-150, a reboiler, HE-NCC-350, and a condenser,

HE-NCC-351. An airlift transfers waste from the Blend Tank VES-NCC-101 to VES-NCC-152 and is gravity fed to the evaporator, VES-NCC-150. Steam is used to heat the feed in a reboiler. This feed is circulated from the reboiler through the flash column, where vapor is separated from the liquid. The vapor phase rises in the flash column and encounters a cyclone that separates the liquid from the vapor. The liquid drops to the bottom of the flash column and is recycled back to the reboiler. From the cyclone, the vapor and remaining entrained droplets flow through a demister that de-entrains the liquid droplets. The resulting overhead vapor flows into the condenser, HE-NCC-351. The condensate is collected in VES-NCC-122. Any non-condensable vapor is routed to the process offgas system and then to the APS. When conditions warrant, the bottoms are transferred to VES-NCC-119.

Constituents of the feed that have a boiling point equal to or lower than the system temperature produce a vapor. Any constituents with a higher boiling point remain in the liquid and are recycled through the evaporator.

Integrated Waste Treatment Unit

The purpose of the IWTU is to process SBW currently located in the TFF, as well as NGLW.

The SBW contained in TFF tanks VES-WM-187, -188, and -189 is transferred to the NWCF Blend and Hold Tanks VES-NCC-101, -102, and -103 where the waste is sampled and/or blended, as necessary, prior to being pumped to the Waste Feed Tank, VES-SRC-131.

From the Waste Feed Tank the waste is pumped to the first of two fluidized bed steam reformers, the DMR, VES-SRC-140. The waste is atomized with a controlled flow of compressed nitrogen and instrument air in the feed injectors and then sprayed into the DMR's heated fluidized bed. Coal is added to the bed to maintain temperature and promote a reducing environment to convert nitrogen oxides to nitrogen gas. The liquid waste is immediately vaporized and the solids from the liquid waste are deposited on the bed particles causing the particles to gradually increase in size over time. The bed media, or treatment product, is drawn off the bottom of the DMR using an auger/grinder system and then pneumatically transported to the Product Receiver/Coolers, VES-SRC-190 and 191. This sodium carbonate-based granular solid treatment product is expected to be classified as remote-handled (RH) transuranic (TRU) mixed waste.

The process gas from the DMR is filtered by the Process Gas Filter, F-SRC-153, and then sent to the second steam reformer, the CRR, VES-SRC-160. The process gasses from the DMR are introduced into the lower part of the CRR, into the heated fluidized bed. In the CRR the offgas is mixed with carbon, oxygen enriched air, nitrogen, and water, as necessary for temperature control. The bed particles in the CRR are not expected to increase significantly in size since the input feed is DMR offgas. The offgas

continues through the Offgas Cooler, COL-SRC-160, which cools the offgas vapor with an atomized water spray. The offgas then passes through the Offgas Filter, F-SRC-160. Next the offgas is routed through the Process HEPA filters, F-SRH-140A/B/C/D, and the Mercury Adsorbers, F-SRH-141A/B, which are filled with sulfur-impregnated granular activated carbon (GAC). Finally, the offgas stream passes through a Continuous Emissions Monitoring System (CEMS) before being combined with HEPA-filtered building ventilation air and exiting the system through a dedicated stack.

Waste treatment product drained from the DMR and elutriated fines collected in offgas cleanup equipment are sent to one of the Product Receiver/Coolers, VES-SRC-190 and 191. The treatment product is cooled via a nitrogen cooling loop and eventually drained from the Product Receiver/Coolers, in a batch mode, into canisters that are positioned one at a time for filling at one of two Canister Filling Stations.

The full canisters are placed in portable concrete storage vaults in a 4 X 4 pattern for a total of 16 canisters to a storage vault. The storage vault is transported to the Vault Storage Area using mechanical means such as fork lifts or air jacks.

When transport trucks and casks are made available from the ultimate disposal facility, the storage vaults are retrieved from storage and located in the Vault Loading Area, adjacent to a truck bay equipped with air locks. Canisters will be loaded into the appropriate cask on the truck and transported to the disposal facility.

A more detailed description of ILWMS tank systems and miscellaneous treatment units is provided in Attachment 1, Section D of this permit.

C-2 WASTE ANALYSIS PLAN: [IDAPA 58.01.05.008 and 012; 40 CFR §§ 264.13(b) and (c), and 270.14(b)(3)]

The regulations under RCRA, as implemented through IDAPA 58.01.05.008 (40 CFR § 264.13), require a waste analysis plan (WAP) for regulated waste management units. This WAP identifies what waste characterization information is needed, the nature and extent of information required, the method(s) by which the information is gathered, and the quality assurance/quality control (QA/QC) goals.

The process outlined in this WAP is implemented for characterization of all mixed/hazardous wastes or potentially hazardous wastes managed at the INTEC units described herein. Wastes subject to this plan include wastes generated from INL operations, treatment residues generated from INL RCRA-regulated waste management activities, and off-Site wastes that have been verified in accordance

with the WAP requirements of IDAPA 58.01.05.008 [40 CFR § 264.13(c)]. As such, this WAP is intended for inclusion in day-to-day waste management operations.

This WAP is established to ensure that all data used for waste characterization is scientifically valid, defensible, and of known precision and accuracy. This objective relies on the identification of appropriate parameters and rationale, analytical methods, sampling methodologies, and quality control.

The objectives of this WAP are as follows:

- Ensure that sufficient information is available to provide safe handling, storage, and treatment of waste materials
- Define the parameters for characterization and the rationale for selection
- Establish consistent sampling, sample management, analytical methods, parameter selection, and controls for wastes received and generated
- Provide a description of the waste stream characterization and approval process from the point of waste generation through final disposition of the waste
- Establish unit-specific waste acceptance criteria (where necessary) for treatment units to ensure that sufficient information is available to determine whether the wastes considered for storage at the respective units meet the requirements established in this permit
- Provide additional requirements for the characterization and acceptance of ignitable wastes
- Define Land Disposal Restriction (LDR) requirements applicable to wastes managed in the miscellaneous treatment, and storage units
- Verify that EPA HWNs for wastes stored or treated are acceptable per the EPA HWNs listed in the Part A.

This WAP will be revised whenever test methods are changed or whenever regulations change that affect the WAP.

C-2a Parameters and Rationale: [IDAPA 58.01.05.008; 40 CFR §§ 264.13(b)(1) and (2)]

Tables C-1 and C-2 outline the parameters for analysis and corresponding rationale that are employed to perform hazardous waste determinations in accordance with IDAPA 58.01.05.006 (40 CFR § 262.11) and to assess LDR requirements. The parameters and rationale presented in these tables are selected to ensure compliance with RCRA and unit-specific waste acceptance requirements and to guarantee safe, compliant treatment and storage. Not all of the parameters identified in Tables C-1 and C-2 are selected for each waste stream. Only the specific parameters applicable to each waste stream proposed for storage or treatment in the ILWMS are evaluated.

Table C-1. Test Methods for Waste Analysis Parameters and Rationale

PARAMETER	TEST METHOD(S)[a]	RATIONALE
Toxicity characteristic	1311 Toxicity Characteristic Leaching Procedure (TCLP) or process knowledge	Determine the waste and LDR status.
Metals: antimony arsenic barium beryllium cadmium chromium lead mercury nickel selenium silver thallium	3005, 3010, 3050, 3051, 3052, 6010, 7470, 7471 or process knowledge	Determine if the waste is characteristically hazardous for toxicity. Determine reasonably expected underlying hazardous constituents (UHCs).
Volatile and semi-volatile organic compounds	5030, 5035, 8015, 8082, 8260, 3510, 3550, 3600, 8270 or process knowledge	Determine whether the waste is characteristically toxic for organic compounds or whether listed waste constituents can be detected. Identify reasonably expected UHCs. Determine the concentration of organic constituents detected.
Flash point	1010, 1020, ASTM D93, D3828 or process knowledge	Determine if waste is characteristically ignitable.
Corrosivity/Acidity, pH or Corrosivity toward steel	ACMM 7012[b], 9040, 9045C, 9041 or process knowledge	Determine if the waste is characteristically corrosive.

Table C-1. Test Methods for Waste Analysis Parameters and Rationale (continued)

PARAMETER	TEST METHOD(S)[a]	RATIONALE
Reactivity (cyanides, sulfides, water reactive, chemical stability, shock sensitive)	C003[c], 9010, 9013, 9014, 9030, 9031, 9034, or process knowledge	Determine if waste is characteristically reactive and prevent mixing of incompatible wastes in tank and treatment systems.
Free liquids	9095 Paint Filter Liquids Test, visual inspection or process knowledge	Determine whether the waste is a solid or a liquid.
Total organic carbon (TOC)	9060 or process knowledge	Determine whether organics may be present in measurable quantities.

ASTM = American Society for Testing and Materials
ACMM = Analytical Chemistry Methods Manual

a. Methods are from *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, unless otherwise stated.
b. G. L. Booman, M. C. Elliot, R. B. Kimball, F. O. Cartan, J. E. Rein, "Determination of Free Acid in the Presence of Hydrolyzable Ions," Analytical Chemistry, 30 No. 2 (February 1958), pp. 284-287.
c. Arthur D. Little, Inc., Sampling and Analysis Methods for Hazardous Waste Combustion, EPA-600/8-84-002, NTIS No. PN84-1555845, February 1984.

Table C-2. Test Methods, Parameters, and Rationale for LDR Status

PARAMETER	TEST METHOD(S)[a]	RATIONALE
Toxicity characteristic	1311 Toxicity Characteristic Leaching Procedure (TCLP) or process knowledge	Determine waste and LDR status for toxicity.
Metals: antimony arsenic barium beryllium cadmium chromium lead mercury nickel selenium silver thallium	3005, 3010, 3050, 3051, 3052, 6010, 7470, 7471 or process knowledge	Determine LDR status for toxicity. Evaluate mercury subcategory and UHCs.
Volatile and semi-volatile organic compounds	5030, 5035, 8015, 8082, 8260, 3510, 3550, 3600, 8270 or process knowledge	Determine listed waste and LDR status for toxicity. Evaluate UHCs.
Flash point	1010, 1020, ASTM D93, D3828 or process knowledge	Determine LDR status for ignitability.
Corrosivity/Acidity, pH or Corrosivity toward steel	ACMM 7012[b], 9040, 9045, 9041 or process knowledge	Determine LDR status for corrosivity.

Table C-2. Test Methods, Parameters, and Rationale for LDR Status (continued)

PARAMETER	TEST METHOD(S)[a]	RATIONALE
Reactivity (cyanides, sulfides, water reactive, chemical stability, shock sensitive)	C003[c], 9010, 9013, 9014, 9030, 9031, 9034, or process knowledge	Determine LDR status for reactivity and subcategory.
Total organic carbon (TOC)	9060 or process knowledge	Determine wastewater or nonwastewater category
Total suspended solids (TSS)	160.1[d] or process knowledge	Determine wastewater or nonwastewater category

ASTM = American Society for Testing and Materials
ACMM = Analytical Chemistry Methods Manual

a. Methods are from *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, unless otherwise stated.
b. G. L. Booman, M. C. Elliot, R. B. Kimball, F. O. Cartan, J. E. Rein, "Determination of Free Acid in the Presence of Hydrolyzable Ions," Analytical Chemistry, 30 No. 2 (February 1958), pp. 284-287.
c. Arthur D. Little, Inc., Sampling and Analysis Methods for Hazardous Waste Combustion, EPA-600/8-84-002, NTIS No. PN84-1555845, February 1984.
d. *Methods for Chemical Analysis for Water and Wastes*, EPA-600/4-79-020.

Wastes are characterized and LDR requirements are determined at the point of generation by facility personnel with assistance from other contractor organizations, as needed, by analyzing the waste or by applying process knowledge. The following are examples of process knowledge:

- Raw materials used – knowledge of the type, quantity, and concentration of raw materials used in the system combined with detailed knowledge of the generating process may provide enough information to adequately characterize the waste.

- Process description – pertinent details of the process generating the waste and the chemicals used in the process must be described. The more complex the process, the more information would be required.

- Chemical/material composition specifications – chemical specifications may be available from the purchase specifications of a particular chemical, from product information provided by the manufacturer, or from the labels for the particular chemical in question. For pure chemicals whose contents and characteristics are well known (e.g., nitric acid), standard chemical reference materials may supply the required information. Standard material composition reference tables may supply the required information for metals,

plastics, and other materials manufactured to certain grades, alloy specifications, etc., whose material contents and characteristics are well known (e.g., Type 304 stainless steel).

- Material Safety Data Sheets (MSDSs) – chemical specifications and related information are available on these standard reference materials. MSDSs may be provided by the manufacturer or acquired through available MSDS databases.

- Process reference materials including laboratory notebooks, strip charts, correspondence, chemical analyses, and analytical reports.

- Analytical reports from non-SW-846 chemical analyses or information from similar processes.

If process knowledge is adequate to ensure that a particular constituent is not present in the waste, then analysis for that constituent will not be performed. For instance, if the waste comes from a well-defined aqueous process, and no organic chemicals are associated with that process, then analysis for volatile or semi-volatile organics will not be conducted. Similarly, if there is no reason to suspect pesticides or herbicides, analysis for those substances will not be conducted. If process knowledge is not sufficient to eliminate a particular parameter, then that parameter will undergo selection for testing.

Specific parameters selected for RCRA characterization analysis are determined on a case-by-case basis. Facility personnel select the appropriate parameters based on knowledge of the waste source, unit-specific waste acceptance criteria, and characterization requirements to identify RCRA-regulated wastes. This ensures that the appropriate parameter selection will be matched with the correct analytical method(s) to generate the data required for subsequent management of the waste within the ILWMS.

All process knowledge determinations and RCRA characterization analytical results are documented in the facility operating record.

LDR requirements identified at the point of generation are carried through the entire ILWMS. Compliance with the required treatment standards specified in IDAPA 58.01.05.011 (40 CFR § 268) is evaluated following treatment in the IWTU. Required LDR notifications are prepared prior to shipment of any treatment residuals for final disposal.

C-2a(1) Waste Acceptance Criteria

Any wastes accepted at the waste management units addressed in this permit must meet the WAC as defined below. Prior to being accepted at these units, a Waste Generator Services (WGS) Facility Representative (FR), with assistance from an assigned WGS Waste Technical Specialist (WTS), evaluates

each waste to ensure the WAC have been met. The waste acceptance process is described in detail in Section C-2a(2) of this WAP. The WAC are dependent on the waste form, EPA HWNs specified on the Part A, method of characterization, waste characteristics, and packaging. Waste generators or INTEC point-of-generation personnel, in cooperation with WGS, are responsible for performing necessary characterization in accordance with the methods specified in this section (See Tables C-1 and C-2).

The following wastes are prohibited from the waste management units addressed in this permit:

- Wastes designated with EPA HWNs not identified on the Part A permit application for the specified receiving treatment and/or storage unit
- Incompatible wastes within the same tank system or wastes not compatible with the tank system in which they are stored
- Wastes with no free liquids(except for the IWTU Vault Loading and Vault Storage Areas)
- Wastes with high solids content that cannot be separated from the liquid portion (PEWE, LET&D, and ETS only)
- Foaming agents
- Polymerizing materials in sufficient concentration to preclude effective blending
- High TOC subcategory ignitables (EPA HWN D001 with $\geq$ 10% total organic carbon)
- Waste containing mercury $\geq$ 3,000 ppm in solution (for the ETS and IWTU)
- Waste containing mercury $\geq$ 260 ppm (for the PEWE and LET&D)
- Ethylene
- Glycerol
- Sodium Glycerite
- Stoddard Solvent
- Unstable, shock-sensitive, and Department of Transportation (DOT)-defined pyrophoric materials
- Unknown wastes
- Wastes containing DOT Class 1 explosives or Class 4 Division 4.1 flammable solids meeting the definition of a wetted explosive, as identified in 49 CFR 173 Subpart C
- Active pathogens, infectious, or etiologic agents

- Wastes that do not comply with the 40 CFR 268.3 dilution prohibition
- Wastes that generate liquid treatment residuals possessing constituents that do not comply with the WAC of downstream treatment, storage, or disposal units (e.g., the LET&D facility). This assessment is performed on a case-by-case basis.

C-2a(2) Waste Acceptance Process

When an activity is expected to generate a new waste, or upon the generation of a waste, a WGS FR is contacted for guidance and a Waste Determination and Disposition Form (WDDF) is completed if the waste stream does not match an existing profile. The WDDF provides the preacceptance certification needed prior to accepting on-Site wastes.

The first two parts of the WDDF are prepared by the generator with assistance from WGS and other organizations, as necessary, to document the characteristics, pertinent details, and probable waste type of the proposed waste based on process knowledge from the generator. The first two parts of the WDDF include:

> Section I: Process Knowledge Evaluation - This section includes information provided by the generator based on their knowledge of the processes and materials involved in generating the waste. Process knowledge is used in addition to or in place of sampling and analysis to determine if a waste is RCRA hazardous and to classify it in order to meet treatment, storage, and disposal requirements. If the waste is clearly not a RCRA-regulated hazardous waste, it is managed in accordance with its properties (e.g., low-level, industrial, etc.).
>
> Section II: Probable Waste Type - This section is used to make a preliminary determination of the waste type and probable waste codes that apply based on an evaluation of the information provided by the generator in Section I.

The third part of the WDDF is completed by the WTS to finalize the planned waste determination and disposition of the proposed waste. This part of the WDDF includes:

> Section III: Waste Determination and Disposition - This section is completed by determining the regulatory and procedural requirements of the waste stream from information included in the first two sections.

The WDDF is a dynamic document that is subject to revision. As a best management practice, an annual review and recertification is required for all active waste streams. The generator is also required to notify WGS of any process changes. WGS evaluates the changes with the generator to determine potential

effects on the waste characterization. If it is determined that the characterization of a given waste stream changes, the WDDF is revised to reflect the change. An example of a typical WDDF is included as Appendix C-3.

Exhibit C-1 presents a flow diagram of the waste acceptance process for on-Site waste. An initial process knowledge evaluation of the waste stream is conducted to determine if the waste is from a recurring stream with an approved waste profile on file. If the stream has an approved profile on file, the process and waste are evaluated to ensure the waste is consistent with the approved profile. All approved waste stream profiles are reevaluated in accordance with Section C-2d, "Frequency of Analysis," of the waste acceptance process.

If the waste is determined to be RCRA-regulated, based on the initial data obtained from the hazardous waste determination, the WTS performs an LDR evaluation and then evaluates the TSDF options available. Once an appropriate TSDF is identified, the WTS arranges for additional waste characterization, as needed, for acceptance to the TSDF. Waste characterization data and supporting documentation are maintained and made available for both generators and TSDFs.

If the waste stream does not meet the acceptance criteria for the intended unit(s), another TSDF is identified (either on- or off-Site) that can compliantly accept the waste. Compliance with "acceptance criteria" implies compliance with the requirements of the unit-specific Part A permit application, Attachment 1, Section D, and adherence to the list of prohibited items in Attachment 2, Section C-2a(1).

When submittal of a new WDDF is required, in accordance with Section C-2d, "Frequency of Analysis," a new waste acceptance evaluation is conducted. Recertification of existing waste streams requires written and signed documentation from the generator stating that the waste stream and corresponding WDDF remain the same as presently approved by the WTS. Recertification also requires that there have been no significant changes in the process generating the waste, the physical and chemical properties of the waste, or the LDR status of the waste per IDAPA regulations. Recertification of waste streams for the ILWMS is conducted annually.

Liquid wastes to be received at the waste management units addressed in this permit may be received from other INL locations. The same characterization and waste acceptance methodology will be applied for wastes received into the ILWMS, regardless of the point of generation.

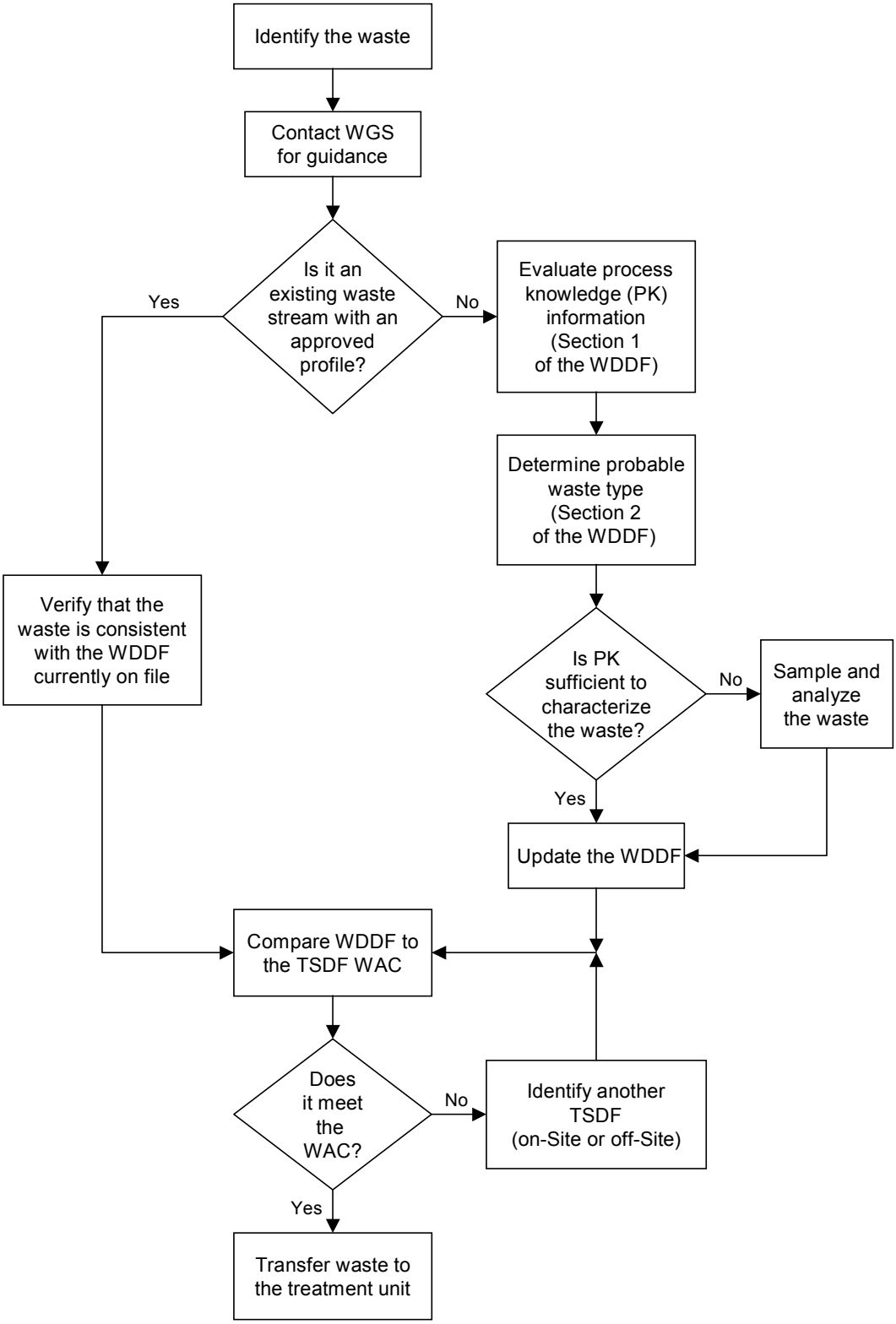

Exhibit C-1. Waste Acceptance Flow Diagram for On-Site Waste.

Wastes transferred within the INTEC perimeter are not subject to DOT shipping requirements. Shipping and receipt of waste from outside the INL is subject to DOT shipping requirements. For those shipments within the INL geographic boundaries, compliance with DOE Order 460.01B (or successor applicable DOE Orders) is required.

LDR Requirements

Point-of-generation facility personnel provide waste characterization information and use this information to complete LDR notifications, per IDAPA 58.01.05.011 (40 CFR § 268.7). In cases where facility personnel determine that an LDR waste does not meet the applicable treatment standard(s) set forth in IDAPA 58.01.05.011 (40 CFR § 268, Subpart D), or exceeds the applicable prohibition level(s) set forth in IDAPA 58.01.05.011 (40 CFR § 268.32) or Section 3004(d) of RCRA, facility personnel provide written notice in accordance with IDAPA 58.01.05.011 (40 CFR § 268.7).

In cases where facility personnel determine that a restricted waste is being managed that can be land-disposed without further treatment, facility personnel submit written notice stating that the waste meets (or is exempt from) applicable treatment standards set forth in IDAPA 58.01.05.011 (40 CFR § 268, Subpart D) and the applicable prohibition level(s) set forth in IDAPA 58.01.05.011 (40 CFR § 268.32) or Section 3004(d) of RCRA. The notice must be in accordance with IDAPA 58.01.05.011 (40 CFR § 268.7).

Required LDR notices are provided by point-of-generation facility personnel. The notifications are reviewed by facility personnel prior to waste treatment and are entered into the treatment unit's operating log. LDR requirements identified at the point of generation are carried through the entire ILWMS. Compliance with the required treatment standards specified in IDAPA 58.01.05.011 (40 CFR § 268) is evaluated following treatment in the IWTU. Required LDR notifications are prepared prior to shipment of any treatment residuals for final disposal.

C-2b Test Methods: [IDAPA 58.01.05.008; 40 CFR § 264.13(b)(2)]

Waste Analysis

Analytical methods employed are primarily taken from *EPA's Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846, Third Edition or later). In those cases where method-defined parameters[1] are required by regulation, SW-846 methods are always employed. Examples of method-defined parameter methods, where the analytical result is wholly dependent on the process used to make the measurement, include the use of the toxicity characteristic leaching procedure (TCLP) to prepare a leachate, flash point, pH, corrosivity tests, and paint filter liquids. The cited test methods will be performed at the laboratories per controlled implementing procedures.

The U.S. EPA provides for a degree of flexibility in the use of SW-846 and other approved methods. This flexibility is dependent on the maintenance of precision, accuracy (or bias), recovery, representativeness, comparability, and sensitivity (detection, quantitation, or reporting limits) relative to the data quality objectives for the intended use of the analytical results. "If an alternative analytical

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[1]The use of an SW-846 method is mandatory for the following Resource Conservation and Recovery Act (RCRA) applications contained in 40 CFR Parts 260 through 270:

- Section 260.22(d)(1)(i) - Submission of data in support of petitions to exclude a waste produced at a particular facility (i.e., delisting petitions)
- Section 261.22(a)(1) and (2) - Evaluation of waste against the corrosivity characteristic
- Section 261.24(a) - Leaching procedure for evaluation of waste against the toxicity characteristic
- Section 261.35(b)(2)(iii)(A) - Evaluation of rinsates from wood preserving cleaning processes
- Sections 264.190(a), 264.314(c), 265.190(a), and 265.314(d) - Evaluation of waste to determine if a free liquid is a component of the waste
- Sections 264.1034(d)(1)(iii) and 265.1034(d)(1)(iii) - Evaluation of organic emissions from process vents
- Sections 264.1063(d)(2) and 265.1063(d)(2) - Evaluation of organic emissions from equipment leaks
- Section 266.106(a) - Evaluation of metals from boilers and furnaces
- Sections 266.112(b)(1) and (2)(i) - Certain analyses in support of exclusion from the definition of a hazardous waste for a residue which was derived from burning hazardous waste in boilers and industrial furnaces
- Sections 268.7(a), 268.40(a), (b), and (f), 268.41(a), 268.43(a) - Leaching procedure for evaluation of waste to determine compliance with land disposal treatment standards
- Sections 270.19(c)(1)(iii) and (iv), and 270.62(b)(2)(i)(C) and (D) - Analysis and approximate quantification of the hazardous constituents identified in the waste prior to conducting a trial burn in support of an application for a hazardous waste incineration permit
- Sections 270.22(a)(2)(ii)(B) and 270.66(c)(2)(i) and (ii) - Analysis conducted in support of a destruction and removal efficiency (DRE) trial burn waiver for boilers and industrial furnaces burning low risk wastes, and analysis and approximate quantification conducted for a trial burn in support of an application for a permit to burn hazardous waste in a boiler and industrial furnace. Federal Register, Thursday, November 20, 1997, Vol. 62, No. 224, 62079.

procedure is employed, then EPA expects the laboratory to demonstrate and document that the procedure is capable of providing appropriate performance for its intended application. This demonstration must not be performed after the fact, but as part of the laboratory's initial demonstration of proficiency with the method. The documentation should be in writing, maintained in the laboratory, and available for inspection upon request by authorized representatives of the appropriate regulatory authorities" (SW-846, Chapter Two, "Choosing the Correct Procedure").

Joint EPA/NRC guidance[2] for mixed waste also provides flexibility in sample sizes with method-defined parameter methods, as long as the resulting test is sufficiently sensitive to measure the constituents of interest at the regulatory levels prescribed in the TCLP. Other variances to published testing and sampling protocols are permissible under 40 CFR §§ 260.20-21, but must be approved prior to implementation by the Director of the Department of Environmental Quality (DEQ).

The EPA allows for the use of recognized methods other than those prescribed in SW-846. "Whenever methods from SW-846 are not appropriate, recognized methods from source documents published by the EPA, American Public Health Association (APHA), American Society for Testing and Materials (ASTM), the National Institute for Occupational Safety and Health (NIOSH), or other recognized organizations with appropriate expertise should be used, if possible" (SW-846, Chapter One).

Because of the broad range of acceptable methods available for testing specific constituents, and with the rapid incorporation/deletion of methods, not all of the SW-846 methods are specified in Tables C-1 and C-2. Only the currently defined parameter methods are specified.

Certain waste streams are generated at the INTEC that require remote handling and are subject to full RCRA characterization requirements. The remote sample handling requirements and specific process stream requirements may cause deviations in some required analyses systems. For example, the EPA has determined that "if the analyst can demonstrate that the test is still sufficiently sensitive (in the case of reduced sample size in a TCLP extraction) to measure the constituents of interest at the regulatory levels specified in the TCLP and representative of the waste stream being tested" then the sample size can be legitimately decreased[3]. Sample size becomes a critical factor, especially with respect to radiation exposure hazards, and therefore, must be a factor for consideration in any sampling or analytical activity.

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[2] *Federal Register*, Thursday, November 20, 1997, Vol. 62, No. 224, 62079.

[3] Federal Register, Thursday, November 20, 1997, Vol. 62, No. 224, 62079.

The analyses may be performed at INL laboratories or at approved off-Site laboratories. Laboratories contracted by the DOE-designated contractor to perform outside work are audited periodically, to ensure that each laboratory's quality control procedures and standard practices manuals meet the requirements for laboratories conducting EPA test procedures. If the laboratory has not been audited, or has failed to conform to the audit criteria, that laboratory is not authorized by the DOE-designated contractor to conduct waste characterization analysis.

Process Knowledge

The EPA/Nuclear Regulatory Commission (NRC) guidance emphasizes the use of process knowledge to determine if a radioactive waste is hazardous, as a way to avoid unnecessary exposures to radioactivity. Examples of the types of process knowledge information used to characterize wastes for the ILWMS are presented in Attachment 2, Section C-2a of this permit. The INL documents process knowledge through WDDFs (waste stream profiles), correspondence, and memoranda maintained in the Document Management System. As a best management practice, the characterization documentation for all active waste streams is reviewed and each stream recertified annually to ensure the information maintained remains accurate and complete.

All waste characterization information, including documentation of process knowledge, is maintained in the facility operating record.

C-2c Sampling Methods: [IDAPA 58.01.05.008 and 005; 40 CFR § 264.13(b)(3), Part 261 Appendix I]

Facility personnel, in conjunction with WGS, and other organizations as needed, are responsible for initially characterizing wastes before they are received into the ILWMS. Personnel can use process knowledge and/or testing to adequately characterize waste. As part of characterization, the appropriate sampling method is selected based on knowledge of the waste material matrix (e.g., solid, liquid, sludge, radiological component) and radiation exposure considerations, as well as the specific analyte of interest. Facility personnel are also responsible for arranging all sampling and laboratory support and for sample shipments. Sampling personnel document the sampling activities and chain of custody.

Representative waste samples are obtained in accordance with the sampling approaches described in Chapter Nine of *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846, current edition). Samples are collected using appropriate equipment and methods identified in, but not limited to, the following sources:

- EPA Test Methods for Evaluating Solid Waste, SW-846, Chapter 10, "Sampling Methods," Third Edition
- 40 CFR 261, Appendix I, "Representative Sampling Methods"
- Annual Book of ASTM Standards, American Society for Testing and Materials, Current issue
- Characterization of Hazardous Waste Sites - A Methods Manual, Volume II, Available Sampling Methods, EPA-600/4-84-076, 2nd Edition, December 1984
- "Characterizing Heterogeneous Wastes: Methods and Recommendations," EPA/600/R-92/033, February 1992
- EPA Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes: A Guidance Manual, April 1994
- Other recognized methods from source documents published by the EPA, American Public Health Association, American Society for Testing and Materials, the National Institute for Occupational Safety and Health, or other recognized organizations with appropriate expertise.

Sampling methods that deviate from approved or other recognized methods must be approved prior to implementation by the Director of the DEQ.

C-2c(1) Standard Sampling Methods

Samples from the ILWMS are typically collected through double hypodermic-needle (double-needle) samplers, sample nozzles, or spigots. Both double-needle samplers and sample nozzles utilize airflow to induce a vacuum that draws liquids from the system into sample vials/containers. Due to the radioactive nature of wastes handled in the ILWMS, much of the tank and miscellaneous treatment systems are constructed below ground for shielding purposes. In order to comply with DOE orders to maintain personnel exposure to radiation as low as reasonably achievable (ALARA), these sampling methods are employed in lieu of mechanical devices such as pumps. Mechanical devices would require the generation of large quantities of decontamination solutions to perform preventive maintenance, require confined space entries, and result in personnel exposure to high radiation. Utilizing airflow sampling devices has resulted in fewer sampling failures and dramatically reduces exposure hazards to sampling personnel. Some gravity-flow spigot samplers are located in areas where access and reduced exposure hazard allow. Appendix IV of this permit contains a report from Science Applications International Corporation entitled, "Final Report for Organics Partitioning Resulting from Operation of an INTEC Double-Needle Sampler, Revision 1," dated September 24, 2002. This study compares organic concentrations obtained from double-needle and spigot sampling techniques to determine whether

potential stripping of organics occurs. The results of these tests indicate that INTEC sample collection and handling procedures do not significantly affect the concentration of volatile or semi-volatile organic constituents in the waste stream.

Liquid sampling is conducted in accordance with approved sampling and operating procedures which provide instructions for sampling and handling high radiation liquids and other special considerations. In general, where standard samples are collected, the following basic sampling procedure is used as appropriate:

- Obtain samples using precleaned sample equipment, in accordance with the applicable method.
- Fill sample containers. Uniquely identify and label each sample, and document necessary information in the field record (e.g., location, time, characteristics).
- Properly clean and decontaminate the exterior of the sample containers and the sampling hardware.
- Complete the chain-of-custody forms and retain a record copy.
- Deliver the samples and associated forms to the laboratory.

Sampling procedures for certain mixed wastes may deviate from the standard sampling protocols, due to the hazards associated with radioactive materials. For example, due to radiological concerns, the use of remotely operated sample transfer systems may limit the size of sample containers, prevent sealing of the transfer receptacle, or preclude chain-of-custody and other documentation from directly accompanying the samples. However, all sampling procedures are consistent with the stated goals of SW-846, to collect representative samples and to maintain their physical and chemical integrity.

Equipment used to sample waste is disposable or designed for decontamination. Contaminated disposable equipment is managed appropriately. Equipment that can be cleaned and reused is thoroughly decontaminated before reuse or storage. Decontamination solutions are managed appropriately.

C-2c(1)(a) Field Records

Records provide direct evidence and support for the necessary technical interpretations, judgments, and discussions concerning project activities. These records, particularly those anticipated to be used as evidentiary data, directly support current or ongoing technical studies and activities, and provide the historical evidence needed for later reviews and analyses.

Field records may consist of bound field notebooks, sample collection forms, personnel qualification and training forms, sample location maps, equipment maintenance documentation, chain-of-custody forms, and/or sample analysis request forms. Records may include, but are not limited to the following, as applicable:

- Sample Collection - To ensure maximum utility of the sampling effort and resulting data, documentation of sampling protocol, as performed in the field, is essential. Sample collection records may contain the names of persons conducting the activity, sample number, sample location, date and time the sample was taken, equipment used, climatic conditions, documentation of adherence to protocol, and unusual observations.

- Chain-of-Custody Records - The chain of custody involving the possession of RCRA characterization samples from the time they are obtained until they are disposed or shipped off-Site are documented, and may include the project name, signatures of samplers, sample number, date and time of collection, grab or composite sample designation, signatures of individuals involved in sample transfer; and if applicable, the air bill or other shipping number.

- Quality Control (QC) Samples - Documentation for generation of QC samples, such as trip and equipment rinsate blanks, duplicate samples, and any field spikes, are maintained.

- Deviations - All deviations from normal sampling and analysis protocols are recorded in the site logbook or project records.

- Reports - A copy of any report issued and any supporting documentation are retained.

C-2c(2) Quality Control

Defensible and valid data are obtained through implementation of the processes controlling characterization and/or sampling and analysis. Such processes include the use of field and laboratory control samples, data validation, sampling performance assessments, and as necessary, corrective action(s) as identified in this section.

C-2c(2)(a) Field Control Samples

Control samples are QC samples that are intended to monitor the performance of the sampling system. In accordance with this WAP, the following field control samples may be collected:

- Field duplicates
- Equipment rinsate
- Trip blank-sample.

C-2c(2)(b) Laboratory Quality Control

Laboratories maintain QA programs to ensure the quality of data produced. Depending on the data end use and overall data quality objectives (DQOs), the laboratory QC samples may include:

- Matrix spike
- Matrix duplicate
- Matrix spike duplicate
- Laboratory blanks
- Control standards.

Off-Site laboratories must be INL approved. This approval process requires off-Site laboratories to pass stringent audit criteria included in the DOE Environmental Management Consolidated Audit Program (EMCAP). The EMCAP maintains audit checklists for such laboratory activities as general laboratory practices, quality assurance management systems, organic/inorganic data quality, radiochemistry data quality, electronic data management, hazardous and radioactive materials management, and industrial hygiene. These checklists are available to all facilities within the DOE complex via the internet, promoting thorough and consistent evaluation of all analytical facilities. Once approved, laboratories are audited at regular intervals to ensure performance and QA/QC standards are met.

C-2c(2)(c) Data Validation

Depending on the data end use and overall project DQOs, data validation may include evaluation of the following subjects:

- Completeness of laboratory records with regard to processing of all required samples and analyses
- Implementation of appropriate procedures
- Evaluation of sample analytical data to required detection and quantity
- Evaluation of QC analytical data to applicable control criteria
- Comparison of sample holding times to the required holding times prescribed by this WAP.

All deviations from the applicable guidance are documented and corrective actions implemented as necessary.

C-2c(2)(d) Sampling Performance Assessment

A key function of a QC program is the periodic assessment of activities for conformance to required protocols. Sampling performance assessments may evaluate the following activities:

- Completeness of Field Reports - This evaluation determines that a complete record exists for each field activity and that the procedures specified by this WAP or the documents implementing this WAP were executed.
- Identification of Valid Samples - This review involves the evaluation and interpretation of field records to detect problems affecting the representativeness of samples.

All resultant concerns are documented and corrective actions implemented as necessary.

C-2c(2)(e) Corrective Action

Corrective action measures can be divided into two categories as follows:

- Project Corrective Action - Corrective actions are performed when the project objectives are not met, when conditions adverse to quality have been identified, or when an assessment of data reveals questionable or unknown data quality. Conditions adverse to quality are identified promptly, and corrected as soon as possible. When significant conditions adverse to quality are identified, the causes are determined, and corrective actions to prevent their recurrence are performed and documented.

- Laboratory Corrective Actions - The laboratory possesses a QA plan identifying analytical acceptance criteria and what actions to take when these criteria are not satisfied.

C-2c(3) Process Sampling

Process samples are collected on a routine basis prior to transfers from waste collection tanks to the PEWE, LET&D, ETS, and IWTU systems. Process samples are analyzed for specified parameters to ensure ILWMS tolerance limits are met and to promote optimum operability of the miscellaneous treatment units. In some instances it may be possible to blend wastes or introduce additives, such as complexing agents, to bring constituents within the unit tolerance limits provided in Attachment 1, Section D-8b(5) of this permit.

Table C-3 identifies where and when process sampling is conducted and identifies the parameters that may be examined for samples from each location. Process samples may also undergo analyses for total radiation or specific radionuclides. These parameters are not listed in Table C-3.

Process sampling is conducted to optimize system performance, not for RCRA characterization of wastes. Therefore chain of custody and RCRA QC procedures are not followed for process samples. In addition, duplicate samples and field blanks are not generally utilized during process sampling activities. However, laboratory QA/QC procedures will be followed at all times to ensure the performance of analytical instrumentation and the validity of sample results. If process sampling results are inconsistent with the waste characterization information provided by the generator or indicate that the waste generating process may have changed, then the waste is recharacterized.

The IWTU Mercury Adsorbers, F-SRH-141 A/B, utilize sulfur impregnated GAC beds to remove vapor phase mercury that may be present in the process gas. Calculation details for the estimated mercury breakthrough for the GAC beds are featured in Appendix D-1 of this permit.

Using the design basis capacities of the IWTU Mercury Adsorbers, which are detailed in Section D of this permit, it is estimated that each bed of GAC media will hold approximately 4,300 lbs of mercury. This value is conservatively based on a bed loading of 15 weight percent. Pilot-scale testing demonstrated mercury retention approaching 20 weight percent (see Appendix XII to this permit).

Table C-3. ILWMS Typical Process Sampling Locations

LOCATION	TIME	SAMPLER TYPE	PARAMETERS	RATIONALE
NWCF Tanks VES-NCD-123, VES-NCD-129,	Prior to each transfer to the PEWE system	Double-needle	Acidity,	Indicator of a representative process sample. Inhibit formation of precipitates. Ensure compatibility.
			Specific gravity,	Indicator of a representative process sample. Promote operational efficiency.
			Aluminum,	Ensure adequate quantity to complex fluorides.
			Chlorides,	Ensure within tolerance range[a].
			Fluorides,	Ensure within tolerance range[a].
			Aluminum:Fluoride ratio,	Ensure that fluorides are adequately complexed.
			Mercury,	Determine mercury loading.
			Sulfates,	Ensure within tolerance range[a].
			Total organic carbon	Ensure compliance with Subparts AA/BB.
VES-NCC-119, VES-NCC-122	Prior to each transfer to the PEWE system unless process knowledge indicates no changes to the wastes (e.g., during ETS processing)	Double-needle	Acidity,	Indicator of a representative process sample. Inhibit formation of precipitates. Ensure compatibility.
			Flashpoint,	Ensure waste is not ignitable.
			Specific gravity,	Indicator of a representative process sample. Promote operational efficiency.
			Aluminum,	Ensure adequate quantity to complex fluorides.
			Chlorides,	Ensure within tolerance range[a].

Table C-3. ILWMS Typical Process Sampling Locations (continued)

LOCATION	TIME	SAMPLER TYPE	PARAMETERS	RATIONALE
			Fluorides, Aluminum:Fluoride ratio, Mercury, Sulfates, Total organic carbon	Ensure within tolerance range[a]. Ensure that fluorides are adequately complexed. Determine mercury loading. Ensure within tolerance range[a]. Ensure compliance with Subparts AA/BB.
Process Condensate Collection Tanks VES-WL-106, VES-WL-107, VES-WL-163	Prior to each transfer to the LET&D unless process knowledge or prior analytical results indicate that the waste is unacceptable for the LET&D	Nozzle	Acidity, Aluminum, Fluoride, Total organic carbon	Indicator of a representative process sample. Inhibit formation of precipitates. Ensure compatibility. Ensure adequate quantity to complex fluorides. Ensure within tolerance range[a]. Ensure compliance with Subparts AA/BB.

Table C-3. ILWMS Typical Process Sampling Locations (continued)

LOCATION	TIME	SAMPLER TYPE	PARAMETERS	RATIONALE
LET&D Bottoms Tank VES-WLL-195	Infrequently, to validate nitric acid concentration	Nozzle	Acidity,	Validate concentration of nitric acid.
			Chlorides,	Determine chloride carryover.
			Fluorides,	Determine fluoride carryover.
			Nitrates	Validate concentration of nitric acid.
Blend and Hold Tanks VES-NCC-101, VES-NCC-102, VES-NCC-103	Prior to each new TFF batch transfer to the ETS	Double-needle	Acidity,	Indicator of a representative process sample. Inhibit formation of precipitates. Ensure compatibility.
			Specific gravity,	Indicator of a representative process sample. Promote operational efficiency.
			Aluminum,	Ensure adequate quantity to complex fluorides.
			Chlorides,	Ensure within tolerance range[a].
			Fluorides,	Ensure within tolerance range[a].
			Aluminum:Fluoride ratio,	Ensure that fluorides are adequately complexed.
			Mercury,	Determine mercury loading.
			Sulfates,	Ensure within tolerance range[a].
			Flashpoint,	Ensure waste is not ignitable.

Table C-3. ILWMS Typical Process Sampling Locations (continued)

LOCATION	TIME	SAMPLER TYPE	PARAMETERS	RATIONALE
VES-NCC-102, VES-NCC-103	Characterization of the TFF tanks is complete. When characterized tanks are blended the ratios for the feed will be used to mathematically determine the process parameter concentrations.	Double-needle	Acidity Specific gravity Chlorides Fluorides Mercury	Indicator of a representative process sample. Inhibit formation of precipitates. Ensure compatibility. Indicator of a representative process sample. Promote operational efficiency. Ensure within tolerance range[a] Ensure within tolerance range[a] Determine mercury loading
F-SRH-141A/B	Monthly[b]	Offgas sampler	Mercury	Determine whether Mercury Adsorber primary and/or secondary bed material should be replaced

a. ILWMS tolerance limits are provided in Section D-8b(5).

b. Inspections will be increased to weekly upon reaching 85% estimated loading of the primary bed (approximately 30 days prior to forecasted breakthrough)

Mercury sample nozzles are provided across each of the carbon beds and also across both combined beds. Mercury detection will be performed by obtaining samples and having the samples analyzed at a laboratory facility on a frequency of once per month. Upon reaching 85% estimated bed loading of the primary bed, based on the bed capacity of approximately 4,300 lbs of mercury, the sampling frequency will be increased to once per week to ensure that breakthrough of the primary bed is detected in a timely fashion. Since the Mercury Adsorbers are configured in series, any mercury that passes through the primary bed upon breakthrough is captured in the secondary bed. It is estimated that a bed will reach 85% loading approximately 30 days prior to breakthrough. With this sampling routine, an excellent history/trend of performance and removal efficiency can be reliably collected and maintained that will provide assurance of continuous efficient mercury removal.

When breakthrough of the primary GAC bed commences, mercury will be detected in the samples taken between the beds. When the mercury concentration in the offgas between the beds exceeds 50,000 µg/dscm, waste feed to the IWTU will be halted, and changeout of the spent GAC media will be initiated.

Monthly sampling of the offgas after the secondary GAC bed will be initiated when the tabulated mercury loading reaches 30% based on feed rates, waste feed composition, and a holding capacity of approximately 4,300 lbs mercury. When the mercury concentration in the offgas approaches 8.0 µg/dscm waste feed to the IWTU will be halted and changeout of the spent GAC media will be initiated.

The spent GAC media will be properly managed, stored, and disposed of in accordance with the hazardous and mixed waste requirements of Section C of this permit.

C-2d Frequency of Analyses: [IDAPA 58.01.05.008; 40 CFR § 264.13(b)(4)]

Waste stream characterizations are reviewed and recertified annually to ensure continued accuracy of the information provided. Typical waste streams managed by the ILWMS are generated several times a year from highly controlled processes in which the waste composition remains consistent for the duration of the year. Recharacterization is required when:

- The process generating an established waste stream changes
- The waste characteristics are highly variable from batch to batch

- There is reason to suspect a change in the waste based on inconsistencies in the packaging or labeling of the wastes, or there are inconsistencies between the waste verification results and the waste characterization data provided by the generator

- Facility personnel reject the waste because it is inconsistent with the profile for that waste.

Facility personnel can require additional waste analysis to substantiate waste characterization data prior to acceptance of a waste.

C-2f Additional Requirements for Ignitable, Reactive, or Incompatible Wastes: [IDAPA 58.01.05.008; 40 CFR §§ 264.13(b)(6), 40 CFR 264.17]

Each waste stream proposed for treatment or storage in the units addressed in this permit is evaluated for all applicable RCRA characteristics by WGS personnel as part of the waste characterization process. Small quantities of low TOC ignitables (EPA HWN D001) may enter the ILWMS. Sampling and analysis has demonstrated that when these small quantities of ignitable waste are aggregated with other wastes to facilitate treatment, the characteristic of ignitability is lost. However, the HWN D001 is tracked through the ILWMS to account for these ignitable materials and any underlying hazardous constituents (UHCs) to ensure proper cradle-to-grave management of mixed and hazardous wastes.

Incompatibility determinations are based on the characterization data developed by WGS during initial characterization activities. The storage and miscellaneous treatment units operate in accordance with defined procedures that demonstrate how these data are used to prevent incompatible wastes, including reactives, from contacting one-another. The tables in Appendix V of 40 CFR 264/265 and 49 CFR § 177.848 are examples of resources that may be used to determine compatibility. In addition, the quantity and concentration of wastes or chemicals to be commingled are considered for compatibility determinations.

In order to protect equipment and promote effective treatment, chemical additives may be introduced into the ILWMS. Chemicals added include:

- Nitric acid – recovered from the LET&D facility or purchased as a commercial product to inhibit the formation of precipitates and to ensure passive layer formation on stainless-steel vessels and piping

- Aluminum nitrate – purchased as commercial product to complex fluorides, reducing corrosion to the system

- Sodium hydroxide (rust remover) – purchased as a commercial product for descaling equipment.

Other chemical commercial products, including oxalic acid and potassium permanganate, may be used during decontamination activities. These chemicals are not added to promote treatment of wastes and are therefore not considered tank treatment (T01).

The chemical additives described above are typically added to tank systems through decontamination headers/lines or through preventative maintenance areas. Mixing occurs via air sparge, mechanical mixers, or recirculation. Chemical addition is controlled through standard operating procedures, which specify the quantity/concentration of each chemical to be added and require review and approval by a system engineer. These controls maintain compatibility and provide adequate protection of equipment.

The WTS evaluates for the characteristic of reactivity during the waste characterization process. If, based on the information provided by the source generating the waste, the waste is a new, unused chemical product that is either a P- or U-listed waste for which reactivity is the basis for listing, the waste is considered a reactive waste. If the waste is a mixture that contains P- or U-listed constituents for which reactivity is the basis for listing, the waste is evaluated to determine if the waste matrix will be a reactive waste. Consideration must be given to concentration, purity, and processes in which the chemicals have been previously employed, the matrix in which they may be combined, specific characteristics of the chemicals (i.e., volatility, mobility, reaction to water and/or other solvents, viscosity, density, pH, etc.), cumulative chemical effects, and the time the chemical constituents have been in contact with each other. The ILWMS will not manage wastes that exhibit the characteristic of reactivity, EPA HWN D003.

The safety analysis documentation for the ILWMS indicates that, under the proper conditions, two potentially explosive reactions could occur. These reactions are tributyl phosphate (TBP) with nitric acid and hexone with nitric acid.

Conditions necessary for a TBP/nitric acid reaction include appropriate TBP concentration and elevated temperature (studies have shown that this reaction does not become extremely exothermic until the solution reaches 186° C).

In order for a hexone/nitric acid reaction to occur, similar conditions must exist. A reaction can only be sustained if an adequate concentration of hexone is present and necessary temperature requirements are met.

Provided as Appendix C-2 to this section of the permit is a report entitled, "Organic Compounds in INTEC Tank Farm Waste," ICP/EXT-05-00962, September 2005. This report summarizes historical analytical results from samples of INTEC TFF wastes. Tables 5, 6, and 8 of this report show analytical results for wastes currently stored in tanks VES-WM-189 and VES-WM-188. The waste contained in VES-WM-187 is derived from similar processes and has been processed and mixed in the ILWMS in the same way as the other tanks. These results show that TFF liquids contain less than or equal to 44 parts per billion of TBP and less than or equal to 10 parts per billion of hexone. Furthermore, TBP and hexone are no longer used at INTEC. Therefore, additional volumes of these compounds will not be introduced into ILWMS feed streams. The low reactant concentrations in the waste that would be available for potentially explosive TBP/nitric acid and hexone/nitric acid reactions mitigate any risk to ILWMS operations.

C-3 WASTE ANALYSIS REQUIREMENTS PERTAINING TO LAND DISPOSAL RESTRICTIONS [IDAPA 58.01.05.011; 40 CFR § 268]

The Hazardous and Solid Waste Amendments to RCRA authorize the land disposal of certain types of wastes only if LDR treatment standards are met. Information provided in this section describes the additional characterization requirements for assessing LDR applicability and compliance with the treatment standards before land disposal.

C-3a Waste Characterization

The ILWMS is a highly acidic waste treatment system. The system is designed and operated as part of an overall liquid waste treatment train. Maintaining an acidic condition is necessary in order to keep metals and radioactive isotopes in solution and prevent chloride- and fluoride-induced corrosion. The waste undergoing treatment is a known restricted waste due to corrosivity, toxicity characteristics for metals, and previous receipt of listed waste into the system.

LDR applicability is determined for each waste at the point of generation based on the EPA HWNs assigned to individual waste streams. Before receipt into the ILWMS, wastes undergo initial characterization for EPA HWN applicability and LDR requirements. Once LDRs are identified, they remain applicable through treatment and/or disposal of the final waste form produced by the IWTU. Final assessment and compliance with LDR treatment standards will take place before land disposal by evaluating the final waste form. This assessment will take place on-Site and appropriate LDR notifications will be completed as described in Attachment 2, Section C-2a(2) of this permit. Applicable

LDR documentation will be provided to the disposal facility in accordance with IDAPA 58.01.05.011 (40 CFR § 268.7).

The characterization process for purposes of LDR is the same as that employed during the initial characterization process noted in past sections. Facility personnel, with the assistance of WGS, and other organizations as needed, conduct hazardous waste determinations before management of the waste. The hazardous waste determination includes, where applicable, characteristic and listed EPA HWN determinations in addition to identification of wastewater and non-wastewater treatability groups, UHCs, LDR subcategories, and LDR treatment standards applicable to the waste.

During the initial characterization process, facility personnel select parameters and rationale for testing based on the rationale presented in Table C-2 and on the applicable LDR requirements found within IDAPA 58.01.05.011 and 40 CFR § 268 or process knowledge. If the waste is determined to be subject to the LDR requirements, facility personnel determine if the waste is a wastewater or non-wastewater and also determine applicable subcategories. Total organic carbon (TOC) and total suspended solids (TSS) analyses may be used to conduct wastewater/non-wastewater determinations, in cases where process knowledge is not adequate. Additional information on the characterization process is found in Sections C-1 and C-2.

Waste generated at the ILWMS from activities such as maintenance and spill cleanup will undergo a hazardous waste determination based on testing and/or process knowledge as outlined within this document before it is returned to the ILWMS or managed elsewhere. If the waste is determined to be subject to LDR requirements, facility personnel will determine if the waste is a wastewater or non-wastewater and applicable subcategories using the parameters shown in Table C-2 or process knowledge.

C-3b Sampling and Analytical Procedures

Sampling and analysis will follow the same approach as outlined within Sections C-2 through C-2c. Test methods used to assess LDR treatment standards will be based on total analysis unless otherwise specified in IDAPA 58.01.05.011 (40 CFR §§ 268.40 through 268.48).

C-3c Frequency of Analysis

Compliance with applicable LDR requirements will be demonstrated and documented prior to disposal of the final waste form. All LDR compliance documentation will be maintained in the facility operating record.

C-3d Additional requirements for treatment facilities

C-3d(2) Analysis of treatment residues

Treatment residues produced by the units described in this permit include: 1) PEWE overhead condensate that is subsequently processed in the LET&D facility; 2) PEWE bottoms that are returned to the TFF; 3) LET&D bottoms that are primarily comprised of recovered nitric acid and used elsewhere at the INTEC in lieu of purchasing commercial-grade nitric acid, 4) ETS overhead condensate that is subsequently processed in the PEWE, 5) ETS bottoms that are returned to the TFF, and 6) IWTU treatment product collected in IWTU reformers and filtration devices. Analyses of many of these treatment residuals for the purposes of RCRA characterization are conducted infrequently because the PEWE, LET&D, and ETS are part of an overall treatment train. The PEWE was constructed of materials compatible with ETS overheads. Since the PEWE is the next step in the overall treatment process, characterization of ETS overhead condensate is not routinely performed. Similarly, the LET&D facility was specifically designed and constructed of materials to process PEWE overhead condensate. Since the LET&D is the next step in the treatment train, characterization of PEWE overhead condensate is not routinely performed. However, process sampling of treatment residuals is normally conducted to ensure optimum operation of the overall treatment process.

Complete RCRA characterization of IWTU treatment product and ILWMS secondary wastes is completed as required by the ultimate disposal facility and is performed as described in C-2a(2) of this permit. Treatment residuals produced from this process will be analyzed for all applicable LDR treatment standards. Compliance with appropriate LDR requirements will be documented prior to land disposal. LDR documentation will be maintained in the facility operating record.

C-3d(3) Sampling and analytical procedures

Sampling and analysis will follow the same approach as outlined within Sections C-2 through C-2c. Test methods used to assess LDR treatment standards will be based on total analysis unless otherwise specified in IDAPA 58.01.05.011 (40 CFR §§ 268.40 through 268.48).

C-3d(4) Frequency of analysis

Compliance with applicable LDR requirements will be demonstrated and documented prior to disposal of the final waste form. All LDR compliance documentation will be maintained in the facility operating record.

C-4 SUBPART AA, SUBPART BB AND SUBPART CC APPLICABILITY [IDAPA 58.01.05.008; 40 CFR §§ 264.1030, 264.1050, AND 264.1080]

40 CFR 264 Subpart AA Applicability

40 CFR 264 Subpart AA requires owners or operators of facilities with process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations managing hazardous wastes with organic concentrations of at least 10 ppmw to either: 1) reduce total organic emissions from all affected process vents at the facility below 1.4 kg/hr (3 lb/hr) and 2.8 Mg/yr (3.1 tons/yr); or 2) reduce, by use of a control device, total organic emissions from all affected process vents at the facility by 95 weight percent. A process vent is defined in 40 CFR 264.1031 as any open-ended pipe or stack that is vented to the atmosphere either directly, through a vacuum-producing system, or through a tank associated with hazardous waste distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations.

The IWTU does not involve distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations. As such, the IWTU stack does not meet the definition of a process vent in IDAPA 58.01.05.008 (40 CFR § 264.1031) and the requirements specified in 40 CFR 264 Subpart AA do not apply.

The PEWE and ETS offgas is processed through vessel offgas systems in Buildings CPP-604 and CPP-659 respectively and then sent to the APS in Building 649, prior to discharge to the main stack. Therefore, the PEWE and ETS vents do not meet the definition of a process vent and IDAPA 58.01.05.008 [40 CFR § 264.1031] does not apply.

Wastes in the process condensate collection tanks (VES-WL-106, -107, and -163) are sampled for TOC before being transferred to the LET&D facility. Historical sample results of the LET&D feed have been in the range of 30 to 200 ppm for TOC. Therefore 40 CFR Subpart AA is applicable to the LET&D facility.

The LET&D facility offgas system TOC emissions are controlled per the following calculations and methodology:

3 lbs/hr (454 g/lb) = 1362 g/hr = 1,362,000 mg/hr;

maximum feed rate = 550 gal/hour;

(550 gal/hr) (3.785 liters/gal) = 2,079 L/hr

(1,362,000 mg/hr) / (2,079 L/hr) = 655.1 milligrams/L = 655.1 ppm

To account for any potential sampling problems or analysis deviation, the LET&D feed limit has been set at 550 ppm. The maximum feed rate is 550 gallons per hour, and the minimum feed rate is design-limited to 275 gallons per hour, which would allow up to 800 ppm organics in the feed, assuming that all the organics are carried out in the offgas.

If sample analyses for TOC were greater than 800 ppm, the solution would not be fed to the LET&D and would be blended with other feed streams and recycled back to the PEWE system for reprocessing. The maximum TOC sample analysis of 800 ppm limits the feed rate of the LET&D to 275 gallons per hour. A TOC sample analysis of 550 ppm allows the LET&D to operate at 550 gallons per hour. The feed rate is adjusted linearly between 550 ppm and 800 ppm. If the feed rate is adjusted to less than the LET&D minimum feed rate of 275 gal/hr, based upon the TOC content of the feed, the system recycles the solution back to the PEWE system.

The feed rate in the LET&D is maintained to ensure TOC emissions are less than 3 lb/hr to ensure compliance with this regulation.

40 CFR 264 Subpart BB Applicability

IDAPA 58.01.05.008 (40 CFR 264 Subpart BB) applies to equipment that contains or contacts hazardous wastes with organic concentrations of at least 10% by weight. Sampling of the PEWE, ETS, and IWTU inputs have shown the maximum TOC contained in the waste to be less than 800 ppm.

Since the TOC is less than 10 percent by weight, the requirements of 40 CFR 264 Subpart BB do not apply.

40 CFR 264 Subpart CC Applicability

40 CFR 264.1080(b)(6) exempts from applicability a waste management unit that is used solely for the management of radioactive mixed waste in accordance with all applicable regulations under the authority of the Atomic Energy Act and the Nuclear Waste Policy Act.

Process liquids associated with the ILWMS are radioactive mixed waste and are exempt from regulation under Subpart CC.

APPENDIX C-1

Feed Composition for the SBW Waste Treatment Process

INEEL/EXT-2000-01378
Revision 4

Feed Composition for the Sodium-Bearing Waste Treatment Process

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June 2004

Idaho National Engineering and Environmental Laboratory
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Feed Composition for the Sodium-Bearing Waste Treatment Process

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ABSTRACT

A settlement agreement between the State of Idaho and the United States Department of Energy mandates that all sodium-bearing waste at the Idaho Nuclear Technology and Engineering Center, within the Idaho National Engineering and Environmental Laboratory, be treated by December 31, 2012. Detailed feed compositions are needed to design a facility to treat this waste. This report presents the expected volumes and compositions of these feed streams and the sources and assumptions used in determining them.

SUMMARY

A sodium-bearing waste (SBW) treatment facility will treat liquids and solids contained in existing tanks at the Idaho Nuclear Technology and Engineering Center (INTEC). The treatment facility will also treat additional liquid waste, called newly generated liquid waste (NGLW) that will be generated after 2005 and stored in separate tanks from the SBW.

This report presents the most recent compilation of volumes and compositions of the feed streams to the treatment processes. This report also identifies the assumptions and source documents used in calculating the treatment process feed compositions and the uncertainties in these compositions. Feeds to the treatment process will include SBW from Tanks WM-187, WM-188, and WM-189, and NGLW from Tanks WM-100, WM-101, and WM-102.

Tank WM-189 presently contains waste near its administrative capacity and no additions to this tank are expected. As of June 1, 2004, Tank WM-188 contained about 259,000 gallons of waste. Approximately 26,000 gallons of additional waste will be added to Tank WM-188 by the end of FY 2005. The composition presented in this report for waste in Tank WM-189 is based on sample analyses. The projected composition of waste in Tank WM-188 (when full) is based on analyses of a sample taken when the tank was approximately 75% full, analyses of wastes added to the tank since that time and estimated compositions of wastes that will be added to the tank.

Tank WM-187 presently contains heels that have been flushed from six other Tank Farm Facility (TFF) tanks. The dilute liquid waste in the tank is presently being evaporated to make room for concentrated waste from Tank WM-180. Transfers in and out of Tank WM-187 are expected to be complete by the end of FY 2005. A projected composition of the final waste in WM-187 is contained in this report, and is based on compositions of the different wastes that make up the final tank contents. Because of the tank heels collected in Tank WM-187, this tank has the highest undissolved solids content of any of the tanks.

Based on projections of the volumes of NGLW streams generated between now and the end of 2012, a composition of the total NGLW as of 2012 has been calculated and is presented in this report. For some NGLW streams, chemical composition data are available and have been used in generating the treatment facility feed composition. However, data for radionuclide concentrations in NGLW are extremely limited. Thus, radionuclide concentrations in NGLW are based on data for SBW. Starting in FY 2006, NGLW will be collected in tanks WM-100, WM-101, and WM-102.

Supplemental feed characterization data presented in this report includes liquid and solids properties, analysis data for past tank solids samples, estimates of uncertainties in tank compositions, and concentrations of organic species in SBW.

Analyses have been performed on 11 samples of tank solids from eight TFF tanks. These analyses provide data of both the chemical and physical properties of the solids. Tank solids have been found to be largely amorphous and contain high concentrations of Si, P, Zr, O, and Al. Equipment limitations have prevented obtaining a well-mixed sample of solids in Tank WM-187. Analysis data of solids from Tank WM-187 reflects this fact and suggests that compositional changes may occur during transfer of solids from one tank to another.

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ACRONYMS

CMACT	Calcination with MACT upgrade SBW treatment alternative
DEA	diethanolamine
EDF	engineering design file
ETS	Evaporator Tank System (formerly the High-Level Liquid Waste Evaporator)
ICPP	Idaho Chemical Processing Plant
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LDUA	light-duty utility arm
LET&D	Liquid Effluent Treatment and Disposal (facility)
MACT	maximum achievable control technology
NGLW	newly generated liquid waste
NWCF	New Waste Calcining Facility
PEW	process equipment waste
PEWE	Process Equipment Waste Evaporator
PSD	particle size distribution
RCRA	Resource Conservation and Recovery Act
SBW	sodium-bearing waste
SG	specific gravity
SVOCs	semi-volatile organic compounds
TEA	triethanolamine
TFF	Tank Farm Facility
TIC	total inorganic carbon
TOC	total organic carbon
TRU	transuranic
UDS	undissolved solids
VOCs	volatile organic compounds
WCF	Waste Calcining Facility
WIR	Waste Incidental to Reprocessing

GLOSSARY

Alternative: A holistic solution for sodium-bearing waste (SBW) treatment, including the process/technologies used, and in the larger context, the program/project and its cost, schedule, and regulatory and stakeholder environment.

Calcine/MACT or "CMACT": An SBW treatment alternative that includes upgrades to the calciner in the NWCF, a new Maximum Achievable Control Technology (MACT) compliance facility, a scrub treatment process, and possibly a new calcine packaging facility.

CsIX or Cesium Ion Exchange/TRU Grout: An SBW treatment alternative that includes filtration of solids, cesium removal by ion exchange and one of several possible methods for stabilization of the cesium-free contact-handled transuranic (TRU) waste, namely, grouting, absorption on silica gel or absorption on another sorbent. The baseline process is grouting and the name would change if another stabilization method were chosen.

Direct Evaporation: An SBW treatment alternative involving concentration of SBW by evaporation to the extent that it solidifies upon cooling into a disposable waste.

Heels: The initial residual volume left in the Tank Farm tanks consisting of concentrated SBW liquid and tank solids after removal of the liquid waste by existing steam jets.

Newly Generated Liquid Waste: Liquid waste from a variety of sources that in the past has been evaporated and added to the liquid waste in the below-grade tanks at INTEC. Sources include leachates from treating contaminated high efficiency particulate air filters, decontamination liquids from INTEC operations that may or may not be associated with INTEC waste management activities, and liquid wastes from other INEEL facilities. INTEC has historically used this term to refer to liquid waste streams (past and future) that were not part of spent fuel reprocessing. NGLW will be stored along with SBW in the TFF tanks until September 2005 whereupon present plans call for its segregated storage. Since it is mixed with the existing SBW in the TFF tanks it does not formally exist as a separate entity and will not until segregation starts in 2005.

Sludge: The mixture of tank solids and interstitial liquid.

Sodium-bearing waste: The term is non-specific and can range in meaning from SBW liquid minus tank solids to all Tank Farm tank contents (SBW liquid and all tank solids). SBW is mixed hazardous, radioactive waste generated as a by-product of spent nuclear fuel reprocessing. It consists in minor part of second and third cycle extraction wastes but is mostly made up of decontamination solutions used over the years in support of operations. It is relatively high in sodium and potassium content from the solutions used for decontamination. Hence the name, SBW, and its separate tracking and management at INTEC. SBW is high in transuranics (TRU) and is best characterized as mixed transuranic waste.

Steam Reforming: An SBW treatment alternative involving heating SBW with additives and steam to form a solid particulate waste.

Tank solids: Any and all solids contained in the Tank Farm tanks.

Tank solids, settled: Heavier tank solids that lay at the bottom of the tanks.

Tank solids, entrained: Tank solids, both suspended and settled, that are sucked up by the steam jets and transported with the liquid SBW to further treatment.

Feed Composition for the Sodium-Bearing Waste Treatment Process

1. INTRODUCTION

Radioactive liquid waste has been generated over the last five decades at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly called the Idaho Chemical Processing Plant, as a result of nuclear fuel reprocessing activities. From December 1963 until June 2000, the Waste Calcining Facility (WCF) and the New Waste Calcining Facility (NWCF) processed the liquid waste into a granular, solid form. As of June 1, 2004, approximately 960,000 gallons of waste remained in Tank Farm tanks at INTEC.[a] Waste in the Tank Farm is referred to as sodium-bearing waste (SBW). Additional liquid waste, called newly generated liquid waste (NGLW), is being generated and will be generated in the future as a result of filter leach operations, equipment and building decontamination activities, Resource Conservation and Recovery Act (RCRA) closure activities, and other operations at INTEC.

Five processes have been developed and evaluated for treating these wastes (Barnes 2004).

- Cesium ion exchange (CsIX) followed by immobilization of the ion exchange effluent
- Calcination using the NWCF with an upgraded off-gas treatment system to comply with Maximum Achievable Control Technology (MACT) standards
- Steam reforming
- Direct evaporation
- Vitrification.

Feasibility studies have been performed on each of these treatment alternatives. To perform conceptual and detailed designs, feed compositions, volumes, and properties are needed. This report presents a compilation of SBW and NGLW feed characterization data.

Based on present Tank Farm management plans, the feed to any SBW/NGLW treatment process is expected to be stored in six tanks. SBW will be stored in three Tank Farm tanks – WM-187, WM-188, and WM-189. These tanks each have a capacity of 300,000 gallons. NGLW will be stored in three 18,400-gal tanks – WM-100, WM-101, and WM-102. Solids contained in heels from other Tank Farm tanks have been flushed to tank WM-187. Thus, Tank WM-187 contains a relatively high proportion (~7 wt %) of solids. Waste in WM-188 and WM-189 have a lower proportion (<1 wt %) of solids.

1.1 Source Characterization Data and Documents

Over the years, numerous compilations of Tank Farm waste compositions have been prepared for different purposes. Documents that contain information relevant to present or future tank compositions are briefly described below.

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[a] This volume excludes about 35,000 gallons of flush water remaining in Tanks WM-181, -182, -183, -184, -185 and -186.

1.1.1 Historical and Present Tank Farm Liquid Composition

Engineering Design File (EDF) 1598 contains a brief review of previous documents containing Tank Farm composition data, a compilation of Tank Farm liquid composition analytical data up through January 2000, estimates of Tank Farm solids volume, and an estimate of NGLW composition.

1. M. D. Staiger, C. B. Millet, R. A. Nickelson, R. A. Wood, A. Chambers, 2001, "Tank Farm Facility, Tank and Waste Data*," Engineering Design File EDF-1598*, February 27, 2001.

EDF-1598 compiles analytical results of samples taken from each of the Tank Farm tanks consistent with the liquid waste present in the tanks as of late 2000. In addition, a waste composition for each tank is presented based on averages of analytical results, for those species for which data are available, and estimates for other chemical and radionuclide species. Estimates were based on calculations by Doug Wenzel using ORIGEN2 assuming concentrations in SBW are proportional to all the fuel processes at INTEC over the life of the plant. The results of these calculations for a theoretical average SBW were used to estimate individual species and tank concentrations by assuming that the ratio of the individual species to ^{137}Cs in the waste is proportional to the ratio of the individual species to ^{137}Cs in the "Average SBW". Wenzel's calculations are documented in the following reports:

2. D. R. Wenzel, 1997, "Evaluation of Radionuclide Inventory for Sodium-Bearing Waste," *Engineering Design File EDF-FDO-006/CPP-97080*, November 26, 1997.
3. D. R. Wenzel, 1999, "Calculation of July 1999 Radionuclide Inventory for Sodium-Bearing Waste," *INEEL Interoffice Correspondence*, Wen-20-99, May 18, 1999.
4. D. R. Wenzel, 2000, "Calculation of July 1999 Inventories for INTEC Wastes," *INEEL Interoffice Memorandum*, Wen-27-99, originally issued November 7, 1999 and reissued with corrections August 2000.
5. D. R. Wenzel, 2002, "Relative Inventories of Reactor-Produced Species in INTEC Waste Types," *Engineering Design File EDF-CRPD-001*, November 4, 2002.

Clark Millet maintains a spreadsheet known as the "Tank Farm Composition Database" that includes sample analyses data as well as summary concentrations for each Tank Farm tank. The tables contained in EDF-1598 (Staiger 2001) of both analyses data and summary averages and estimates reflect the Tank Farm Composition Database spreadsheet that was current at the time EDF-1598 was being prepared. A later documentation of summary tank compositions is given in:

6. C. B. Millet, 2003, "Composition of Tank Farm Waste as of October 2002," *INEEL Interoffice Memorandum* Mil-07-02, December 12, 2002 (reissued with one correction September 24, 2003).

Updates to the Tank Farm Composition Database continued after publication of EDF-1598 as described in:

7. D. R. Tyson, 2002, "Validation of the Radionuclide Mass Balance Used in the INTEC SBW WIR Determination Report," *Engineering Design File EDF-1920*, Revision 4, August 29, 2002.
8. M. C. Swenson, 2003, "Validation of the Radionuclide Inventory and Mass Balance Used in the INTEC SBW and Tank Farm Residuals WIR Determination Reports," *Engineering Design File EDF-1920 INEEL/EXT-2001-534*, Revision 5, October 24, 2003.

For the Tank Farm, EDF-1920 reports only radionuclide inventories, and although updated as of late 2003, reports the waste radionuclide inventories as of July 1, 1999.

In early FY 2003 the Tank Farm Composition Database was again updated to:

- Incorporate analysis data from samples taken from Tank WM-180 in 2000
- Incorporate analysis data from samples taken from Tank WM-189 in 2002
- Update the waste volumes and radionuclide decay basis from July 1, 1999 to January 1, 2003
- Adjust the waste compositions in WM-182 and WM-183 due to water flushes of these tanks
- Adjust the WM-185 waste composition due to additions of water and waste from WM-183 transferred in 2000 and 2001
- Adjust the waste composition of WM-187 due to additions of waste to the tank in 2002
- Incorporate additional updates by Doug Wenzel of ORIGEN2 calculations of SBW radionuclide inventories.

The Tank Farm Composition Database serves as the common source and control point for all estimates of present Tank Farm liquid waste composition. The composition will be updated again when all the waste is contained in the three Tanks WM-187, -188, and -189 and the other tanks have been rinsed.

Jerry Christian evaluated data from samples taken in 2000 of Tank WM-180 waste and recommended a surrogate composition for waste from this tank. A comparison of the Tank WM-180 liquid composition based on 2000 sample analyses with analyses of samples taken in 1993 is given in Table 34 (see Section 3.3). Christian's report also contains compositional data for the solids in WM-180, both analytical data and results of thermodynamic modeling, and a recommended composition for simulating WM-180 waste.

9. J. D. Christian, 2001, *Composition and Simulation of Tank WM-180 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-2001-00600, May 2001.

The SBW in Tank WM-180 will be concentrated by evaporation in late 2004, and the concentrate sent to Tank WM-187. The analysis reported by Christian was used to simulate the evaporation of this waste and calculate the expected future composition of Tank WM-187. The simulation was performed using Aspen Plus, with ASPEN property models tuned to data from historical evaporation of INTEC wastes.

10. J. A. Nenni, 2004, "ETS Process Parameter and Outlet Stream Predictions for WM-180 Feed," *INEEL Interoffice Memeorandum to J. P. Law,* JAN-04-04, February 16, 2004.

Tom Batcheller and Dean Taylor evaluated liquid and solids analytical data from FY 2002 WM-189 samples and present their results in the document below. In addition to a recommended composition for Tank WM-189 waste, Batcheller and Taylor present uncertainties associated with each component concentration. No additional waste has been or will be added to Tank WM-189; hence the composition for this tank at the time of treatment will be the same as the analyses reported by Batcheller and Taylor.

11. T. A. Batcheller, D. D. Taylor, 2003, *Characterization of Tank WM-189 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-02-01171 Rev. 1, July 2003.

Samples from Tank WM-188 were taken in late November 2002 and analyzed in 2003. The reference below contains the results of the analyses for both liquids and solids from the tank. In contrast

to the procedure used for Tank WM-189 solids, the solids from WM-188 were washed with water prior to analysis. Tank WM-188 was approximately 75% full when sampled, and additional waste has been and will continue to be added to WM-188 through FY 2005

12. V. J. Johnson, R. L. Demmer, T. A. Batcheller, 2003a, Characterization of Tank WM-188 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center, INEEL/EXT-03-00478, June 2003.

1.1.2 Tank Solids Compositions

Samples of undissolved solids have been taken from Tank Farm tanks on eleven occasions. Christian (2001), Batcheller (2003) and Johnson (2003a) report analyses of solids from Tanks WM-180, WM-189 and WM-188 respectively. Waste from each of these tanks was transferred by steam jet to a tank in the NWCF blend and hold cell, where it was sampled. Solids contained in the samples were thus solids entrained with the liquid waste during jet transfer.

Samples of the heel in Tanks WM-182, WM-183, and WM-188 were taken directly using the Light Duty Utility Arm (LDUA) sample end effector. Results of the analyses of these samples are contained in the following reports:

13. M. Patterson, 1999, *Light Duty Utility Arm Deployment in Tank WM-188*, INEEL/EXT-99-01302, December 1999.
14. *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, DOE/IC-10802, (2001) Appendix B, "Data Summary for Tanks WM-182 and WM-183," DOE/ID-10802, November 2001.
15. A. Poloski, 2000a, "Solids Characterization," *Engineering Design File EDF-TST-001*, September 20, 2000.

The above two references contain chemical and physical property data for solids that were present in the heels of Tanks WM-182 and WM-183 when sampled in 2000. Solids from these two tanks have since been flushed to Tank WM-187.

Revision 4 of EDF-1920 (Tyson 2002) includes a summary of the inventory of radionuclides in each tank, and makes a significant correction to the ^{137}Cs concentration of WM-182 solids reported by Poloski. The radionuclide inventories shown by Tyson for tanks other than WM-182, WM-183, and WM-188 are estimates.

Johnson and Demmer report the results of analyses of a sample taken from Tank WM-181 in 2003. Solids in WM-181 were flushed to Tank WM-187 in mid-2004.

16. V. J. Johnson, R. L. Demmer, 2003b, *Characterization of Tank WM-181 Sodium-Bearing Waste Solids at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-03-00979, September 2003.

Mike Swenson compiled some older analyses of tank solids, includes a description of sources of solids that went into the Tank Farm tanks and also includes some data that show how solids composition varies with particle size. While the analyses he reports do not represent solids in any present tank, the data is useful in determining the potential range of solids composition.

17. M. C. Swenson, 1992, "Historical Tank Farm Sample Results," *INEL Correspondence*, MCS-27-92, December 17, 1992.

WM-187 was sampled multiple times in late 2003 and early 2004, and results of the analysis of solids from these samples are reported in Section 3.2 of this report. Characterization of solids from Tank WM-186 was performed in 2003 as part of work to develop a tank solids simulant, and the results reported in Revision 3 of this report (Barnes 2003). A summary composition is retained in this report (see Table 28). Techniques used to characterize the solids included transmission electron microscopy, scanning electron microscopy, x-ray fluorescence, and x-ray diffraction. Some of these analyses were repeated for a sample of Tank WM-187 solids taken in late 2003; some of these results will be contained Wendt, 2004 (see #20 below). Additional results from these analyses will be discussed in a report to be written by Stuart Janikowski and published later this year.

1.1.3 Tank Solids Mass Estimates and Properties

EDF-TST-001 (Poloski 2002a) gives estimates of the volume of "sludge" (the solids/liquid residual in a tank after removing liquid waste) in each tank. Poloski used these estimated tank sludge volumes plus a solids concentration as documented in EDF-15722-040 (see the reference below) to derive estimates of the mass of tank solids present in each tank.

18. A. P. Poloski, 2000b, "INTEC Tank Farm Sludge Density Measurements/Calculations," *Engineering Design File 15722-040*, July 12, 2000.

Poloski's estimates of the mass of tank solids have been used in INTEC Waste Incidental to Reprocessing (WIR Determination) documents and various SBW treatment mass balances made in previous years. New estimates are proposed in Section 3.1 of this report for use in Conceptual Designs for SBW treatment alternatives.

Poloski (2002b) also documents the volume fraction of solids in WM-183 sludge and the solids particle density from measurements of the mass and volume of the sludge sample, the weight fraction of water in the sludge, and the density of water. EDF-TST-001 (Poloski 2002a) includes particle size distribution data for solids from Tanks WM-182 and WM-183 and settling rate data for solids from Tank WM-182. Christian (2001) includes particle size distribution data for Tank WM-180 solids. Batcheller (2003) presents particle size distribution data for solids from WM-189 as well as other solids and sludge properties. A summary of solids property data including that for the most recent sample from Tank WM-187 is presented in Section 3.5 of this report. Additional solids property data has been obtained in conjunction with the development of simulants for SBW solids. The initial stimulant development work was performed at the Savannah River Technical Center and is reported by John Harbor:

19. J. R. Harbour, R. F. Schumacher, A. Choi, A. K. Hansen, 2002, *Development of an Initial Simulant for the Idaho Tank Farm Solids*, WSRC-TR-2002-00436, November 11, 2002.

Continued characterization of physical properties of tank sludges for the purpose of stimulant development has been performed and reported by Dan Wendt. Wendt includes data for sludge density, viscosity, and settling rates for different sludge solids concentrations as well as actual waste.

20. D. Wendt, 2004, *INTEC SBW Solid Sludge Surrogate Recipe and Validation*, ICP/EXT-04-00415 Rev. 0, June 2004.

1.1.4 NGLW Stream Volumes and Compositions

Joe Nenni compiled compositional data for NGLW streams based on analysis of samples taken from FY-1999 through FY-2002. He includes compositional data for cations, anions, pH or acidity, undissolved solids (UDS), total inorganic carbon (TIC), total organic carbon (TOC), semi volatile organic compounds, and volatile organic compounds. No radionuclide compositional data are included.

21. J. A. Nenni, 2002, "Balance-of-Plant Sample Data Compilation," *Engineering Design File,* EDF-2506, September 2002.

Julia Tripp compiled NGLW compositional data from sample analysis prior to FY-1999. Compositions are provided by NGLW stream and include, when available, radionuclide activities.

22. J. L. Tripp, 1998, *Supporting Information for the INEEL Liquid Waste Management Plan*, Appendix B, INEEL/EXT-98-00730, July 1998.

The latest projections of the volumes of wastes that will be generated by various operations at INTEC are given in the following document:

23. R. Demmer, 2002, *INTEC Waste Minimization Plan*, PLN-225, October 15, 2002.

Demmer also includes a comparison of projections with actual generation rates for NGLW streams in each of the years 1998-2001. Following the guidelines of PLN-225, volumes of waste projected to be generated from 2004-2012 are summarized in Tables 11 and 12 of Section 2.4 of this report.

1.1.5 Present and Future Liquid Volumes

Present Tank Farm tank volumes are based on tank level measurements. A web-based monthly update of tank volumes is available at http://icpweb.inel.gov/intec/tank-farm-data/. An Excel spreadsheet model (see Palmer 2000) is used to project future tank volumes. This model includes volumes of NGLW generated each year, volumes of NGLW after concentration by evaporation, and volumes of Tank Farm tanks by month. As Tank Farm management plans and assumptions change, the model is updated. The most recent update was made by Clark Millet in early March 2004 to incorporate the consolidation of SBW into the three tanks, WM-187, WM-188, and WM-189. Portions of the data in this unpublished spreadsheet ("2012 Model – Barnes7," March 8, 2004) are contained in this report.

1.1.6 Tank Farm Background Information

Brent Palmer has documented the history and discussed operation of the INTEC Tank Farm, INTEC waste management equipment, and SBW and NGLW management plans. While the plans and waste compositions in the report below are no longer current, the history and discussion of equipment and INTEC operations is useful.

24. W. B. Palmer, C. B. Millet, M. D. Staiger, M. C. Swenson, W. B. McNaught, F. S. Ward, 2000, *INTEC Waste Management Through 2070,* INEEL/EXT-2000-01005, December 2000.

1.2 Feeds to the Alternative Treatment Processes

Waste to be treated by the SBW Treatment Facility includes:

1. SBW stored in Tank WM-187, including solids and liquid. Heel solids from Tanks WM-181, WM-182, WM-183, WM-184, WM-185, and WM-186 have been collected in Tank WM-187. Following collection of these heels, much of the liquid content of the tank will be removed. Concentrate from evaporation of Tank WM-180 SBW will then be added to the tank. Small additions of other wastes generated in 2004 and 2005 are expected to fill this tank.
2. SBW stored in Tank WM-188, including liquid and a relatively small amount of undissolved solids. Tank WM-188 is presently about 90% full; waste will continue to be added through FY 2005.
3. SBW stored in Tank WM-189, including liquid and a relatively small amount of undissolved solids. Tank WM-189 is presently full (near its administrative limit) and no changes in waste composition are expected for this tank.
4. NGLW that will be collected in Tanks WM-100, WM-101, and WM-102 from FY 2006 through the end of SBW treatment. Transfers into and out of these tanks will be made until (and possibly during) the period of SBW treatment. Should NGLW generation prior to the start-up of the SBW treatment facility exceed the capacity of these tanks, other INTEC tanks would also be used to store NGLW.

The following sections discuss differences in the feeds to each of the treatment processes. Additional discussion of possible tank mixing scenarios is given in Section 3.4.

1.2.1 CsIX/TRU Grout

Several strategies for processing the waste in the CsIX/ treatment alternative are possible. One strategy would be to sequentially process the waste by tank. For example, waste from Tank WM-187 could be processed first, then waste from WM-188, followed by waste from WM-189, and finally NGLW. Other strategies would involve changing the order of tanks processed or blending wastes from different SBW and/or NGLW tanks in the treatment facility receiving tank prior to feeding to treatment operations. If processed tank by tank, the feed to the treatment process would vary from the relatively high solid waste of WM-187 to the low solids waste of the other tanks. In addition to processing the bulk volume of waste from each tank, the heel will also need to be processed. The heels would be flushed to the treatment facility using water.

The CsIX/TRU Grout process will generate small amounts of dilute aqueous wastes that can be processed in existing INTEC evaporators and the concentrate returned to the treatment process. These wastes include water from rinsing tank solids and/or spent ion exchange media, condensate from drying tank solids and spent ion exchange media, and vent gas condensate.

1.2.2 Calcination/MACT

If calcination is selected for SBW treatment, decontamination of NWCF cells could begin as early as 2005 or 2006, resulting in waste not generated for the other options. This NWCF cell decontamination waste would be concentrated and added to WM-188 through FY 2005 or WM-100, WM-101, and WM-102 after 2005. Unlike the CsIX process, no dilute liquid wastes are expected to be generated continually during operation, but wastes would be generated intermittently during scheduled and unscheduled shutdowns, and also from decontamination activities after SBW processing is complete.

A separate study (Wood 2002) has recommended that solids be mixed with liquid tank waste in TFF tanks and processed together (co-processed) in the calciner. The present plan for Tank Farm management includes the addition of concentrated SBW, primarily from Tank WM-180, to Tank WM-187. Mixing pumps would need to be installed in WM-187 to maintain a homogeneous blend of solids and liquid to be fed to treatment. Mixing pumps could be installed WM-188 and/or WM-189 as well, and waste transfers made between the four tanks WM-187, WM-188, WM-189, and WM-190 to produce a feed with a more consistent solids content than if all the solids remain in WM-187. A discussion of possible tank mixing scenarios is given is Section 3.4.

1.2.3 Steam Reforming

The waste feed to the Steam Reforming process would be nearly identical to the feed for the Calcination/MACT alternative. Minor differences in NGLW composition between these two alternatives, because of differences in NGLW streams, would cause very minor differences in feed composition. Like calcination, solids would be co-processed.

1.2.4 Direct Evaporation

Co-processing of solids has also been recommended and demonstrated for the Direct Evaporation process (Packer 2003; Griffith 2003). Feeds to the process would essentially be the same as the feeds for the calcination and steam reforming alternatives, with only small differences due to differences in NGLW composition and volume between what would be generated for the direct evaporation alternative and the calcination or steam reforming alternative. No NGLW is expected to be generated by the Direct Evaporation process.

1.2.5 Vitrification

A mass balance was prepared in 2001 assuming separate vitrification of SBW liquids and solids (Quigley 2001). No glass formulation tests have been performed with simulants for tank solids either alone or with SBW liquid. The high phosphate content of SBW solids will severely limit its waste loading in a borosilicate glass. Further evaluations would be needed to determine whether to coprocess tank solids with SBW liquid or process the two wastes separately.

1.3 Tank Farm Management

Figure 1 illustrates management of INTEC wastes from February 2004 through June 2004. During this time, Tank WM-187 received dilute wastes. Figure 2 illustrates management of INTEC wastes from July 2004 through September 2005. During this period, waste will be received into Tanks WM-187 and WM-188, but Tank WM-187 will contain concentrated waste. After September 2005, no changes will be made to the waste in Tanks WM-187, WM-188, and WM-189, and all waste generated will be stored in Tanks WM-100, WM-101, and WM-102, as illustrated in Figure 3.

As of January 31, 2004, Tank WM-187 contained 150,900 gallons of SBW solids plus dilute aqueous waste. In early-2004, Tanks WM-103, WM-104, WM-105, WM-106, and WM-181 were washed, with the wash water added to Tank WM-187. Flushes from WM-103, WM-104, WM-105 and WM-106 were very dilute, but the flush from WM-181 contained approximately 15,000 gallons of heel, both solids and concentrated liquid. In mid-2004, most of the liquid waste in WM-187 will then be sent to the Evaporator Tank System (ETS), reducing the volume of waste in WM-187 to an estimated 45,000

gallons.[b] Then concentrate from evaporation of Tank WM-180 waste will be added to Tank WM-187. The total waste from WM-180 is expected to amount to about 230,000 gallons, including both the evaporator concentrate and heel flush. An additional 10,000 gallons of NGLW generated in 2004 and 2005 is expected to be added to WM-187, filling the remaining tank capacity.

The volume of waste in Tank WM-188 as of January 31, 2004 was 241,000 gallons. Evaporator concentrates have been and will be added in 2004 and 2005 to fill this tank. Tank WM-189 presently contains 279,700 gallons of waste. No changes are anticipated in the waste contained in Tank WM-189.

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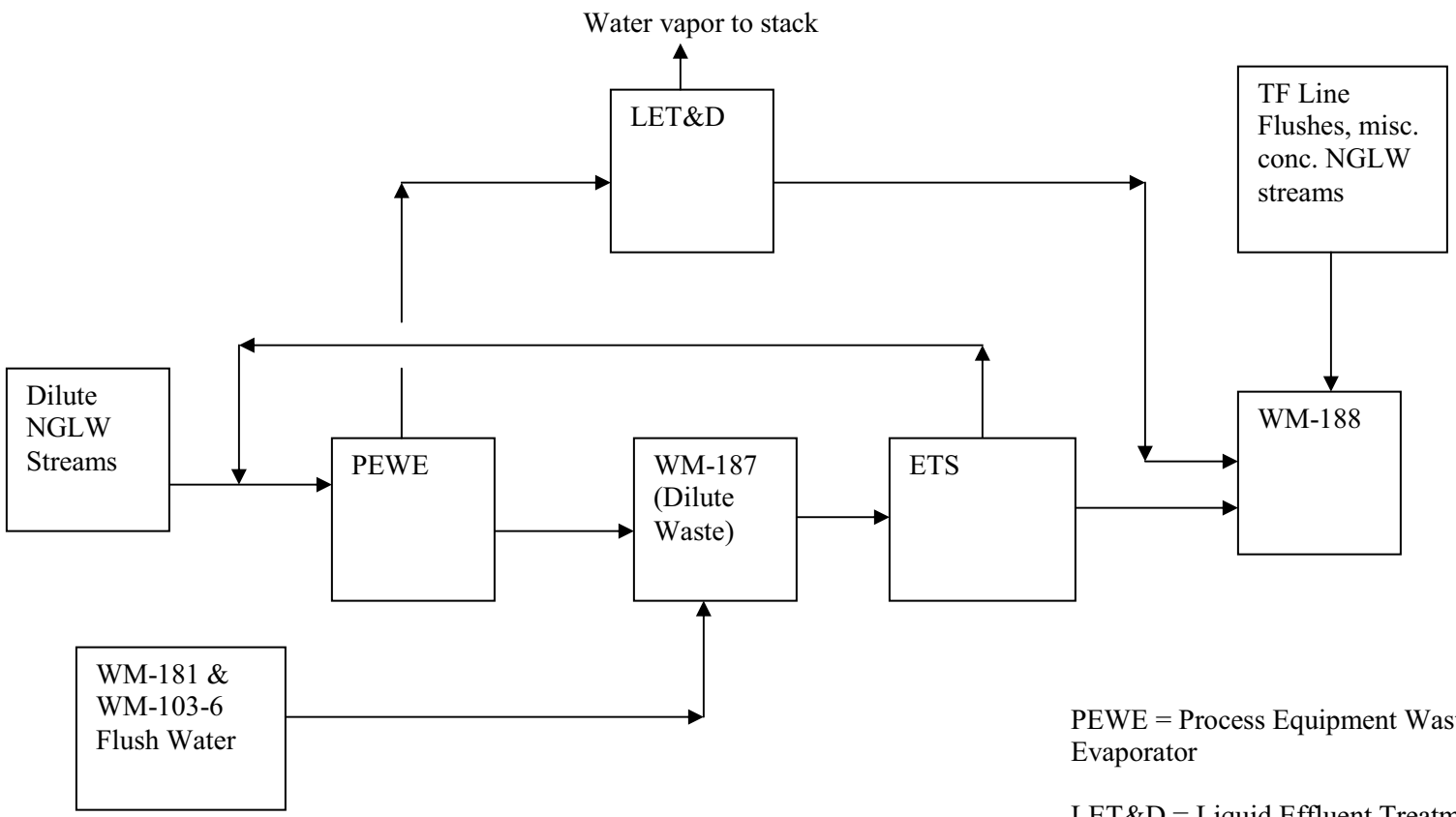
[b] The estimate of 45,000 gallons was made in March 2004 and is shown in the Tank Farm management scenario spreadsheet. However, evaporation of Tank WM-187 was stopped in April when the level was at 58,000 gallons. Hence it is likely the minimum volume of the tank after the next evaporation will be around 60,000 gallons.



PEWE = Process Equipment Waste Evaporator

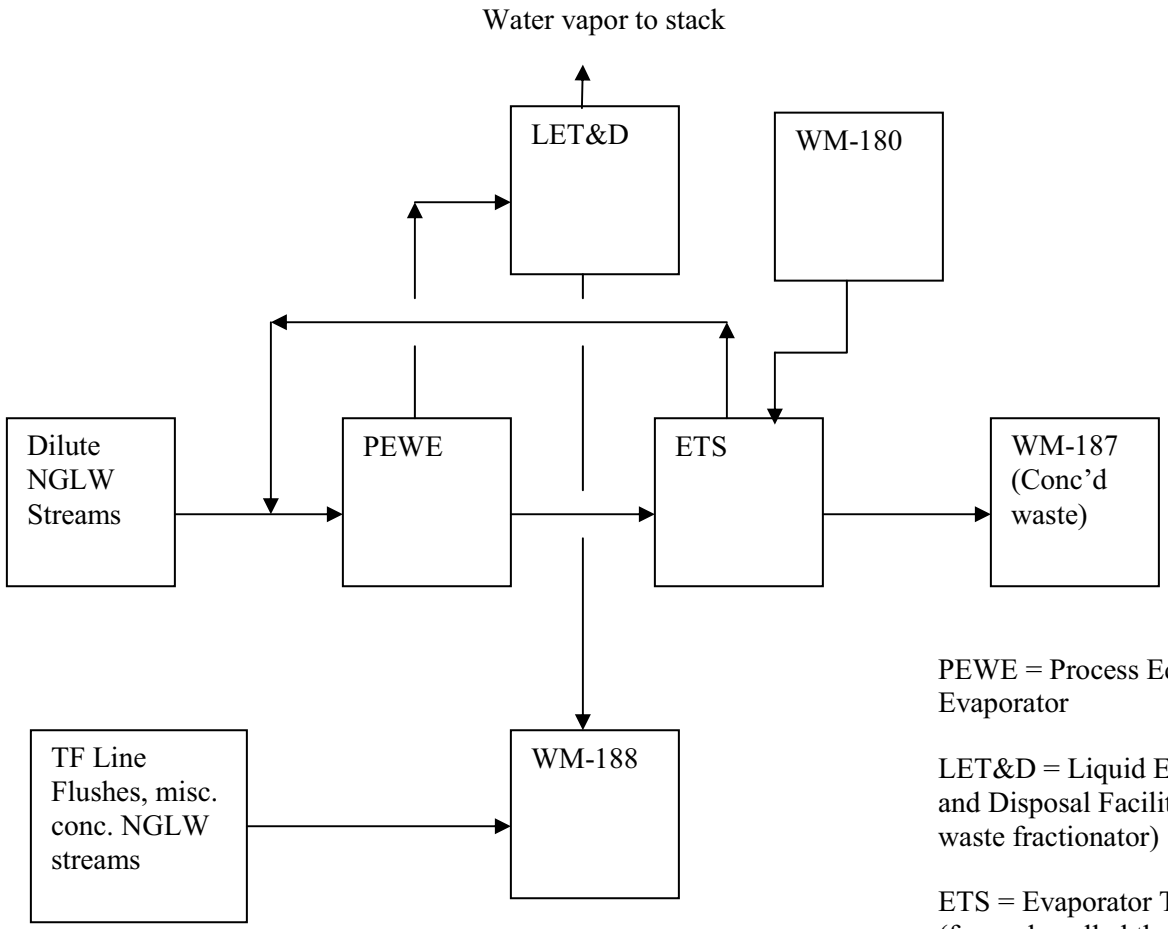
LET&D = Liquid Effluent Treatment and Disposal Facility (includes a waste fractionator)

ETS = Evaporator Tank System (formerly called the High Level Liquid Waste Evaporator)

NGLW = Newly Generated Liquid Waste

TF = INTEC Tank Farm

Figure 1. Tank Farm Management February 2004 – June 2004.



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NGLW = Newly Generated Liquid Waste

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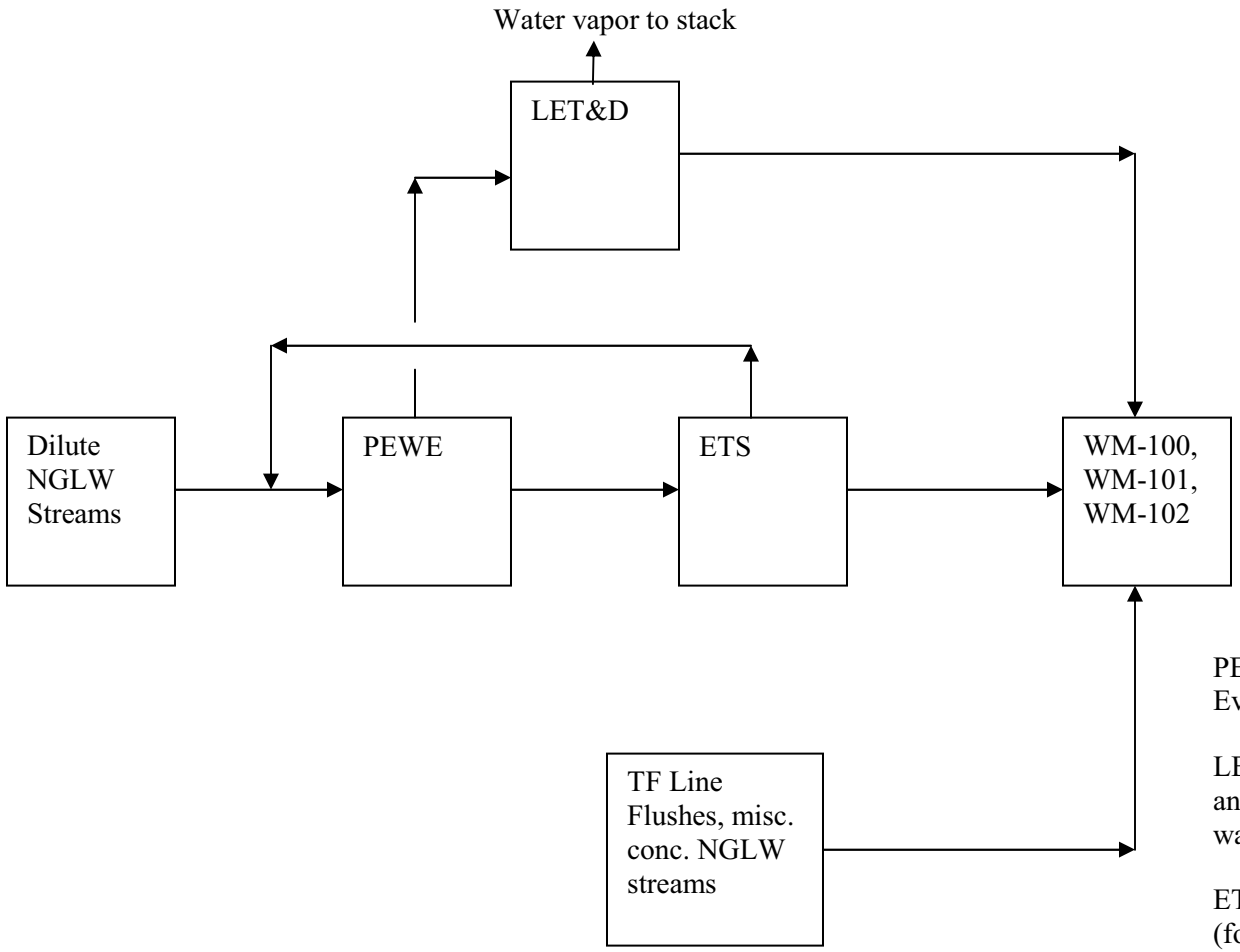
Figure 2. Tank Farm Management, July 2004 – September 2005.



PEWE = Process Equipment Waste Evaporator

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NGLW = Newly Generated Liquid Waste

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Figure 3. INTEC Waste Management after September 2005.

2. PROJECTED WASTE COMPOSITIONS

This section identifies the sources and amounts of wastes that will be in tanks fed to the treatment process. It also projects compositions of the liquids, solids, and combined liquids and solids in these tanks and discusses the basis for calculating these compositions.

2.1 WM-187 Composition

The starting point for calculation of the future composition of WM-187 waste is the composition as of September 2002 as documented by Clark Millet (Millet 2003). Table 1 summarizes the path from the September 2002 composition to the future composition in September 2005. No changes in the tank waste are anticipated after September 2005.

Table 1. Basis for Tank WM-187 waste composition.

	Gallons	**Composition ID**
Volume Sept 30, 2002	137,300	WM-187-0
Transfer of WM-183 waste	15,400	WM-183-0
Water with WM-183 flush	77,100	Water
Subtotal	229,800	WM-187-1
Sent to Evaporator	212,300	WM-187-1
Remaining in WM-187	17,500	WM-187-1
Waste from WM-184	5,100	WM-184-0
Waste from WM-185	12,900	WM-185-0
Waste from WM-186	19,700	WM-186-0
Waste from WM-181	23,000	WM-181-0
Water with WM-181/4/5/6 flushes	152,700	Water
NGLW added through June 2004	3,606	NGLW-1
Subtotal	234,506	WM-187-2
Sent to Evaporator	189,546	WM-187-2
Remaining in WM-187	44,960	WM-187-2

	Liquid (Gallons)	Composition ID	**Solids** (Gallons)	Composition ID	**Total** (Gallons)	Composition ID
Initial WM-187 waste	31,750	WM-187-2	13,210	WM-187-S1	44,960	
Added from WM-180 evaporation	203,913	WM-180-C	87	WM-180-S	204,000	
WM-180 heel	5,625	WM-180-0	661	WM-180-S	6,286	
Water from WM-180 heel flush	20,000	Water			20,000	
WM-190	500	WM-190-0			500	
Water from WM-190 transfer	300	Water			300	
NGLW, July 2005 - March 2005	8,874	NGLW-2			8,874	
Final WM-187 Volume	**270,963**	**WM-187-L**	**13,958**	**WM-187-S**	**284,920**	**WM-187**

The composition of the waste in Tank WM-187 after Tank WM-183 flushes were added was calculated by adding the initial tank contents (WM-187-0, as reported by Millet 2003), the waste heel from WM-183 (WM-183-0, also as reported by Millet 2003), and the amount of water used to flush WM-183. The resulting composition was named "WM-187-1." Seven wastes were then added together to calculate the composition of the Tank WM-187 waste after flushing Tanks WM-184, WM-185, WM-186,

and WM-181. These seven streams included 17,500 gallons of waste initially in the tank (composition "WM-187-1"), heels from the four tanks flushed (compositions as reported by Millet, 2003), 152,700 gallons of water used in flushing, and 3,606 gallons of NGLW. The calculation of the NGLW composition is described in Section 2.4. The resulting composition was called "WM-187-2". Of the 234,506 gallons of WM-187-2 waste, 189,546 gallons of the liquid is expected to be drawn off to the evaporator, leaving 44,960 gallons in the tank. It was assumed that the waste remaining in the tank contained all the solids present in the full volume.

Based on an estimate of 100,000 kg of solids in WM-187 (see Section 3.1), and a solids particle density of 2 kg/liter (Poloski 2000b), the volume of solids in the tank equates to 13,210 gallons, and implies that the tank sludge contains 31,730 gallons of interstitial liquid. This volume of liquid, of composition "WM-187-2," was combined with the volumes of six other wastes as shown in Table 1 to obtain the final composition of Tank WM-187 liquid waste. The sources for the compositions of the other wastes include Nenni (2004) for concentrated waste from WM-180; Millet (2003) for the WM-180 heel liquid and WM-190 heel liquid; and calculation of the NGLW-2 composition as described in Section 2.4.

The composition of the final solids in Tank WM-187 was calculated based on an initial Tank WM-187 solids composition, prior to the addition of WM-180 waste, and adding to these the solids from WM-180. The composition of the WM-180 heel solids was assumed to be the same as the entrained WM-180 solids, which were analyzed in 2000 (Christian 2000).

Because of the uncertainty in the amount of solids in Tank WM-187, compositions were calculated based on the expected amount of solids, 70% of the expected amount, and 130% of the expected amount. Table 2 shows the composition of Tank WM-187 liquid only and liquid plus the expected solids. Table 3 shows the composition of waste in Tank WM-187 waste at the low and high ends of the estimated solids quantity.

The concentrations of nitrates shown in Tables 2-3 have been adjusted from measured values to achieve an overall charge balance in the total composition. The specific gravity and concentrations for total organic carbon (TOC) shown in Tables 2 and 3 are estimates. The TOC concentrations are based on TOC analysis of waste samples from Tanks WM-188 and WM-189. The specific gravity is based on a correlation of specific gravity for historic tank samples and total dissolved solids.

The composition of solids only is shown in Table 4. The solids composition is based in part on the analytical results of the most recent sample from Tank WM-187, but where these results significant diverge from previous samples, it is based on solids analyses data averages. Uncertainties in the liquid and solids compositions are discussed in Section 3.3.

Table 2. Tank WM-187 composition.

	Liquid only	With solids		Liquid only	With solids		Liquid only	With solids		Liquid only	With solids
Gal	270,963	284,920		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.30	1.32	PO_4^{-3}	1.38E-02	3.22E-01	Th-232	4.26E-16	4.26E-16	Tc-98	1.55E-12	1.55E-12
			Pu^{+4}	6.32E-06	2.30E-05	Th-234	1.25E-08	1.25E-08	Tc-99	1.06E-05	6.43E-05
	mol/liter	mol/liter	K^{+}	2.23E-01	2.24E-01	Pa-231	5.38E-11	5.38E-11	Ru-106	5.60E-07	1.72E-06
H+	1.09E+00	1.04E+00	Pr^{+4}	5.21E-06	4.96E-06	Pa-233	1.76E-06	1.76E-06	Rh-102	5.19E-10	5.19E-10
Al^{+3}	6.73E-01	7.08E-01	Pm^{+3}	7.63E-10	2.21E-07	Pa-234m	1.25E-08	1.25E-08	Rh-106	5.60E-07	1.72E-06
Am^{+}	9.41E-08	1.30E-07	Rh^{+4}	2.25E-06	2.14E-06	U-232	1.20E-09	4.03E-09	Pd-107	9.95E-09	9.95E-09
Sb^{+5}	5.36E-07	3.24E-05	Rb^{+}	3.46E-06	3.29E-06	U-233	4.81E-11	9.70E-11	Cd-113m	2.00E-06	2.00E-06
As^{+5}	4.92E-04	5.53E-04	Ru^{+3}	1.28E-04	1.10E-03	U-234	1.18E-06	1.51E-06	In-115	6.06E-17	6.06E-17
Ba^{+2}	5.54E-05	1.20E-04	Sm^{+3}	3.43E-06	3.36E-06	U-235	4.38E-08	7.49E-08	Sn-121m	4.03E-08	4.03E-08
Be^{+2}	7.81E-06	1.79E-05	Se^{+4}	1.11E-05	1.24E-04	U-236	6.38E-08	1.17E-07	Sn-126	2.47E-07	7.54E-07
B^{+3}	1.26E-02	1.35E-02	Si^{+4}	5.37E-05	5.93E-01	U-237	3.87E-09	3.87E-09	Sb-125	8.03E-06	8.18E-04
Br^{-}	1.90E-07	1.81E-07	Ag^{+}	5.43E-06	9.11E-04	U-238	2.76E-08	3.36E-08	Sb-126m	2.47E-07	2.47E-07
Cd^{+2}	8.03E-04	8.62E-04	Na^{+}	2.20E+00	2.13E+00	Np-237	1.76E-06	4.07E-16	Sb-126	3.46E-08	3.46E-08
Ca^{+2}	4.98E-02	4.95E-02	Sr^{+2}	1.22E-04	1.22E-04	Np-238	5.91E-11	1.54E-06	Te-123	2.31E-19	2.31E-19
Ce^{+4}	4.83E-05	9.53E-05	SO_4^{-2}	7.04E-02	7.32E-02	Np-239	1.67E-08	4.58E-11	Te-125m	1.90E-06	1.90E-06
Cs^{+}	1.17E-05	8.31E-05	Tc^{+7}	6.30E-06	3.83E-05	Pu-236	1.65E-09	5.89E-09	I-129	2.83E-08	9.39E-08
Cl^{-}	3.34E-02	3.99E-02	Te^{+4}	1.85E-06	1.76E-06	Pu-238	6.28E-04	2.15E-03	Cs-134	8.52E-06	7.41E-05
Cr^{+3}	3.67E-03	4.34E-03	Tb^{+4}	1.32E-09	1.25E-09	Pu-239	8.98E-05	3.26E-04	Cs-135	5.18E-07	1.46E-06
Co^{+2}	1.97E-05	3.44E-05	Tl^{+3}	1.00E-07	4.25E-05	Pu-240	6.08E-06	2.24E-05	Cs-137	3.04E-02	8.25E-02
Cu^{+2}	6.93E-04	7.91E-04	Th^{+4}	7.28E-07	6.92E-07	Pu-241	1.66E-04	1.56E-03	Ba-137m	2.87E-02	7.80E-02
Eu^{+3}	3.15E-07	3.02E-07	Sn^{+4}	1.05E-06	3.48E-03	Pu-242	4.84E-09	1.72E-08	La-138	1.15E-16	1.15E-16
F^{-}	5.06E-02	7.40E-02	Ti^{+4}	6.09E-05	1.91E-03	Pu-244	4.08E-16	1.29E-15	Ce-142	1.80E-11	1.80E-11
Gd^{+3}	1.82E-04	1.86E-04	U^{+4}	4.36E-04	5.76E-04	Am-241	7.76E-05	1.07E-04	Ce-144	3.77E-07	1.16E-06
Ge^{+4}	5.48E-09	5.22E-09	V^{+5}	9.69E-04	9.48E-04	Am-242m	9.16E-09	9.16E-09	Pr-144	3.77E-07	3.92E-07
In^{+3}	8.63E-07	8.63E-07	Y^{+3}	4.27E-06	4.06E-06	Am-242	9.11E-09	9.11E-09	Nd-144	9.68E-16	9.68E-16
I^{-}	1.58E-06	4.38E-06	Zn^{+2}	1.05E-03	1.22E-03	Am-243	1.29E-08	2.37E-08	Pm-146	3.06E-08	3.06E-08
Fe^{+3}	2.17E-02	3.57E-02	Zr^{+4}	1.70E-04	5.41E-02	Cm-242	8.04E-09	1.34E-08	Pm-147	1.03E-04	3.11E-04
La^{+3}	5.73E-06	5.45E-06	O-2		9.29E-01	Cm-243	1.71E-08	6.24E-08	Sm-146	1.66E-13	1.66E-13
Pb^{+2}	1.34E-03	1.35E-03	H2O	4.74E+01	4.53E+01	Cm-244	1.04E-06	5.06E-06	Sm-147	4.43E-12	4.43E-12
Li^{+}	3.96E-04	6.43E-04				Cm-245	1.80E-10	8.60E-10	Sm-148	2.28E-17	2.28E-17
Mg^{+2}	1.30E-02	1.41E-02		g/liter	g/liter	Cm-246	1.18E-11	5.60E-11	Sm-149	2.02E-18	2.02E-18
Mn^{+4}	1.52E-02	1.59E-02	TOC	0.53	0.50				Sm-151	2.02E-04	6.18E-04
Hg^{+2}	2.07E-03	2.23E-03	UDS	0	93	H-3	1.99E-05	1.99E-05	Eu-150	8.66E-12	8.66E-12
Mo^{+6}	2.00E-04	5.05E-04				Be-10	1.81E-12	1.81E-12	Eu-152	1.52E-06	2.52E-06
Nd^{+3}	1.85E-05	1.76E-05		Ci/liter	Ci/liter	C-14	7.23E-11	2.21E-10	Eu-154	5.92E-05	9.24E-05
Np^{+4}	1.06E-05	1.10E-05		(Jan, 2003)	(Jan, 2003)	Se-79	2.63E-07	8.77E-07	Eu-155	9.56E-05	1.61E-04
Ni^{+2}	1.48E-03	1.80E-03	Ra-226	4.93E-12	4.93E-12	Rb-87	1.76E-11	1.76E-11	Gd-152	8.56E-19	8.56E-19
Nb^{+5}	3.39E-06	1.66E-03	Ac-227	2.32E-11	2.32E-11	Sr-90	2.38E-02	2.53E-02	Ho-166m	2.77E-11	2.77E-11
NO_3^{-}	5.60E+00	5.44E+00	Th-230	4.95E-10	1.88E-09	Y-90	2.38E-02	2.53E-02	Co-60	6.57E-06	1.18E-05
Pd^{+4}	5.86E-06	2.19E-03	Th-231	1.26E-08	1.26E-08	Zr-93	1.33E-06	1.33E-06	Ni-63	2.80E-05	6.61E-05

Table 3. Tank WM-187 composition with minimum and maximum solids.

	Min Solids	**Max solids**		**Min Solids**	**Max solids**		**Min Solids**	**Max solids**		**Min Solids**	**Max solids**
Gallon	284,920	284,920		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.31	1.32	PO_4^{-3}	2.31E-01	4.13E-01	Th-232	4.23E-16	4.30E-16	Tc-98	1.54E-12	1.57E-12
			Pu^{+4}	1.92E-05	2.68E-05	Th-234	1.24E-08	1.26E-08	Tc-99	4.81E-05	8.05E-05
	mol/liter	mol/liter	K^{+}	2.21E-01	2.26E-01	Pa-231	5.33E-11	5.43E-11	Ru-106	1.37E-06	2.07E-06
H+	1.05E+00	1.03E+00	Pr^{+4}	4.99E-06	4.93E-06	Pa-233	1.75E-06	1.78E-06	Rh-102	5.15E-10	5.23E-10
Al^{+3}	6.91E-01	7.24E-01	Pm^{+3}	1.55E-07	2.88E-07	Pa-234m	1.24E-08	1.26E-08	Rh-106	1.37E-06	2.07E-06
Am^{+4}	1.19E-07	1.42E-07	Rh^{+4}	2.15E-06	2.12E-06	U-232	3.19E-09	4.87E-09	Pd-107	9.86E-09	1.00E-08
Sb^{+5}	2.32E-05	4.16E-05	Rb^{+}	3.31E-06	3.27E-06	U-233	8.22E-11	1.12E-10	Cd-113m	1.98E-06	2.02E-06
As^{+5}	5.27E-04	5.78E-04	Ru^{+3}	8.11E-04	1.39E-03	U-234	1.41E-06	1.62E-06	In-115	6.01E-17	6.11E-17
Ba^{+2}	1.00E-04	1.40E-04	Sm^{+3}	3.35E-06	3.37E-06	U-235	6.51E-08	8.47E-08	Sn-121m	3.99E-08	4.06E-08
Be^{+2}	1.50E-05	2.08E-05	Se^{+4}	1.09E-04	1.39E-04	U-236	1.01E-07	1.34E-07	Sn-126	6.03E-07	9.06E-07
B^{+3}	1.32E-02	1.39E-02	Si^{+4}	4.16E-01	7.70E-01	U-237	3.84E-09	3.91E-09	Sb-125	5.75E-04	1.06E-03
Br^{-}	1.82E-07	1.80E-07	Ag^{+}	6.40E-04	1.18E-03	U-238	3.17E-08	3.55E-08	Sb-126m	2.45E-07	2.49E-07
Cd^{+2}	8.42E-04	8.82E-04	Na^{+}	2.12E+00	2.13E+00	Np-237	4.04E-16	1.88E-06	Sb-126	3.43E-08	3.49E-08
Ca^{+2}	4.92E-02	4.98E-02	Sr^{+2}	1.20E-04	1.23E-04	Np-238	1.48E-06	5.40E-11	Te-123	2.29E-19	2.33E-19
Ce^{+4}	8.09E-05	1.10E-04	SO_4^{-2}	7.17E-02	7.48E-02	Np-239	4.54E-11	1.52E-08	Te-125m	1.88E-06	1.91E-06
Cs^{+}	6.63E-05	9.99E-05	Tc^{+7}	2.87E-05	4.80E-05	Pu-236	4.81E-09	6.96E-09	I-129	7.44E-08	1.13E-07
Cl^{-}	3.75E-02	4.22E-02	Te^{+4}	1.77E-06	1.75E-06	Pu-238	1.80E-03	2.50E-03	Cs-134	5.45E-05	9.37E-05
Cr^{+3}	4.12E-03	4.56E-03	Tb^{+4}	1.26E-09	1.25E-09	Pu-239	2.73E-04	3.80E-04	Cs-135	1.18E-06	1.75E-06
Co^{+2}	3.01E-05	3.88E-05	Tl^{+3}	3.77E-05	4.74E-05	Pu-240	1.83E-05	2.66E-05	Cs-137	6.69E-02	9.80E-02
Cu^{+2}	7.54E-04	8.27E-04	Th^{+4}	6.97E-07	6.87E-07	Pu-241	1.27E-03	1.85E-03	Ba-137m	6.33E-02	9.27E-02
Eu^{+3}	3.03E-07	3.00E-07	Sn^{+4}	2.46E-03	4.50E-03	Pu-242	1.40E-08	2.03E-08	La-138	1.14E-16	1.16E-16
F^{-}	6.65E-02	8.14E-02	Ti^{+4}	1.38E-03	2.44E-03	Pu-244	1.02E-15	1.56E-15	Ce-142	1.78E-11	1.82E-11
Gd^{+3}	1.83E-04	1.89E-04	U^{+4}	5.32E-04	6.20E-04	Am-241	9.80E-05	1.17E-04	Ce-144	9.30E-07	1.40E-06
Ge^{+4}	5.25E-09	5.18E-09	V^{+5}	9.41E-04	9.54E-04	Am-242m	9.08E-09	9.24E-09	Pr-144	3.89E-07	3.95E-07
In^{+3}	8.56E-07	8.71E-07	Y^{+3}	4.09E-06	4.04E-06	Am-242	9.04E-09	9.19E-09	Nd-144	9.60E-16	9.76E-16
I^{-}	3.52E-06	5.23E-06	Zn^{+2}	1.16E-03	1.28E-03	Am-243	2.05E-08	2.70E-08	Pm-146	3.04E-08	3.09E-08
Fe^{+3}	3.16E-02	3.97E-02	Zr^{+4}	3.83E-02	6.99E-02	Cm-242	1.17E-08	1.51E-08	Pm-147	2.49E-04	3.73E-04
La^{+3}	5.48E-06	5.42E-06	O-2	6.53E-01	1.21E+00	Cm-243	4.98E-08	7.51E-08	Sm-146	1.65E-13	1.68E-13
Pb^{+2}	1.33E-03	1.36E-03	H2O	4.61E+01	4.45E+01	Cm-244	3.91E-06	6.21E-06	Sm-147	4.40E-12	4.47E-12
Li^{+}	5.91E-04	6.95E-04				Cm-245	6.66E-10	1.05E-09	Sm-148	2.26E-17	2.30E-17
Mg^{+2}	1.37E-02	1.45E-02		g/liter	g/liter	Cm-246	4.34E-11	6.86E-11	Sm-149	2.01E-18	2.04E-18
Mn^{+4}	1.56E-02	1.63E-02	TOC	0.51	0.50				Sm-151	4.94E-04	7.42E-04
Hg^{+2}	2.21E-03	2.26E-03	UDS	65	121	H-3	1.97E-05	2.02E-05	Eu-150	8.58E-12	8.73E-12
Mo^{+6}	4.15E-04	5.94E-04				Be-10	1.79E-12	1.82E-12	Eu-152	2.21E-06	2.83E-06
Nd^{+3}	1.77E-05	1.75E-05		Ci/liter	Ci/liter	C-14	1.77E-10	2.66E-10	Eu-154	8.25E-05	1.02E-04
Np^{+4}	1.08E-05	1.12E-05		(Jan, 2003)	(Jan, 2003)	Se-79	7.17E-07	1.04E-06	Eu-155	1.41E-04	1.82E-04
Ni^{+2}	1.69E-03	1.91E-03	Ra-226	4.89E-12	4.97E-12	Rb-87	1.75E-11	1.78E-11	Gd-152	8.49E-19	8.63E-19
Nb^{+5}	1.29E-03	2.03E-03	Ac-227	2.30E-11	2.34E-11	Sr-90	2.47E-02	2.59E-02	Ho-166m	2.75E-11	2.80E-11
NO_3^{-}	5.43E+00	5.45E+00	Th-230	1.47E-09	2.29E-09	Y-90	2.47E-02	2.59E-02	Co-60	1.03E-05	1.33E-05
Pd^{+4}	1.54E-03	2.84E-03	Th-231	1.25E-08	1.27E-08	Zr-93	1.32E-06	1.35E-06	Ni-63	2.78E-05	2.83E-05

Table 4. Tank WM-187 composition of solids.

	Weight percent		Weight percent		Ci/kg		Ci/kg
Al^{+3}	1.72E+00	Ni^{+2}	2.36E-02	C-14	1.58E-09	Eu-155	6.96E-04
Sb^{+5}	4.02E-03	Nb^{+5}	1.23E-01	Co-60	5.60E-05	Th-230	1.47E-08
As^{+5}	6.82E-03	NO_3^-	5.65E+00	Ni-59	4.98E-05	U-232	3.00E-08
Ba^{+2}	9.81E-03	Pd^{+4}	2.48E-01	Ni-63	4.11E-04	U-233	5.16E-10
Be^{+2}	9.35E-05	PO_4^{-3}	3.10E+01	Se-79	5.68E-06	U-234	3.35E-06
B^{+3}	1.61E-02	K^+	4.51E-01	Sr-90	1.42E-02	U-235	3.31E-07
Cd^{+2}	1.11E-02	Ru^{+3}	1.05E-01	Y-90	1.42E-02	U-236	5.68E-07
Ca^{+2}	7.20E-02	Se^{+4}	4.21E-03	Tc-99	5.78E-04	U-238	6.32E-08
Ce^{+4}	7.29E-03	Si^{+4}	1.79E+01	Ru-106	1.23E-05	Np-237	1.73E-06
Cs^+	8.08E-03	Ag^+	1.05E-01	Rh-106	1.23E-05	Pu-236	3.82E-08
Cl^-	3.05E-01	Na^+	3.92E-01	Sn-126	5.37E-06	Pu-238	1.23E-02
Cr^{+3}	4.44E-02	Sr^{+2}	4.95E-04	Sb-125	8.72E-03	Pu-239	1.88E-03
Co^{+2}	9.35E-04	SO_4^{-2}	5.89E-01	I-129	6.94E-07	Pu-240	1.47E-04
Cu^{+2}	8.42E-03	Tl^{+3}	3.56E-03	Cs-134	7.07E-04	Pu-241	1.05E-02
F^-	5.29E-01	Sn^{+4}	4.36E-01	Cs-135	1.00E-05	Pu-242	1.11E-07
Gd^{+3}	1.82E-03	Ti^{+4}	9.16E-02	Cs-137	5.51E-01	Pu-244	9.52E-15
Fe^{+3}	8.19E-01	U^{+4}	2.22E-02	Ba-137m	5.21E-01	Am-241	3.05E-04
Pb^{+2}	1.34E-02	V^{+5}	1.40E-03	Ce-144	8.33E-06	Am-243	1.14E-07
Li^+	1.31E-03	Zn^{+2}	1.48E-02	Pr-144	8.33E-06	Cm-242	5.77E-08
Mg^{+2}	3.88E-02	Zr^{+4}	5.19E+00	Pm-147	2.21E-03	Cm-243	4.50E-07
Mn^{+4}	7.88E-02	O-2	1.59E+01	Sm-151	4.40E-03	Cm-244	4.09E-05
Hg^{+2}	1.95E-02	H2O	1.80E+01	Eu-152	1.06E-05	Cm-245	6.93E-09
Mo^{+6}	3.10E-02	Total	1.00E+02	Eu-154	3.48E-04	Cm-246	4.49E-10
assumed specific gravity		2.0					

2.2 WM-188 Composition

In October 2002, Tank WM-188 contained 211,100 gallons of waste. The tank was sampled and both liquid and solids were analyzed (Johnson 2003a). An estimated 5,000 kg of solids, equivalent to a volume of about 660 gallons, are contained in the tank. Additions to the tank from October 2002 to March 31, 2004 have amounted to 47,000 gallons. An estimated additional 1,600 gallons will be added in April and May 2004. Then, starting in June 2004, Tank WM-187 waste (mostly the heel and wash water from Tank WM-181) will be evaporated and the concentrate added to Tank WM-188. Other additions to WM-188 include NGLW generated from June 2004 through September 2005, and a small amount of waste from the dilute heel in Tank WM-180.

Table 5. Basis for Tank WM-188 waste composition.

	Gallons	Stream Name
Liquid waste in tank October 2002	210,440	WM-188-0
Estimated solids in tank October 2002	660	WM-188-S
Concentrate added through May 2004	48,600	ETS-1
NGLW added June 2004 through Sept 2005	5,500	NGLW-3
Evaporator concentrate from WM-181	16,400	WM-181-0
Evaporator concentrate from final WM-180 heel	70	WM-180-H
Final volume	**281,670**	**WM-188**
Gallons solids	660	WM-188-S
Gallons liquid	281,010	WM-188-L

Table 6 shows the composition of waste in Tank WM-188 waste assuming 5,000 kg of solids. As for Tank WM-187, there is uncertainty in the amount of solids in Tank WM-188. Thus, Table 7 shows composition for the case of no solids (equivalent to the composition of the liquid only), and the case of twice as many solids as shown in Table 6.

In 1999 when Tank WM-188 was last at heel level, the tank was inspected by video and very few solids (~1/4-in) were seen in the tank (Patterson 2000). Since then, the waste that has been added to the tank has been SBW from other tanks that has undergone further concentration by evaporation.

A 236-ml portion of the 2002 WM-188 sample was allowed to settle, and after 7 days, the solids had settled into a sludge layer of about 3.6 ml. The concentration of solids in the sample may not necessarily equal that in the tank, but if they were equal, the sludge in the tank would amount to about 11,000 gallons. Assuming a solids particle density of 2 kg/liter, 5000 kg would occupy about 6% of this volume. The volume fraction of the WM-188 sludge was not measured, but was found to be about 7% for sludge from Tank WM-189.[c]

As was done for Tank WM-187, the concentrations of nitrates shown in Tables 6 and 7 have been adjusted from measured values to achieve an overall charge balance in the total composition. The specific gravity and TOC are based on sample analysis (Johnson, 2003a).

[c] Batcheller (2003, see Section 3.3.2) calculates the interstitial liquid volume of a 15 ml sample of WM-189 sludge to be 14 ml. Hence the volume of the undissolved solids is approximately 1 ml and the volume fraction of undissolved solids 1/15 = 6.7%. Unpublished results for the February 2004 WM-187 sample show the sludge to be 11 vol % solids, and two measurements of an earlier WM-187 sample give results of 9.4 and 10.5 vol % solids in the sludge.

Table 6. Tank WM-188 waste composition, liquids and solids.

Gallons	281,670		mol/liter		Ci/liter		Ci/liter
SG	1.32	PO_4^{-3}	1.38E-02	Th-232	9.75E-16	Tc-98	3.55E-12
		Pu^{+4}	5.37E-06	Th-234	2.85E-08	Tc-99	2.49E-05
	mol/liter	K^{+}	1.77E-01	Pa-231	1.23E-10	Ru-106	1.31E-06
H+	2.68E+00	Pr^{+4}	1.19E-05	Pa-233	4.03E-06	Rh-102	1.19E-09
Al^{+3}	6.77E-01	Pm^{+3}	1.74E-09	Pa-234m	2.85E-08	Rh-106	1.31E-06
Am^{+4}	8.32E-08	Rh^{+4}	5.14E-06	U-232	2.95E-09	Pd-107	2.27E-08
Sb^{+5}	5.82E-06	Rb^{+}	7.91E-06	U-233	1.18E-10	Cd-113m	4.57E-06
As^{+5}	1.04E-05	Ru^{+3}	2.29E-04	U-234	1.29E-06	In-115	1.39E-16
Ba^{+2}	7.92E-05	Sm^{+3}	7.83E-06	U-235	1.08E-07	Sn-121m	9.20E-08
Be^{+2}	1.88E-05	Se^{+4}	6.92E-06	U-236	5.01E-08	Sn-126	5.77E-07
B^{+3}	2.19E-02	Si^{+4}	1.45E-02	U-237	9.42E-09	Sb-125	2.45E-05
Br^{-}	4.35E-07	Ag^{+}	1.87E-05	U-238	1.53E-08	Sb-126m	5.65E-07
Cd^{+2}	3.32E-03	Na^{+}	1.52E+00	Np-237	4.03E-06	Sb-126	7.91E-08
Ca^{+2}	6.55E-02	Sr^{+2}	9.88E-05	Np-238	8.08E-10	Te-123	5.27E-19
Ce^{+4}	3.50E-05	SO_4^{-2}	3.76E-02	Np-239	2.28E-07	Te-125m	4.33E-06
Cs^{+}	3.66E-05	Tc^{+7}	1.48E-05	Pu-236	3.99E-09	I-129	7.49E-08
Cl^{-}	3.06E-02	Te^{+4}	4.66E-06	Pu-238	6.43E-04	Cs-134	7.62E-05
Cr^{+3}	5.42E-03	Tb^{+4}	3.01E-09	Pu-239	7.31E-05	Cs-135	1.20E-06
Co^{+2}	4.88E-05	Tl^{+3}	3.07E-06	Pu-240	1.47E-05	Cs-137	7.06E-02
Cu^{+2}	7.73E-04	Th^{+4}	3.27E-05	Pu-241	4.08E-04	Ba-137m	6.68E-02
Eu^{+3}	7.21E-07	Sn^{+4}	1.82E-04	Pu-242	1.18E-08	La-138	2.63E-16
F^{-}	3.53E-02	Ti^{+4}	1.39E-04	Pu-244	3.13E-17	Ce-142	4.11E-11
Gd^{+3}	1.86E-04	U^{+4}	4.07E-04	Am-241	6.82E-05	Ce-144	8.80E-07
Ge^{+4}	1.25E-08	V^{+5}	4.16E-05	Am-242m	2.37E-08	Pr-144	8.80E-07
In^{+3}	1.97E-06	Y^{+3}	9.76E-06	Am-242	2.36E-08	Nd-144	2.21E-15
I^{-}	3.61E-06	Zn^{+2}	9.43E-04	Am-243	3.36E-08	Pm-146	7.00E-08
Fe^{+3}	2.56E-02	Zr^{+4}	5.93E-03	Cm-242	4.66E-08	Pm-147	2.39E-04
La^{+3}	1.31E-05	O-2	2.16E-02	Cm-243	3.92E-08	Sm-146	3.80E-13
Pb^{+2}	1.03E-03	H2O	4.55E+01	Cm-244	1.09E-06	Sm-147	1.01E-11
Li^{+}	3.63E-04			Cm-245	4.12E-10	Sm-148	5.21E-17
Mg^{+2}	2.58E-02		g/liter	Cm-246	2.71E-11	Sm-149	4.62E-18
Mn^{+4}	1.66E-02	TOC	0.40			Sm-151	4.71E-04
Hg^{+2}	7.10E-03	UDS	4.69	H-3	1.68E-05	Eu-150	1.98E-11
Mo^{+6}	2.85E-04			Be-10	4.13E-12	Eu-152	3.49E-06
Nd^{+3}	4.22E-05		Ci/liter	C-14	1.69E-10	Eu-154	2.54E-04
Np^{+4}	2.41E-05		(Jan, 2003)	Se-79	7.09E-07	Eu-155	2.26E-04
Ni^{+2}	2.59E-03	Ra-226	1.15E-11	Rb-87	4.03E-11	Gd-152	1.96E-18
Nb^{+5}	1.80E-04	Ac-227	5.42E-11	Sr-90	5.25E-02	Ho-166m	6.33E-11
NO_3^{-}	6.71E+00	Th-230	1.18E-09	Y-90	5.25E-02	Co-60	5.85E-05
Pd^{+4}	3.98E-04	Th-231	2.95E-08	Zr-93	3.05E-06	Ni-63	4.60E-05

Table 7. Tank WM-188 composition without solids and with twice the expected solids.

	No Solids	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**
Gal	281,670	281,670		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.31	1.32	PO_4^{-3}	1.21E-03	2.68E-02	Th-232	9.77E-16	9.95E-16	Tc-98	3.56E-12	3.62E-12
			Pu^{+4}	5.39E-06	5.49E-06	Th-234	2.86E-08	2.91E-08	Tc-99	2.39E-05	2.64E-05
	mol/liter	mol/liter	K^{+}	1.76E-01	1.83E-01	Pa-231	1.23E-10	1.26E-10	Ru-106	1.28E-06	1.36E-06
H+	2.68E+00	2.73E+00	Pr^{+4}	1.19E-05	1.22E-05	Pa-233	4.04E-06	4.12E-06	Rh-102	1.19E-09	1.21E-09
Al^{+3}	6.74E-01	6.95E-01	Pm^{+3}	1.75E-09	1.78E-09	Pa-234m	2.86E-08	2.91E-08	Rh-106	1.28E-06	1.36E-06
Am^{+4}	8.34E-08	8.49E-08	Rh^{+4}	5.15E-06	5.25E-06	U-232	2.89E-09	3.07E-09	Pd-107	2.28E-08	2.32E-08
Sb^{+5}	4.71E-06	7.04E-06	Rb^{+}	7.93E-06	8.07E-06	U-233	1.16E-10	1.22E-10	Cd-113m	4.58E-06	4.67E-06
As^{+5}	7.86E-06	1.30E-05	Ru^{+3}	1.71E-04	2.91E-04	U-234	1.27E-06	1.34E-06	In-115	1.39E-16	1.41E-16
Ba^{+2}	7.78E-05	8.24E-05	Sm^{+3}	7.85E-06	7.99E-06	U-235	1.06E-07	1.11E-07	Sn-121m	9.22E-08	9.40E-08
Be^{+2}	1.78E-05	2.02E-05	Se^{+4}	4.37E-06	9.57E-06	U-236	4.91E-08	5.24E-08	Sn-126	5.67E-07	6.00E-07
B^{+3}	2.17E-02	2.26E-02	Si^{+4}	7.79E-04	2.83E-02	U-237	9.34E-09	9.72E-09	Sb-125	1.91E-05	3.04E-05
Br^{-}	4.36E-07	4.44E-07	Ag^{+}	5.80E-06	3.18E-05	U-238	1.51E-08	1.59E-08	Sb-126m	5.67E-07	5.77E-07
Cd^{+2}	3.31E-03	3.40E-03	Na^{+}	1.52E+00	1.57E+00	Np-237	4.04E-06	4.12E-06	Sb-126	7.93E-08	8.08E-08
Ca^{+2}	6.53E-02	6.74E-02	Sr^{+2}	9.79E-05	1.02E-04	Np-238	8.15E-10	8.20E-10	Te-123	5.29E-19	5.38E-19
Ce^{+4}	3.41E-05	3.67E-05	SO_4^{-2}	3.68E-02	3.92E-02	Np-239	2.30E-07	2.31E-07	Te-125m	4.35E-06	4.43E-06
Cs^{+}	3.53E-05	3.87E-05	Tc^{+7}	1.42E-05	1.45E-05	Pu-236	4.05E-09	4.03E-09	I-129	7.36E-08	7.79E-08
Cl^{-}	2.99E-02	3.20E-02	Te^{+4}	4.67E-06	4.76E-06	Pu-238	6.46E-04	6.54E-04	Cs-134	7.56E-05	7.86E-05
Cr^{+3}	5.35E-03	5.62E-03	Tb^{+4}	3.02E-09	3.08E-09	Pu-239	7.32E-05	7.47E-05	Cs-135	1.19E-06	1.25E-06
Co^{+2}	4.81E-05	5.07E-05	Tl^{+3}	1.92E-06	4.27E-06	Pu-240	1.49E-05	1.48E-05	Cs-137	6.96E-02	7.33E-02
Cu^{+2}	7.69E-04	7.96E-04	Th^{+4}	3.28E-05	3.34E-05	Pu-241	4.09E-04	4.17E-04	Ba-137m	6.58E-02	6.94E-02
Eu^{+3}	7.23E-07	7.36E-07	Sn^{+4}	4.70E-05	3.17E-04	Pu-242	1.20E-08	1.19E-08	La-138	2.63E-16	2.68E-16
F^{-}	3.54E-02	3.61E-02	Ti^{+4}	6.65E-05	2.14E-04	Pu-244	3.20E-17	3.13E-17	Ce-142	4.12E-11	4.20E-11
Gd^{+3}	1.85E-04	1.91E-04	U^{+4}	4.02E-04	4.23E-04	Am-241	6.84E-05	6.96E-05	Ce-144	8.64E-07	9.17E-07
Ge^{+4}	1.26E-08	1.28E-08	V^{+5}	4.05E-05	4.36E-05	Am-242m	2.39E-08	2.41E-08	Pr-144	8.64E-07	9.17E-07
In^{+3}	1.98E-06	2.01E-06	Y^{+3}	9.79E-06	9.97E-06	Am-242	2.38E-08	2.40E-08	Nd-144	2.22E-15	2.26E-15
I^{-}	3.62E-06	3.69E-06	Zn^{+2}	9.37E-04	9.71E-04	Am-243	3.37E-08	3.43E-08	Pm-146	7.02E-08	7.15E-08
Fe^{+3}	2.51E-02	2.67E-02	Zr^{+4}	3.34E-03	8.59E-03	Cm-242	4.68E-08	4.76E-08	Pm-147	2.35E-04	2.49E-04
La^{+3}	1.31E-05	1.34E-05	O-2		4.32E-02	Cm-243	3.92E-08	4.02E-08	Sm-146	3.80E-13	3.88E-13
Pb^{+2}	1.03E-03	1.06E-03	H2O	4.56E+01	4.50E+01	Cm-244	1.08E-06	1.12E-06	Sm-147	1.02E-11	1.03E-11
Li^{+}	3.52E-04	3.82E-04				Cm-245	4.12E-10	4.22E-10	Sm-148	5.22E-17	5.32E-17
Mg^{+2}	2.57E-02	2.65E-02		g/liter	g/liter	Cm-246	2.71E-11	2.78E-11	Sm-149	4.63E-18	4.72E-18
Mn^{+4}	1.66E-02	1.70E-02	TOC	0.40	0.41				Sm-151	4.63E-04	4.91E-04
Hg^{+2}	7.12E-03	7.25E-03	UDS	0	9.4	H-3	1.69E-05	1.72E-05	Eu-150	1.98E-11	2.02E-11
Mo^{+6}	2.69E-04	3.06E-04				Be-10	4.14E-12	4.22E-12	Eu-152	3.47E-06	3.60E-06
Nd^{+3}	4.23E-05	4.31E-05		Ci/liter	Ci/liter	C-14	1.66E-10	1.75E-10	Eu-154	2.53E-04	2.60E-04
Np^{+4}	2.42E-05	2.46E-05		(Jan, 2003)	(Jan, 2003)	Se-79	6.03E-07	8.29E-07	Eu-155	2.25E-04	2.33E-04
Ni^{+2}	2.55E-03	2.69E-03	Ra-226	1.13E-11	1.15E-11	Rb-87	4.04E-11	4.12E-11	Gd-152	1.96E-18	2.00E-18
Nb^{+5}	3.11E-05	3.30E-04	Ac-227	5.32E-11	5.42E-11	Sr-90	5.24E-02	5.39E-02	Ho-166m	6.35E-11	6.47E-11
NO_3^{-}	6.71E+00	6.87E+00	Th-230	1.13E-09	1.16E-09	Y-90	5.24E-02	5.39E-02	Co-60	5.83E-05	6.01E-05
Pd^{+4}	3.75E-04	4.30E-04	Th-231	2.89E-08	2.95E-08	Zr-93	3.06E-06	3.11E-06	Ni-63	4.62E-05	4.70E-05

Table 8. Tank WM-188 solids composition.

	Weight percent		Weight percent		Ci/kg		Ci/kg
Al^{+3}	2.28E+00	Ni^{+2}	5.56E-02	C-14	7.27E-10	Eu-155	4.50E-04
Sb^{+5}	2.91E-03	Nb^{+5}	2.96E-01	Co-60	7.75E-05	Th-230	2.71E-09
As^{+5}	4.02E-03	NO_3^-	1.68E+01	Ni-59	2.30E-05	U-232	7.25E-09
Ba^{+2}	4.56E-03	Pd^{+4}	5.40E-02	Ni-63	3.81E-04	U-233	1.25E-10
Be^{+2}	2.01E-04	PO_4^{-3}	2.64E+01	Se-79	2.62E-06	U-234	1.18E-06
B^{+3}	6.47E-02	K^+	1.93E+00	Sr-90	5.51E-02	U-235	8.89E-08
Cd^{+2}	3.38E-02	Ru^{+3}	1.26E-01	Y-90	5.51E-02	U-236	1.35E-07
Ca^{+2}	3.75E-01	Se^{+4}	4.31E-03	Tc-99	2.23E-04	U-238	2.09E-08
Ce^{+4}	3.01E-03	Si^{+4}	8.23E+00	Ru-106	5.66E-06	Np-237	6.41E-07
Cs^+	3.93E-03	Ag^+	2.97E-02	Rh-106	5.66E-06	Pu-236	7.97E-09
Cl^-	5.88E-01	Na^+	5.52E+00	Sn-126	2.47E-06	Pu-238	2.45E-03
Cr^{+3}	9.73E-02	Sr^{+2}	2.20E-03	Sb-125	1.17E-03	Pu-239	3.36E-04
Co^{+2}	1.10E-03	SO_4^{-2}	1.69E+00	I-129	3.20E-07	Pu-240	3.07E-05
Cu^{+2}	8.64E-03	Tl^{+3}	5.03E-03	Cs-134	1.70E-04	Pu-241	1.89E-03
F^-	0.00E+00	Sn^{+4}	3.41E-01	Cs-135	4.61E-06	Pu-242	2.32E-08
Gd^{+3}	3.93E-03	Ti^{+4}	7.47E-02	Cs-137	2.62E-01	Pu-244	1.99E-15
Fe^{+3}	6.86E-01	U^{+4}	3.30E-02	Ba-137m	2.47E-01	Am-241	5.31E-05
Pb^{+2}	2.73E-02	V^{+5}	1.20E-03	Ce-144	3.84E-06	Am-243	2.59E-08
Li^+	1.68E-03	Zn^{+2}	1.15E-02	Pr-144	3.84E-06	Cm-242	5.29E-11
Mg^{+2}	7.20E-02	Zr^{+4}	5.04E+00	Pm-147	1.02E-03	Cm-243	2.71E-08
Mn^{+4}	9.07E-02	O-2	7.36E+00	Sm-151	2.03E-03	Cm-244	1.70E-06
Hg^{+2}	0.00E+00	H2O	2.16E+01	Eu-152	6.89E-06	Cm-245	2.88E-10
Mo^{+6}	3.24E-02	Total	100.00	Eu-154	2.12E-04	Cm-246	1.87E-11
assumed specific gravity		2.0					

The solids composition shown in Table 8 is based on analyses data from a sample of WM-188 waste taken in FY 2003 (see Johnson 2003a). The sample was allowed to settle, the sludge layer then filtered, the solids washed with water and isopropyl alcohol and then dried. The dried solids were fused, dissolved in nitric acid or water and then analyzed using the same techniques as used for the tank liquid.

The elements Sb, As, Be, Ce, Cs, Li, Se, Tl, U and V were not detected in the sample; values shown above are based on detection limits. No analyses for Cl, F or Hg were performed for this sample; values shown above were based on the average of analyses of other tank solids samples. The concentration of water shown in Table 8 is meant to be all hydrated water. No analysis for hydrated water was performed, the value of 21.6% is an estimate based primarily on the concentration of sulfates and phosphates and some assumed hydrate compounds. The concentration of oxides in the solids was calculated by charge balance. Finally, the concentrations of all chemical species except hydrated water were normalized to arrive at the values shown above.

The solids sample was analyzed for twenty radionuclides. Of these twenty, two were not detected (^{59}Ni and ^{95}Zr), and the analytical result for one (^{242}Cm) was negative. Concentrations shown in Table 8 for radionuclides other than these 17 were derived from activities for solids from Tanks WM-182 and WM-183 as published by Swenson (MCS-06-02, 2002). To arrive at these estimates, the activities shown in Table A of MCS-06-02 for Tanks WM-182 and WM-183 were first decayed to January, 2003. The

averages of the decayed activity for each radionuclide in the two tanks were then used to calculate ratios. These ratios were then used to estimate activities for Tank WM-188 radionuclides. For example, the activity of ^{135}Cs in WM-188 solids was estimated by multiplying the measured activity of ^{137}Cs in the WM-188 sample by the ratio of ^{135}Cs to ^{137}Cs in Tank WM-182 and WM-183 solids.

2.3 WM-189 Composition

Samples were taken from Tank WM-189 in March 2002. No waste has been added to this tank since that time or is expected to be in the future. Three separate samples of the liquid were taken via airlifting tank waste to the NWCF, where it could be sampled. A sample of tank waste near the bottom of the tank was then taken using the tank steam jet. The sampling procedure, analysis methods and results were reported by Batcheller and Taylor (2003). Table 9 shows the composition of waste in WM-189 with an estimated amount of solids. Table 10 shows the composition of the waste with no solids and with twice the expected amount.

Table 9. WM-189 waste composition, liquids and solids.

Gallons	**279,800**		**mol/liter**		**mol/liter**		**Ci/liter**		**Ci/liter**
SG	1.34	Hg^{+2}	6.45E-03	Y^{+3}	7.01E-06	Pu-238	4.08E-04	Sn-121m	6.61E-08
		Mo^{+6}	3.11E-04	Zn^{+2}	1.08E-03	Pu-239	4.65E-05	Sn-126	4.29E-07
	mol/liter	Nd^{+3}	3.03E-05	Zr^{+4}	5.57E-03	Pu-240	1.03E-05	Sb-125	2.38E-05
H+	2.86E+00	Np^{+4}	1.73E-05	O-2	4.34E-02	Pu-241	4.14E-04	Sb-126m	4.06E-07
Al^{+3}	7.24E-01	Ni^{+2}	2.41E-03	H2O	4.27E+01	Pu-242	8.04E-09	Sb-126	5.69E-08
Am^{+4}	8.94E-08	Nb^{+5}	5.48E-04			Pu-244	6.88E-16	Te-123	3.79E-19
Sb^{+5}	9.81E-06	NO_3^-	7.53E+00		g/liter	Am-241	7.36E-05	Te-125m	3.11E-06
As^{+5}	1.06E-05	Pd^{+4}	5.15E-05	TOC	0.58	Am-242m	1.50E-08	I-129	5.58E-08
Ba^{+2}	5.91E-05	PO_4^{-3}	2.65E-02	UDS	9.4	Am-242	1.50E-08	Cs-134	4.17E-05
Be^{+2}	2.22E-05	Pu^{+4}	3.86E-06			Am-243	2.14E-08	Cs-135	8.93E-07
B^{+3}	2.16E-02	K^+	2.29E-01		Ci/liter	Cm-242	2.97E-08	Cs-137	5.23E-02
Br^-	3.12E-07	Pr^{+4}	8.56E-06		(Jan, 2003)	Cm-243	2.83E-08	Ba-137m	4.95E-02
Cd^{+2}	3.92E-03	Pm^{+3}	1.31E-09	Ra-226	8.10E-12	Cm-244	1.06E-06	La-138	1.89E-16
Ca^{+2}	7.36E-02	Rh^{+4}	3.69E-06	Ac-227	3.81E-11	Cm-245	2.98E-10	Ce-142	2.96E-11
Ce^{+4}	3.73E-05	Rb^+	5.68E-06	Th-230	8.39E-10	Cm-246	1.96E-11	Ce-144	6.56E-07
Cs^+	2.95E-05	Ru^{+3}	2.89E-04	Th-231	2.07E-08			Pr-144	6.56E-07
Cl^-	2.22E-02	Sm^{+3}	5.63E-06	Th-232	7.00E-16	H-3	9.61E-06	Nd-144	1.59E-15
Cr^{+3}	5.84E-03	Se^{+4}	9.76E-06	Th-234	2.05E-08	Be-10	2.97E-12	Pm-146	5.03E-08
Co^{+2}	4.84E-05	Si^{+4}	2.80E-02	Pa-231	8.83E-11	C-14	1.26E-10	Pm-147	1.78E-04
Cu^{+2}	9.70E-04	Ag^+	2.80E-05	Pa-233	2.90E-06	Se-79	6.49E-07	Sm-146	2.73E-13
Eu^{+3}	5.18E-07	Na^+	2.07E+00	Pa-234m	2.05E-08	Rb-87	2.90E-11	Sm-147	7.28E-12
F^-	1.37E-02	Sr^{+2}	1.43E-04	U-232	2.03E-09	Sr-90	3.91E-02	Sm-148	3.74E-17
Gd^{+3}	1.37E-04	SO_4^{-2}	1.08E-01	U-233	8.02E-11	Y-90	3.91E-02	Sm-149	3.32E-18
Ge^{+4}	9.01E-09	Tc^{+7}	7.16E-06	U-234	1.75E-06	Zr-93	2.19E-06	Sm-151	3.51E-04
In^{+3}	1.42E-06	Te^{+4}	7.22E-06	U-235	6.07E-08	Tc-98	2.55E-12	Eu-150	1.42E-11
I^-	2.59E-06	Tb^{+4}	2.17E-09	U-236	7.90E-08	Tc-99	1.20E-05	Eu-152	2.55E-06
Fe^{+3}	2.81E-02	Tl^{+3}	4.34E-06	U-237	6.36E-09	Ru-106	9.73E-07	Eu-154	1.85E-04
La^{+3}	9.41E-06	Th^{+4}	3.48E-05	U-238	4.35E-08	Rh-102	8.52E-10	Eu-155	1.67E-04
Pb^{+2}	1.17E-03	Sn^{+4}	3.12E-04	Np-237	2.90E-06	Rh-106	9.73E-07	Gd-152	1.41E-18
Li^+	4.04E-04	Ti^{+4}	2.20E-04	Np-238	4.71E-10	Pd-107	1.63E-08	Ho-166m	4.55E-11
Mg^{+2}	2.23E-02	U^{+4}	6.69E-04	Np-239	1.33E-07	Cd-113m	3.28E-06	Co-60	3.68E-05
Mn^{+4}	1.95E-02	V^{+5}	2.74E-05	Pu-236	2.78E-09	In-115	9.95E-17	Ni-63	3.13E-05

Table 10. Tank WM-189 composition without solids and with twice the expected solids.

	No Solids	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**
Gallons	279,800	279,800		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.34	1.34	PO_4^{-3}	2.07E-03	5.27E-02	Th-232	7.04E-16	6.97E-16	Tc-98	2.56E-12	2.54E-12
			Pu^{+4}	3.88E-06	3.84E-06	Th-234	2.06E-08	2.04E-08	Tc-99	9.96E-06	1.41E-05
	mol/liter	mol/liter	K^{+}	2.25E-01	2.32E-01	Pa-231	8.88E-11	8.79E-11	Ru-106	9.24E-07	1.02E-06
H+	2.88E+00	2.85E+00	Pr^{+4}	8.60E-06	8.52E-06	Pa-233	2.91E-06	2.88E-06	Rh-102	8.56E-10	8.48E-10
Al^{+3}	7.19E-01	7.28E-01	Pm^{+3}	1.26E-09	1.37E-09	Pa-234m	2.06E-08	2.04E-08	Rh-106	9.24E-07	1.02E-06
Am^{+4}	8.92E-08	8.96E-08	Rh^{+4}	3.71E-06	3.67E-06	U-232	1.97E-09	2.09E-09	Pd-107	1.64E-08	1.63E-08
Sb^{+5}	7.59E-06	1.20E-05	Rb^{+}	5.71E-06	5.65E-06	U-233	7.94E-11	8.10E-11	Cd-113m	3.30E-06	3.27E-06
As^{+5}	5.55E-06	1.56E-05	Ru^{+3}	1.72E-04	4.05E-04	U-234	1.75E-06	1.76E-06	In-115	1.00E-16	9.91E-17
Ba^{+2}	5.62E-05	6.20E-05	Sm^{+3}	5.65E-06	5.60E-06	U-235	6.01E-08	6.12E-08	Sn-121m	6.64E-08	6.58E-08
Be^{+2}	2.02E-05	2.42E-05	Se^{+4}	4.62E-06	1.49E-05	U-236	7.81E-08	7.99E-08	Sn-126	4.08E-07	4.51E-07
B^{+3}	2.12E-02	2.21E-02	Si^{+4}	3.09E-04	5.57E-02	U-237	6.39E-09	6.33E-09	Sb-125	1.28E-05	3.48E-05
Br^{-}	3.14E-07	3.11E-07	Ag^{+}	2.05E-06	5.40E-05	U-238	4.35E-08	4.35E-08	Sb-126m	4.08E-07	4.04E-07
Cd^{+2}	3.91E-03	3.93E-03	Na^{+}	2.06E+00	2.08E+00	Np-237	2.91E-06	2.88E-06	Sb-126	5.71E-08	5.66E-08
Ca^{+2}	7.31E-02	7.42E-02	Sr^{+2}	1.42E-04	1.45E-04	Np-238	4.79E-10	4.62E-10	Te-123	3.81E-19	3.77E-19
Ce^{+4}	3.55E-05	3.92E-05	SO_4^{-2}	1.07E-01	1.10E-01	Np-239	1.35E-07	1.30E-07	Te-125m	3.13E-06	3.10E-06
Cs^{+}	2.68E-05	3.21E-05	Tc^{+7}	5.94E-06	8.39E-06	Pu-236	2.72E-09	2.84E-09	I-129	5.30E-08	5.85E-08
Cl^{-}	2.07E-02	2.37E-02	Te^{+4}	7.26E-06	7.19E-06	Pu-238	3.87E-04	4.30E-04	Cs-134	4.03E-05	4.31E-05
Cr^{+3}	5.69E-03	5.99E-03	Tb^{+4}	2.18E-09	2.16E-09	Pu-239	4.35E-05	4.94E-05	Cs-135	8.54E-07	9.33E-07
Co^{+2}	4.68E-05	4.99E-05	Tl^{+3}	2.03E-06	6.66E-06	Pu-240	1.01E-05	1.06E-05	Cs-137	5.01E-02	5.46E-02
Cu^{+2}	9.62E-04	9.78E-04	Th^{+4}	3.50E-05	3.46E-05	Pu-241	3.98E-04	4.30E-04	Ba-137m	4.74E-02	5.16E-02
Eu^{+3}	5.20E-07	5.15E-07	Sn^{+4}	4.14E-05	5.83E-04	Pu-242	7.85E-09	8.22E-09	La-138	1.90E-16	1.88E-16
F^{-}	1.37E-02	1.36E-02	Ti^{+4}	7.29E-05	3.67E-04	Pu-244	6.73E-16	7.04E-16	Ce-142	2.97E-11	2.94E-11
Gd^{+3}	1.35E-04	1.39E-04	U^{+4}	6.68E-04	6.70E-04	Am-241	7.34E-05	7.37E-05	Ce-144	6.23E-07	6.89E-07
Ge^{+4}	9.05E-09	8.96E-09	V^{+5}	2.53E-05	2.96E-05	Am-242m	1.51E-08	1.50E-08	Pr-144	6.23E-07	6.89E-07
In^{+3}	1.42E-06	1.41E-06	Y^{+3}	7.05E-06	6.98E-06	Am-242	1.50E-08	1.49E-08	Nd-144	1.60E-15	1.58E-15
I^{-}	2.61E-06	2.58E-06	Zn^{+2}	1.07E-03	1.09E-03	Am-243	2.13E-08	2.16E-08	Pm-146	5.05E-08	5.01E-08
Fe^{+3}	2.70E-02	2.91E-02	Zr^{+4}	3.56E-04	1.08E-02	Cm-242	2.98E-08	2.95E-08	Pm-147	1.69E-04	1.87E-04
La^{+3}	9.45E-06	9.37E-06	O-2		8.69E-02	Cm-243	2.82E-08	2.85E-08	Sm-146	2.74E-13	2.71E-13
Pb^{+2}	1.16E-03	1.18E-03	H2O	4.29E+01	4.25E+01	Cm-244	1.05E-06	1.07E-06	Sm-147	7.32E-12	7.25E-12
Li^{+}	3.83E-04	4.25E-04				Cm-245	2.96E-10	2.99E-10	Sm-148	3.76E-17	3.72E-17
Mg^{+2}	2.21E-02	2.24E-02		g/liter	g/liter	Cm-246	1.95E-11	1.97E-11	Sm-149	3.34E-18	3.31E-18
Mn^{+4}	1.95E-02	1.96E-02	TOC	0.59	0.58				Sm-151	3.33E-04	3.69E-04
Hg^{+2}	6.48E-03	6.42E-03	UDS	0	18.9	H-3	9.66E-06	9.57E-06	Eu-150	1.43E-11	1.41E-11
Mo^{+6}	2.80E-04	3.41E-04				Be-10	2.98E-12	2.95E-12	Eu-152	2.50E-06	2.61E-06
Nd^{+3}	3.05E-05	3.02E-05		Ci/liter	Ci/liter	C-14	1.19E-10	1.32E-10	Eu-154	1.84E-04	1.86E-04
Np^{+4}	1.74E-05	1.73E-05		(Jan, 2003)	(Jan, 2003)	Se-79	4.34E-07	8.63E-07	Eu-155	1.63E-04	1.70E-04
Ni^{+2}	2.33E-03	2.49E-03	Ra-226	8.14E-12	8.06E-12	Rb-87	2.91E-11	2.88E-11	Gd-152	1.41E-18	1.40E-18
Nb^{+5}	2.49E-04	8.47E-04	Ac-227	3.83E-11	3.80E-11	Sr-90	3.88E-02	3.95E-02	Ho-166m	4.57E-11	4.53E-11
NO_3^{-}	7.53E+00	7.52E+00	Th-230	8.17E-10	8.60E-10	Y-90	3.88E-02	3.95E-02	Co-60	3.62E-05	3.73E-05
Pd^{+4}	3.61E-06	9.94E-05	Th-231	2.08E-08	2.06E-08	Zr-93	2.20E-06	2.18E-06	Ni-63	3.14E-05	3.11E-05

Based on recent analyses (Batcheller 2003), Tank WM-189 waste has a TOC content of 0.6 g/liter, including 0.16 mg/liter volatile organics and 1.1 mg/liter semi-volatile organics.

Compositions shown in Tables 9 and 10 assume a solids composition equal to that of Tank WM-188, shown in Table 8. A large fraction of the waste in Tanks WM-188 and WM-189 was from the same source, hence it is reasonable that the solids should be similar in composition. Analyses were performed of a solids sample from Tank WM-189 (Batcheller 2003), but the solids were not washed prior to drying and hence included a large fraction (estimated to be about 78% of the total solids) of dissolved solids that crystallized upon drying. A comparison of the tank composition based on the WM-189 solids analysis to what is shown in Table 9 is given in Table 35.

2.4 Newly Generated Liquid Waste (NGLW)

Waste from 24 different sources are projected to be added to Tank Farm tanks or to WM-100, WM-101, and WM-102 as NGLW over the next nine years. Table 11 shows the projected volumes of waste that will be generated from 2004 to 2012. These estimated volumes do not include any dilute aqueous waste generated by a SBW treatment process, or decontamination wastes generated prior to treatment in preparing the NWCF should it be selected as the treatment method. A description of each stream can be found in the Waste Minimization Plan (Demmer 2002).

Table 12 shows typical concentration factors for each of these waste streams and expected volumes after concentration. Table 12 also shows that after concentration only a few streams account for the majority of the waste volume (4 streams account for 79% of the total, 10 streams for 96%, and 14 streams for 99%).

In this section, the composition of eleven streams, amounting to 96.8% of the total as concentrated waste, is first presented. Then, using these compositions, results of modeling the evaporation of these dilute wastes are presented which define compositions and volumes that will need to be treated in the SBW treatment facility.

Table 11. Projected dilute NGLW volumes.

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Total** Dilute
Waste Stream	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons
NWCF operations (ETS)	500	500	500	500	0	0	0	0	0	2,000
Tank Farm Vessel Flushes	171,000	0	0	0	0	100,000	50,000	50,000	0	371,000
Tank Farm Line Flushes	3,400	3,400	3,400	3,400	500	500	500	500	500	16,100
Vault Flush	0	0	0	0	14,400	14,400	14,400	14,400	14,400	72,000
Filter Leach (1st leach)	2,389	2,389	2,389	2,389	2,389	2,389	2,389	2,389	2,389	21,504
Filter Leach	9,558	9,558	9,558	9,558	9,558	9,558	9,558	9,558	9,558	86,018
PBF D&D	30,000	0	0	0	0	0	0	0	0	30,000
FAST Operations	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	315,000
CPP-603 Basin Water	600,000	900,000	0	0	0	0	0	0	0	1,500,000
CPP-603 Operations	10,000	10,000	0	0	0	0	0	0	0	20,000
TAN Pool Water	0	0	750,000	0	0	0	0	0	0	750,000
MTR Canal Water	0	0	0	125,000	0	0	0	0	0	125,000
TAN V-Tank	0	0	0	0	6,000	0	0	0	0	6,000
NWCF Utility Tunnel	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	13,500
CPP-604 Sumps	15,000	15,000	15,000	15,000	3,000	3,000	3,000	3,000	3,000	75,000
Tank Farm Sumps	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	0	240,000
LET&D	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	11,700
LET&D Bottoms	2,500	2,500	2,500	2,500	2,500	2,500	2,500	0	0	17,500
CPP-601 (Lab Drains)	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
NWCF Decon Facility	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	292,500
CPP-601/627/640 Deactivation	0	0	0	0	45,000	0	0	0	0	45,000
Misc. Deactivation Rinses	0	0	0	0	0	0	0	4,000	5,000	9,000
TRA-689 Decon Solution	0	0	0	0	0	0	0	35,000	0	35,000
PEW Descale	1,200	1,200	1,200	1,200	400	400	400	400	400	6,800
Misc. Balance of Plant	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
Total gallons	**814,847**	**1,084,847**	**924,847**	**299,847**	**224,047**	**173,047**	**173,047**	**209,547**	**145,547**	**4,420,622**

Table 12. Initial estimates of concentrated NGLW volumes.

Waste Stream	Typical Concentration Factors PEWE	ETS	Total Volume Dilute	Volume after PEWE	Volume after ETS	% of total concentrated	Rank
			gal	gal	gal		
NWCF Operations (ETS)	1	1	2,000	2,000	2,000	2.48%	8
Tank Farm Vessel Flushes	1	200	371,000	371,000	1,855	2.30%	9
Tank Farm Line Flushes	1	1	16,100	16,100	16,100	20.00%	2
Vault Flush	20	2	72,000	3,600	1,800	2.24%	10
Filter Leach (1st leach)	1	2	21,504	21,504	10,752	13.36%	3
Filter Leach	10	2	86,018	8,602	4,301	5.34%	3
PBF D&D	1000	2	30,000	30	15	0.02%	21
FAST Operations	1000	2	315,000	315	158	0.20%	17
CPP-603 Basin Water	1000	2	1,500,000	1,500	750	0.93%	12
CPP-603 Operations	1000	2	20,000	20	10	0.01%	22
TAN Pool Water	1000	2	750,000	750	375	0.47%	14
MTR Canal Water	1000	2	125,000	125	63	0.08%	19
TAN V-Tank	1000	2	6,000	6	3	0.004%	24
NWCF Utility Tunnel	1000	2	13,500	14	7	0.01%	23
CPP-604 Sumps	1000	2	75,000	75	38	0.05%	20
Tank Farm Sumps	1000	2	240,000	240	120	0.15%	18
LET&D	35	2	11,700	334	167	0.21%	16
LET&D Bottoms	1	1	17,500	17,500	17,500	21.74%	1
CPP-601 (Lab Drains)	35	2	180,000	5,143	2,571	3.19%	6
NWCF Decon Facility	10	2	292,500	29,250	14,625	18.17%	4
CPP-601/627/640 Deactivation	10	2	45,000	4,500	2,250	2.80%	7
Misc. Deactivation Rinses	20	2	9,000	450	225	0.28%	15
TRA-689 Decon Solution	35	2	35,000	1,000	500	0.62%	13
PEW Descale	1	2	6,800	6,800	3,400	4.22%	5
Misc. Balance of Plant	100	2	180,000	1,800	900	1.12%	11
Total gallons			**4,420,622**	**492,658**	**80,484**	**100.00%**	

2.4.1 Compositions of Individual Waste Streams

This section details compositions of individual waste streams.

2.4.1.1 LET&D Bottoms. The Liquid Effluent Treatment and Disposal Facility (LET&D) processes the overhead from the PEW evaporator by fractionation. The fractionator overheads are filtered and released to the atmosphere. The fractionator bottoms is concentrated nitric acid with small concentrations of halides and metals. Samples of LET&D bottoms were taken in 1999 and 2000 from the LET&D bottoms tank, WLL-195, and are reported in the Balance of Plant Analysis Report (Nenni 2002). The composition of LET&D bottoms, shown in Table 13, is largely based on these analyses.

Table 13. Estimated LET&D bottoms composition.

	Mol/liter	
H^{+}	1.21E+01	
Al^{+3}	5.61E-02	
Sb^{+5}	6.92E-07	1
As^{+5}	1.62E-06	1
Ba^{+2}	9.77E-07	
Be^{+2}	8.65E-07	
B^{+3}	2.10E-04	2
Cd^{+2}	1.89E-07	1
Ca^{+2}	7.44E-04	2
Cl^{-}	6.57E-03	2
Cr^{+3}	1.70E-03	
Co^{+2}	1.75E-04	
Cu^{+2}	8.54E-05	
F^{-}	7.16E-03	1
Fe^{+3}	2.92E-04	2
Pb^{+2}	4.62E-07	1
Mn^{+4}	5.83E-05	
Hg^{+2}	2.34E-04	
Ni^{+2}	1.94E-03	
NO_3^{-}	1.23E+01	3
PO_4^{-3}	7.49E-05	2
K^{+}	2.51E-03	2
Se^{+4}	1.27E-06	1
Ag^{+}	1.91E-07	1
Na^{+}	2.40E-02	2
S^{+6}	1.09E-03	2
Tl^{+3}	5.75E-07	1
U^{+4}	5.68E-07	1
V^{+5}	1.67E-06	
Zn^{+2}	1.50E-05	
Zr^{+4}	2.91E-06	2
	g/liter	
UDS	2.22E-02	
TIC	4.47E-02	
TOC	1.41E-02	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data for three samples. Data points with qualifying flags were excluded from the averages.

Estimates of species that were not analyzed were obtained by multiplying the ratio of the concentration of a given species in SBW by the average ratio of a representative species in the LET&D bottoms to the concentration of these same species in SBW. To estimate the concentration of chloride, the fluoride ratio was used. The other estimated species are all nonvolatile and the average ratio for barium, manganese, and zinc was used to estimate the nonvolatile species.

If the calciner is in operation, the LET&D bottoms can be used as make-up acid for scrub solution. It can also be used in the filter leach operation.

2.4.1.2 Tank Farm Line Flushes. This waste is generated when Tank Farm lines are flushed to reduce radiation fields to allow hands-on maintenance work. This waste continues to be generated during regular maintenance and testing of line integrity, and prior to valve box upgrades. This waste stream should be reduced to a minimum after the valve box upgrades are completed in FY 2006. The composition of Tank Farm line flushes was assumed equal to the average SBW composition as of September 30, 2002.

2.4.1.3 Filter Leach. This waste is generated from preparing spent HEPA filters for disposal. As of 2004, approximately 50 filters await treatment. The filter leach composition, shown in Table 14, is based on the analyses of five samples from NWCF Decontamination Tanks NCD-123 and NCD-129 taken in 1999 and 2001. The data for these samples is compiled in the Balance of Plant Analysis Report (Nenni 2002). Concentrations shown in Table 14 are averages of data and estimates for species not analyzed. The ratio of concentration of a species in the filter leach waste to the concentration of the same species in SBW, averaged for all species measured in filter leach samples, was used to estimate concentrations of non-analyzed species.

Table 14. Estimated filter leach composition.

	Mol/liter	
H+	5.45E-01	
Al^{+3}	1.83E-03	
Sb^{+5}	5.54E-06	
As^{+5}	1.49E-06	1
Ba^{+2}	8.49E-06	
Be^{+2}	1.33E-07	1
B^{+3}	6.35E-04	2
Cd^{+2}	1.34E-06	
Ca^{+2}	2.25E-03	2
Cl^{-}	8.54E-04	2
Cr^{+3}	6.08E-05	
Co^{+2}	3.75E-07	1
Cu^{+2}	1.96E-05	
F^{-}	2.15E-03	1
Fe^{+3}	8.84E-04	2
Pb^{+2}	8.45E-06	
Mn^{+4}	2.11E-04	
Hg^{+2}	4.13E-06	
Ni^{+2}	2.86E-05	
NO_3^{-}	6.57E-01	3
PO_4^{-3}	2.26E-04	2
K^{+}	7.60E-03	2
Se^{+4}	1.33E-06	1
Ag^{+}	7.12E-07	1
Na^{+}	7.26E-02	2
S^{+6}	3.31E-03	2
Tl^{+3}	5.79E-07	1
U^{+4}	1.16E-06	1
V^{+5}	8.42E-07	1
Zn^{+2}	1.38E-04	
Zr^{+4}	8.79E-06	2
	g/liter	
UDS	1.50E-02	
TIC	5.88E-02	
TOC	7.03E-01	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data for five samples. Data points with qualifying flags were excluded from the averages.

2.4.1.4 NWCF Decon Facility. The NWCF Decon Facility waste is generated from decontamination of equipment, treatment of debris, and collection of Utility Tunnel water. Compositional data from 1997 for the NWCF Decon Facility Waste is contained in *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp 1998). The data include low, average, and high concentration values for six chemical species plus TIC, TOC and UDS. Averages are based on 6 to 20 data points depending on the component. Table 15 shows these averages plus estimates for other species. Estimates were based either on the average SBW or the Process Equipment Waste Evaporator (PEWE) descale composition. Estimates based on SBW were calculated by multiplying the SBW concentration for that specie by the average ratio of decon facility Al and U concentration to SBW Al and U concentration. Since the makeup NWCF Decon solution uses the same chemicals as the PEWE descale (see Section

2.4.1.5), concentrations of the major metal species in the chemicals (Na, K, Cr, and Mn) were assumed the same for the NWCF Decon Facility waste as for the PEWE Descale waste. Table 15 shows the estimated composition of the NWCF Decon Facility waste.

Table 15. Estimated NWCF Decon Facility composition.

	Mol/liter	
H^{+}	7.41E-01	
Al^{+3}	1.23E-02	
Sb^{+5}	4.29E-07	2
As^{+5}	2.80E-06	2
Ba^{+2}	8.47E-07	2
Be^{+2}	2.36E-07	2
B^{+3}	2.71E-04	2
Cd^{+2}	4.14E-05	2
Ca^{+2}	9.59E-04	2
Cl^{-}	1.34E-03	
Cr^{+3}	1.16E-03	1
Co^{+2}	5.48E-07	2
Cu^{+2}	1.30E-05	2
F^{-}	6.21E-03	
Fe^{+3}	3.77E-04	2
Pb^{+2}	1.84E-05	2
Mn^{+4}	6.12E-03	1
Hg^{+2}	2.17E-05	
Ni^{+2}	3.03E-05	2
NO_3^{-}	1.45E+00	3
PO_4^{-3}	9.65E-05	
K^{+}	1.17E-01	1
Se^{+4}	8.19E-07	2
Ag^{+}	2.97E-08	2
Na^{+}	5.25E-01	1
S^{+6}	9.99E-04	
Tl^{+3}	2.29E-07	2
U^{+4}	5.55E-06	
V^{+5}	5.42E-06	2
Zn^{+2}	1.61E-05	2
Zr^{+4}	3.75E-06	2
	g/liter	
UDS	0.79	
TIC		
TOC	0.67	

1. Green shading indicates estimate based on PEWE descale makeup formulation.

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data.

2.4.1.5 PEWE Descale. During operation of the PEWE, a silicate scale builds up on the reboiler heating surface. PEWE descale waste is generated when this scale is removed. The PEWE descale waste composition is based on the following make-up formulation given in *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp 1998):

- 300 gallons TURCO ARR diluted with water to 2 lb/gal (TURCO ARR assumed to be 70 wt % NaOH, 15 wt % triethanolamine, 5 wt % diethanolamine and 5 wt % kerosene)
- 300 gallons TURCO 4502 diluted with water to 0.5 lb/gal (TURCO 4502 assumed to be 77 wt % KOH, 20 wt % $KMnO_4$, 3 wt % K_2CrO_3)

- 300 gal oxalic acid solution at 0.5 lb oxalic acid per gallon
- 300 gal 6 N HNO_3.

Table 16 lists the composition calculated using the above formulation.

Table 16. PEWE descale composition.

	mol/liter
H^+	1.22E-01
NO_3^-	7.92E-01
K^+	1.17E-01
Mn^{+7}	6.12E-03
Cr^{+6}	1.16E-03
Na^+	5.25E-01
	g/liter
Oxalic acid	7.50
Kerosene	1.50
TEA	4.50
DEA	1.50
TOC	14.99

2.4.1.6 CPP-601 – Lab Drains. This waste is generated by Analytical Laboratory operations, CPP-601 sumps, and pilot plant operations. Nenni (2002) reports analytical data for sixteen samples from the CPP-601 Deep Tanks, and averages of these data are shown in Table 17. Additional data from earlier samples are available in Tripp (1998) but were not used in calculating the composition below. Table 17 also shows the composition range of this waste stream.

Table 17. CPP-601 Deep Tank waste composition.

	Mol/liter	Range of concentration Relative to average Max/Ave	Min/Ave	
H+	3.57E-01	+96%	-63%	1
Al^{+3}	4.28E-03	+340%	-81%	
Sb^{+5}	3.30E-07	+159%	-90%	1
As^{+5}	2.61E-07	+205%	-80%	1
Ba^{+2}	1.35E-06	+270%	-62%	
Be^{+2}	5.89E-07	+354%	-81%	
B^{+3}	1.15E-04			2
Cd^{+2}	1.54E-06	+323%	-77%	
Ca^{+2}	4.08E-04			2
Cl^{-}	2.97E-03	+20%	-20%	
Cr^{+3}	1.77E-05	+111%	-53%	
Co^{+2}	1.13E-06	+173%	-47%	
Cu^{+2}	1.11E-05	+60%	-59%	
F^{-}	1.15E-03	+111%	-40%	1
Fe^{+3}	1.60E-04			2
Pb^{+2}	3.28E-06	+306%	-80%	
Mn^{+4}	1.46E-05	+103%	-54%	
Hg^{+2}	1.14E-05	+206%	-89%	
Ni^{+2}	9.09E-06	+60%	-44%	
NO_3^{-}	3.86E-01			3
PO_4^{-3}	4.11E-05			2
K^{+}	1.38E-03			2
Se^{+4}	1.73E-07	+96%	-77%	1
Ag^{+}	5.15E-07	+640%	-92%	1
Na^{+}	1.32E-02			2
S^{+6}	5.99E-04			2
Tl^{+3}	7.87E-08	+77%	-72%	1
U^{+4}	1.06E-06	+97%	-44%	
V^{+5}	1.92E-07	+139%	-79%	1
Zn^{+2}	2.99E-05	+382%	-68%	
Zr^{+4}	1.59E-06			2
	g/liter			
UDS	1.05E-01	+185%	-97%	
TIC	1.90E-02	+145%	-82%	1
TOC	1.24E-01	+113%	-65%	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data for sixteen samples. Data points with qualifying flags were excluded from the averages.

2.4.1.7 CPP-601/627/640 Deactivation Waste. Table 18 shows the composition of deactivation wastes from CPP-601, CPP-627, and CPP-640. Concentrations are taken from *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp, 1998) and are averages of 4 to 26 data points, depending on the chemical specie.

Table 18. CPP-601/627/640 deactivation waste composition.

	Mol/liter	
H+	4.58E-02	
Al^{+3}	7.18E-04	
Sb^{+5}	4.27E-08	Red shading indicates value was
As^{+5}	2.02E-08	estimated based on concentrations
Ba^{+2}	2.92E-08	of other known species and the concentration
Be^{+2}	1.28E-08	of the unknown species in SBW.
B^{+3}	2.69E-05	
Cd^{+2}	3.85E-07	No shading indicates the average of
Ca^{+2}	9.53E-05	analytical data for 4-26 samples.
Cl^{-}	1.24E-04	
Cr^{+3}	1.06E-06	
Co^{+2}	5.45E-08	
Cu^{+2}	1.29E-06	
F^{-}	7.53E-05	
Fe^{+3}	3.75E-05	
Pb^{+2}	1.51E-07	
Mn^{+4}	2.63E-05	
Hg^{+2}	6.48E-07	
Ni^{+2}	3.12E-06	
NO_3^{-}	4.92E-02	
PO_4^{-3}	9.60E-06	
K^{+}	9.44E-05	
Se^{+4}	2.18E-08	
Ag^{+}	2.19E-08	
Na^{+}	6.26E-04	
S^{+6}	5.62E-05	
Tl^{+3}	2.28E-08	
U^{+4}	2.24E-09	
V^{+5}	5.39E-07	
Zn^{+2}	1.60E-06	
Zr^{+4}	3.73E-07	
	g/liter	
UDS	1.75E-02	
TIC		
TOC	8.51E-03	

2.4.1.8 NWCF Operations – ETS. This waste has been called "Deep Recycle" in the past. When the calciner is not operating, the waste is generated by the Evaporator Tank System, primarily as condensate from ETS off-gas. Table 19 shows an estimated composition of this waste. The composition is based on analysis of 13 samples from the NWCF Fluoride Hot Sump Tank, NCC-119, taken from December 1998 to March 2000, plus daily logs of NWCF scrub composition from May 14, 1998 to April 8, 1999 and from March 7, 2000 to May 28, 2000. This composition may not be applicable to waste generation in the future if the calciner is not operating. For concentrations derived solely from NCC-119 analyses, Table 19 shows the standard deviation of the data points.

Table 19. Estimated NWCF Operation – deep recycle waste composition.

	Mol/liter	Standard deviation Mol/liter		
H+	2.74		4	
Al^{+3}	8.41E-01		4	
Sb^{+5}	6.12E-06		2	1. Gray shading indicates data contains
As^{+5}	5.17E-05	4.8E-05	1	flags, typically below detection
Ba^{+2}	6.63E-06	5.5E-06	1	limits or detected in blank
Be^{+2}	7.73E-06	6.7E-06	1	
B^{+3}	3.86E-03		2	2. Red shading indicates value was
Cd^{+2}	3.84E-04	4.3E-04		estimated based on concentrations
Ca^{+2}	1.37E-02		2	of other known species and the concentration
Cl^{-}	0.0615		4	of the unknown species in SBW
Cr^{+3}	9.24E-04	8.3E-04		
Co^{+2}	9.33E-06	9.2E-06	1	3. Blue shading indicates that value was
Cu^{+2}	5.16E-05	4.0E-05	1	obtained by charge balance
F^{-}	6.11E-02	6.4E-02	1	
Fe^{+3}	5.37E-03		2	4. Green shading indicates value is an
Pb^{+2}	1.38E-04	1.7E-04		average based on logs of scrub composition
Mn^{+4}	1.48E-03	1.4E-03		
Hg^{+2}	8.74E-02	4.9E-02	4	No shading indicates the average of
Ni^{+2}	2.30E-04	1.5E-04		analytical data for thirteen samples.
NO_3^{-}	5.99		3	
PO_4^{-3}	1.38E-03		2	
K^{+}	4.62E-02		2	
Se^{+4}	1.17E-05		2	
Ag^{+}	1.48E-06	1.0E-06	1	
Na^{+}	4.41E-01		2	
S^{+6}	2.01E-02		2	
Tl^{+3}	3.27E-06		2	
U^{+4}	2.91E-05	2.5E-05		
V^{+5}	2.75E-06	7.9E-07		
Zn^{+2}	1.32E-04	1.0E-04	1	
Zr^{+4}	5.34E-05		2	
	g/liter			
UDS	6.31			
TIC				
TOC	0.13			

2.4.1.9 Tank Farm Vessel Flushes. The composition of Tank Farm vessel flush is equivalent to the composition of waste in the vessel being flushed diluted by the volume of water used to flush the tank. Tanks WM-180, WM-181, WM-103, WM-104, WM-105, and WM-106 are scheduled to be flushed in 2004. Then in the 2010-2012 time period, Tanks WM-187, WM-188, and WM-189 will be flushed after being emptied of waste.

2.4.1.10 Vault Flush. The composition of vault flush waste, after concentration by a factor of 40, was assumed equal to the average composition of SBW as of September 30, 2002.

2.4.1.11 CPP-603 Basin Water. This waste stream is created from emptying the water in the CPP-603 basins when they are taken out of service. Concentrations for most species are taken from Supporting Information for the INEEL Liquid Waste Management Plan (Tripp 1998); others were estimated based on the average SBW composition and the ratio of total dissolved solids in the CPP-603 basin water to that in SBW.

Table 20. Estimated CPP-603 Basin water composition.

	Mol/liter	
H^{+}	1.00E-08	
Al^{+3}	4.15E-06	
Sb^{+5}	2.12E-09	2
As^{+5}	8.47E-08	2
Ba^{+2}	4.28E-11	
Be^{+2}	7.65E-09	2
B^{+3}	4.25E-06	
Cd^{+2}	6.06E-11	
Ca^{+2}	3.37E-04	
Cl^{-}	1.35E-03	
Cr^{+3}	1.45E-07	1
Co^{+2}	4.46E-08	1
Cu^{+2}	7.43E-08	1
F^{-}	1.10E-05	
Fe^{+3}	3.92E-07	
Pb^{+2}	1.45E-11	
Mn^{+4}	1.91E-08	
Hg^{+2}	2.49E-06	2
Ni^{+2}	9.85E-08	1
NO_3^{-}	2.56E-03	
PO_4^{-3}	2.86E-06	2
K^{+}	7.55E-05	
Se^{+4}	7.26E-11	
Ag^{+}	2.65E-09	2
Na^{+}	3.91E-03	4
S^{+6}	3.45E-05	2
Tl^{+3}	2.39E-11	
U^{+4}	2.99E-11	
V^{+5}	2.00E-11	
Zn^{+2}	1.67E-07	
Zr^{+4}	6.70E-07	2
	g/liter	
UDS	1.40E-03	2
TIC	5.91E-02	3
TOC	2.64E-06	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on the average SBW concentration and the ratio of total dissolved solids (TDS) in the waste to TDS in SBW

3. Blue shading indicates that value was obtained by charge balance

4. Green shading indicates value was determined by the measured TDS in the waste

No shading indicates results from samples taken in 1995 and 1998.

2.4.2 Composition of Combined Newly Generated Liquid Waste

The compositions shown in Section 2.4.1 for NGLW streams were used along with results of ASPEN simulations of evaporation of these streams to calculate NGLW added to Tank Farm tanks in 2004-5 and collected in WM-100, WM-101, and WM-102 in 2005-2012.

Tables 1 and 5 show three additions of NGLW to Tanks WM-187 and WM-188. "NGLW-1" includes NGLW streams generated February through June 2004. Five NGLW streams make up 96 volume percent of this waste. Using the dilute compositions shown in Section 2.4.1 for these five streams, evaporation of the combined waste was simulated using an Aspen Plus model. The simulation showed that the waste could be concentrated by a factor of 79. The resulting concentrate composition was expanded in components by assuming the average SBW concentration, adjusted by the ratio of total dissolved solids in the concentrated NGLW to total dissolved solids in average SBW, for species not shown in NGLW composition slates, such as radionuclides. The simulation feed volume was based on $5/12^{ths}$ (5 months) of the 2004 NGLW generation rate. The simulation concentrate volume was divided by the factor 0.96 to account for the other NGLW streams that will be part of this waste.

A similar procedure was used to calculate the composition of stream "NGLW-2." NGLW-2 includes the same streams as NGLW-1 generated July 2004 through September 2005. The 2005 generation volumes of these streams was used to determine a combined composition, and the 2005 volume adjusted by the factor 15/12. Simulation of evaporation of this waste showed that a concentration factor of 153 could be obtained. This factor is higher than that obtained for NGLW-1 because it contains a higher fraction of CPP-603 basin water, a more dilute waste.

The third NGLW waste added to the Tank Farm, "NGLW-3," is a blend of NGLW streams that are not concentrated by evaporation. This waste consists of about 4,800 gal of Tank Farm line flushes and 700 gal of NWCF Operations waste.

Compositions and volumes of the above three NGLW streams were used in the calculation of the final composition of Tanks WM-187 and WM-188. Additional calculations were made to estimate the composition of NGLW generated after 2005. The steps involved in these calculations are outlined below:

1. Based on projected waste generation volumes and compositions for these wastes shown in Section 2.4.1, a blended composition was calculated for each year, 2005 through 2012.
2. These blended compositions and dilute volumes were input into an Aspen Plus evaporation model, simulating concentration of the waste for each year to a 1.3 specific gravity endpoint.
3. Based on the predicted simulation condensate volume and acid content, the amount of LET&D bottoms that would be generated was calculated.
4. The predicted bottoms volume was adjusted to account for minor NGLW streams not included in the simulation.
5. The calculated LET&D bottoms, simulated evaporator concentrate, and estimated quantities of NGLW streams that are not evaporated were combined to obtain total, concentrated NGLW volumes and compositions for each year.

These NGLW compositions are shown in Table 21. Also shown in Table 21 is an estimate of the composition of the present waste in WM-100, WM-101 and WM-102. This estimate is based on compositions and volumes of dilute NGLW waste streams generated 1998-2003. Table 22 shows the composition of NGLW as of the end of 2010 and 2012.

Table 21. Estimated NGLW composition by year.

Year	Initial Inventory	2006	2007	2008	2009	2010	2011	2012
Gallons	12,100	11,348	10,855	6,974	7,285	7,285	9,218	7,116
	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter
H^{+}	2.85E+00	3.41E+00	3.38E+00	3.89E+00	3.92E+00	3.92E+00	3.53E+00	4.06E+00
Al^{+3}	3.70E-01	3.06E-01	3.15E-01	1.66E-01	1.50E-01	1.50E-01	2.50E-01	1.31E-01
Sb^{+5}	1.07E-05	9.67E-06	9.54E-06	1.31E-05	1.20E-05	1.20E-05	1.18E-05	1.24E-05
As^{+5}	3.25E-05	6.02E-05	6.22E-05	2.78E-05	2.61E-05	2.61E-05	2.28E-05	2.70E-05
Ba^{+2}	1.90E-05	3.46E-05	3.50E-05	2.96E-05	2.77E-05	2.77E-05	3.56E-05	2.66E-05
Be^{+2}	5.53E-06	7.11E-06	7.26E-06	4.95E-06	4.56E-06	4.56E-06	6.63E-06	4.20E-06
B^{+3}	3.54E-03	7.77E-03	7.97E-03	5.00E-03	4.55E-03	4.55E-03	7.16E-03	4.06E-03
Cd^{+2}	3.15E-04	9.96E-04	1.03E-03	5.12E-04	4.82E-04	4.82E-04	8.73E-04	4.04E-04
Ca^{+2}	1.25E-02	2.61E-02	2.67E-02	1.72E-02	1.56E-02	1.56E-02	2.42E-02	1.40E-02
Cl^{-}	4.25E-02	1.65E-02	1.69E-02	1.04E-02	1.01E-02	1.01E-02	1.22E-02	9.67E-03
Cr^{+3}	4.46E-03	5.54E-03	5.51E-03	6.44E-03	5.98E-03	5.98E-03	6.41E-03	6.04E-03
Co^{+2}	9.16E-06	3.29E-05	3.29E-05	4.30E-05	3.30E-05	3.30E-05	4.30E-05	3.23E-05
Cu^{+2}	1.23E-04	3.49E-04	3.57E-04	2.42E-04	2.18E-04	2.18E-04	3.34E-04	1.97E-04
F^{-}	4.84E-02	3.39E-02	3.38E-02	3.67E-02	3.57E-02	3.57E-02	3.21E-02	3.53E-02
Fe^{+3}	4.92E-03	1.05E-02	1.08E-02	6.85E-03	6.23E-03	6.23E-03	9.73E-03	5.58E-03
Pb^{+2}	1.44E-04	4.61E-04	4.74E-04	2.50E-04	2.35E-04	2.35E-04	4.11E-04	2.01E-04
Mn^{+4}	2.18E-02	2.47E-02	2.45E-02	3.09E-02	2.89E-02	2.89E-02	2.94E-02	2.95E-02
Hg^{+4}	3.02E-02	5.48E-03	5.71E-03	6.83E-04	6.64E-04	6.64E-04	1.23E-03	5.31E-04
Ni^{+2}	2.66E-04	9.86E-04	1.00E-03	8.27E-04	6.83E-04	6.83E-04	1.03E-03	6.27E-04
NO_3^{-}	6.70E+00	7.51E+00	7.49E+00	8.09E+00	7.84E+00	7.84E+00	7.95E+00	7.97E+00
PO_4^{-3}	1.25E-03	2.46E-03	2.51E-03	1.67E-03	1.51E-03	1.51E-03	2.29E-03	1.37E-03
K^{+}	4.31E-01	4.44E-01	4.37E-01	5.86E-01	5.51E-01	5.51E-01	5.42E-01	5.66E-01
Se^{+4}	9.01E-06	6.97E-06	6.97E-06	7.62E-06	6.98E-06	6.98E-06	7.55E-06	7.03E-06
Ag^{+}	2.88E-06	3.55E-06	3.57E-06	3.56E-06	3.22E-06	3.22E-06	3.81E-06	3.16E-06
Na^{+}	2.09E+00	2.37E+00	2.35E+00	2.83E+00	2.65E+00	2.65E+00	2.76E+00	2.69E+00
S^{+6}	1.67E-02	3.01E-02	3.08E-02	2.03E-02	1.87E-02	1.87E-02	2.81E-02	1.71E-02
Tl^{+3}	2.83E-06	2.11E-06	2.09E-06	2.66E-06	2.34E-06	2.34E-06	2.40E-06	2.39E-06
U^{+4}	3.83E-05	1.58E-04	1.63E-04	8.09E-05	7.65E-05	7.65E-05	1.40E-04	6.39E-05
V^{+5}	2.46E-05	1.28E-04	1.32E-04	7.12E-05	6.40E-05	6.40E-05	1.15E-04	5.39E-05
Zn^{+2}	3.48E-04	5.85E-04	5.92E-04	5.22E-04	4.82E-04	4.82E-04	6.08E-04	4.65E-04
Zr^{+4}	6.13E-05	4.42E-04	4.58E-04	1.92E-04	1.80E-04	1.80E-04	3.75E-04	1.39E-04
	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter
UDS	5.3	3.7	3.7	4.3	4.0	4.0	3.8	4.1
TOC	4.5	4.9	4.8	5.6	5.2	5.2	4.9	5.4

Table 22. Estimated composition of combined generated waste.

Year	2010	2012		2010	2012		2010	2012		2010	2012
Gal	55,850	72,180		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.33	1.34	PO_4^{-3}	6.87E-03	6.96E-03	Th-232	8.97E-16	9.10E-16	Tc-98	2.29E-12	2.32E-12
			Pu^{+4}	5.11E-06	5.18E-06	Th-234	2.62E-08	2.66E-08	Tc-99	1.30E-05	1.31E-05
	mol/liter	mol/liter	K^{+}	4.85E-01	5.01E-01	Pa-231	1.13E-10	1.15E-10	Ru-106	1.18E-06	1.19E-06
H+	3.48E+00	3.54E+00	Pr^{+4}	1.10E-05	1.11E-05	Pa-233	3.71E-06	3.76E-06	Rh-102	1.09E-09	1.11E-09
Al^{+3}	2.63E-01	2.49E-01	Pm^{+3}	1.60E-09	1.63E-09	Pa-234m	2.62E-08	2.66E-08	Rh-106	1.18E-06	1.19E-06
Am^{+4}	7.65E-08	7.76E-08	Rh^{+4}	4.73E-06	4.79E-06	U-232	2.52E-09	2.55E-09	Pd-107	2.09E-08	2.12E-08
Sb^{+5}	1.09E-05	1.12E-05	Rb^{+}	7.28E-06	7.38E-06	U-233	1.01E-10	1.03E-10	Cd-113m	4.21E-06	4.27E-06
As^{+5}	4.17E-05	3.78E-05	Ru^{+3}	1.89E-04	1.92E-04	U-234	1.73E-06	1.75E-06	In-115	1.28E-16	1.29E-16
Ba^{+2}	2.89E-05	2.95E-05	Sm^{+3}	7.21E-06	7.31E-06	U-235	8.07E-08	8.18E-08	Sn-121m	8.47E-08	8.59E-08
Be^{+2}	5.86E-06	5.79E-06	Se^{+4}	7.50E-06	7.46E-06	U-236	7.88E-08	7.99E-08	Sn-126	5.20E-07	5.28E-07
B^{+3}	5.71E-03	5.73E-03	Si^{+4}	5.62E-04	5.70E-04	U-237	8.15E-09	8.27E-09	Sb-125	1.71E-05	1.73E-05
Br^{-}	4.00E-07	4.06E-07	Ag^{+}	3.33E-06	3.37E-06	U-238	4.01E-08	4.07E-08	Sb-126m	5.20E-07	5.28E-07
Cd^{+2}	6.60E-04	6.62E-04	Na^{+}	2.44E+00	2.50E+00	Np-237	3.71E-06	3.76E-06	Sb-126	7.28E-08	7.39E-08
Ca^{+2}	1.94E-02	1.95E-02	Sr^{+2}	1.46E-04	1.48E-04	Np-238	2.96E-10	3.00E-10	Te-123	4.85E-19	4.92E-19
Ce^{+4}	4.82E-05	4.89E-05	SO_4^{-2}	2.32E-02	2.32E-02	Np-239	8.34E-08	8.46E-08	Te-125m	3.99E-06	4.05E-06
Cs^{+}	3.07E-05	3.12E-05	Tc^{+7}	7.72E-06	7.83E-06	Pu-236	2.89E-09	2.93E-09	I-129	6.64E-08	6.73E-08
Cl^{-}	1.98E-02	1.78E-02	Te^{+4}	5.81E-06	5.89E-06	Pu-238	5.66E-04	5.74E-04	Cs-134	5.17E-05	5.24E-05
Cr^{+3}	5.53E-03	5.69E-03	Tb^{+4}	2.77E-09	2.81E-09	Pu-239	7.06E-05	7.16E-05	Cs-135	1.09E-06	1.10E-06
Co^{+2}	2.90E-05	3.11E-05	Tl^{+3}	2.39E-06	2.39E-06	Pu-240	1.07E-05	1.08E-05	Cs-137	6.39E-02	6.48E-02
Cu^{+2}	2.54E-04	2.59E-04	Th^{+4}	2.69E-05	2.73E-05	Pu-241	3.42E-04	3.46E-04	Ba-137m	6.04E-02	6.13E-02
Eu^{+3}	6.63E-07	6.73E-07	Sn^{+4}	3.51E-05	3.56E-05	Pu-242	8.54E-09	8.66E-09	La-138	2.42E-16	2.45E-16
F^{-}	3.79E-02	3.69E-02	Ti^{+4}	8.33E-05	8.45E-05	Pu-244	2.29E-17	2.32E-17	Ce-142	3.79E-11	3.84E-11
Gd^{+3}	2.15E-04	2.18E-04	U^{+4}	1.02E-04	1.03E-04	Am-241	6.30E-05	6.39E-05	Ce-144	7.94E-07	8.05E-07
Ge^{+4}	1.15E-08	1.17E-08	V^{+5}	8.27E-05	8.40E-05	Am-242m	1.36E-08	1.38E-08	Pr-144	7.94E-07	8.05E-07
In^{+3}	1.82E-06	1.84E-06	Y^{+3}	8.99E-06	9.11E-06	Am-242	1.35E-08	1.37E-08	Nd-144	2.04E-15	2.06E-15
I^{-}	3.32E-06	3.37E-06	Zn^{+2}	5.00E-04	5.10E-04	Am-243	1.92E-08	1.94E-08	Pm-146	6.45E-08	6.54E-08
Fe^{+3}	7.79E-03	7.82E-03	Zr^{+4}	2.63E-04	2.65E-04	Cm-242	3.41E-08	3.45E-08	Pm-147	2.16E-04	2.19E-04
La^{+3}	1.21E-05	1.22E-05	O-2			Cm-243	3.60E-08	3.65E-08	Sm-146	3.49E-13	3.54E-13
Pb^{+2}	3.10E-04	3.12E-04	H2O	4.35E+01	4.32E+01	Cm-244	1.44E-06	1.46E-06	Sm-147	9.33E-12	9.46E-12
Li^{+}	4.53E-04	4.60E-04				Cm-245	3.78E-10	3.83E-10	Sm-148	4.79E-17	4.86E-17
Mg^{+2}	2.49E-02	2.53E-02		g/liter	g/liter	Cm-246	2.49E-11	2.53E-11	Sm-149	4.26E-18	4.32E-18
Mn^{+4}	2.59E-02	2.67E-02	TOC	4.9	5.0				Sm-151	4.25E-04	4.31E-04
Hg^{+2}	9.03E-03	7.20E-03	UDS	4.2	4.1	H-3	1.94E-05	1.97E-05	Eu-150	1.82E-11	1.85E-11
Mo^{+6}	3.11E-04	3.15E-04				Be-10	3.80E-12	3.85E-12	Eu-152	3.19E-06	3.23E-06
Nd^{+3}	3.89E-05	3.94E-05		Ci/liter	Ci/liter	C-14	1.52E-10	1.54E-10	Eu-154	2.09E-04	2.12E-04
Np^{+4}	2.22E-05	2.25E-05		(Jan, 2003)	(Jan, 2003)	Se-79	5.53E-07	5.61E-07	Eu-155	1.92E-04	1.95E-04
Ni^{+2}	7.34E-04	7.62E-04	Ra-226	1.04E-11	1.05E-11	Rb-87	3.71E-11	3.76E-11	Gd-152	1.80E-18	1.83E-18
Nb^{+5}	1.19E-04	1.20E-04	Ac-227	4.89E-11	4.95E-11	Sr-90	5.01E-02	5.08E-02	Ho-166m	5.83E-11	5.91E-11
NO_3^{-}	7.35E+00	7.45E+00	Th-230	1.04E-09	1.06E-09	Y-90	5.01E-02	5.08E-02	Co-60	4.13E-05	4.19E-05
Pd^{+4}	1.40E-04	1.42E-04	Th-231	2.66E-08	2.70E-08	Zr-93	2.81E-06	2.85E-06	Ni-63	4.37E-05	4.43E-05

2.5 SBW Treatment Facility Feed Compositions

Compositions for both SBW and NGLW wastes have been presented in Sections 2.1-2.4. Table 23 shows a summary of the volumes of waste to be treated and tables containing compositions for these wastes.

Table 23. Summary of waste to be processed.

	CsIX		**Other Processes**
	gal liquid	kg solid	gal liquid plus solids
WM-187	270,963	105,000	284,920
WM-188	281,670	5,000	281,670
WM-189	279,800	10,000	279,800
NGLW	72,180	1,130	72,180
Total	**904,613**	**121,130**	**918,570**
	Composition		Composition
WM-187	Table 2, "Liquid only"		Table 2. "With solids"
	Table 4 (solids)		
WM-188	Table 7, "No solids"		Table 6
	Table 8 (solids)		
WM-189	Table 10, "No solids"		Table 9
	Table 8 (solids)		
NGLW	Table 22		Table 22

Volumes in Table 23 do not show any steam jet dilution to blend the wastes or transfer wastes to the treatment facility. Water to transfer heels to treatment is also not shown. Existing steam jets typically add about 5% to the volume of tank waste in transfers to the NWCF. Possible blend scenarios and blend compositions are discussed in Section 3.4. Liquid volumes shown in Table 23 for the CsIX process for Tanks WM-188 and WM-189 neglect the small volume of solids in these tanks.

Concentrations shown in Tables 2, 3, 6, 7, 9 and 10 have been adjusted to ensure charge balance and consistency between radionuclide activities and chemical concentrations. Nitrate concentrations were adjusted to obtain charge balance.

To check for consistency between radionuclide activities and chemical concentrations, activities of radionuclides were converted to molar concentrations and compared to concentrations measured or estimated for the respective chemical species. If the sum of the concentrations of all isotopes of an element, converted from activities, was greater than the chemical concentration for that element, the chemical concentration was replaced by that sum.[d] For example, if the concentration of Americium (as calculated by converting ^{241}Am, ^{242m}Am, ^{242}Am, and ^{243}Am concentrations in curies per liter to moles per liter and summing) was greater than the molar concentration of Am reported as a chemical species, then the sum of the isotopes was used as the chemical concentration. If the chemical concentration was greater than the sum of the radionuclide concentrations, and no non-radioactive isotopes occur for that element, the radionuclide concentrations were increased to be consistent with the chemical concentration. Adjustments were made for the elements U, Np, Am, Pu, Tc, and In.

[d] In most cases, the chemical concentration is greater than that of the same species calculated from isotopic concentrations because of nonradioactive isotopes.

Chemical species present in concentrations less than 10^{-9} mol/liter and isotopes having concentrations less than 10^{-15} mol/liter were not included in Table 18.[e] For the generated waste, concentrations of species for which no analytical data or other estimates were available were assumed equal to the average concentration in the SBW tanks for that species.

[e] If the activity was greater than 10^{-8} Ci/liter, the radionuclide was retained even if its molar concentration was less than 10^{-15}.

3. SUPPLEMENTAL FEED CHARACTERIZATION INFORMATION

This section provides more detail and discussion regarding the quantity of solids in the Tank Farm, the composition of tank solids, uncertainties in the waste compositions shown in this report, possible tank blending scenarios and resulting tank compositions, waste physical properties, and organics in the waste.

3.1 Tank Solids Quantity

Light Duty Utility Arm (LDUA) video evidence of the height of tank sludge layers, along with measurement of sludge samples from these tanks, provided good estimates of solids quantities for three tanks. Tank WM-188 was sampled using the LDUA in 1998 (Patterson 1999); and WM-182 and WM-183 in 2000 (Poloski 2000a). Based on the videos, the sludge layers in Tanks WM-188, WM-182, and WM-183 were estimated to be 0.25-inch, 4 inches, and 8 inches respectively. Using the history of each tank as a guide, and measurements from WM-183 samples that showed the sludge was approximately 25 vol % solids and that the solids had a particle density of 2 kg/liter, Poloski estimated sludge volumes (Poloski 2000a) and Tyson estimated the corresponding mass of solids in each tank in the Tank Farm (Tyson 2002). These sludge volume and mass estimates, shown in Table 24, have been widely used since they were developed for SBW treatment studies, (Barnes 2002) the SBW Waste Incidental to Reprocessing (WIR) evaluation (Tyson 2002), and the basis for the radiological source term for Tank Farm safety analyses (Swenson 2002).

Table 24. Estimated solids quantities based on LDUA samples and videos.

Tank	Sludge Height (in.)	Sludge on Walls (equiv. in.)	Total Sludge (equiv. in.)	Total Solids (kg)
WM-180 (like WM-182)	4.00	0.50	4.5	10,452
WM-181 (like WM-182)	4.00	0.50	4.5	10,452
WM-182	4.00	0.50	4.5	10,452
WM-183	8.00	0.50	8.5	19,743
WM-184 (like WM-182)	4.00	0.50	4.5	10,452
WM-185 (like WM-182)	4.00	0.50	4.5	10,452
WM-186 (like WM-182)	4.00	0.50	4.5	10,452
WM-187 (like WM-188)	0.25	0.25	0.5	1,161
WM-188	0.25	0.25	0.5	1,161
WM-189 (like WM-188)	0.25	0.25	0.5	1,161
Total	**32.75**	**4.25**	**37.0**	**85,941**

Since the estimates listed in Table 24 were made, the following tank farm changes have occurred: (1) wastes from Tanks WM-181, WM-184, WM-186, and WM-185 have been evaporated to heel level and the concentrate added to Tanks WM-188 and WM-189, (2) Tanks WM-189, WM-188, WM-181, and WM-187 have been sampled, and (3) solids in Tanks WM-181, WM-182, WM-183, WM-184, WM-185, and WM-186 have been flushed to WM-187. Because of these changes, solids remain only in Tanks WM-187, WM-180, WM-188, and WM-189. The solids in WM-180 are scheduled to be flushed to WM-187 later in 2004.

During evaporation of waste from Tank WM-186, as the waste was lowered to about the 15,000 gallon level, severe plugging problems were experienced in ETS instrument probes and some other lines (Swenson 2001). Evaporation of waste from Tanks WM-181 and WM-185, in addition to WM-186, was stopped when high undissolved solids caused plugging in instrument probes.[f] The heel level of each of these three tanks when processing by evaporation was stopped was between 13,000 and 23,000 gallons. The solids seen in the evaporator probes suggest that there may be more solids in these tanks than shown in Table 24, which, for tanks WM-181, WM-185, WM-186 and others, was based on a heel of only 5,000 gallons in each tank.

In March 2002, a sample from near the bottom of Tank WM-189 was taken using an existing steam jet located approximately 2-inches off the tank bottom. The 165 ml sample was allowed to settle for 24 hours, at which time a sludge layer of approximately 22 ml was seen (Batcheller 2003). In contrast, undissolved solids from a sample taken by steam jet, ~3-inches off the bottom, from Tank WM-180 were measured to be only 0.23 g/liter. While a direct comparison of data from these two tank samples is difficult, it appears that the WM-189 sample had considerably more solids than the WM-180 sample.

In light of the above indications that there could be more solids than originally estimated, the following estimates are proposed for the quantity of solids that will be present in the tanks at the commencement of SBW treatment, and have been used in composition estimates earlier in this report.

Table 25. Updated solids estimate.

	Expected	**Maximum**
WM-187	105,000 kg	135,000 kg
WM-188	5,000 kg	10,000 kg
WM-189	10,000 kg	20,000 kg
Total	**120,000 kg**	**165,000 kg**

The basis for the above estimates is as follows:

- **WM-187**: Summing the volume of heels flushed to WM-187 and assuming an average 16 vol % solids[g] in the sludge and a solids density of 2 kg/liter results in as estimate of 100,000 kg, exclusive of solids from WM-180. Tank WM-180 has not yet been emptied and so the heel level is not known. For WM-180, assuming 3-inches of sludge with an average solids content of 16-vol %[g] and a solids density of 2 g/cm^3 is equivalent to about 5,000 kg of solids. Thus the total solids estimated to be in Tank WM-187 is 105,000 kg. This expected amount estimate is consistent with the actual tank level on April 3, 2004 (58,000 gallons) and a solids content of about 18 vol %. The maximum amount was estimated by adding 30% (30,000) to the 100,000 kg estimate. The maximum estimate is consistent with the maximum solids content seen in any heel (25 vol %, WM-183), taking into account that not all solids from WM-181 and none from WM-180 had been flushed to WM-187 as of April 3, 2004.

- **WM-188 and WM-189**: When Tank WM-188 was at heel level, LDUA videos showed very few (~1/4 inch) solids (Patterson 1999). WM-188 has since been filled with ETS concentrate. A sample taken from WM-189, which was filled with much the same evaporator concentrate, showed

[f] Personal communication with Dan Griffith, October 23, 2002.

[g] A solids content of 16 vol % is based on the solids content of WM-183 heel in early 1997 and also the average of WM-183 LDUA sludge sample solids content (25 %) and WM-189 sludge solids content (~7%).

significantly more solids than similar samples from WM-180 and WM-188. Consistent with this observation is the fact that high solids waste streams (NWCF flushes and off-gas scrub) have been added to WM-189 and not to WM-188. Thus, Tank WM-189 should have more solids than WM-180 or WM-188. For lack of additional data, the amount of solids WM-188 was assumed to be equal to that estimated for WM-180 (5,000 kg) and the amount in WM-189 twice the amount in WM-180. The estimated expected amount of settled solids in WM-189 is consistent with the measured solids content of a sample from that tank and a heel volume of about 20,000 gallons.

3.2 Tank Solids Composition

After 2004, SBW will be contained in three INTEC Tank Farm tanks. The majority of the solids (~90%) will be contained in one tank, WM-187. It has not been possible to obtain a well-mixed, representative sample of solids from this tank. However, eleven samples from eight tanks have been taken since 1999 that have contained solids. This section presents a compilation, comparison and review of the solids analytical data. It also contains the basis for determining the average composition of solids in Tank WM-187.

Mike Swenson compiled older data for tank solids, mostly from the mid-1980's (Swenson 1992). In general, this older data is similar to more recent analyses, and indicate that the primary chemical species present in the solids are zirconium and phosphate, with smaller amounts of aluminum, iron, silicon, sodium, potassium, boron, nickel and tin. Other information in Swenson's report suggests the solids could contain significant levels of fluorides and noble metals.

Direct sampling of tank heels using the LDUA was performed in three tanks in 1999. Table 26 shows the results of analyses of these samples.

Table 26. Analyses of solids samples from Tanks WM-182, WM-183, and WM-188.

	WM-182 mg/kg	**WM-183** mg/kg	**WM-188** mg/kg		**WM-182** mg/kg	**WM-183** mg/kg	**WM-188** mg/kg
Al^{+3}	21,880	24,911	35,406	Sr^{+2}	<9	11	
Sb^{+5}	<14	32	<34	SO_4^{-2}	33,240	13,647	
As^{+5}	281	56	351	S^{+6}	8,743	2,849	
Ba^{+2}	127	24	12,542	Tc^{+7}		0	
Be^{+2}	<1	<0.9	0.2	Tl^{+3}	<17	<14	<783
B^{+3}	150	182	<482	Sn^{+4}	4,072	1,466	
Cd^{+2}	325	142	1,189	Ti^{+4}	650	711	
Ca^{+2}	1,765	1,868	5,630	U^{+4}	<46	0.193	
Ce^{+4}	<21	20		V^{+5}	13	11	6
Cs^{+}	42	9	<128	Zn^{+2}	179	148	126
Cl^{-}	2,015	1,308		Zr^{+4}	101,470	34,867	70,600
Cr^{+3}	552	949	1,341	Total	437,827	486,039	165,675
Co^{+2}	<9	9	9	TOC			<1215
Cu^{+2}	298	166					
F^{-}	14,800	4,373			WM-182	WM-183	WM-188
Gd^{+3}	53	170			mCi/g	mCi/g	mCi/g
Fe^{+3}	4,476	17,967	5,769		(Jan, 2000)	(Jan, 2000)	(March, 1999)
Pb^{+2}	369	274	647	Am-241	8.46E-04	2.45E-04	2.11E-04
Li^{+}	6	4		Sb-125	5.77E-02	2.90E-03	1.12E-02
Mg^{+2}	410	434		Cs-134	6.64E-03	5.89E-04	7.97E-03
Mn^{+4}	565	740	758	Cs-137	4.24E-01[a]	8.68E-01	2.44E+00
Hg^{+2}	310	324	1,566	Co-60	2.14E-04		6.30E-04
Mo^{+6}	2,495	694	2,770	Cm-244	2.84E-06		
Ni^{+2}	309	417	427	Eu-154	1.48E-03	7.56E-04	5.43E-04
Nb^{+5}	1,279	623	5,370	I-129	<2.22E-07	<9.03E-08	<1.53E-03
NO_3^{-}	70,720	174,955		Np-237	1.68E-06	1.76E-06	2.85E-06
Pd^{+4}	5,766	1,444		Pu-238	1.93E-02	4.00E-03	7.56E-03
PO_4^{-3}	68,410	125,612		Pu-239	1.47E-03	1.25E-03	4.30E-04
P^{+5}	9,586	4,607	17,700	Sr-90	2.29E-01	1.82E-01	5.46E+00
K^{+}	7,050	10,900		Tc-99	2.63E-03	3.29E-05	4.49E-03
Ru^{+3}	829	2,126	<313	H-3	1.15E-05		
Se^{+4}	91	<13	<1,720	U-234	<2.40E-06	3.30E-06	<2.10E-05
Si^{+4}	43,920	35,344		U-235	2.61E-07	9.29E-08	1.97E-07
Ag^{+}	65	220	9	U-236	3.05E-07	<3.40E-08	<2.20E-07
Na^{+}	30,400	21,400		U-238	3.83E-08	6.91E-08	1.18E-07

[a] Concentration corrected based on reissued lab report

Table 27 shows results of analyses of samples taken of Tank Farm waste transferred to the NWCF blend and hold cell for sampling. Tank WM-180 was sampled in June 2000; the tank was full of waste at the time of sampling. The solids were obtained from the waste sample by allowing two weeks for settling, drawing off liquid, and centrifuging the remaining sample. The solids were not washed but Jerry Christian states that approximately 4% of the weight of the dried solids was due to dissolved solids in interstitial liquid that crystallized during drying (Christian 2000). The WM-180 analytical results shown in Table 27 are as reported by Garn (2001).

Tanks WM-181, WM-186 and WM-188 were sampled in 2003. Tanks WM-181 and WM-186 were at heel level when sampled, while WM-188 was about three-quarters full of liquid. Solids from each of these tanks were washed with water prior to analysis. Results of analyses of WM-180, WM-181,

and WM-188 samples are shown in Table 27. Solids from WM-186 were analyzed by different methods, (see Section 3.4 of Rev. 3 of this report) and results are shown in Table 28.

Table 27. Analysis data for tank solids samples obtained through NWCF.

	WM-180	**WM-181**	**WM-188**		**WM-180**	**WM-181**	**WM-188**
	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg
Al^{+3}	59,619	5,870	14,568	Na^{+}	81,200	2,926	35,291
Sb^{+5}	41	19	<9	Sr^{+2}	23		14
As^{+5}	<10	36	<40	SO_4^{-2}	9,220	3,974	10,787
Ba^{+2}	34	10	29	S^{+6}	5,199		3,711
Be^{+2}	<2	0.23	<2	Tc^{+7}	0		
B^{+3}	<520	49	413	Tl^{+3}	<1,360	<4	50
Cd^{+2}	183	61	216	Sn^{+4}	2,120	4,117	2,178
Ca^{+2}	4,427	449	2,396	Ti^{+4}	959		477
Ce^{+4}	44		<30	U^{+4}	353		330
Cs^{+}	524		<25	V^{+5}	<13	<5	12
Cl^{-}	909	1,110		Zn^{+2}	200	27	73
Cr^{+3}	692	241	621	Zr^{+4}	27,971	37,930	32,209
Co^{+2}	<15	<1	7	Total	815,414	272,464	258,274
Cu^{+2}	139	41	55		Radionuclides		
F^{-}	93	2,165			mCi/g	mCi/g	mCi/g
Gd^{+3}	84		25		(Oct 2000)	(2003)	(2003)
Fe^{+3}	20,200	3,985	4,385	Am-241	3.20E-04	1.49E-04	5.31E-04
Pb^{+2}	541	47	175	Sb-125	3.37E-03	2.45E-03	1.17E-02
Li^{+}	<160		<17	Cs-134	2.62E-04	3.37E-04	1.70E-03
Mg^{+2}	1,402	235	460	Cs-137	2.63E-01	2.43E-01	2.62E+00
Mn^{+4}	1,618	116	579	Co-60	3.59E-05	7.18E-05	7.75E-04
Hg^{+2}	<8,930	25		Cm-244			1.70E-05
Mo^{+6}	357	283	207	Eu-154	4.32E-04	2.07E-04	2.12E-03
Ni^{+2}	282	57	355	I-129			
Nb^{+5}	<1,040		1,888	Np-237	3.41E-06	6.23E-07	6.41E-06
NO_3^{-}	455,000	645		Pu-238	8.76E-02	1.43E-02	2.45E-02
Pd^{+4}	<760		345	Pu-239	1.31E-02	1.42E-03	3.36E-03
PO_4^{-3}	37,000	197,980	25,428	Sr-90	6.24E-02		5.51E-02
P^{+5}	54,360		54,901	Tc-99	2.42E-05		2.23E-03
K^{+}	15,200	8,761	12,309	H-3			
Ru^{+3}	360		<803	U-234	4.49E-06	3.07E-06	1.18E-05
Se^{+4}	<1,280		<43	U-235	9.24E-08	2.15E-07	8.89E-07
Si^{+4}	20,920		52,601	U-236	1.74E-07	1.86E-07	
Ag^{+}	50	1,299	190	U-238	3.95E-08	2.26E-09	2.09E-07

Table 28. Analysis data for tank solids sample from WM-186.

SEM elemental analysis			
	Min	Ave	Max
	Wt %	Wt %	Wt %
Al	5.84	6.26	6.76
Fe	0.94	1.47	2.01
K	1.07	1.14	1.22
Na	0.36	0.64	1.01
O	49.62	50.2	50.63
P	10.74	11.01	11.19
Si	11.63	11.85	12.01
Zr	16.07	17.4	18.3
Total	**96.27**	**99.97**	**103.13**

X-ray fluorescence analysis, water washed	
	Wt %
Zr	74.71
K	6.55
Fe	5.80
Ca	3.70
Sn	2.08
Mn	1.93
Zn	1.26
Nb	1.20
Ti	0.92
Cr	0.84
Ni	0.40
Hg	0.32
Br	0.22
Au	0.09
Total	**100.02**

Tank WM-187 has been sampled several times between July 2003 and February 2004. The tank heel at the time of the first sample contained only solids from Tanks WM-182 and WM-183, while heels from WM-184, WM-185, and WM-186 had been added before the second sample was taken. Prior to the final sample, taken in February 2004, a portion of the heel from WM-181 had been transferred to WM-187 in an attempt to include these solids in the tank sample. Then, five separate transfers of about 6,000 gallons each were made back and forth between WM-187 and the sampling tanks, NCC-102 and NCC-103. This was done in an attempt to better mix the solids in Tank WM-187. Following these transfers, a transfer of about 1100 gallons was made from WM-187 and sampled. However, the particle size distribution of solids from the final sample shows a smaller average particle size that any of the other tanks or samples. Hence, the final sample may contain a disproportionately high fraction of smaller, more mobile particles than contained in the total solids in the tank. Results of analyses of the second sample will be reported by Janikowski later this year, while results for the first and third sample are shown in Table 29.

Table 29. Analysis data for tank solids samples from WM-187.

	WM-187 Sample 1	**WM-187** Sample 3		**WM-187** Sample 1	**WM-187** Sample 3
	mg/kg	mg/kg		mg/kg	mg/kg
Al^{+3}	10,616	11,059	Th^{+4}	60	16
Sb^{+5}	<64	40	Sn^{+4}	4,208	4,363
As^{+5}	98	68	Ti^{+4}	1,429	
Ba^{+2}	12	98	W^{+4}	230	402
Be^{+2}	<2	<1	U^{+4}	<236	<222
B^{+3}	130	161	V^{+5}	<28	<14
Cd^{+2}	11	6	Y^{+3}	<33	<31
Ca^{+2}	570	536	Zn^{+2}	196	148
Ce^{+4}	<30	73	Zr^{+4}	66,464	38,644
Cs^{+}	68	81			
Cr^{+3}	307	444	Cl^{-}	14,394	3,051
Co^{+2}	<10	<9	NO_3^{-}	56,514	1,034
Cu^{+2}	69	84	PO_4^{-3}	221,788	231,089
Gd^{+3}	8	5	SO_4^{-2}	18,429	4,386
Hf^{+4}	166	66	F^{-}	2,584	30
Fe^{+3}	20,119	6,100			
Pb^{+2}	<37	76		**Ci/g**	**Ci/g**
Li^{+}	<14	<13	Am-241	3.0E-07	2.3E-07
Mg^{+2}	247	388	Sb-125	6.7E-06	9.1E-07
Mn^{+4}	62	71	Cs-134	5.1E-07	1.3E-07
Hg^{+2}	329	60	Cs-137	1.2E-03	2.8E-04
Mo^{+6}	923	310	Co-60	6.9E-08	2.7E-08
Ni^{+2}	43	52	Cm-242	1.4E-10	
Nb^{+5}	1,641	1,235	Cm-244	6.0E-10	8.3E-10
P^{+5}	4,587	79,682	Eu-154	2.8E-07	1.6E-07
K^{+}	3,475	3,360	Np-237	1.7E-09	1.7E-09
Se^{+4}	<49	<42	Pu-238	9.9E-06	2.0E-05
Si^{+4}	104,669	149,374	Pu-239	2.3E-06	3.4E-06
Ag^{+}	91	3,686	Sr-90	1.7E-05	1.4E-05
Na^{+}	637	2,924	Tc-99	3.5E-06	2.2E-07
Sr^{+2}	7	5	H-3	5.8E-08	2.8E-10
S^{+6}	2,728	1,747	U-234	3.5E-09	1.7E-09
Te^{+4}	<61		U-235	5.3E-10	
Tl^{+3}	<49	<36	U-238	1.3E-10	

To compare the solids composition data from the different tanks, the following adjustments or corrections were made:

- Contributions due to interstitial liquid were subtracted from the raw analytical results for Tanks WM-182 and WM-183. From mass and volume measurements made during drying the WM-183 LDUA sample, it was determined interstitial liquid accounted for 27.6 wt % of the dried solids

sample. Analytical data for WM-183 liquid samples taken at the same time as the sludge sample was used to make this adjustment. The same fraction of interstitial liquid was assumed for the WM-182 sample, since no drying measurements were available. For a few species such as nitrate and ^{155}Eu, this subtraction gave negative concentrations, which were then changed to zero. A correction for interstitial liquid was also made to the composition WM-180 solids.

- Weight fractions of oxide for each sample were calculated by charge balance.
- The amount of hydrated water was estimated for samples for which it was not measured. The amount of hydrated water was estimated by assuming a 3 to 1 molar ratio of hydrates to phosphates and sulfates and a ratio of 1.16 moles hydrate per mole of nitrate.
- Analyses were not performed for some species for every sample. For these cases, the average concentration from tank samples for which these analyses were made was assumed.
- All phosphorus was assumed present as phosphate and all sulfur as sulfate. The higher concentration of phosphorus or phosphate was assumed for the phosphate concentration and the higher concentration of sulfur or sulfate was assumed for sulfate.

Table 30 shows the adjusted solids compositions. Values shown in italics correspond to undetected species, and the value shown for these species is the detection limit. Solids from Tank WM-186 were analyzed by different methods that the other samples and concentrations shown are normalized, whereas concentrations for the other tanks are not.

Both similarities and difference can be seen in solids concentrations shown in Table 30. The predominant anions in all samples but one are phosphate and oxide, while the predominant cations in all samples are silicon, zirconium and aluminum. Sodium, potassium, sulfate, iron, chloride, fluoride and tin occur in lesser but significant concentrations in most samples. Solids in Tank WM-180 appear to be the least similar to those in other tanks, being very high in nitrate and high in sodium relative to the other samples. Also, the sum of the concentrations for Tank WM-180 is slightly greater than unity, in contrast to all other tanks (except the normalized WM-186). The two samples from WM-187 show high concentrations of silicon and low concentrations of sodium, potassium and calcium relative to the other tank samples, even though these solids came from the other tanks.

Table 31 compares concentrations of major radionuclides, and shows large variations in concentrations between samples from the different tanks. No radionuclide analyses were performed for the sample from Tank WM-186. Concentrations shown in Table 31 for samples taken prior to 2003 were adjusted by decaying activities to January 2003.

Table 30. Comparison of tank solids compositions.

	WM-180	**WM-181**	**WM-182**	**WM-183**	**WM-186**	**WM-187-1**	**WM-187-3**	**WM-188-1**	**WM-188-2**
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Al+3	58,460	5,870	12,425	10,489	52,507	10,616	11,059	35,406	14,568
Sb+5	40	19	*17*	41	41	*64*	40	*34*	*29*
As+5	*7*	36	335	73	148	98	68	351	*40*
Ba+2	34	10	145	18	1,661	12	98	12,542	29
Be+2	*2*	*2*	*1*	*1*	1	*2*	*1*	*2*	*2*
B+3	*511*	49	100	51	261	130	161	*482*	413
Cd+2	177	61	282	32	276	11	6	1,189	216
Ca+2	4,303	449	1,214	449	7,866	570	536	5,630	2,396
Ce+4	43	35	*19*	15	35	*30*	73	35	*30*
Cs+	524	126	45	0	133	68	81	*128*	25
Cl-	909	1,110	1,891	1,168	3,451	14,394	3,051	3,754	3,754
Cr+3	681	241	486	398	1,786	307	444	1,341	621
Co+2	*15*	*1*	*10*	2	8	*10*	*9*	9	7
Cu+2	136	41	331	77	119	69	84	113	55
F-	33	2,165	16,603	4,426	5,916	2,584	30	4,307	0
Gd+3	81	25	24	8	38	8	5	25	25
Fe+3	20,120	3,985	4,251	20,123	12,330	20,119	6,100	5,769	4,385
Pb+2	524	47	314	76	257	*37*	76	647	175
Li+	*160*	35	5	2	34	*14*	*13*	35	*17*
Mg+2	1,383	235	434	195	462	247	388	477	460
Mn+4	1,568	116	271	106	4,103	62	71	758	579
Hg+2	*8,904*	25	73	0	680	329	60	1,566	0
Mo+6	356	283	2,958	816	1,267	923	310	2,770	207
Ni+2	275	57	281	129	850	43	52	427	355
Nb+5	*1,004*	0	1,526	818	2,551	1,641	1,235	5,370	1,888
NO3-	434,300	645	0	0	0	56,514	1,034	0	0
Pd+4	*760*	2,476	6,888	1,913	2,045	2,476	2,476	2,476	345
PO4-3	166,590	197,980	81,686	166,567	283,160	221,788	231,089	60,814	168,335
K+	14,710	8,003	4,924	9,243	9,562	3,475	3,360	8,003	12,309
Ru+3	359	1,051	980	2,798	1,110	1,051	1,051	*313*	803
Se+4	*1,279*	*52*	109	*16*	530	*49*	*42*	*1,720*	*43*
Si+4	20,920	71,114	52,416	46,707	99,395	104,669	149,374	71,114	52,601
Ag+	49	1,299	77	291	865	91	3,686	9	190
Na+	78,160	2,926	18,885	3,945	5,368	637	2,924	20,521	35,291
Sr+2	22	9	*5*	0	10	7	5	9	14
SO4-2	15,140	3,974	36,996	13,903	17,530	18,429	4,386	14,802	10,787
Tl+3	*1,359*	*4*	*19*	*16*	267	*49*	*36*	*783*	*50*
Sn+4	2,120	4,117	4,863	1,942	4,422	4,208	4,363	0	2,178
Ti+4	959	916	774	939	1,956	1,429	916	916	477
U+4	348	*206*	*46*	206	189	*236*	*222*	206	*330*
V+5	*10*	5	0	11	38	*28*	*14*	6	*12*
Zn+2	196	27	177	57	2,679	196	148	126	73
Zr+4	27,970	37,930	121,001	46,051	145,947	66,464	38,644	70,600	32,209
O-2	32,694	55,747	96,591	48,073	157,146	96,258	143,008	140,932	60,942
Hydrates	250,001	115,119	67,300	102,611	171,001	155,669	134,324	42,935	101,864
Total	**1,148,196**	**518,623**	**537,778**	**484,801**	**1,000,000**	**786,112**	**745,154**	**519,452**	**509,130**

Table 31. Comparison of solids radiological composition.

	Cs-137	Sr-90	U-235	U-238	Pu-238	Pu-239
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
WM-180	0.21	4.8E-02	8.9E-08	3.8E-08	8.1E-02	1.3E-02
WM-181	0.24	6.0E-03	2.2E-07	2.3E-09	1.4E-02	1.4E-03
WM-182	0.34	8.5E-03	2.3E-07	2.2E-08	1.4E-02	1.2E-03
WM-183	0.72	6.8E-03	1.5E-07	3.6E-08	2.9E-03	1.0E-03
WM-187-1	1.18	1.7E-02	5.3E-07	1.3E-07	9.9E-03	2.3E-03
WM-187-2	0.28	1.4E-02	5.3E-07	1.3E-07	2.0E-02	3.4E-03
WM-188-1	1.93	2.0E-01	1.7E-07	6.8E-08	5.6E-03	3.6E-04
WM-188-2	0.26	5.5E-02	8.9E-08	2.1E-08	2.4E-03	3.4E-04
Minimum	0.21	0.006	8.9E-08	2.3E-09	2.4E-03	3.4E-04
Maximum	1.93	0.20	5.3E-07	1.3E-07	8.1E-02	1.3E-02
Average	0.64	0.04	2.5E-07	5.5E-08	1.9E-02	2.9E-03
Median	0.31	0.02	1.9E-07	3.7E-08	1.2E-02	1.3E-03
Standard Deviation	0.62	0.07	1.8E-07	4.8E-08	2.6E-02	4.2E-03
(Max-Ave)/SD	2.1	2.4	1.6	1.5	2.4	2.4
(Ave-Min)/SD	0.7	0.6	0.9	1.1	0.6	0.6
SD/Average	1.0	1.5	0.7	0.9	1.4	1.5

Revision 3 of this report (Barnes 2003) included an estimated composition of solids that would be in Tank WM-187. Table 32 compares the results of the FY 2004 WM-187 solids sample analysis to the predicted composition for major chemical and radionuclide species. As seen in the table, the concentrations of numerous species fall outside the expected range. This comparison suggests that tank samples may not be representative of a tank's total solids. As discussed in Section 3.3, it may also suggest that transfers of solids between tanks can result in compositional changes.

Because of the differences between the recent WM-187 sample analyses results and the composition expected, the present assumed composition of Tank WM-187 solids (Table 4) is not identical to the recent sample analyses. If the concentration of a chemical species in the recent analysis was outside the range of the concentrations of tanks that were flushed to WM-187, then it was replaced by the average concentration of those tanks plus both WM-187 sample analyses. Concentrations shown in Table 4 for Al, Cd, F, Gd, Pb, Mn, Hg, Ni, and Ag are averages. Concentrations for Ca, Fe, PO_4, K, SO_4, Zr, and H_2O were normalized to bring the sum of all species to 100%. Radionculide concentrations less than 80% or greater than 150% of the average were also replaced by the average.

Table 32. Comparison of recent WM-187 analyses to that predicted from previous data.

	FY-2004	**Rev. 3 SBW Feed Report**			
	Analysis	Low	Expected	High	Comparison of FY-2004
	Wt %	Wt %	Wt %	Wt %	Analysis to Rev. 3 Range
Al^{+3}	1.11	1.2	1.38	2.2	92% of low
Ca^{+2}	0.05	0.093	0.12	0.23	58% of low
Cl^{-}	0.31	0.092	0.21	0.31	100% of high
Fe^{+3}	0.61	0.92	1.1	1.8	66% of low
PO_4^{-3}	23.1	20	25.4	36	close to expected
K^{+}	0.34	1.1	1.27	1.7	31% of low
Si^{+4}	14.9	5.4	6.86	8	187% of high
Na^{+}	0.29	0.96	1.4	2.7	30% of low
SO_4^{-2}	0.44	1.2	2.19	2.8	37% of low
Sn^{+4}	0.44	0.44	0.587	0.67	100% of low
Zr^{+4}	3.86	5.9	9.15	10	65% of low
O^{-2}	14.3	3.4	6.66	4.8	300% of high
Hydrates	13.4	34	41	48	40% of low
Co-60	2.68E-05	3.20E-05	3.77E-05	5.90E-05	84% of low
Sr-90	1.42E-02	8.90E-03	1.00E-02	2.40E-02	within expected range
Tc-99	2.19E-04	7.30E-05	8.99E-05	1.40E-04	157% of high
Cs-137	2.77E-01	2.90E-01	3.55E-01	4.70E-01	96% of low
U-235	5.31E-07	8.80E-08	1.99E-07	3.00E-07	177% of high
U-238	1.28E-07	3.20E-09	1.56E-08	3.30E-08	387% of high
Np-237	1.73E-06	8.50E-07	1.15E-06	1.60E-06	108% of high
Pu-238	1.98E-02	7.10E-03	1.15E-02	2.80E-02	within expected range
Pu-239	3.37E-03	1.22E-03	8.20E-04	4.00E-03	within expected range
Am-241	2.33E-04	1.40E-04	2.98E-04	3.70E-04	within expected range

3.3 Feed Composition Uncertainties

The SBW treatment facility feed could vary from compositions presented in this report for several reasons, including: (1) analytical uncertainties in tank sample analyses, (2) species present in waste for which no analysis was done or which were not detected (2) actual NGLW that differs in rate or composition from that projected, (3) actual amounts of tank solids that differ from estimates, (4) nonrepresentativeness of tank solids samples, (5) processes occurring over time that could change the amount or composition of solids, and (6) potential changes in the tank farm management that could affect volumes and compositions of tank waste.

For recent analyses of Tank WM-189 and WM-188 samples, Batcheller (2003) and Johnson (2003a; 2003b) estimated analytical uncertainties to be 10% for most cations and 20 to 25% for Hg, Sb, Ce, Si, Ag, U, and Te. Anion concentrations were determined by ion chromatography, a different method than that used for cation concentrations, and the uncertainty for anion species is estimated to be larger than for other species, but has not been quantified.

Batcheller (2003) and Johnson (2003a; 2003b) have also reported uncertainties in measured radionuclide concentrations. While the analytical uncertainties for many radionuclides are less than 20%, the uncertainty in uranium and plutonium isotopes ranges from 13 to 100%. Typically, analyses of a tank waste sample are performed for only 15 to 25 isotopes. Concentrations of others are estimates, based on the assumption that the radionuclide concentrations in present waste are proportional to all the nuclear fuel processed at the ICPP over the lifetime of the plant. The uncertainty for these estimates is expected to be ±100%, but could be larger.

SBW contains a very large number of species due to its source. Typically, samples are analyzed for about 50 chemical species. Concentrations reported for others are estimates and could contain large errors. When analyses do not detect an element in a sample, the element is assumed present at a concentration corresponding to the detection limit, and these concentrations could have large errors. However, both for species not detected and species estimated, because their concentrations in the SBW are very small, these uncertainties are expected to have a negligible effect on most treatment processes.

Approximately 6 to 8% of the total liquid feed will be NGLW. Although the uncertainty in generated waste composition is high, the effect of this uncertainty on the SBW treatment facility feeds will be low for several reasons. The NGLW compositional data that are available generally show that the composition of NGLW, when concentrated, is similar to SBW composition. Thus, deviations from historical analyses will likely still fall within the range of SBW compositions for most species. And since NGLW itself is a blend of several dozen different waste streams, compositional variations in a few of the streams will have only a small effect on the composition of the final concentrated waste. Finally, the NGLW could be blended with SBW to further reduce the effect uncertainties and fluctuations in NGLW composition would have on the treatment process.

The uncertainty in the total quantity of tank solids is discussed in Section 3.1. The total volume of waste (liquid plus solids) is known to a high degree of accuracy based on tank volume measurements. For treatment processes that co-process solids and liquids, if the volume of solids is greater than expected, the volume of liquid will be less, and the effect on the process will be small. For the CsIX treatment process, or any other process that treats the solids separately, some of the equipment may be sized based on solids throughput, and thus will be affected by the total tank solids quantity. However, for any treatment process, the effect of more solids on individual equipment should be evaluated during design.

The goal of all SBW treatment processes is to produce a solid waste product from the mostly liquid SBW. For most unit operations of most processes, solids in the feed are like ‘inerts” – that is, their

composition will have little or no effect on the design. If the solids are chemically changed in the process, such as in a glass melter, their composition becomes more important to the design. Thus, even though there are significant uncertainties in the solids composition, these uncertainties are expected to have a negligible effect on most unit operations of a treatment process. The primary exemption to this statement would be a glass melter.

The variation in tank solids composition is detailed in Section 3.2. The analysis of the July 2003 Tank WM-187 samples provides one estimate of the uncertainties in these compositions. Table 33 shows a comparison between the results of analysis of this sample and the expected composition, based on analysis of samples from samples of Tanks WM-182 and WM-183, the source of the solids in WM-187 at the time it was sampled.

Table 33. Comparison of WM-187 solids composition to source tank solids composition.

	2:1 blend WM-183:WM-182	**WM-187-1**	**Ratio** WM-187/blend	**Ratio** WM-187/182	**Ratio** WM-187/WM-183
	Wt %	Wt %			
Al^{+3}	1.11	1.06	0.95	0.85	1.01
Ca^{+2}	0.07	0.06	0.81	0.47	1.27
Cl^{-}	0.14	1.44	10.22	7.61	12.33
Cr^{+3}	0.04	0.03	0.72	0.63	0.77
F^{-}	0.85	0.26	0.30	0.16	0.58
Fe^{+3}	1.48	2.01	1.36	4.73	1.00
Mo^{+6}	0.15	0.09	0.60	0.31	1.13
NO_3^{-}	0.00	5.65			
PO_4^{-3}	13.83	22.18	1.60	2.72	1.33
K^{+}	0.78	0.35	0.45	0.71	0.38
Si^{+4}	4.86	10.47	2.15	2.00	2.24
Na^{+}	0.89	0.06	0.07	0.03	0.16
SO_4^{-2}	2.16	1.84	0.85	0.50	1.33
Sn^{+4}	0.29	0.42	1.44	0.87	2.17
Ti^{+4}	0.09	0.14	1.62	1.84	1.52
Zr^{+4}	7.10	6.65	0.94	0.55	1.44
O^{-2}	6.42	9.63	1.50	1.00	2.00
H2O	9.08	15.57	1.71	2.31	1.52
Total	49.37	77.91			
	Ci/kg	**Ci/kg**			
Sr-90	7.3E-03	1.7E-02	2.37	2.05	2.58
Sb-125	1.2E-02	6.7E-03	0.57	0.21	4.03
Cs-134	9.2E-04	5.1E-04	0.56	0.22	2.35
Cs-137	5.9E-01	1.2E+00	1.99	3.42	1.64
Eu-154	4.9E-04	2.8E-04	0.58	0.39	0.76
U-234	3.8E-06	3.5E-06	0.93	0.64	1.20
U-235	1.8E-07	5.3E-07	3.01	2.34	3.51
U-238	3.2E-08	1.3E-07	4.05	5.76	3.52
Np-237	1.7E-06	1.7E-06	0.97	1.00	0.95
Pu-238	6.7E-03	9.9E-03	1.47	0.69	3.37
Pu-239	1.1E-03	2.3E-03	2.14	1.92	2.26
Am-241	3.4E-04	3.0E-04	0.88	0.46	1.60

If all samples were perfectly representative of well-mixed solids in the respective tanks, and no composition change occurred washing solids from WM-182 and WM-183 to WM-187, all ratios in the "WM-187/Blend" column would equal 1. The table shows ratios for a few species close to 1, but most are not. This implies nonrepresentative samples and/or composition changes due to precipitation or dissolution during or after solids transfer. Table 33 also shows ratios of the WM-187 sample concentration to those of solids from the two source tanks, WM-182 and WM-183. Comparing the three columns of ratios, it appears that tank WM-187 solids are closer in composition to WM-183 or the blend than they are to WM-182. This implies that some blending of the solids in WM-187 may have taken place.

Comparing results from analysis of the most recent Tank WM-187 sample to a predicted composition leads to similar conclusions. Some species, such as Hg and PO_4 are close to the predicted concentrations, while others are either significantly higher (Si, Cl, NO_3, O) or lower (Ca, K, Na, Fe, Zr, F, SO_4).

While changes in Tank Farm management could affect waste composition, any change from this time forward will have a minimal effect because one tank is now full, another is nearly full, and the third should be nearly full by the end of 2004. Thus, there is neither time nor tank space to make much of a change. Should the waste generated by Tank WM-180 evaporation unexpectedly exceed the capacity of Tank WM-187, another tank would need to be used to store the excess. Because present projections show WM-187 with about 15,000 gallons of spare capacity at the end of 2005, the risk of exceeding its capacity is low.

Tables 34 and 35 provide additional estimates of the uncertainty in SBW sample analyses. Table 34 compares results of liquid analyses for two samples from the same tank (WM-180), one sample taken in 1993 and the second in 2000. Approximately 278,900 gallons of waste were in WM-180 at the time of sampling in 1993. Later, about 400 gallons of waste and 2000 gallons of water were added, 3400 gallons were transferred out of WM-180 in 1997, and 2600 gallons were transferred to the NWCF for sampling in 2000. Thus, at most, 1% of the difference between the two analyses can be accounted for by additions to the tank; the remainder of the difference provides an estimate of the uncertainty in the composition. While the differences between the two sets of analyses are within ~10% for most species, larger differences are seen for a few species.

Table 35 provides an estimate of the how uncertainty in the solids composition affects the total waste composition in a tank. The table compares concentrations of the total waste in WM-189 based on two separate analyses of solids. As mentioned in Section 2.3, the sample of solids from Tank WM-189 was dried with interstitial liquid, the undissolved solids accounting for only about 22% of the total solids. Table 35 compares the total tank waste composition calculated assuming the solids have the composition of the WM-188 solids to the composition using the WM-189 undissolved solids/dissolved solids analyses. Differences are within about 10% for all major species except fluoride and phosphate.

Table 34. Comparison of analyses of WM-180 samples.

	1993 Mol/liter	**2000** Mol/liter	**Ratio** 2000/1993
H^{+}	1.14E+00	1.10E+00	0.96
Al^{+3}	5.90E-01	6.63E-01	1.12
Ba^{+2}	5.10E-05	5.58E-05	1.09
B^{+3}	1.02E-02	1.23E-02	1.20
Cd^{+2}	7.73E-04	7.54E-04	0.98
Ca^{+2}	3.39E-02	4.72E-02	1.39
Cl^{-}	3.11E-02	3.00E-02	0.96
Cr^{+3}	3.29E-03	3.35E-03	1.02
F^{-}	4.18E-02	4.74E-02	1.13
Fe^{+3}	1.75E-02	2.17E-02	1.24
Pb^{+2}	1.23E-03	1.31E-03	1.06
Hg^{+2}	9.89E-04	2.02E-03	2.04
Ni^{+2}	1.48E-03	1.47E-03	0.99
NO_3^{-}	4.56E+00	5.01E+00	1.10
K^{+}	1.83E-01	1.96E-01	1.07
Se^{+2}	1.04E-05	1.46E-04	14.0
Ag^{+}	4.43E-06	5.29E-06	1.19
Na^{+}	2.00E+00	2.06E+00	1.03
SO_4^{-2}	4.28E-02	6.98E-02	1.63

Table 35. Comparison of two methods of calculating the composition of WM-189 waste.

Concentration based on WM-189 solids analyses divided by concentration based on WM-188 solids analyses			
	Ratio		**Ratio**
H^{+}	1.00	Sr-90	0.93
Al^{+3}	1.04	Cs-137	0.90
Ca^{+2}	1.04	U-238	1.08
Cl^{-}	0.92	Np-237	0.95
F^{-}	0.74	Pu-238	0.89
Fe^{+3}	1.04	Pu-239	0.88
Hg^{+2}	0.94	Am-241	1.09
NO_3^{-}	0.98		
PO_4^{-3}	0.31		
K^{+}	1.06		
Na^{+}	1.09		
SO_4^{-2}	1.01		
Zr^{+4}	1.09		

3.4 Solids Co-processing Scenarios

Consolidation of SBW into Tanks WM-187, WM-188, and WM-189 requires redefining a scenario to more evenly distribute tank solids within the entire SBW inventory from what has been presented in previous reports (such as Rev. 3 of this report or Wood 2002). For treatment alternatives that co-process undissolved solids with SBW liquid, solids distribution is needed to (1) reduce the concentration of undissolved solids from that in the initial waste in WM-187 in order to avoid settling of solids in lines during transfer of waste to treatment,[h] (2) to minimize effects of the solids on the performance of the treatment process, due both to physical and chemical differences in the solids and liquids, and (3) to potentially simplify waste qualification by having a more narrow feed composition band.

One option is to install mixing pumps only in Tank WM-187, and design a new receiving tank or tanks to blend waste received from different Tank Farm Tanks. Waste would be transferred from WM-187 and either WM-188 or WM-189 to the new receiving tank, mixed in the new tank and then fed to the treatment process. This scenario has the advantages of the using the minimum number of mix pumps and not using Tank WM-190. However, this scenario would require frequent, short-duration transfers of waste or a very large new tank. Another major disadvantage of this scheme is that it is likely that samples would need to be taken and analyzed each time the receiving tank was filled, for the purpose of waste qualification. In other scenarios, sampling is limited to samples from 300,000-gal tanks, greatly reducing the number of samples. A third disadvantage is that this scenario would require the transfer of Tank WM-187 waste with high solids to the treatment facility, and may result in solids settling if the existing jet transfer and transfer lines are used. While a cost /benefit analysis has not been performed for this scenario, the negative impact on waste qualification and potential for solids settling is likely to outweigh the benefits of this scheme.

A second option would be to use Tank WM-190 as the feed blend tank. A “batch” of feed would be made up in Tank WM-190 by transferring waste from WM-187, WM-188, WM-189, and the NGLW tanks. Feed to SBW treatment would then consist of three batches of nearly identical composition (the average of all SBW plus NGLW) plus a smaller final batch containing heel solids from WM-188 and WM-189. This scenario is shown in Table 36.

For this option, mixing pumps would be installed in Tanks WM-187 and WM-190. Installation of pumps in WM-190 could be done while the tank is empty and essentially free from contamination. The first two feed batches would be made up of equal amounts of waste from WM-187, WM-188, WM-189, and the NGLW tanks. For the second batch, the NGLW tanks would be emptied to allow for a later transfer of waste from WM-188. This waste would be held in the NGLW tanks for later blending with the heels flushed from WM-188 and WM-189. The third feed batch would be made up of waste from WM-187, WM-188, and WM-189, and would reduce the waste to heel level in each of these tanks. These heels would be flushed to WM-190, and then the flush water evaporated. The evaporator concentrate would be added back to WM-190 after emptying the tank to heel level, and the waste temporarily stored in the NGLW tanks would also be added to WM-190 to complete the make up of the fourth and final treatment feed batch. Additional tanks, such as WL-101 and/or WL-102 may be needed to store the evaporator concentrate if WM-100, WM-101, and WM-102 reach their capacities. After Batch 4 is processed, Tank WM-190 would be flushed to the NGLW tanks.

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[h] Or alternatively, to avoid the expense of a new transfer system from the Tank Farm to the treatment facility

Table 36. Tank mix scenario using Tank WM-190 for blending.

	WM-187	WM-188	WM-189	NGLW Tanks	WM-190	Waste to Treatment
Initial waste volume, gallons	279,608	284,381	279,800	72,180	0	
Initial undissolved solids, g/liter	99.4	4.6	9.4	4.1		
Batch 1 transfers, gallons	-92,000	-64,000	-85,000	-36,090	285,402	299,673
undissolved solids, g/liter						31.1
Batch 2 transfers, gallons	-92,000	-64,000	-85,000	-36,090	285,402	299,673
undissolved solids, g/liter						31.1
Batch 3 transfers, gallons	-92,000	-95,000	-90,000		285,310	299,576
undissolved solids, g/liter						31.2
Transfer to NGLW tanks, gallons		-53,000		54,590		
Heel, gallons	3,608	8,381	19,800			
Flushing Heel to WM-190, gallons	-3,608	-8,381	-19,800		181,789	
Evaporation of WM-190, gallons					-180,000	
Addition of concentrated waste					31,789	
Batch 4 transfer, gallons				-54,590	88,017	92,418
undissolved solids, g/liter						41.1
Total waste to treatment, gallons						**991,338**

A second scenario would use WM-189 as the feed blend tank. Mixing pumps would be installed in Tanks WM-187 and WM-189. An initial transfer of about 141,000 gallons of waste would be made from WM-189 to WM-190, to provide capacity in Tank WM-189 to receive higher solids content waste from WM-187. Four sequential feed batches would be made up in Tank WM-189, the first two of waste from WM-189, WM-187, and NGLW, and the second two of waste from WM-188, WM-187, and NGLW. While Batch 4 is being processed in the treatment facility, Tank WM-188 could be flushed to Tank WM-187. Most of the solids initially in Tank WM-189 will have been processed with Batches 1-4, and thus less SBW would need to be saved for treating the final heel solids. This waste could initially be held in WM-190 and then transferred to one of the NGLW tanks, or transferred directly to one of the NGLW tanks after it has been emptied. Table 37 shows about 10,000 gallons from WM-189 and 16,000 gallons from WM-188 for this final batch, but the scenario could be adjusted to have all the waste come from just one of these tanks. When emptied of waste, the heel in WM-190 can be flushed to WM-187. Then upon completion of treatment of Batch 4, the heel in WM-189 can also be flushed to WM-187. The dilute liquid in Tank WM-187 would be evaporated, with the evaporator concentrate stored temporarily in the NGLW tanks. When the level in Tank WM-187 was brought down to the solids layer, evaporation of the tank would be stopped and the concentrate from the NGLW tanks added to make up the fifth and final treatment batch. Tank and feed volumes for this scenario are shown in Table 37.

Table 37. Tank mix scenario using Tank WM-189 for blending.

	WM-187	WM-188	WM-189	NGLW Tanks	WM-190	Waste to Treatment
Initial waste volume, gallons	279,608	284,381	279,800	72,180	0	
Initial undissolved solids, g/liter	99.4	4.6	9.4	4.1		
Tank transfer, gallons			-140,800		145,024	
Batch 1, gallons	-64,000		-220,506	-18,045		231,532
undissolved solids, g/liter						33.2
Batch 2, gallons	-64,000		-221,521	-18,045	-133,024	232,597
undissolved solids, g/liter						32.8
Transfer, gallons		-16000			16,480	
Batch 3, gallons	-74,000	-130,000	-228,706	-18,045		240,142
undissolved solids, g/liter						31.0
Batch 4, gallons	-74,000	-130,000	-228,706	-18,045		240,142
undissolved solids, g/liter			31.0			31.0
Final heel	3,608	8,381	3,000		28,480	
Flushing Heel to WM-187	193,469					
Evaporation of WM-187	-173,500					
Batch 5 transfer				43,469		45,642
undissolved solids, g/liter						33.4
Total waste to treatment, gallons			**942,909**			**990,054**

Other schemes are certainly possible. For example, four feed batches rather than three could be prepared in Tank WM-190, which may improve the mix pump performance by reducing the height of waste in a tank. A summary of advantages and disadvantages of the two schemes is given below:

Advantages	WM-190 Blend Tank Scenario	WM-189 Blend Tank Scenario
Mix pumps installed in only two tanks	x	x
Mix pumps installed in an empty, nonrad tank	x	
Minimum treatment facility feed batches	x	
Most homogeneous blending of tank wastes	x	
Possible better mixing due to smaller feed batches		x
Uniform undissolved solids concentration in all feed batches		x
Greater flexibility to accommodate uncertainty in NGLW volume		x
Flushing of at least one tank can occur during SBW treatment		x
Minimal use of WM-190, allowing it to be availableas a spare for part of the time		x
Does not require use of tanks other than the four TF tanks and the 3 NGLW tanks		x

Blended waste compositions based on the WM-189 Blend Tank Scenario are shown in Table 38.

Table 38. Tank blend compositions for WM-189 Blend Scenario.

	Batch 1	**Batch 2**	**Batch 3**	**Batch 4**	**Batch 5**
Gallons	231,532	232,597	240,142	240,142	45,642
SG	1.25	1.21	1.22	1.22	1.24
	mol/liter	**mol/liter**	**mol/liter**	**mol/liter**	**mol/liter**
H+	2.25E+00	2.15E+00	2.03E+00	2.03E+00	2.43E+00
Al^{+3}	6.40E-01	6.16E-01	6.03E-01	6.03E-01	6.50E-01
Am^{+4}	9.46E-08	9.15E-08	9.10E-08	9.10E-08	8.34E-08
Sb^{+5}	1.56E-05	1.52E-05	1.40E-05	1.40E-05	8.82E-06
As^{+5}	1.62E-04	1.61E-04	1.79E-04	1.79E-04	5.26E-05
Ba^{+2}	7.02E-05	6.81E-05	8.21E-05	8.21E-05	7.07E-05
Be^{+2}	1.84E-05	1.77E-05	1.61E-05	1.61E-05	1.86E-05
B^{+3}	1.69E-02	1.62E-02	1.64E-02	1.64E-02	1.97E-02
Br^{-}	2.65E-07	2.55E-07	3.22E-07	3.22E-07	3.47E-07
Cd^{+2}	2.59E-03	2.46E-03	2.11E-03	2.11E-03	3.10E-03
Ca^{+2}	5.85E-02	5.60E-02	5.22E-02	5.22E-02	6.26E-02
Ce^{+4}	5.21E-05	5.08E-05	5.20E-05	5.20E-05	3.82E-05
Cs^{+}	4.27E-05	4.16E-05	4.78E-05	4.78E-05	3.56E-05
Cl^{-}	2.54E-02	2.47E-02	3.02E-02	3.02E-02	2.66E-02
Cr^{+3}	5.07E-03	4.88E-03	4.70E-03	4.70E-03	5.12E-03
Co^{+2}	4.04E-05	3.87E-05	3.94E-05	3.94E-05	4.43E-05
Cu^{+2}	8.08E-04	7.76E-04	6.82E-04	6.82E-04	7.87E-04
Eu^{+3}	4.40E-07	4.23E-07	5.34E-07	5.34E-07	5.75E-07
F^{-}	3.13E-02	3.08E-02	4.47E-02	4.47E-02	2.91E-02
Gd^{+3}	1.49E-04	1.44E-04	1.74E-04	1.74E-04	1.58E-04
Ge^{+4}	7.64E-09	7.34E-09	9.27E-09	9.27E-09	1.00E-08
In^{+3}	1.21E-06	1.17E-06	1.47E-06	1.47E-06	1.58E-06
I^{-}	3.00E-06	2.91E-06	3.56E-06	3.56E-06	3.11E-06
Fe^{+3}	2.70E-02	2.60E-02	2.54E-02	2.54E-02	2.55E-02
La^{+3}	7.99E-06	7.67E-06	9.69E-06	9.69E-06	1.04E-05
Pb^{+2}	1.08E-03	1.04E-03	9.96E-04	9.96E-04	1.03E-03
Li^{+}	4.51E-04	4.37E-04	4.29E-04	4.29E-04	3.74E-04
Mg^{+2}	1.89E-02	1.82E-02	2.02E-02	2.02E-02	2.20E-02
Mn^{+4}	1.80E-02	1.73E-02	1.59E-02	1.59E-02	1.64E-02
Hg^{+2}	4.97E-03	4.75E-03	5.07E-03	5.07E-03	6.04E-03
Mo^{+6}	3.47E-04	3.36E-04	3.33E-04	3.33E-04	2.92E-04
Nd^{+3}	2.58E-05	2.47E-05	3.12E-05	3.12E-05	3.37E-05

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter
Np^{+4}	1.50E-05	1.44E-05	1.81E-05	1.81E-05	1.93E-05
Ni^{+2}	1.97E-03	1.89E-03	2.01E-03	2.01E-03	2.30E-03
Nb^{+5}	7.91E-04	7.71E-04	6.19E-04	6.19E-04	4.04E-04
NO_3^-	6.51E+00	6.26E+00	5.87E+00	5.87E+00	6.43E+00
Pd^{+4}	6.47E-04	6.43E-04	9.02E-04	9.02E-04	4.02E-04
PO_4^{-3}	1.05E-01	1.04E-01	1.07E-01	1.07E-01	4.13E-02
Pu^{+4}	9.03E-06	8.87E-06	1.04E-05	1.04E-05	5.93E-06
K^+	2.35E-01	2.27E-01	2.03E-01	2.03E-01	1.86E-01
Pr^{+4}	7.26E-06	6.98E-06	8.81E-06	8.81E-06	9.50E-06
Pm^{+3}	6.21E-08	6.18E-08	6.93E-08	6.93E-08	1.89E-08
Rh^{+4}	3.13E-06	3.01E-06	3.80E-06	3.80E-06	4.10E-06
Rb^+	4.82E-06	4.63E-06	5.85E-06	5.85E-06	6.31E-06
Ru^{+3}	4.89E-04	4.78E-04	4.77E-04	4.77E-04	3.02E-04
Sm^{+3}	4.80E-06	4.62E-06	5.82E-06	5.82E-06	6.25E-06
Se^{+4}	4.06E-05	4.01E-05	4.25E-05	4.25E-05	1.66E-05
Si^{+4}	1.80E-01	1.79E-01	1.91E-01	1.91E-01	6.36E-02
Ag^+	2.69E-04	2.67E-04	2.91E-04	2.91E-04	9.10E-05
Na^+	2.00E+00	1.93E+00	1.67E+00	1.67E+00	1.65E+00
Sr^{+2}	1.29E-04	1.25E-04	1.02E-04	1.02E-04	1.08E-04
SO_4^{-2}	8.57E-02	8.21E-02	4.46E-02	4.46E-02	6.06E-02
Tc^{+7}	1.54E-05	1.51E-05	2.04E-05	2.04E-05	1.33E-05
Te^{+4}	5.19E-06	4.95E-06	3.51E-06	3.51E-06	4.95E-06
Tb^{+4}	1.84E-09	1.77E-09	2.23E-09	2.23E-09	2.40E-09
Tl^{+3}	1.45E-05	1.43E-05	1.49E-05	1.49E-05	6.40E-06
Th^{+4}	2.27E-05	2.16E-05	2.00E-05	2.00E-05	2.87E-05
Sn^{+4}	1.15E-03	1.13E-03	1.17E-03	1.17E-03	4.72E-04
Ti^{+4}	6.64E-04	6.54E-04	6.70E-04	6.70E-04	2.96E-04
U^{+4}	5.60E-04	5.38E-04	4.06E-04	4.06E-04	4.78E-04
V^{+5}	2.85E-04	2.82E-04	3.21E-04	3.21E-04	1.06E-04
Y^{+3}	5.95E-06	5.72E-06	7.22E-06	7.22E-06	7.79E-06
Zn^{+2}	1.01E-03	9.75E-04	9.25E-04	9.25E-04	9.47E-04
Zr^{+4}	1.82E-02	1.80E-02	1.99E-02	1.99E-02	9.23E-03
O-2	2.82E-01	2.80E-01	2.98E-01	2.98E-01	9.89E-02
H2O	4.10E+01	3.95E+01	4.18E+01	4.18E+01	4.16E+01

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	g/liter	**g/liter**	**g/liter**	**g/liter**	**g/liter**
TOC	8.69E-01	8.48E-01	7.47E-01	7.47E-01	4.43E-01
UDS	3.15E+01	3.11E+01	3.14E+01	3.14E+01	1.29E+01
	Ci/kg	**Ci/kg**	**Ci/kg**	**Ci/kg**	**Ci/kg**
	Jan-03	**Jan-03**	**Jan-03**	**Jan-03**	**Jan-03**
Ra-226	6.94E-12	6.67E-12	8.41E-12	8.41E-12	9.01E-12
Ac-227	3.27E-11	3.14E-11	3.96E-11	3.96E-11	4.24E-11
Th-230	1.09E-09	1.06E-09	1.28E-09	1.28E-09	1.03E-09
Th-231	1.78E-08	1.71E-08	2.15E-08	2.15E-08	2.31E-08
Th-232	6.00E-16	5.77E-16	7.27E-16	7.27E-16	7.79E-16
Th-234	1.75E-08	1.69E-08	2.13E-08	2.13E-08	2.28E-08
Pa-231	7.57E-11	7.28E-11	9.18E-11	9.18E-11	9.83E-11
Pa-233	2.48E-06	2.39E-06	3.01E-06	3.01E-06	3.22E-06
Pa-234m	1.75E-08	1.69E-08	2.13E-08	2.13E-08	2.28E-08
U-232	2.51E-09	2.44E-09	3.03E-09	3.03E-09	2.54E-09
U-233	8.19E-11	7.92E-11	1.01E-10	1.01E-10	9.63E-11
U-234	1.58E-06	1.53E-06	1.30E-06	1.30E-06	1.37E-06
U-235	6.27E-08	6.06E-08	8.75E-08	8.75E-08	8.29E-08
U-236	8.50E-08	8.23E-08	6.93E-08	6.93E-08	6.14E-08
U-237	5.45E-09	5.24E-09	6.91E-09	6.91E-09	7.38E-09
U-238	3.80E-08	3.65E-08	2.17E-08	2.17E-08	2.48E-08
Np-237	1.99E-06	1.90E-06	2.47E-06	2.47E-06	3.08E-06
Np-238	4.27E-07	4.25E-07	4.76E-07	4.76E-07	1.23E-07
Np-239	8.45E-08	8.02E-08	1.30E-07	1.30E-07	1.64E-07
Pu-236	3.49E-09	3.39E-09	4.19E-09	4.19E-09	3.49E-09
Pu-238	8.80E-04	8.63E-04	1.05E-03	1.05E-03	6.45E-04
Pu-239	1.23E-04	1.21E-04	1.46E-04	1.46E-04	7.97E-05
Pu-240	1.31E-05	1.27E-05	1.57E-05	1.57E-05	1.29E-05
Pu-241	7.01E-04	6.86E-04	7.27E-04	7.27E-04	4.74E-04
Pu-242	1.01E-08	9.86E-09	1.23E-08	1.23E-08	1.02E-08
Pu-244	7.63E-16	7.39E-16	4.16E-16	4.16E-16	3.40E-16
Am-241	7.79E-05	7.53E-05	7.48E-05	7.48E-05	6.85E-05
Am-242m	1.24E-08	1.19E-08	1.67E-08	1.67E-08	1.82E-08
Am-242	1.24E-08	1.19E-08	1.66E-08	1.66E-08	1.81E-08
Am-243	2.07E-08	1.99E-08	2.69E-08	2.69E-08	2.67E-08
Cm-242	2.38E-08	2.28E-08	3.20E-08	3.20E-08	3.55E-08

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
	Jan-03	Jan-03	Jan-03	Jan-03	Jan-03
Cm-243	3.68E-08	3.58E-08	4.32E-08	4.32E-08	3.50E-08
Cm-244	2.14E-06	2.09E-06	2.26E-06	2.26E-06	1.32E-06
Cm-245	4.43E-10	4.32E-10	5.17E-10	5.17E-10	3.84E-10
Cm-246	2.90E-11	2.83E-11	3.38E-11	3.38E-11	2.52E-11
H-3	1.27E-05	1.24E-05	1.67E-05	1.67E-05	1.37E-05
Be-10	2.54E-12	2.44E-12	3.08E-12	3.08E-12	3.30E-12
C-14	1.47E-10	1.43E-10	1.71E-10	1.71E-10	1.48E-10
Se-79	6.67E-07	6.45E-07	6.96E-07	6.96E-07	6.56E-07
Rb-87	2.48E-11	2.39E-11	3.01E-11	3.01E-11	3.22E-11
Sr-90	3.39E-02	3.26E-02	4.01E-02	4.01E-02	4.26E-02
Y-90	3.39E-02	3.26E-02	4.01E-02	4.01E-02	4.26E-02
Zr-93	1.88E-06	1.80E-06	2.28E-06	2.28E-06	2.44E-06
Tc-98	2.11E-12	2.02E-12	2.57E-12	2.57E-12	2.84E-12
Tc-99	2.59E-05	2.54E-05	3.43E-05	3.43E-05	2.22E-05
Ru-106	1.14E-06	1.11E-06	1.33E-06	1.33E-06	1.15E-06
Rh-102	7.30E-10	7.02E-10	8.85E-10	8.85E-10	9.48E-10
Rh-106	1.14E-06	1.11E-06	1.33E-06	1.33E-06	1.15E-06
Pd-107	1.40E-08	1.35E-08	1.70E-08	1.70E-08	1.82E-08
Cd-113m	2.81E-06	2.70E-06	3.41E-06	3.41E-06	3.65E-06
In-115	8.53E-17	8.20E-17	1.03E-16	1.03E-16	1.11E-16
Sn-121m	5.67E-08	5.44E-08	6.87E-08	6.87E-08	7.35E-08
Sn-126	5.02E-07	4.87E-07	5.84E-07	5.84E-07	5.06E-07
Sb-125	2.41E-04	2.40E-04	2.67E-04	2.67E-04	8.54E-05
Sb-126m	3.48E-07	3.34E-07	4.22E-07	4.22E-07	4.52E-07
Sb-126	4.87E-08	4.68E-08	5.91E-08	5.91E-08	6.33E-08
Te-123	3.25E-19	3.12E-19	3.94E-19	3.94E-19	4.21E-19
Te-125m	2.67E-06	2.56E-06	3.23E-06	3.23E-06	3.46E-06
I-129	6.40E-08	6.20E-08	7.45E-08	7.45E-08	6.53E-08
Cs-134	4.91E-05	4.76E-05	6.80E-05	6.80E-05	6.00E-05
Cs-135	1.02E-06	9.84E-07	1.19E-06	1.19E-06	1.05E-06
Cs-137	5.86E-02	5.68E-02	6.85E-02	6.85E-02	6.10E-02
Ba-137m	5.54E-02	5.37E-02	6.48E-02	6.48E-02	5.77E-02
La-138	1.62E-16	1.55E-16	1.96E-16	1.96E-16	2.10E-16

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
	Jan-03	Jan-03	Jan-03	Jan-03	Jan-03
Ce-142	2.53E-11	2.43E-11	3.07E-11	3.07E-11	3.29E-11
Ce-144	7.70E-07	7.47E-07	8.96E-07	8.96E-07	7.73E-07
Pr-144	5.56E-07	5.34E-07	6.58E-07	6.58E-07	7.12E-07
Nd-144	1.36E-15	1.31E-15	1.65E-15	1.65E-15	1.77E-15
Pm-146	4.31E-08	4.14E-08	5.23E-08	5.23E-08	5.60E-08
Pm-147	2.08E-04	2.01E-04	2.42E-04	2.42E-04	2.09E-04
Sm-146	2.34E-13	2.25E-13	2.83E-13	2.83E-13	3.03E-13
Sm-147	6.24E-12	6.00E-12	7.56E-12	7.56E-12	8.10E-12
Sm-148	3.21E-17	3.08E-17	3.89E-17	3.89E-17	4.16E-17
Sm-149	2.85E-18	2.74E-18	3.45E-18	3.45E-18	3.70E-18
Sm-151	4.11E-04	3.98E-04	4.78E-04	4.78E-04	4.13E-04
Eu-150	1.22E-11	1.17E-11	1.48E-11	1.48E-11	1.58E-11
Eu-152	2.45E-06	2.36E-06	2.91E-06	2.91E-06	2.89E-06
Eu-154	1.51E-04	1.45E-04	1.82E-04	1.82E-04	2.02E-04
Eu-155	1.58E-04	1.52E-04	1.87E-04	1.87E-04	1.87E-04
Gd-152	1.20E-18	1.16E-18	1.46E-18	1.46E-18	1.56E-18
Ho-166m	3.90E-11	3.75E-11	4.73E-11	4.73E-11	5.06E-11
Co-60	2.81E-05	2.69E-05	3.85E-05	3.85E-05	4.40E-05
Ni-63	4.01E-05	3.90E-05	4.86E-05	4.86E-05	3.99E-05

3.5 Solids & Slurry Properties

Poloski (2000b) reports that the particle density of air-dried solids from the WM-183 LDUA sample was measured to be 1.88 g/ml. Using measurements of the sludge sample mass, volume and percent water for the same tank sample, a solids particle density of 1.98 g/ml can be derived. These values are commonly rounded to a bulk density of 2.0 g/ml for dried tank solids.

The measured bulk density of solids from several tanks is shown below:

	g/ml
WM-181	0.786
WM-188	0.838
WM-187-1	0.459
WM-187-3	0.421

Particle size distributions (PSD) have been reported for WM-180 solids (Christian 2001), WM-182 and WM-183 solids (Poloski 2000a), WM-189 solids (Batcheller 2003), WM-188 solids (Johnson 2003a), WM-181 solids (Johnson 2003b), and were recently measured for WM-187 solids from the most recent Tank WM-187 sample. The WM-180 solid particles were normally distributed between 2 and 65 µm, with the center of the distribution at 10 µm (Christian 2001). PSDs for WM-182 and WM-183 sonicated

solids show median particle sizes of 8 µm and 12 µm respectively. Without sonification, the WM-182 and WM-183 solids size distributions are shifted to larger particle sizes (Poloski 2000a). Particle sizes for the WM-189 sludge sample ranged from 0.5 to 100 µm with a peak at approximately 20 µm (Batcheller 2003). WM-188 particles, without sonification, were distributed between 0.5 and 60 µm, with the average size 4 µm (Johnson 2003a). WM-181 particles were distributed between 0.5 and 30 µm, with the average size about 9 µm (Johnson 2003b). A comparison of particle size distribution for solids from different tanks is shown in Figure 4.

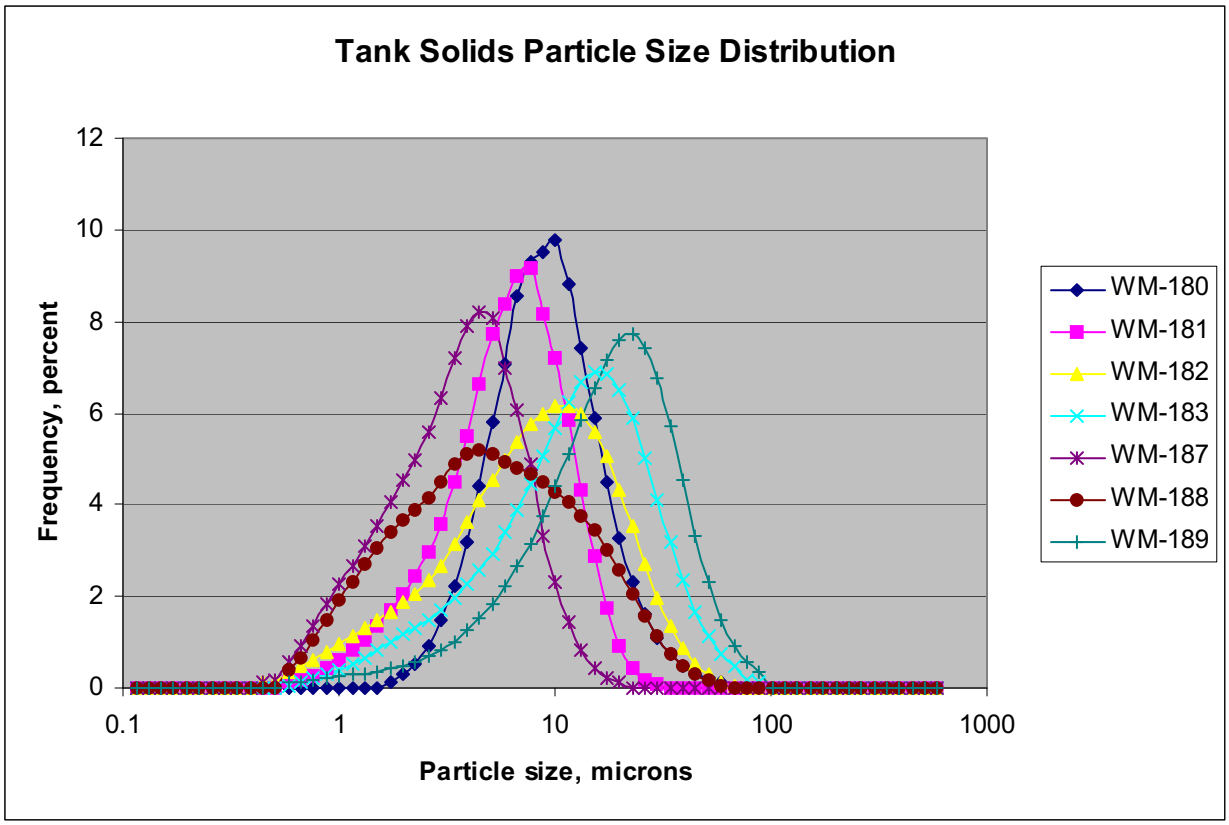

Figure 4. Comparison of solids particle size distribution analyses.

A comparison of settling rate data is shown on Figure 5. Data plotted on Figure 5 is based on measurements of the settled or sludge volume taken at various time intervals.

The solids from the tanks differed in settling. WM-188 and WM-189 both settled by the accumulated sediment method. The solution was cloudy until enough particles agglomerated and then they fell out of solution very rapidly. Once agglomerated, the WM-189 solids settled much faster than the other tanks. Solids in WM-182, WM-183, WM-186, and WM-187 samples all settled by the flocculated sedimentation method. The solution started to clear at the top and slowly cleared to the final volume. Tank WM-181 solids settled completely in about 35 minutes to a volume of 6.5 ml. Then over the next 4 days, this settled volume compressed to 2.1 ml.

The color of the solids differed as well. WM-189 solids were silica like. WM-188 were dark brown-black. Most of the other tanks were a dark gray to black color. A couple samples had a very fine dusting of white solids on top.

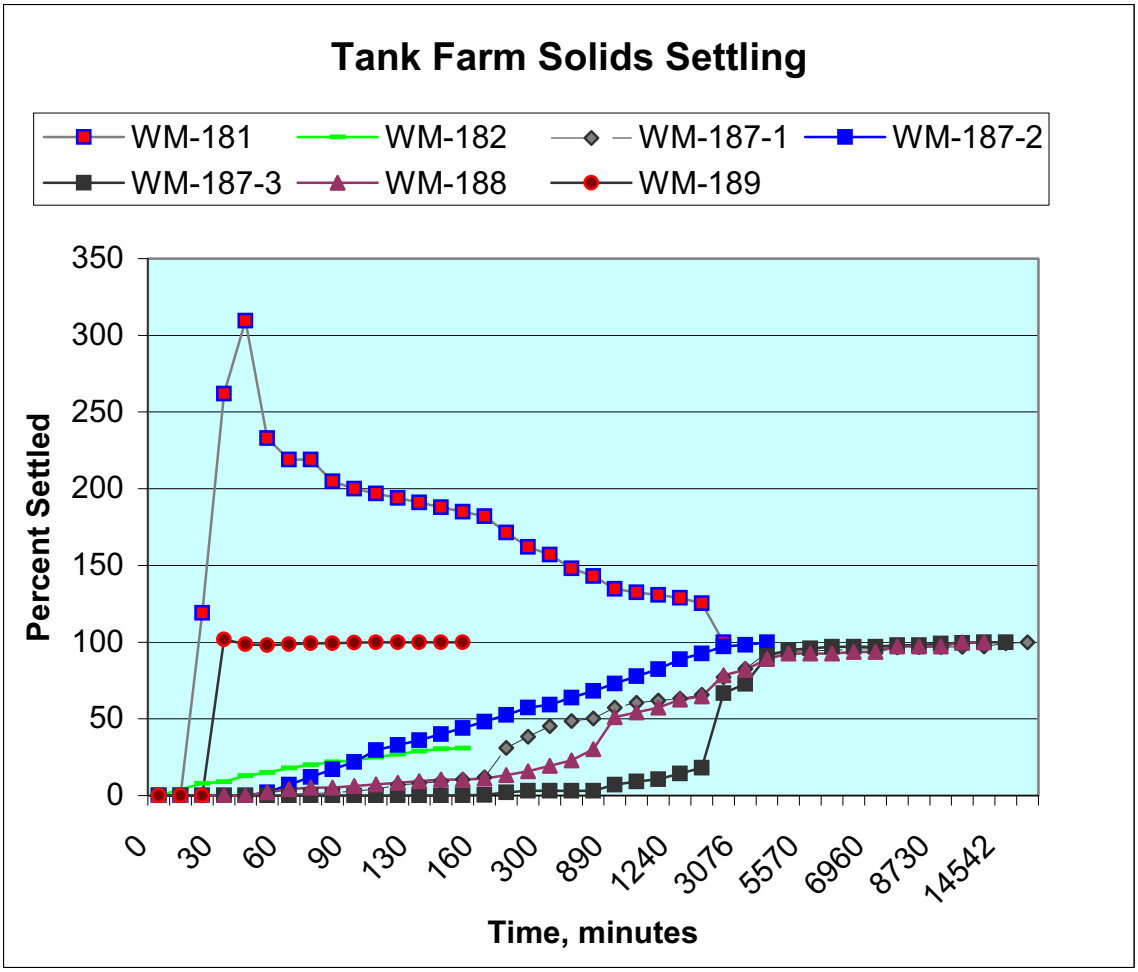

Figure 5. WM-189 and WM-182 relative volume % settled sludge vs. settling time.

Viscosity measurements were made on both the settled WM-182 sludge and the same sludge diluted with an equal volume of demineralized water. Poloski (2001) fit the data to the following flow curves:

Undiluted WM-182 sludge:
Shear stress, dyne/cm^2 = 7.25 x (shear rate, sec^{-1})$^{0.619}$ R^2 = 0.997

Diluted WM-182 sludge:
Shear stress, dyne/cm^2 = 10.25 x (shear rate, sec^{-1})$^{0.218}$ R^2 = 0.988

The viscosity of WM-182 undiluted sludge was approximately 200 cP (Poloski 2001), WM-182 sludge diluted with an equal volume of water about 50 cP (Poloski 2001), WM-189 sludge 3.5 cP (Batcheller 2003), WM-188 sludge 5.5 cP (Johnson 2003a), WM-181 sludge 2.76 cP (Johnson 2003b), and WM-187 sludge 2.71 cP. These viscosities are highly dependent upon the solids content of the sample. Wendt (2004) provides a more detailed analysis of sludge viscosity.

3.6 Liquid Waste Properties

The specific gravity for the liquid waste in Tanks WM-188 is 1.32 (Johnson 2003a) and in Tank WM-189, 1.34 (Batcheller 2003). The specific gravity of the liquid waste in Tank WM-187, when full, is expected to be 1.30.

The viscosity of a liquid sample from Tank WM-188 was measured to be 1.81 cP (Johnson 2003a) and the Tank WM-189 liquid viscosity was measured at 1.94 cP (30.2^{o}C, 60 rpm) (Batcheller 2003). These viscosity values are consistent with measurements of samples from other tanks (Poloski 2001):

WM-180	2.2 cP
WM-181	1.8 cP
WM-182	1.3 cP
WM-186	1.8 cP.

Solids in samples from the above tanks were allowed to settle prior to withdrawing a portion of the liquid for the viscosity measurements. The lower viscosity of WM-182 liquid may be explained by water dilution of the waste prior to sampling.

Batcheller (2003) reports and discusses viscosity data for the WM-189 bottom sample as received. This sample contained about 9 g/liter UDS. At 60 rpm (73.4 sec^{-1} shear rate) the viscosity was 2.6 cP, while at 30 rpm (36.7 sec^{-1} shear rate) the viscosity was 2.1 cP.

Wendt (2004) presents additional data and discussion of the viscosity of tank slurries with different solids fractions.

The thermal conductivity of WM-180 and WM-189 SBW simulants was measured to be 0.547 W/(mK) and 0.525 W/(mK) respectively (Gembarovic 2003). The specific heat for the both simulants was approximately 3.2 W-s/g-K, increasing slightly with temperature (Gembarovic 2003). Gembarovic and Taylor present additional thermal property for SBW simulants as is and neutralized up to a pH of 9-11.

3.7 Organic Species in Liquid Waste

Estimated concentrations for total organics in various tank wastes are shown in Tables 2, 3, 6, 7, 9, 10, and 13-20. This section provides additional information regarding organic species in SBW.

Analysis of samples of Tank WM-189 waste showed 0.092-0.3 mg/liter volatile organic compounds and 0.24-2.0 mg/liter semi-volatile organic compounds (Batcheller 2003). The volatile and semi-volatile compounds amount to only a very small fraction of the TOC in these samples, which was measured to be 513-625 mg/liter. Analysis of a Tank WM-188 sample showed volatile organics present at a concentration of 0.45 mg/liter, semi-volatile organics at a concentration of 0.45 mg/liter, and TOCs at 435 mg/liter (Johnson 2003a).

Other samples of tank wastes have been analyzed for organic compounds.[i] While these samples were from tanks that typically contained reprocessing wastes rather than SBW, the results, in general,

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[i] See Appendix B of the *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, DOE/ID-10802, November, 2001 and SBW analyses reported in *Analysis of the HLW Calcined During the NWCF Campaign H-4*, LMITCO Internal Report, INEEL/INT-98-00931, September 1998.

may be applicable to SBW. This data is summarized in Table 39. The same analyses reported the following compounds undetected: carbon disulfide, 2-butanone, 1,1,1-trichloroethane, carbon tetrachloride, benzene, 4-methyl-2-pentanone, toluene, and phenol.

Table 39. Summary of organic analyses of TFF samples.

Compound	Concentration Range µg/liter	Validation Flag[a]	Tank	Reference
2,4-Dinitrophenol	52-260	J	WM-182	DOE/ID-10802
2-Butanone	9-10	J	WM-182	DOE/ID-10802
Acetone	49-230	E, J	WM-182, WM-183	DOE/ID-10802
Acetone	7-86	J	WM-185, WM-188	INEEL/INT-98-00931
Arochlor-1260	2.5- 2.8	J	WM-183	DOE/ID-10802
Benzene	5-84	J	WM-182	DOE/ID-10802
Bromomethane	98	J	WM-182	DOE/ID-10802
Chloroethane	8	J	WM-182	DOE/ID-10802
Chloromethane	34-530	E, J	WM-182, WM-183	DOE/ID-10802
Ethylbenzene	3-4	J	WM-182	DOE/ID-10802
Xylene (total meta and para)[b]	14	J	WM-182	DOE/ID-10802
N-nitrosodimethylamine	16-31	J	WM-182	DOE/ID-10802
Tributyl phosphate	50	J	WM-182	DOE/ID-10802
Tributyl phosphate	12-58	J, N, B	WM-185, WM-188	INEEL/INT-98-00931
Triphenylester phosphoric acid	61	J, N	WM-188	INEEL/INT-98-00931
Unknown phthalates	1600	J	WM-188	INEEL/INT-98-00931
Unknown semi-volatiles	1100-6500	J, B	WM-185, WM-188	INEEL/INT-98-00931
Organomercury compound	62	J	WM-189	INEEL/INT-98-00931
Pyridine	26-160	E	WM-185, WM-189	INEEL/INT-98-00931
2-Nitropyridine	520	J, N	WM-188	INEEL/INT-98-00931
Dinitrobenzene	30-55	J	WM-185, WM-188	INEEL/INT-98-00931
Chlorinated dinitrobenzene	32	J	WM-188	INEEL/INT-98-00931
Bis (2-ethylhexyl) phthalate	41	J, N	WM-188	INEEL/INT-98-00931
Dibutyl phthalate	200	J, N	WM-189	INEEL/INT-98-00931
Diethyl phthalate	44	J, N	WM-185	INEEL/INT-98-00931
Butylated hydoxytoluene	18	J, N	WM-188	INEEL/INT-98-00931
Diisopropyl ether	36	J, N	WM-185	INEEL/INT-98-00931
Dimethyl sulfone	33	J	WM-185	INEEL/INT-98-00931
Benzylquinoline	500	J	WM-185	INEEL/INT-98-00931

[a] J = estimated; N = tentatively identified; B = compound associated with blank; E = concentration exceeds calibration range.

[b] ortho-xylene was not detected in samples from WM-185 and WM-188

Additional analysis data is available for organic compounds in waste from Tanks WM-189 and WM-185 sampled in 1999 in the NWCF blend and hold cell tanks (Young 2000). Analyses were performed for 68 semivolatile species. No compounds were present at a concentration greater than the detection limit.

Another study evaluated the destruction of 22 different volatile and 21 different semi-volatile organic compounds in simulated SBW (Soelberg 2002). The surrogate waste included nitric acid, aluminum sulfate, calcium chloride, iron sulfate, potassium fluoride, and sodium sulfate. The spiked organic compounds represented a wide range of organic classes and functional groups. Concentrations of the organic species in the simulant were measured at intervals during a 32-day period. Some of the results of this study were as follows:

- Except for chloromethane and bromomethane, levels of all volatile organic compounds (VOCs) decreased over time. The most volatile species rapidly decreased, sometimes to near 0% of the initial spike concentration, even prior to the Day 1 analysis. Lower volatility organic compounds and those with higher water solubility (like acetone, methylisobutylketone, methylene chloride, and carbon disulfide) either decreased more slowly, or showed erratic results. However they nevertheless almost always decreased to 30% or less of the initial spike concentration after 32 days. All VOCs, even those species with slower or erratic depletion rates, would be expected to be highly depleted from the actual SBW that has been held in storage for many years and also exposed to 100°C temperatures during evaporation processes.
- Measured levels of semivolatile organic compounds (SVOCs) decreased more slowly, and in some cases were more erratic, than the VOCs. More reactive SVOCs, like those with double bonds (1,7-octadiene and hexachlorobutadiene) and phenyl groups (cresol, analine, and phenol) were rapidly depleted to a concentration near zero.
- More stable SVOCs like ethers (1,4-dioxane) and water-soluble species like pyridine were depleted more slowly to a relatively stable level, and may not be highly depleted even after long time durations. Levels of some other SVOCs (like nonanoic acid and the nitrophenols) were erratic, and suggest that either (a) in some samples, recovery of these more water-soluble compounds was poor, or (b) these compounds were being formed later in the longer-duration samples.
- The VOC gas chromatography/mass spectrometer scans were evaluated to find any tentatively identified compounds that were not included in the spike compounds and that could have been reaction products of the spiked VOCs. No tentatively identified compounds were detected in appreciable amounts. Even if some reactions of spiked VOCs resulted in reaction products, these products were either (a) volatilized, or (b) too water-soluble to efficiently extract from the aqueous media to be detected.
- Some SVOC tentatively identified compounds were detected in the SVOC scans and suggest that nitration, oxidation, and chlorination reactions occurred in the samples and could occur in the SBW during storage.

As shown in Table 16, oxalic acid, diethanolamine, triethanolamine, and kerosene are part of the decontamination solution used to remove scale from the PEWE evaporator. These compounds or products from the reaction of these compounds with species in SBW are thus likely present in the SBW waste tanks.

Trace amounts of organics may be contained in the tank solids. Analysis of a dried sample of WM-187 solids showed no detectable SVOCs and no detectable polychlorinated biphenyl compounds. Analysis of an undried sample of Tank WM-187 sludge showed a total of less than 1 mg/kg of VOCs. The concentration of 2-butanone in this sample was measured to be 44 μg/kg; concentrations of all other organics detected were flagged as estimated amounts or exceeding the instrument calibration range. These compounds included bromomethane (120 μg/kg), acetone (200 μg/kg), methylene chloride (4.5 μg/kg), 4-methyl-2-pentanone (8 μg/kg), chlorobenzene (3 μg/kg), and 15 unknown compounds.

3.8 NGLW Evaporation & Storage

Tanks WM-100, WM-101, and WM-102 currently contain about 12,000 gallons of waste. Starting in 2005, additional NGLW will be added to these tanks. Based on present projected NGLW generation rates, the three tanks will be filled to their combined maximum capacity of about 55,200 gallons near the end of 2010. If the start of treatment were delayed past 2010, additional storage for NGLW would likely be required. The PEWE bottoms tank, VES-WL-101, has a capacity of 18,400 gallons. The ETS uses the Fluoride Hot Sump Tank in the NWCF, VES-NCC-119, to collect evaporator bottoms. The capacity of this tank is about 5,000 gallons.

The maximum volume of dilute NGLW expected to be generated in any year is 1,084,000 gallons (see Table 12). Concentration of this waste by the PEWE is expected to require about 36 weeks, based on a processing rate of 30,000 gal/week. The ETS has capacity far in excess of what will be required to concentrate NGLW.

4. RECOMMENDATIONS

To reduce uncertainties in the feed compositions to a future SBW treatment facility, the following activities are recommended:

- Review solids analysis methods and procedures and evaluate ways to obtain a tighter material balance when analyzing solids. Based on this evaluation, modify or update procedures for analyzing solids from tank farm tanks.
- Review and evaluate possible ways to obtain more representative solids samples
- Review and evaluate possible ways to more accurately determine the quantity or level of undissolved solids in Tanks WM-187, WM-188 and WM-189.
- After Tank WM-187 is full, sample and analyze waste in this tank. Analyses of both liquid and solids are needed. Potentially, the solids present in the tank could change in composition with the planned addition of concentrated waste to the tank or over time after the tank has been filled. Thus, periodic resampling (every 1-2 years) and analysis of solids in the sample is recommended.
- After Tank WM-188 is full, sample and analyze waste in this tank. Sufficient sample should be obtained to be able to analyze both liquid and solids.
- Resample Tank WM-189 and analyze the solids only using the updated procedure.
- Sample and analyze the NGLW tanks (WM-100, WM-101 and WM-102) annually.

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REV. 3

TFP

INTEC Projects Documents Transmittal

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Date June 30, 2004

Project No. 22681

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2	To:	C.M. Barnes, BBWI	MS 3670		
1		W.L. Bauer, NE-ID	MS 1154		
1		J.B. Bosley, BBWI	MS 3404		
1		J.T. Case, NE-ID	MS 1154		
1		J. Johnson, BBWI	MS 7113		
1		J.P. Law, BBWI	MS 5111		
1		K.A. Lockie, NE-ID	MS 1154		
1		V.C. Maio, BBWI	MS 3670		
1		C.B. Millet, BBWI	MS 3404		
1		J.H. Valentine,BBWI	MS 3404		
1		C.W. Olsen, BBWI	MS 3404		
1		A.L. Olson, BBWI	MS 3670		
1		W.A. Owca, NE-ID	MS 1235	1	To: Project File 1.2.1 & 1.8.6
1		M.C. Swenson, BBWI	MS 3404		
1		M.D. Staiger, BBWI	MS 3404		
1		J. I. Pruitt, BBWI (w/o att.)	MS 3404		

Remarks:

The Following Documents are Enclosed

Drawing or Item Number	Rev	Title Description
INEEL/EXT-2000-01378	4	Feed Composition for the Sodium-Bearing Waste Treatment Process

From C.W. Olsen/lb

Section SBW to WIPP

Charles M Barnes/BMC/CC01/INEEL/US	To	LoAnn W Belnap/LOA/CC01/INEEL/US@INEL
	cc	
06/22/2004 03:06 PM	bcc	
	Fax to	
	Subject	SBW Feed Report Backup Files

LoAnn:

I put all the supporting files (mostly Excel files) for Rev 4 of the SBW Feed Report in the following folder \Idaho Tank Farm Project\SBWT Facility Project\Supporting Information\SBW Feed Report 6-04

Depending on how long this server lasts, it may be beneficial to put these files somewhere else, or on a CD. I will leave that to your judgment.

Charles

TFP

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RECORDS TRANSMITTAL

SBWTF-2002

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APPENDIX C-2

Organic Compounds in INTEC Tank Farm Waste

ICP/EXT-05-00962

Organic Compounds in INTEC Tank Farm Waste

M. C. Swenson

September 2005

Idaho Cleanup Project

The Idaho Cleanup Project is operated for the
U.S. Department of Energy by CH2M • WG Idaho, LLC

ICP/EXT-05-00962

Organic Compounds in INTEC Tank Farm Waste

M. C. Swenson

September 2005

Idaho Cleanup Project

Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE-NE Idaho Operations Office
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ABSTRACT

Approximately 830,000 gallons of liquid, radioactive, sodium-bearing waste (SBW) are currently stored in three 300,000-gallon tanks at the Idaho Nuclear Technology and Engineering Center Tank Farm. Designing and permitting a SBW treatment facility requires characterization of the waste. This report documents the organic content of the current Tank Farm waste. The wastes remaining in the three tanks are the same waste type (SBW), have similar chemical composition, have undergone similar treatment (evaporation), and were derived from the same or similar sources. Wastes from two of the three tanks have been characterized for organics. The measured organic content of the waste is low, less than 1 g/l of total organic carbon and generally no detectable, specific volatile or semi-volatile compounds.

Although the contents of one tank have not been characterized for organics, the organic content of the wastes in all three tanks is similar due to the similarity in the sources and treatment of the wastes. The organic content of the wastes that have been analyzed, along with that of historical wastes, is characteristic of the waste in the tank that has not been analyzed.

SUMMARY

Approximately 830,000 gallons of liquid, radioactive, sodium-bearing waste (SBW) are stored in three 300,000-gallon tanks at the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm. Designing and permitting a SBW treatment facility requires characterization of the waste. This report documents the organic content of the current Tank Farm waste. The waste in tanks VES-WM-188 and VES-WM-189 have been analyzed. The VES-WM-189 waste contains very low concentrations (less than laboratory detectable concentrations of about ten parts per billion) of specific volatile and semi-volatile organic compounds, and less than one gram per liter of total organic carbon. The waste in VES-WM-188 also has very low concentrations of specific volatile organic compounds (generally less than detectable amounts), no detectable polychlorinated biphenyls, and less than one gram per liter of total organic carbon. The semi-volatile organic analysis of the VES-WM-188 waste was not successful. The composition of the waste in VES-WM-187 has changed recently, due to transfers of waste in and out of the tank associated with tank cleaning activities elsewhere in the Tank Farm. Consequently, the waste currently in VES-WM-187 has not been analyzed for organic compounds. The waste in all three tanks is the same type (SBW), came from similar sources, has undergone the same treatment (concentration by evaporation), and has similar chemical content and radioactivity. Waste sample data show the concentrations of organic compounds in the current wastes are similar to those of historical wastes from which the waste is derived. Therefore, the organic content of the waste in VES-WM-187 should be similar to that of the waste in VES-WM-188 and VES-WM-189.

There have been four main potential sources of organic compounds in the Tank Farm waste. They include the uranium extraction and purification processes, the calcination facilities, the analytical laboratories, and equipment decontamination activities. Although some INTEC aqueous wastes had the potential to contain small amounts of organic compounds, the INTEC liquid waste storage and treatment conditions (high nitric acid concentration, concentration of the waste by evaporation, waste agitation, and the use of steam jets and air lifts to transfer waste eliminated most of the volatile and semi-volatile organic compounds from the wastes. Historical analytical data show there have generally been no reproducible detections of specific volatile or semi-volatile organic compounds in the Tank Farm wastes. The few volatile and semi-volatile organic compounds that have been detected were present in very low concentrations, often noted as laboratory contaminants, found in trip blanks, and generally not found in repeated analyses of the same waste. Therefore, their presence in detectable concentrations is suspect. Current and historical analytical data confirm the total organic content of Tank Farm wastes is low (less than 1 gram per liter).

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Organic Compounds in INTEC Tank Farm Waste

1. INTRODUCTION

Spent nuclear fuel was reprocessed between 1953 and 1992 at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly called the Idaho Chemical Processing Plant (ICPP). Fuel reprocessing recovered enriched uranium and valuable nuclear reaction byproducts for the Department of Energy (DOE). Fuel reprocessing also generated radioactive liquid wastes that were stored in the INTEC Tank Farm. Between 1963 and 2000, most of the liquid waste was removed from the Tank Farm and converted into a solid, granular form called calcine. In April 1992, the DOE announced that spent nuclear fuel would no longer be reprocessed and initiated a shutdown of the reprocessing facilities at INTEC. Although fuel reprocessing ceased in 1992, calcination of the Tank Farm waste continued through 2000, when it ended pending a determination on how to treat the remaining waste. During the 40 years of calciner operation, approximately eight million gallons of liquid waste were removed from the Tank Farm and converted into 156,000 cubic feet of calcine (Staiger and Swenson 2005). The calcine is currently stored in six calcined solids storage facilities pending a decision on its final treatment and disposition.

Although the bulk of the liquid waste that was sent to the Tank Farm was removed and calcined, approximately 830,000 gallons of waste remain in three 300,000-gallon tanks. Designing and permitting a treatment facility for the remaining waste requires characterization of the waste. The chemical content and radioactivity of the waste have been documented elsewhere. This report documents the organic content of the waste, based upon historical and recent waste sample analyses, as well as process knowledge.

There have been four primary potential sources of organics to the Tank Farm. They include the raffinates from the uranium extraction and purification processes, waste (primarily off-gas scrubbing solution) from the calcination facilities, analytical laboratory wastes, and spent decontamination solution. This report describes the potential sources of organic compounds in the Tank Farm waste. It provides historical sample data that show the organic compound concentrations in the Tank Farm wastes were small, regardless of the type of waste or potential source of organics. Although some wastes may have contained low concentrations of organics when they were generated, historical sample data show there have generally been no detectable, specific, volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) in the Tank Farm wastes. The liquid waste storage conditions and treatment systems destroyed the bulk of the VOCs and SVOCs that may have originally been in the wastes. The historical analytical data are presented because the current wastes are derived from historical wastes, and current waste compositions can be inferred from historical data when current data are not available. The historical data, current data, and process knowledge provide assurance that the organic content of the current waste is known, even for waste that has not been analyzed for organics.

This report provides recent analytical data to document the organic content of the current Tank Farm wastes. The waste currently in VES-WM-189 (one of the three tanks that store waste) has been characterized for VOCs, SVOCs, and total organic carbon. The waste in VES-WM-188 has been analyzed for VOCs, polychlorinated biphenyls (PCBs), and total organic carbon. The waste currently in VES-WM-187 has not been analyzed for organic compounds. The waste in all three tanks is the same type of waste, has similar chemical composition, and came from the same or similar sources. All three tanks contain concentrate from the evaporation of wastes previously stored in the Tank Farm. Much of that waste was analyzed for organics prior to its evaporation. Both the evaporated concentrate and its predecessor solutions contained similar concentrations of organic compounds. Therefore, although not all of the current wastes have been fully characterized for organics, their organic content is similar to wastes that have been analyzed (each other and historical wastes).

2. SOURCES OF ORGANICS IN TANK FARM WASTE

The INTEC Tank Farm has received and stored radioactive, aqueous wastes since 1953. The Tank Farm received wastes from a variety of sources. Some of the wastes had the potential to contain small amounts of organic compounds. There have been four primary potential sources of organics to the Tank Farm; the uranium extraction and purification processes, the calcination facilities, analytical laboratories, and equipment decontamination activities.

2.1 Organics in Fuel Reprocessing Waste

Reprocessing spent nuclear fuel consisted of dissolving the fuel with acid, recovering enriched uranium from the acidic, dissolver-product solution, and purifying the recovered uranium. The uranium recovery and purification processes included three steps, often called "cycles." The first cycle separated the uranium in the dissolver-product solution from the bulk of the fission products, cladding material, and other components of the spent nuclear fuel. The second and third cycles purified the uranium by separating it from actinides such as plutonium. Each of the uranium recovery and purification cycles used an organic solution to selectively extract the uranium from the aqueous feed stream. Each uranium recovery and purification cycle produced an aqueous waste (raffinate) that was stored in the Tank Farm. First-cycle raffinate was the single largest source of waste to the Tank Farm waste and contained the bulk of the radioactive fission products originally in the fuel. The second and third-cycle raffinates were smaller in volume and contained much less radioactivity than first-cycle raffinate.

The organic extractants used in the uranium recovery and purification processes were potential sources of organic compounds in the Tank Farm waste. Originally, all three fuel-reprocessing cycles used hexone (methyl isobutyl ketone or 4-methyl-2-pentanone) as the organic extractant. INTEC changed the fuel reprocessing chemistry in the late 1950s and began using a solution of tributyl phosphate (TBP) dissolved in kerosene as the first-cycle organic extractant. The second and third-cycle uranium purification processes continued to use hexone as the organic extractant.

Organic contamination of the fuel reprocessing raffinates was possible from the mixing of aqueous and organic solutions during uranium recovery and purification. Hexone, the organic used in the original first-cycle uranium extraction system and in the second and third-cycle uranium purification processes, is slightly soluble in water (about 2 percent or 20 g/l). Therefore, first-cycle raffinate from the 1950s and all of the second and third-cycle raffinates likely contained some hexone when they were initially produced. The kerosene used in the first-cycle extraction process during most of the fuel reprocessing history is "insoluble" in aqueous solutions. However, trace amounts, less than the laboratory detection quantities of a few parts per billion (ppb), may have been in the first-cycle raffinate sent to the Tank Farm after the late 1950s.

Fuel reprocessing no longer occurs at INTEC. The last first-cycle raffinate was generated in the late 1980s. The last second and third-cycle raffinates were generated in the early 1990s. Virtually all of the first-cycle raffinate was removed from the Tank Farm by 1998 and converted into a solid, granular form (calcine). Fuel reprocessing has not been a potential source of organic compounds to the Tank Farm since the early 1990s.

2.2 Organics in Calcination Facility Waste

Some waste from the calcination facilities was a potential source of organics to the Tank Farm. From August 1970 through May 2000, the calcination facilities burned kerosene to generate heat for the

calcination process. The kerosene was atomized with oxygen and sprayed into the fluidized calciner bed where it burned. The heat of combustion vaporized the water from the Tank Farm waste, leaving the dissolved constituents as a solid granular product called calcine. This method of burning kerosene within the fluidized bed of the calciners was called in-bed combustion (IBC).

The majority of the kerosene burned efficiently in the calciners. However, the relatively cool operating temperature range (500-600°C) of the calciners was not high enough for highly efficient combustion of the more stable and difficult to oxidize kerosene components such as aromatic compounds. Consequently, some products of incomplete combustion (PICs) formed. An extensive sampling program found small concentrations of PICs in the calciner off gas during emissions inventory testing (Boardman et. al. 1999, Young et. al. 2000, and Boardman et. al. 2001).

An off-gas quench and scrub system removed some of the PICs from the calciner off gas. Analyses of off-gas scrub solution samples obtained during the emissions testing program in 1999 and 2000 found low concentrations [<1 part per million (ppm)] of a few PICs (Young 2000). The bulk of the scrub solution was recycled into the calciner feed system, and the PICs in the scrub solution were destroyed or volatilized when they were fed to the calciner. However, during process upsets or following a calciner shutdown, some calciner scrub solution was sent to the Tank Farm. That scrub solution was a potential source of organics (PICs) to the Tank Farm.

Calcination of Tank Farm waste ceased in May 2000. The calciner scrub solution, with its low level of PICs, is no longer a potential source of organics to the Tank Farm.

2.3 Organics in Laboratory Waste

The INTEC analytical laboratories have been a potential source of organics to the Tank Farm. The INTEC laboratories use small quantities (gallon, pint, or smaller) of organic reagents in various analytical procedures. The laboratories do not send waste organic solutions to the Tank Farm. However, the laboratory disposes radioactive, aqueous wastes to the Process Equipment Waste (PEW) Evaporator feed collection system. Some of those wastes may be contaminated with organic reagents that are soluble in aqueous solutions. The PEW Evaporator feed system collects dilute, low-activity, aqueous wastes from a variety of sources, concentrates the wastes, and sends the concentrate to the Tank Farm. Thus, organic-contaminated wastes from the analytical laboratories are a potential source of organics to the Tank Farm via the PEW Evaporator.

Although the laboratories continue to operate today, the INTEC Liquid Waste Management System Permit (Volume 14) requires the analytical laboratories to maintain very low discharges of organics to the PEW Evaporator feed collection system. Historical and current Tank Farm waste analyses have included wastes generated by the analytical laboratories. Any contribution of organics by the analytical laboratories to the Tank Farm waste is included in both current and historical waste sample data.

2.4 Organics in Decontamination Waste

Some of the chemicals used to decontaminate process equipment were a potential source of organics to the Tank Farm. Much of the INTEC process equipment required “hands on” maintenance and repair work. Prior to performing such work, the processes were shut down and the equipment was decontaminated to lower the radiation fields and reduce radiation exposure to maintenance personnel. Various methods were used to decontaminate equipment, including flushing the equipment with cleaning solutions to remove radioactive contamination. The primary cleaning/decontamination reagents were water and nitric acid. However, some of the more aggressive decontamination procedures used organic

compounds as cleaning/decontamination solutions (Johnson and Westra 1979). Organic compounds were typically used to complex radionuclides that were present as metal ions and prevent them from adsorbing onto the surface of the equipment.

Most of the acid-resistant metals (stainless steels) used in the INTEC processes had protective metal-oxide surface films that adsorbed radionuclides from waste solutions. In some cases, films or scale formed on the surface of equipment by deposition of species from the solution having low or marginal solubility. Such surface films also adsorbed radionuclides. Sometimes, equipment decontamination required the removal of the protective metal oxide film and scale in order to remove the adsorbed radionuclides. Removal of the surface films was done using corrosive decontamination reagents such as alkaline or acidic permanganate and oxalic acid. Radionuclides that were removed with the surface film were kept in solution (preventing their re-adsorption onto the equipment surfaces) by the addition of anionic organic compounds that formed stable complexes with the cationic radionuclides. The organic compounds most commonly used for such complexing were tartaric acid, citric acid, and ethylenediaminetetraacetic acid (EDTA). The radionuclide/organic complexes were rinsed from the equipment with the spent decontamination solution.

Most of the spent decontamination solution that contained organic chemicals was sent to the PEW Evaporator, where it was combined with other dilute wastes and concentrated. The Evaporator concentrate was sent to the Tank Farm for storage. Thus, decontamination reagents were a potential source of organic compounds in the Tank Farm waste.

3. ORGANIC CONTENT OF TANK FARM WASTES

The organic content of the Tank Farm waste was affected by the waste storage and treatment conditions. Originally segregation of Tank Farm wastes made some wastes more prone to have some organics than other wastes. However, all of the current wastes have been blended and concentrated, thus homogenizing the wastes and eliminating the historical segregation factor. The waste chemistry, especially the nitric acid content of the waste, has also affected the organic content of the waste. Waste treatment and storage conditions, including concentration of the wastes by evaporation, agitation (air sparging), and transferring wastes with steam powered jet pumps also affected the concentrations of organics in the waste.

3.1 Storage of Tank Farm Wastes

Originally, first-cycle raffinate was stored separately from other wastes because of its high fission product content and heat generation rate. First-cycle raffinate had design requirements (such as cooled tanks) that other wastes did not have. First-cycle raffinate had the potential for organic contamination from the hexone (1950s) and TBP/kerosene (1960s through 1980s) that were used in the first-cycle process.

Second and third-cycle raffinates were originally stored with the PEW Evaporator concentrate due to their low fission product activity and heat generation rates. With time, this waste became known by its current name of sodium-bearing waste (SBW). The name came from the relatively high sodium ion concentration (1-2 molar) in the waste. The high sodium concentration came from wastes generated by scrubbers, ion exchangers, and equipment decontamination that used sodium-containing chemicals such as sodium carbonate and sodium hydroxide. Most of the SBW began as dilute waste that was concentrated in the PEW Evaporator. The resulting concentrate was sent to the Tank Farm. The SBW had the potential to contain organics from second and third-cycle raffinates (hexone) and the PEW Evaporator concentrate (laboratory reagents and decontamination chemicals).

Over time, the waste storage philosophy (and plant piping configuration) changed. After the 1950s, most of the second-cycle raffinate was stored with the first-cycle raffinate (instead of the SBW) because it was chemically compatible with first-cycle raffinate and the calcination process. This provided a potential source of hexone to the first-cycle raffinate. The third-cycle raffinate was stored with the PEW Evaporator concentrate until the 1980s, when piping configuration changes allowed it to be stored with the first-cycle raffinate.

By 1998, only SBW remained in the INTEC Tank Farm. From 1990 through 2000 the SBW was calcined, and from 2000 through 2004 the remaining SBW was blended and concentrated by evaporation. This reduced the total waste volume and allowed several tanks to be emptied and removed from service. It also homogenized the inventory of the SBW currently stored in the INTEC Tank Farm.

3.2 Destruction of Organics in Tank Farm Wastes

Although there were potential sources of organics in the Tank Farm wastes, laboratory tests showed most of the VOCs and SVOCs that may have originally been in the wastes were destroyed by the chemistry, treatment, and storage conditions of the waste. Studies and tests by Radian (1995) and Science Applications International Corporation, or SAIC, (2002) evaluated the fate of organic compounds in Tank Farm wastes. The Radian test spiked simulated Tank Farm waste with 21 volatile and 23 semi-volatile target organic compounds. The spiked solutions were sampled and analyzed over a month-long period. The test found the concentrations of both the target VOCs and SVOCs in the simulated waste generally decreased over time. The concentrations of some organics decreased very rapidly, from concentrations of several thousand ppb to less than detectable quantities (typically about 10 ppb) in a few hours to days.

The rate of decrease depended on the reactivity of each individual organic component. A similar study by SAIC also found a decrease in the organic content of organic-spiked solutions over time. Both studies concluded the organics were destroyed, decomposed, or volatilized due to the high nitric acid concentration in the waste and the storage conditions of the waste.

Historically, Tank Farm wastes varied in chemical and radiochemical composition, depending on the process that generated the waste. However, one common factor among the Tank Farm wastes was a high (1-3 molar) nitric acid concentration. This was due to the extensive use of nitric acid in fuel reprocessing, as a decontamination chemical, in the calciner off-gas scrubbing systems, and elsewhere at INTEC. Based on the Radian and SAIC studies, the nitric acid in the waste likely destroyed most of the VOCs and SVOCs that may have originally been in the Tank Farm wastes.

Neither the Radian nor the SAIC study included the effect of evaporation on the amount of organics in the waste. The evaporation process accelerates the destruction and loss of organics. Computer simulations of the behavior of VOCs and SVOCs in the PEW Evaporator showed most of the organics in the dilute feed solution volatilized during the evaporation process and were not in the concentrate sent to the Tank Farm (Schindler 1999). The computer simulations used commercially available software [ASPEN PLUS™ and OLI System Incorporated's ESP (Environmental Simulation Program)] to estimate the concentrations of organics in the PEW Evaporator concentrate. The computer simulations evaluated 17 VOCs and SVOCs that may have entered the PEW Evaporator feed system, based on INTEC process knowledge, chemical usage, waste sample results, etc. The study concluded no more than one percent of any of the organic compounds evaluated were retained in the Evaporator concentrate. For most organic species, the amount retained in the Evaporator concentrate was several orders of magnitude less than one percent of the amount in the feed solution. The amount retained in the concentrate depended on the solubility and volatility of each compound. Therefore, although some of the dilute wastes sent to the PEW Evaporator may have contained VOCs or SVOCs, virtually none of them were retained in the concentrate that was sent to the Tank Farm.

Historically, evaporators concentrated most of the SBW before it was sent to the Tank Farm. Evaporators in the fuel reprocessing facility concentrated the second and third-cycle raffinates, and the PEW Evaporator concentrated most of the rest of the SBW. In addition, the Evaporator Tank System (ETS), also known as the high-level liquid waste (HLLW) evaporator, recently concentrated the SBW remaining in the Tank Farm.

As a result of the liquid waste treatment, chemistry, and storage conditions, the Tank Farm waste contains very low concentrations (typically less than laboratory detection values) of VOCs and SVOCs.

3.3 Organic Compound Data for Historical Tank Farm Wastes

Hundreds of samples of Tank Farm waste have been analyzed over the 50-year history of the Tank Farm. The bulk of the samples were analyzed for chemicals and radionuclides necessary for the operation of the Tank Farm, calciners, and other waste treatment processes. The analyses included the principal waste components (such as aluminum (Al), zirconium (Zr), and fluoride), constituents such as chloride that were significant to operational concerns such as corrosion, and radionuclides such as cesium (Cs-137) and strontium (Sr-90) that were important to radiation shielding and dose calculations. However, prior to 1990, there were few, if any, detailed analyses for organic compounds in the Tank Farm waste. The concentration of organics had been presumed to be low by process knowledge.

Beginning in 1990, Tank Farm waste samples were analyzed to characterize the waste in compliance with the Resource Conservation and Recovery Act (RCRA). The RCRA waste characterization included organic analyses. The Tank Farm wastes sampled since 1990 have included the various types of wastes

that have been generated and stored throughout the history of the Tank Farm. The sampled wastes include first-cycle (Al and Zr) raffinates, second and third-cycle raffinates, SBW, and mixed wastes (blends of SBW, calciner scrub and decontamination solution, fuel reprocessing raffinates, etc.). The organic analyses have included VOCs, SVOCs, PCBs, and total organic carbon.

Historical Tank Farm waste samples have generally contained no (detectable) specific, target VOCs or SVOCs, regardless of the type or source of the waste. The total concentration of specific and tentatively identified VOCs and SVOCs has typically been less than one part per million. The total organic carbon has typically been less than one gram per liter.

Organic compound data for historical Tank Farm wastes are presented in this report because they help validate the data from the recent samples of the current SBW. The current wastes were derived from historical wastes (by blending and concentrating) and therefore should have similar organic content. The current SBW, like that of historical waste, has virtually no specific VOCs or SVOCs and a low (less than 1 g/L) concentration of total organic carbon. The similarity in the organic content of the current and historical wastes provides assurance that the organic data for the current wastes are reliable. The historical data also help provide assurance that the organic content of the waste in VES-WM-187, which is derived from historical wastes but has not been characterized for organics, is similar to that of both historical and current wastes.

The historical organic compound data in this report differ from that in some reports (Abbott et. al. 1999). Such reports used conservative, bounding values for the organic content of Tank Farm wastes, estimated from INTEC chemical receipts, for risk assessments or worst-case dose calculations. Such estimates did not take into consideration any destruction or removal of the organics by acids, evaporation, waste agitation, etc. Such documents acknowledge the organic concentration data from waste sample analyses are much lower for species for which both estimates and analytical data are available.

3.3.1 Volatile Organic Compounds in Historical Tank Farm Wastes

Table 1 includes data from some of the earliest (1990) analyses for VOCs. Table 2 includes later (1993) VOC data. In general, the number of specific analytes increased with time. Thus, the 1990 sample analyses have fewer analytes than subsequent analyses. The sample data in Tables 1 and 2 show historical Tank Farm wastes, with one exception, did not contain repeatable, detectable amounts of specific VOCs. Most of the analytes had concentrations below the laboratory detection limits (about 10 ppb). Small concentrations of VOCs were detected in a few of the waste samples. However, the detected analytes were present in very small concentrations, found in trip blanks and thus noted by the laboratory as likely lab contaminants (such as acetone), and not found in repeated analyses of the same waste.

Hexone (4-methyl 2-butanone) was the exception to the generalization that VOCs were not regularly detected in the Tank Farm wastes. Table 2 shows three waste samples from VES-WM-100 taken in 1993 consistently had detectable levels of hexone. The concentration of hexone was small, from 0.15 to 0.41 ppm, but above the detection level of 0.010 ppm. At the time, VES-WM-100 contained one-year-old second and third-cycle raffinates. The second and third-cycle uranium purification system used hexone as an organic extractant. Hexone is slightly soluble in water, so its presence in the waste was not unexpected.

Table 1. Volatile organic compound data from representative 1990 Tank Farm waste samples.

Waste Tank		WM-182	WM-185	WM-188	WM-188
Sample Log Number		90-10218	90-09042	90-09149	90-09157
Waste Description		First-Cycle Al Raffinate with Large Fraction (30%) Second/Third-Cycle Raffinates	SBW (PEW Evaporator Concentrate and Small Amounts of First, Second, and Third-Cycle Raffinates)	First-Cycle Zr Raffinate	First-Cycle Zr Raffinate
Volatile Organic Compound	**CAS Number**	**microgram/kg (ppb)**	**microgram/kg (ppb)**	**microgram/kg (ppb)**	**microgram/kg (ppb)**
1,1,1-Trichloroethane	71-55-6	<1.64	<1.6	<1.76	<1.74
Acetone	67-64-1	43[1]	<20.4	<26.4	<26.1
Benzene	71-43-2	9.4[1]	<9.38	<10.3	<10.2
Carbon Tetrachloride	56-23-5	<1.64	<1.6	<1.76	<1.74
Chloroform	67-66-3	<2.46	<2.4	<2,64	<1.74
Hexone	108-10-1	<7.37	<7.2	<7.93	<7.82
Methylene Chloride	75-09-2	<6.23	<60.8	<66.9	<66.1
Tetrachloroethylene	127-18-4	<0.82	<0.8	<0.88	<0.87
Trichloroethylene	79-01-6	<1.64	<1.6	<1.76	<1.74
Toluene	108-88-3	<7.9	<7.4	<8.17	<8.06

Note 1. Acetone and benzene were noted as being possible laboratory contaminants for this sample.

The 1993 VES-WM-100 waste was included in Table 2 as a "worst-case" sample in terms of VOCs in Tank Farm wastes. Generally, second and third-cycle raffinates were concentrated in an evaporator, which would have driven off the hexone, prior to being sent to the Tank Farm. The second and third-cycle raffinates in the 1993 VES-WM-100 waste had not been concentrated in an evaporator, resulting in higher than normal hexone concentrations. Although hexone was detected (0.15 to 0.41 ppm) in the VES-WM-100 waste, it was much lower than the amount that likely existed (20,000 ppm or 2%) when the waste was initially generated. This shows the bulk of the hexone had been destroyed or removed, even without evaporation, by the waste storage conditions (nitric acid, air sparging, etc.). The waste in VES-WM-100 was calcined in 1993 and is not part of the SBW currently in the Tank Farm.

The 1993 VES-WM-100 data in Table 2 is for "pure" second and third cycle wastes that had not been evaporated or blended with any other waste. Second and third-cycle wastes were generated in relatively small quantities and were usually blended with other wastes (SBW or first-cycle raffinate) for storage. Typically, Tank Farm wastes contained small fractions of second and third-cycle wastes (less than 10% each) that had been concentrated in an evaporator prior to storage in the Tank Farm. The existing SBW contains a total of about 6% second and third-cycle (combined) raffinate (Loos 2004). Historically, SBW has typically had no detectable hexone, as shown by the sample data on Tables 1 and 2.

Tables 1 and 2 include sample data for waste from tank VES-WM-182. At the time (1990 and 1993), VES-WM-182 contained first-cycle Al raffinate with a higher-than-normal fraction (30% combined) of second and third-cycle raffinates (Loos 2004). Despite its high fraction of second and third-cycle raffinates, the VES-WM-182 waste contained no detectable hexone (<0.010 ppm) in either the 1990 or 1993 sample analyses. The VES-WM-182 waste was typical of historical Tank Farm waste and the current SBW in which the second and third-cycle wastes had been evaporated and blended with other wastes.

Table 2. Volatile organic compound data from representative 1993 Tank Farm waste samples.

Waste Tank		WM-100	WM-180	WM-181	WM-182	WM-185	WM-188	WM-189
Sample Log Number(s)		93-082013, -08216, and - 08223	93-020710, -02089, and -021310	93-021411, -02205, and -022314	93-03234 and -050726	93-102912	93-09136	93-092315 and -092413
Waste Description		Second and Third-Cycle Raffinate	SBW (PEW Evaporator Concentrate and Second/Third - Cycle Raffinates)	SBW (PEW Evaporator Concentrate and Second/Third-Cycle Raffinates)	First-Cycle Al Raffinate with Large Fraction (30%) of Second/Third -Cycle Raffinate	SBW with Small Fraction of First-Cycle Raffinate	First-Cycle Zr (Fluorinel) Raffinate	Mixture: Primarily NWCF Scrub and Decon Solution
Volatile Organic Compound	**CAS Number**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**
1,1,1-Trichloroethane	71-55-6	<50	<10	<10	<10	<10	<50	<25
1,1,2,2-Tetrachloroethane	79-34-5	<50	<10	<10	<10	<10	<50	<25
1,1,2-Trichloroethane	79-00-5	<50	<10	<10	<10	<10	<50	<25
1,1-Dichloroethane	75-34-3	<50	<10	<10	<10	<10	<50	<25
1,1-Dichloroethene	75-35-4	<50	NA	NA	NA	<10	<50	<25
1,2-Dichloroethane	107-06-2	<50	<10	<10	<10	<10	<50	<25
1,2-Dichloropropane	78-87-5	<50	<10	<10	<10	<10	<50	<25
2-Butanone (methy ethyl ketone)	78-93-3	<50 to 54	NA	NA	NA	<10	<50	<25
2-Hexanone	591-78-6	<50	1-2[1]	5 to 35[1]	<10	<10	<50	<25
4-Methyl-2-pentanone (methyl isobutyl ketone or hexone)	108-10-1	150 to 410	1[2] and <10	2 to 4[2] and <10	<10	<10	<50	<25
Acetone	67-64-1	1000 to 1700[3]	NA	NA	Note 4	<10	68[6]	150 to 720[3]
Benzene	71-43-2	<50	<10	<10	<10	<10	<50	<25
Bromodichloromethane	75-27-4	<50	<10	<10	<10	<10	<50	<25
Bromoform	75-25-2	<50	<10	<10	<10	<10	<50	<25
Bromomethane	74-83-9	<50	NA	NA	NA	<10	170[6]	41 to 170[5]
Carbon disulfide	75-15-0	<50	NA	NA	NA	<10	<50	<25
Carbon tetrachloride	56-23-5	<50	<10	<10	<10	<10	<50	<25
Chlorobenzene	108-90-7	NA	NA	NA	NA	<10	<50	<25
Chloroform	67-66-3	<50	<10	<10	<10	<10	<50	<25
See notes at end of table on next page.								

Table 2. Volatile organic compound data from representative 1993 Tank Farm waste samples. (Continued)

Waste Tank		**WM-100**	**WM-180**	**WM-181**	**WM-182**	**WM-185**	**WM-188**	**WM-189**
Waste Storage Tank and Sample Log Number		Logs 93-082013, 08216, and 08223	Logs 93-020710, 02089, and 021310	Logs 93-021411, 02205, and 022314	Logs 93-03234 and 050726	Log 93-102912	Log 93-09136	Logs 93-092315 and 092413
Waste Description		Second and Third Cycle Raffinate	SBW (PEW Evaporator Concentrate and Second/Third-Cycle Raffinates)	SBW (PEW Evaporator Concentrate and Second/Third-Cycle Raffinates)	First-Cycle Al Raffinate with Large Fraction (30%) of Second/Third-Cycle Raffinate	SBW (PEW Evaporator Concentrate and Second/Third-Cycle Raffinates)	First-Cycle Zr Raffinate	Mixture: Primarily NWCF (Scrub and Decon Solution)
Volatile Organic Compound	**CAS Number**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**	**microgram/L**
Chloromethane	74-87-3	<50	NA	NA	NA	<10	300[6]	<25
cis-1,2-Dichloroethene	156-59-2	<50	<10	<10	<10	<10	<50	<25
cis-1,3-Dichloropropene	10061-01-5	<50	<10	<10	<10	<10	<50	<25
Dibromochloromethane	124-48-1	<50	<10	<10	<10	<10	<50	<25
Ethylbenzene	100-41-4	<50	<10	<10	<10	<10	<50	<25
Methylene Chloride	75-09-2	<50	<10	<10	<10	<10	62	<25
o-Xylene	95-47-6	<50	<10	<10	<10	<10	<50	<25
Styrene	100-42-5	<50	<10	<10	<10	<10	<50	<25
Tetrachloroethene	127-18-4	<50	<10	<10	<10	<10	<50	<25
Toluene	108-88-3	<50	<10	<10	<10	<10	<50	<25
trans-1,2-Dichloroethene	156-60-5	<50	<10	<10	<10	<10	<50	<25
trans-1,3-Dichloropropene	10061-02-6	<50	<10	<10	<10	<10	<50	<25
Trichloroethene	79-01-6	<50	<10	<10	<10	<10	<50	<25
Vinyl Chloride	75-01-4	<50	NA	NA	NA	<10	<50	<25
Xylene, Isomers m and p	1330-20-7	<50	<10	<10	<10	<10	<50	<25

Note 1. 2-Hexanone was estimated at less than the minimum qualification level (MQL). Found in VES-WM-181 trip blank and was likely a lab contaminant.

Note 2. Hexone was estimated at less than the minimum qualification level (MQL). Hexone was noted by the lab as a possible lab contaminant.

Note 3. Acetone was a possible lab contaminant as it was also in trip or system blank.

Note 4. Acetone was a tentatively identified compound but not estimated. It was identified as a possible lab contaminant.

Note 5. Bromomethane was detected in both the trip and system blanks. It was a possible laboratory contaminant.

Note 6. Though not specified for the VES-WM-188 sample, acetone, bromomethane, and chloromethane were common lab contaminants found in trip or system blanks of other samples (i.e. VES-WM-189 sample)

NA = Not Analyzed

Table 2 and other tables in this report often include data from multiple samples from a given tank of waste. This is evident by the information in the "Sample Log Number" line which often lists multiple log numbers (corresponding to multiple samples) for a given tank of waste. For the purpose of brevity, data from multiple samples from a given waste are typically included in a single column under the tank number. Usually, specific analytes were not detected in the waste samples, and the laboratory detection value is given in the data tables. In the few cases where multiple samples contained varying detected concentrations of a given analyte, the data tables show the lowest and highest detected value from among the multiple samples of the waste.

3.3.2 Semi-volatile Organic Compounds in Historical Tank Farm Waste

Table 3 shows the results of eight SVOC sample analyses of four wastes in the mid to late 1990s. Table 3 includes two samples of first-cycle Zr raffinate, four samples of SBW, and two samples of mixed wastes (blends of SBW, calciner scrub and decontamination solution, fuel reprocessing raffinates, etc.). Three waste samples came from VES-WM-185; two in 1993 and one in 1999 (the first numbers, 93 and 99, in the sample log number correspond to the year in which the sample was taken). The three VES-WM-185 samples came from the same waste. There were no waste transfers into VES-WM-185 between the two sample dates, thus its waste composition did not change. Three samples came from waste from VES-WM-189; one in 1993, one in 1996, and one in 1999. The 1993 and 1996 VES-WM-189 samples came from virtually the same waste. A small amount of waste was added to VES-WM-189 after the 1993 sample was taken, increasing the waste volume by about 10%. However, the source of the new waste was the same as the original waste, so there should have been no significant change in the waste composition. VES-WM-189 was emptied and refilled between 1996 and 1999. Therefore, the 1999 waste in VES-WM-189 was different than the 1993/1996 waste.

The sample data in Table 3 generally show no (detectable) specific SVOCs in the Tank Farm waste. The laboratory detection values generally varied from 5 to 25 parts per billion (ppb). The number of specific analytes increased with time, so the 1999 and 1996 analyte list is more extensive than that of 1993. Some nitrated aromatics (2-nitophenyl and 2-4-dintirophenyl) were found at low concentrations (<0.10 ppm) in some of the 1993 samples. Nitrated aromatics are possible PICs from the combustion of kerosene in the calciner. Small concentrations (less than 1 ppm) of PICs were detected in the calciner off-gas scrub solution during calciner emissions testing (Boardman et. al. 2001). The 1993 VES-WM-189 waste included a large amount of calciner decontamination and scrub solution that could have contained PICs from the calcination process. However, the nitrated aromatics were found only in the 1993 analysis, not in the subsequent (1996) analysis of the same waste. The reason for this anomaly is not certain. The 1993 analyses may have been inaccurate or the organics may have been destroyed in storage. In any event, the detected concentrations of the nitrated organics in 1993 were low.

The concentrations of specific SVOCs in historical Tank Farm wastes were generally below the laboratory detection limits (5 to 25 ppb). In the few instances when specific SVOCs were detected, the amounts were small (<0.1 ppm) and were not found in repeated analyses of the same or similar wastes.

Table 3. Semi-volatile organic compound data of representative historical Tank Farm wastes.

Waste Tank		WM-189		WM-188	WM-185		WM-189
Waste Description		Mixed Wastes--Primarily NWCF Scrub and Decon Solution derived from first-cycle raffinate		First Cycle Zr (Fluorinel) Raffinate	SBW –With Small Amount of First-Cycle Raffinate		SBW--With NWCF Scrub/Decon Solution and ETS Concentrate
Sample Log Number		93-092411	96-06111	93-07174, 93-07175	93-072115 93-07222	99-05241	99- 03111
Semi-Volatile Organic Compound	CAS Number	Concentration (ppb)		Concentration (ppb)	Concentration (ppb)		Concentration (ppb)
1,2,4-Trichlorobenzene	120-82-1	<10	<6.9	<10	10[1]	<25	<25
1,2-Dichlorobenzene	95-50-1	<10	<7.3	<10	<10	<25	<25
1,3-Dichlorobenzene	541-73-1	<10	<6.1	<10	<10	<25	<25
1,4-Dichlorobenzene	106-46-7	<10	<1.8	<10	10[1]	<25	<25
2,2'-Oxybis(1-chloropropane)	108-60-1	<10	<6.1	<10	<10	<25	<25
2,4,5-Trichlorophenol	95-95-4	<10	<17.4	<10	<10	<25	<25
2,4,6-Trichlorophenol	88-06-2	<10	<10.1	<10	<10	<25	<25
2,4-Dichlorophenol	120-83-2	<10	<7.6	<10	<10	<25	<25
2,4-Dimethylphenol	105-67-9	<10	<16.6	<10	<10	<25	<25
2,4-Dinitrophenol	51-28-5	81.14	<26.6	10[1]	10[1]	<25	<25
2,6-Dinitrotoluene	606-20-2	<10	<7.9	10[1]	<10	<25	<25
2-Chloronapthalene	91-58-7	<10	<10.4	<10	<10	<25	<25
2-Chlorophenol	95-57-8	<10	<5.6	<10	<10	<25	<25
2-Methylnaphthalene	91-57-6	<10	<7.0	<10	<10	<25	<25
2-Methylphenol	95-48-7	<10	<5.0	<10	<10	<25	<25
2-Nitroaniline	88-74-4	10[1]	<6.3	<10	<10	<25	<25
2-Nitrophenol	88-75-5	89.47	<7.3	35.32	19.55	<25	<25
3-Nitroaniline	99-09-2	<10	<6.3	<10	10[1]	<25	<25
4-Chloro-3-methylphenol	59-50-7	<10	<7.6	<10	<10	<25	<25
4-Chloroaniline	106-47-8	<10	<26.9	10[1]	<10	<25	<25
4-Methylphenol	106-44-5	10[1]	<5.4	10[1]	<10	<25	<25
Acenaphthene	83-82-9	<10	<5.6	<10	38.64	<25	<25
Acenaphthylene	208-96-8	<10	<6.9	<10	<10	<25	<25
Bis(2-chloroethoxy)methane	111-91-1	<10	<7.7	<10	<10	<25	<25
Bis(2-Chloroethyl)ether	111-44-4	<10	<6.9	<10	<10	<25	<25
Dimethylphthalate	131-11-3	<10	<6.9	<10	<10	<25	<25
Hexachlorobutadiene	87-68-3	<10	<9.8	<10	<10	<25	<25
Hexachlorocyclopentadiene	77-47-4	<10	<13.0	<10	<10	<25	<25
Hexachloroethane	67-72-1	<10	<8.5	<10	<10	<25	<25
Isophorone	78-59-1	<10	<7.2	<10	<10	<25	<25
Naphthalene	91-20-3	<10	<7.7	<10	10[1]	<25	<25
Nitrobenzene	98-95-3	<10	<8.7	<10	<10	<25	<25
N-Nitroso-dimethylamine	62-75-9	<10	<10.7	<10	<10	<25	<25
N-Nitroso-di-n-propylamine	621-64-7	<10	<13.1	<10	<10	<25	<25
Phenol	108-95-2	<10	<5.7	<10	<10	<25	<25

Note 1. Estimated value (below minimum quantification level).
NA = Not Analyzed

Table 3. Semi-volatile organic compound data of representative historical Tank Farm wastes. (continued)

Waste Tank		WM-189		WM-188	WM-185		WM-189
Waste Description		Mixed Wastes--Primarily NWCF Scrub and Decon Solution		First-Cycle Zr (Fluorinel) Raffinate	SBW –With Small Amount of First-Cycle Raffinate		SBW--With NWCF Scrub/Decon Solution and ETS Concentrate
Sample Log Number		93-092411	96-06111	93-07174, 93-07175	93-72115 93-07222	99-05241	99-03111
Semi-Volatile Organic Compound	CAS Number	Concentration (ppb)		Concentration (ppb)	Concentration (ppb)		Concentration (ppb)
2,4-Dinitrotoluene	121-14-2	NA	<9.8	NA	NA	<25	<25
3,3'-Dichlorobenzidine	91-94-1	NA	<66.3	NA	NA	<25	<25
4,6-Dinitro-2-methylphenol	534-52-1	NA	<5	NA	NA	<25	<25
4-Bromophenyl-phenylether	101-55-3	NA	<6.7	NA	NA	<25	<25
4-Chlorophenyl-phenylether	7005-72-3	NA	<7.3	NA	NA	<25	<25
4-Nitroaniline	100-01-6	NA	<4.2	NA	NA	<25	<25
4-Nitrophenol	100-02-7	NA	<18.6	NA	NA	<25	<25
Anthracene	120-12-7	NA	<5.2	NA	NA	<25	<25
Azobenzene	103-33-3	NA	<10	NA	NA	<25	<25
Benzo(a)anthracene	56-55-3	NA	<7.8	NA	NA	<25	<25
Benzo(a)pyrene	50-32-8	NA	<1.3	NA	NA	<25	<500
Benzo(b)fluoranthene	205-99-2	NA	<7.3	NA	NA	<25	<500
Benzo(g,h,i)perylene	191-24-2	NA	<3.2	NA	NA	<25	<500
Benzo(k)fluoranthene	207-08-9	NA	<5.7	NA	NA	<25	<500
bis(2-Ethylhexyl)phthalate	117-81-7	NA	<7.9	NA	NA	<25	<25
Butylbenzylphthalate	85-68-7	NA	<8.2	NA	NA	<25	<25
Carbazole	86-74-8	NA	<10	NA	NA	<25	<25
Chrysene	218-01-9	NA	<8.3	NA	NA	<25	<25
Dibenzo(a,h)anthracene	53-70-3	NA	<4.8	NA	NA	<25	<500
Dibenzofuran	132-64-9	NA	<4.1	NA	NA	<25	<25
Diethylphthalate	84-66-2	NA	<8.5	NA	NA	<25	<25
Di-n-butylphthalate	84-74-2	NA	<2.6	NA	NA	<25	<25
Di-n-octylphthalate	117-84-0	NA	<2.9	NA	NA	<25	<500
Fluoranthene	206-44-0	NA	<8.2	NA	NA	<25	<25
Fluorene	86-73-7	NA	<4.6	NA	NA	<25	<25
Hexachlorobenzene	118-74-1	NA	<7	NA	NA	<25	<25
Indeno(1,2,3-cd)pyrene	193-39-5	NA	<35.5	NA	NA	<25	<500
N-Nitrosodiphenylamine	86-30-6	NA	<10	NA	NA	<25	<25
Pentachlorophenol	87-86-5	NA	<13.3	NA	NA	<25	<25
Phenanthrene	85-01-8	NA	<6.5	NA	NA	<25	<25
Pyrene	129-00-0	NA	<11.7	NA	NA	<25	<25
Pyridine	110-86-1	NA	<10	NA	NA	<25	<25
Tri-n-butyl phosphate	126-73-8	NA	<10	NA	NA	<25	<25

Note 1. Estimated value (below minimum quantification level).
NA = Not Analyzed

3.3.3 Total Organic Carbon in Historical Tank Farm Waste

Several historical Tank Farm wastes were analyzed for total organic carbon (TOC). This analysis determines the total concentration of organic carbon from VOCs, SVOCs, and other organic molecules whose volatility is too low to be classified as either a VOC or SVOC. The TOC analysis would include residues from decontamination chemicals that would not be found with a VOC or SVOC analysis. Table 4 shows typical TOC data for wastes that were primarily SBW and typical of the waste from which the current SBW is derived. Table 4 shows the TOC concentration of multiple analyses of the same waste (VES-WM-189) varied significantly (factor of 4). However, despite the variability, the SBW in the various tanks all had similar TOC concentrations of less than 1 g/l (ranging from 0.1 to 0.6 g/l).

Table 4. Total organic carbon in typical historical Tank Farm wastes.

Waste Tank	WM-189				WM-183	WM-185	WM-189	
Waste Description	Mixed Wastes--Primarily First-Cycle Raffinate and NWCF Scrub/Decon Solution				SBW –With Small Amount of First-Cycle Raffinate	SBW –With Small Amount of First-Cycle Raffinate	SBW--With NWCF Scrub/Decon Solution and ETS Concentrate	
Sample Log Number	96-060311	96-06111	96-080510	96-08283	96-080715	99-05241	99-03111	00-3231
Total Organic Carbon (g/l)	0.466	0.642	0.146	0.128	0.175	0.232	0.204	0.123

3.4 Organic Compounds in Existing Tank Farm Waste

Concentrated SBW is currently stored in three tanks, VES-WM-187, VES-WM-188 and VES-WM-189. The waste in VES-WM-189 has been analyzed for VOCs, SVOCs, and TOC. The waste in VES-WM-188 has been analyzed for VOCs, SVOCs, PCBs, and TOC. It was also analyzed for SVOCs, but the analysis was not successful. The waste in VES-WM-187 has not been analyzed for organics.

3.4.1 Organic Compound Data for Current VES-WM-189 Waste

The waste in VES-WM-189 was sampled in March 2002 and analyzed for organic compounds (sample log numbers 02-03111, 02-03121, and 02-03141). The tank contained 282,000 gallons of waste when it was sampled. After VES-WM-189 was sampled, it received 2,700 gallons of waste in 2004, and "lost" 2,700 gallons due to instrument calibrations, for a net change of zero gallons. The current (August 2005) waste volume in VES-WM-189 is 282,000 gallons. The 2,700 gallons of waste that were added to the tank after it had been sampled were concentrated SBW from the ETS and PEW Evaporator. The new waste came from sources similar to the SBW already in VES-WM-189 when it was sampled. Because the new waste came from sources similar to the sampled waste and is only 1% of the total waste volume, the March 2002 liquid waste sample is representative of the waste currently in VES-WM-189.

Tables 5 and 6 summarize the results of the VOC and SVOC analyses respectively of the VES-WM-189 waste. The tables include both specific analytes and tentatively identified compounds (TICs). The concentrations of most of the analytes are below the laboratory detection value. The few detected analytes have shaded backgrounds to facilitate finding them in the tables. The concentrations of most detected analytes also include one or more letters that are laboratory qualifier flags (LQFs). The LQFs provide information about the detected analyte, such as whether the analyte was detected in a sample blank, was an estimated value, etc. The LQF definitions are provided at the ends of the tables.

Table 5. Volatile organic compounds in the SBW currently stored in VES-WM-189.

Volatile Organic Compound	CAS Number	Sample Log Numbers and Analyte Concentrations (microgram/L)					
		02-03111	02-03111 (repeat)	02-03121	02-03121 (repeat)	02-03141*	02-03141* (repeat)
1,1,1-Trichloroethane	71-55-6	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	79-34-5	<10	<10	<10	<10	<10	<10
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	79-00-5	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	75-34-3	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	75-35-4	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	107-06-2	<10	<10	<10	<10	<10	<10
1,2-Dichloropropane	78-87-5	<10	<10	<10	<10	<10	<10
2-Butanone	78-93-3	<10	<10	<10	<10	<10	<10
2-Hexanone	591-78-6	<10	<10	<10	<10	<10	<10
4-Methyl-2-pentanone	108-10-1	<10	<10	<10	<10	<10	<10
Acetone	67-64-1	33 BY	<10	11 BY	6 JBY	<10	<10
Benzene	71-43-2	<10	<10	<10	<10	<10	<10
Bromodichloromethane	75-27-4	<10	<10	<10	<10	<10	<10
Bromoform	75-25-2	<10	<10	<10	<10	<10	<10
Bromomethane	74-83-9	13 B	<10	32 B	<10	59	<10
Carbon disulfide	75-15-0	<10	<10	<10	<10	<10	<10
Carbon tetrachloride	56-23-5	<10	<10	<10	<10	<10	<10
Chlorobenzene	108-90-7	<10	<10	<10	<10	<10	<10
Chloroethane	75-00-3	<10	<10	<10	<10	<10	<10
Chloroform	67-66-3	<10	<10	<10	<10	<10	<10
Chloromethane	74-87-3	23 M	<10	35 M	<10	75 M	<10
cis-1,2-Dichloroethene	156-59-2	<10	<10	<10	<10	<10	<10
cis-1,3-Dichloropropene	10061-01-5	<10	<10	<10	<10	<10	<10
Dibromochloromethane	124-48-1	<10	<10	<10	<10	<10	<10
Ethylbenzene	100-41-4	<10	<10	<10	<10	<10	<10
Methylene Chloride	75-09-2	<10	<10	<10	<10	<10	<10
o-Xylene	95-47-6	<10	<10	<10	<10	<10	<10
Styrene	100-42-5	<10	<10	<10	<10	<10	<10
Tetrachloroethene	127-18-4	<10	<10	<10	<10	<10	<10

Table 5. Volatile organic compounds in the SBW currently stored in VES-WM-189. (Continued)

Volatile Organic Compound	CAS Number	Sample Log Numbers and Analyte Concentrations (microgram/L)					
		02-03111	02-03111 (repeat)	02-03121	02-03121 (repeat)	02-03141	02-03141 (repeat)
trans-1,2-Dichloroethene	156-60-5	<10	<10	<10	<10	<10	<10
trans-1,3-Dichloropropene	10061-02-6	<10	<10	<10	<10	<10	<10
Trichloroethene	79-01-6	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane	75-69-4	<10	<10	<10	<10	<10	<10
Vinyl Chloride	75-01-4	<10	<10	<10	<10	<10	<10
Xylene, Isomers m and p	1330-20-7	<20	<20	<20	<20	<20	<20
Number of Tentatively Identified VOCs (TICs)		3 TICs		1 TIC		5 TICs	
Total mass of TICs (mg/L)		0.031 mg/L		0.016 mg/L		0.161 mg/L	
*All analytes for sample log 020314-1 have LQF = H							

Laboratory Qualifier Flags (LQFs) definitions:

B = analyte also detected in blank
J = estimated (extrapolated) value
M = quantified from first or higher order regression fit calibration curve with correlation coefficient <0.999
Y = analyte is a solvent used in hot cell for other procedures
H = hold time exceeded

Table 6. Semi-volatile organic compounds in the SBW currently stored in VES-WM-189.

Semi-volatile Organic Compound	CAS Number	Sample Log Number and Analyte Concentrations			
		02-03111 (microgm/L)	02-03111 (repeat) (microgm/L)	02-03121 (microgm/L)	02-03141* (microgm/L)
1,2,4-Trichlorobenzene	120-82-1	<6	<6	<6	<6
1,2-Dichlorobenzene	95-50-1	<5	<5	<5	<8
1,3-Dichlorobenzene	541-73-1	<7	<7	<7	<9
1,4-Dichlorobenzene	106-46-7	<8	<8	<8	<9
2,4,5-Trichlorophenol	95-95-4	<4	<4	<4	<8
2,4,6-Trichlorophenol	88-06-2	<12	<12	<12	<9
2,4-Dichlorophenol	120-83-2	<6	<6	<6	<6
2,4-Dimethylphenol	105-67-9	<3	<3	<3	<10
2,4-Dinitrophenol	51-28-5	<13	<13	<13	<8
2,4-Dinitrotoluene	121-14-2	<8	<8	<8	<8
2,6-Dinitrotoluene	606-20-2	<11	<11	<11	<8
2-Chloronaphthalene	91-58-7	<7	<7	<7	<7
2-Chlorophenol	95-57-8	<8	<8	<8	<8
2-Methylnaphthalene	91-57-6	<9	<9	<9	<7
2-Methylphenol (o-Cresol)	95-48-7	<9	<9	<9	<7
2-Nitroaniline	88-74-4	<9	<9	<9	<8
2-Nitrophenol	88-75-5	<8	<8	<8	<8
3 and 4-methylphenol	106-44-5	<11	<11	<11	<5
3,3'-Dichlorobenzidine	91-94-1	<12	<12	<12	<8
3-Nitroaniline	99-09-2	<16	<16	<16	<4
4,6-Dinitro-2-methylphenol	534-52-1	<13	<13	<13	<7
4-Bromophenyl phenyl ether	101-55-3	<12	<12	<12	<8
4-Chloro-3-methylphenol	59-50-7	<6	<6	<6	<5
4-Chloroaniline	106-47-8	<3	<3	<3	<14
4-Chlorophenyl phenyl ether	7005-72-3	<14	<14	<14	<8
4-Nitroaniline	100-01-6	<10	<10	<10	<5
4-Nitrophenol	100-02-7	<30	<30	<30	<2
Acenaphthylene	208-96-8	<6	<6	<6	<6
Anthracene	120-12-7	<8	<8	<8	<6
Azobenzene	103-33-3	<15	<15	<15	<11
Benzo(a)anthracene	56-55-3	<9	<9	<9	<7
Benzo(a)pyrene	50-32-8	<8	<8	<8	<6
Benzo(b)fluoranthene	205-99-2	<8	<8	<8	<6
Benzo(g,h,i)perylene	191-24-2	<8	<8	<8	<6
Benzo(k)fluoranthene	207-08-9	<8	<8	<8	<7
Benzyl butyl phthalate	85-68-7	<9	<9	<9	<10
bis-(2-chloroethoxy)methane	111-91-1	<6	<6	<6	<5
bis-(2-Chloroethyl)ether	111-44-4	<7	<7	<7	<11
bis(2-Chloroisopropyl)ether	108-60-1	<5	<5	<5	<6
bis-(2-ethylhexyl)phthalate	117-81-7	46 M	31 M	<9	25
Carbazole	86-74-8	<6	<6	<6	<6

Table 6. Semi-volatile organic compounds in the SBW currently stored in VES-WM-189. (continued)

Semi-volatile Organic Compound	Semi-volatile Organic Compound	Sample Log Number and Analyte Concentrations			
		020311-1 (microgm/L)	020311-1 (repeat) (microgm/L)	020312-1 (microgm/L)	020314-1 (microgm/L)
Chrysene	218-01-9	<7	<7	<7	<11
Dibenzo(a,h)anthracene	53-70-3	<8	<8	<8	<6
Dibenzofuran	132-64-9	<11	<11	<11	12 J
Diethyl Phthalate	84-66-2	<12	<12	<12	<11
Dimethyl phthalate	131-11-3	<9	<9	<9	<8
Di-n-butyl phthalate	84-74-2	<12	<12	<12	<14
Di-n-octyl phthalate	117-84-0	20	16 J	<6	<7
Fluoranthene	206-44-0	<11	<11	<11	<5
Fluorene	86-73-7	<10	<10	<10	<5
Hexachlorobenzene	118-74-1	<39	<39	<39	<5
Hexachlorobutadiene	87-68-3	<40	<40	<40	<7
Hexachlorocyclopentadiene	77-47-4	<30	<30	<30	<7
Hexachloroethane	67-72-1	<5	<5	<5	<8
Indeno(1,2,3-cd)pyrene	193-39-5	<9	<9	<9	<6
Isophorone	78-59-1	<6	<6	<6	82
Naphthalene	91-20-3	<7	<7	<7	<5
Nitrobenzene	98-95-3	<7	<7	<7	<11
n-Nitrosodimethylamine	62-75-9	<24	<24	<24	<8
n-Nitrosodi-n-propylamine	621-64-7	<9	<9	<9	<8
n-Nitrosodiphenylamine	86-30-6	<7	<7	<7	<9
Pentachlorophenol	87-86-5	<19	<19	<19	<11
Phenanthrene	85-01-8	<6	<6	<6	<6
Phenol	108-95-2	<18	<18	<18	<3
Pyrene	129-00-0	<6	<6	<6	<6
Pyridine	110-86-1	<15	<15	<15	<9
tri-n-butyl phosphate	126-73-8	11 BJM	11 BJM	11 BJM	44
Number of Tentatively Identified SVOCs (TICs)		20 TICs	19 TICs	6 TICs	20 TICs
Total mass of TICs (mg/L)		1.1 mg/L	0.741 mg/L	0.226 mg/L	1.8 mg/L
*All analytes for sample log 020314-1 have LQF = H					

Laboratory Qualifier Flags (LQFs) definitions:

B = analyte also detected in blank

J = estimated (extrapolated) value

M = quantified from first or higher order regression fit calibration curve with a correlation coefficient of <0.999

H = hold time exceeded

Tables 5 and 6 show most of the VOC and SVOC constituents in VES-WM-189 have concentrations below the laboratory detection level (about 10 ppb). The few detected compounds are present in very low concentrations. The VOC and SVOC data in Tables 5 and 6 are consistent with the historical Tank Farm sample data summarized in sections 3.2.1 and 3.2.2 of this report. Some of the detected compounds may have been laboratory contaminants because they were commonly used laboratory reagents (such as acetone), were not consistently detected in all samples, or were detected in the sample blanks.

The TOC content of the three VES-WM-189 samples ranged from 0.513 to 0.624 g/L. These values are similar to the historical TOC data for SBW shown on Table 4.

3.4.2 Organic Compound Data for Current VES-WM-188 Waste

The waste in VES-WM-188 was sampled in November 2002 (sample log 021125-2) when the tank contained 214,000 gallons of waste. The VES-WM-188 sample was successfully analyzed for VOCs, PCBs, and total organic carbon. The sample was also analyzed for SVOCs. The SVOC analysis found no specific analytes above the laboratory detection values and no TICs. However, due to equipment problems, laboratory personnel reported the SVOC analysis had "no meaningful results".[1] Therefore, the SVOC data are not included in this report.

When it was sampled in November 2002, VES-WM-188 contained 211,000 gallons of SBW. That waste had originally been in VES-WM-181, -184, -185, and -186 and had been concentrated in the ETS. The waste in VES-WM-189 also came from the same tanks and was also concentrated in the ETS. During 2001, the ETS concentrate was added alternately to VES-WM-188 and VES-WM-189 in an effort to equilibrate the waste compositions in the two tanks. Because of this, the wastes in VES-WM-188 and VES-WM-189 are very similar, including their organic content.

After VES-WM-188 was sampled in November 2002, it was filled with additional SBW. Between 2002 and 2004, tanks VES-WM-181, -182, -183, -184, -185 and -186 were cleaned in preparation for RCRA tank closure. The tank heels (residual liquids and solids in the bottom of the tanks) were flushed with demineralized water into VES-WM-187. The liquid that accumulated in VES-WM-187 was concentrated in the ETS, and the concentrate was sent to VES-WM-188. This increased the VES-WM-188 volume to 264,000 gallons by July 2004. The 53,000 gallons of waste came primarily from the same tanks and was concentrated in the same fashion as the 211,000 gallons that were sampled in November 2002. Therefore, the composition of the new (53,000 gallons) of waste was very similar to the waste that had been sampled in November 2002.

In July 2004, the ETS began concentrating the SBW in VES-WM-180. Some of the VES-WM-180 concentrate went into VES-WM-188, bringing its waste volume to its current (August 2005) value of 283,000 gallons. Historical samples of the SBW in VES-WM-180 (Swenson 2004) show its composition was similar to the SBW that had been in VES-WM-181, -184, and -186, which was concentrated and sent to VES-WM-188 and VES-WM-189. The 1993 RCRA characterization of the VES-WM-180 waste (see Table 2) showed it had no (detectable) specific VOCs. Historical analyses of other SBW showed they generally had no (detectable) specific SVOCs (see Table 3). Due to the similarity in waste sources and compositions, the organic content of the 19,000 gallons of concentrate from the evaporation of the VES-WM-180 waste was likely similar to the waste already in VES-WM-188. As a result, the November 2002 sample data is representative of the waste currently in VES-WM-188.

[1] CWI Intranet Memo from J. D. Long to M. C. Swenson, "WM-188 Volatiles Data", dated June 16, 2005.

Table 7 contains the results of the PCB analysis of the VES-WM-188 waste. The concentrations of all the specific PCBs were less than the laboratory detection values. This is consistent with historical Tank Farm sample data. There are less historical Tank Farm data for PCBs than other organic compounds. This is because PCBs were never part of any INTEC process and were known by process knowledge to have not been in the Tank Farm wastes. Consequently, relatively few analyses of Tank Farm waste have been made for PCBs.

Table 7. Polychlorinated biphenyls in the SBW currently stored in VES-WM-188.

Polychlorinated Biphenyl	CAS Number	Log 021125-2 Concentration (milligram/kg or parts per million)
PCB-1016	12674-11-2	< 0.306
PCB-1221	11104-28-2	< 0.202
PCB-1232	11141-16-5	< 0.247
PCB-1242	53469-21-9	< 0.347
PCB-1248	12672-29-6	< 0.258
PCB-1254	11097-69-1	< 0.298
PCB-1260	11096-82-5	< 0.253

Table 8 summarizes the results of the VOC analysis of the VES-WM-188 waste. The data in Table 8 are consistent with the historical Tank Farm waste VOC analyses summarized in section 3.2.1 and with the current VES-WM-189 waste analysis. The concentrations of VOCs in the VES-WM-188 waste are very low. Most of the specific analytes have concentrations below the laboratory detection level (about 10 ppb). Bromomethane was the only specific analyte detected in the VOC analysis, and it had a very low concentration 33 ppb). Though the bromomethane concentration in Table 8 has no laboratory qualifier flags, it has been noted as a laboratory contaminant in the past (see Tables 2 and 4).

The TOC concentration in the VES-WM-188 waste sample was 0.416 g/L. This value is consistent with the historical SBW data shown on Table 4 and with the VES-WM-189 waste analysis.

3.4.3 Organic Compound Data for Current VES-WM-187 Waste

During the past few years, VES-WM-187 has been the collection tank for the wastes and rinse solutions generated by cleaning other tanks in the INTEC Tank Farm. As such, it has been periodically filled with dilute tank cleaning/flush solution, and then emptied when the dilute waste was concentrated in the ETS. The bulk of the ETS concentrate generated from tank cleaning/flush solutions is now stored in VES-WM-188 and VES-WM-189. Recent samples of the VES-WM-187 waste have been taken, but the analyses have been limited to those species needed for immediate waste treatment (evaporation) and have not included organic compounds.

Some of the waste currently in VES-WM-187 is derived from tank cleaning/flushing solution, similar to those of VES-WM-188 and VES-WM-189. The portion of the VES-WM-187 waste that came from cleaning/flushing solution should have an organic content similar to the wastes in VES-WM-188 and VES-WM-189, which have been analyzed for organics.

Table 8. Volatile organic compounds in the SBW currently stored in VES-WM-188.

Volatile Organic Compound	CAS Number	Log 021125-2 (microgram/kg)
1,1,1-Trichloroethane	71-55-6	<2
1,1,2,2-Tetrachloroethane	79-34-5	<2
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	<2
1,1,2-Trichloroethane	79-00-5	<2
1,1-Dichloroethane	75-34-3	<2
1,1-Dichloroethene	75-35-4	<2
1,2-Dichloroethane	107-06-2	<2
1,2-Dichloropropane	78-87-5	<2
2-Butanone (methy ethyl ketone)	78-93-3	<4
2-Hexanone	591-78-6	<2
4-Methyl-2-pentanone (methyl isobutyl ketone or hexone)	108-10-1	<2
Acetone	67-64-1	<2
Benzene	71-43-2	<2
Bromodichloromethane	75-27-4	<2
Bromoform	75-25-2	<2
Bromomethane	74-83-9	33
Carbon disulfide	75-15-0	<13
Carbon tetrachloride	56-23-5	<3
Chlorobenzene	108-90-7	<2
Chloroform	67-66-3	<2
Chloromethane	74-87-3	<1
cis-1,2-Dichloroethene	156-59-2	<2
cis-1,3-Dichloropropene	10061-01-5	<2
Dibromochloromethane	124-48-1	<2
Ethylbenzene	100-41-4	<2
Methylene Chloride	75-09-2	<3
o-Xylene	95-47-6	<2
Styrene	100-42-5	<2
Tetrachloroethene	127-18-4	<2
Toluene	108-88-3	<2
trans-1,2-Dichloroethene	156-60-5	<2
trans-1,3-Dichloropropene	10061-02-6	<2
Trichlorofluoromethane	75-69-4	<2
Trichloroethene	79-01-6	<2
Vinyl Chloride	75-01-4	<2
Xylene, Isomers m and p	1330-20-7	<3
Number of Tentatively Identified VOCs (TICs)	NA	1
Total mass of TICs (mg/kg)	NA	0.033

Most (about three fourths) of the waste in VES-WM-187 came from VES-WM-180. During 2004, waste from VES-WM-180 was concentrated in the ETS and most of the concentrate was sent to VES-WM-187. The waste in VES-WM-180 was SBW that came from the same or similar sources as other historical SBW. Historical samples of the SBW in VES-WM-180 (Swenson 2004) show its composition was similar to the SBW that had been in VES-WM-181, -184, and -186 and was concentrated and sent to VES-WM-188 and VES-WM-189. The 1993 RCRA characterization of the VES-WM-180 waste (see Table 2) showed it had no (detectable) specific VOCs. Historical analyses of similar SBW found no (detectable) specific SVOCs (see Table 3).

The consistency of the organic content of recent and historical Tank Farm wastes suggests the organic content of the VES-WM-180 waste was similar to that of other historical SBW that were concentrated in the ETS and whose concentrates are now stored in VES-WM-188 and VES-WM-189. Therefore, due to the similarity of waste sources and compositions, the organic content of the SBW currently stored in VES-WM-187 should be similar to the SBW currently stored in VES-WM-188 and VES-WM-189.

4. CONCLUSION

Some Tank Farm wastes had the potential to contain small amounts of organics when they were initially generated. However, the liquid waste storage and treatment conditions, including high acid content, evaporation, steam jetting, air lifting, and tank agitation destroyed or removed most of the VOCs and SVOCs from the waste.

SBW is currently stored in three 300,000-gallon tanks. The waste in VES-WM-189 has been analyzed for VOCs, SVOCs, and total organic carbon. The waste in VES-WM-188 has been analyzed for VOCs, PCBs, and total organic carbon. The organic compound data from the VES-WM-188 and VES-WM-189 sample analyses are consistent with historical SBW sample data. The wastes in VES-WM-188 and VES-WM-189 generally contain no (detectable) specific VOCs or SVOCs. The few detected VOCs and SVOCs had very low concentrations (less than 0.1 ppm), were rarely detected in repeated analyses of the same waste, and may have been laboratory contaminants. The waste analyses also found no (detectable) PCBs. The total organic carbon concentration in the wastes was also low (less than 1 gram per liter).

The waste currently in VES-WM-187 has not been characterized for organic compounds. However, it is the same general type of waste (SBW) as that stored in VES-WM-188 and VES-WM-189, and came from the same or similar sources. The wastes in all three tanks have had similar storage conditions and waste treatments. The chemistry of all three tanks is similar. Sample analyses have shown the organic content of VES-WM-188 and VES-WM-189 is similar to each other and to historical Tank Farm wastes. Historical data and process knowledge support the conclusion that the organic content of the waste in VES-WM-187 is similar to that of the waste in VES-WM-188 and VES-WM-189.

5. REFERENCES

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APPENDIX C-3

Example of an INL Waste Determination and Disposition Form

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

SECTION I: PROCESS KNOWLEDGE EVALUATION (Completed by the generator with assistance from the Facility Representative)

1. Waste Generation Location: Facility: Building/Room: Area: Generator: Facility Rep.:

2. Process and Waste Description:

3. Were any waste minimization activities a part of this process: ☐ Yes ☐ No (If Yes, provide description or reference.)

4. Generation Status (check all that apply): ☐ INL ☐ ICP ☐ non-CERCLA DD&D/RCRA Closure Activities ☐ CERCLA ☐ VCO ☐ Routine Operations

5. Physical Description (check all that apply): ☐ Solid ☐ Sludge ☐ Organic Liquid ☐ Aqueous Liquid ☐ Aerosol ☐ Multiphase ☐ Gas Cylinder ☐ Stabilized/Solidified

6. Sources used for process evaluation (e.g., MSDS, operational logs, procedures, analyses):

7. Waste composition (e.g., paper, plastic, metal, liquid) and percentages (if known):

8. Additional Items of Concern:

A. Are free liquids present? ☐ Yes ☐ No ☐ Unknown

A1. If free liquids are present, are there multiple layers/phases? ☐ Yes ☐ No ☐ Unknown ☐ NA

A2. If multiple layer/phases are present, identify the number of layers/phases and the percentage of each (e.g., 2 layers [50 vol% liquid and 50 vol% sludge]):

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

A3. If free liquids are present, are the Total Suspended Solids (TSS) <1 wt%? ☐ Yes ☐ No ☐ Unknown ☐ NA

A4. If free liquids, are present, is the Total Organic Carbon (TOC) <1 wt%? ☐ Yes ☐ No ☐ Unknown ☐ NA

B. Is asbestos present? ☐ Yes ☐ No ☐ Unknown

B1. If asbestos is present, specify the form: ☐ Friable ☐ Non-friable ☐ Unknown ☐ NA

C. Is this a PCB waste? ☐ Yes ☐ No ☐ Unknown If Yes, complete Form 435.93, "PCB Waste Certification"

D. Is debris present (>60 mm, >50 vol% by visual inspection)? ☐ Yes ☐ No ☐ Unknown

E. Are classified items present? ☐ Yes ☐ No ☐ Unknown

F. Is elemental beryllium or insoluble beryllium compound or alloy containing ≥0.1% beryllium present? ☐ Yes ☐ No ☐ Unknown

G. Are animal carcasses present? ☐ Yes ☐ No ☐ Unknown

G1. If animal carcasses are present, was formaldehyde used as a preservative? ☐ Yes ☐ No ☐ Unknown ☐ NA

H. Are chelating or complexing agents present at a volume >1% of the total volume of waste? ☐ Yes ☐ No ☐ Unknown

I. Are pathogens, infectious wastes, or other etiologic agents present? ☐ Yes ☐ No ☐ Unknown

J. Does the waste have >15 wt% of particles with a diameter <200 micrometers? ☐ Yes ☐ No ☐ Unknown

K. Does the waste contain >1 wt% of particles with a diameter <10 micrometers? ☐ Yes ☐ No ☐ Unknown

9. Does the waste contain accountable nuclear material or source material, or is the waste originating from a nuclear accountable area (see DOE M 470.4-6, Table I-1)?

☐ Yes If Yes, list the isotopes:

☐ No ☐ Unknown

10. Radioisotopes: Are radioisotopes present? ☐ Yes ☐ No ☐ Unknown

A. If No, list references that justify the no-rad determination (e.g., Form 435.02, EDF, analytical data): If Yes, reference source term:

B. Are sealed sources present? ☐ Yes ☐ No ☐ Unknown

B1. If sealed sources are present, do any of them contain transuranic nuclides? ☐ Yes ☐ No ☐ Unknown ☐ NA

B2. If sealed sources are present, do any of them have an activity ≥100 uCi? ☐ Yes ☐ No ☐ Unknown ☐ NA

11. Waste Characteristics (check all that apply):

NOTE: *The waste characteristics may not be known at time of initial determination.*

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

Ignitability	Corrosivity	Reactivity
Flash point less than 60°C (140°F)? ☐ Yes ☐ No ☐ Unknown	pH less than or equal to 2? ☐ Yes ☐ No ☐ Unknown	It is normally unstable and readily undergoes violent change without detonating. ☐ Yes ☐ No ☐ Unknown
Ignitable compressed gas? ☐ Yes ☐ No ☐ Unknown	pH greater than or equal to 12.5? ☐ Yes ☐ No ☐ Unknown	It reacts violently with water. ☐ Yes ☐ No ☐ Unknown
It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard. ☐ Yes ☐ No ☐ Unknown	It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F). ☐ Yes ☐ No ☐ Unknown	It forms potentially explosive mixtures with water. ☐ Yes ☐ No ☐ Unknown
		When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment. ☐ Yes ☐ No ☐ Unknown
It is an oxidizer as defined in 49 CFR 173.127 ☐ Yes ☐ No ☐ Unknown		It is a cyanide or sulfide-bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment. ☐ Yes ☐ No ☐ Unknown
		It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement. ☐ Yes ☐ No ☐ Unknown
		It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.54. ☐ Yes ☐ No ☐ Unknown

Metals and Organics (Select "Yes" if the following are present at any concentration and provide supporting documentation [e.g., EDF, sample analysis, process knowledge statements].)

Metals	Organics			
Arsenic ☐ Yes ☐ No ☐ Unknown	Benzene ☐ Yes ☐ No ☐ Unknown	Cresol ☐ Yes ☐ No ☐ Unknown	Hexachlorobenzene ☐ Yes ☐ No ☐ Unknown	Pyridine ☐ Yes ☐ No ☐ Unknown
Barium ☐ Yes ☐ No ☐ Unknown	Carbon Tetrachloride ☐ Yes ☐ No ☐ Unknown	2,4-D ☐ Yes ☐ No ☐ Unknown	Hexachlorobutadiene ☐ Yes ☐ No ☐ Unknown	Tetrachloroethylene ☐ Yes ☐ No ☐ Unknown

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

Cadmium ☐ Yes ☐ No ☐ Unknown	Chlordane ☐ Yes ☐ No ☐ Unknown	1,4-Dichlorobenzene ☐ Yes ☐ No ☐ Unknown	Hexachloroethane ☐ Yes ☐ No ☐ Unknown	Toxaphene ☐ Yes ☐ No ☐ Unknown
Chromium ☐ Yes ☐ No ☐ Unknown	Chlorobenzene ☐ Yes ☐ No ☐ Unknown	1,2-Dichloroethane ☐ Yes ☐ No ☐ Unknown	Lindane ☐ Yes ☐ No ☐ Unknown	Trichloroethylene ☐ Yes ☐ No ☐ Unknown
Lead ☐ Yes ☐ No ☐ Unknown	Chloroform ☐ Yes ☐ No ☐ Unknown	1,1-Dichloroethylene ☐ Yes ☐ No ☐ Unknown	Methoxyclor ☐ Yes ☐ No ☐ Unknown	2,4,5-Trichlorophenol ☐ Yes ☐ No ☐ Unknown
Mercury ☐ Yes ☐ No ☐ Unknown	o-Cresol ☐ Yes ☐ No ☐ Unknown	2,4-Dinitrotoluene ☐ Yes ☐ No ☐ Unknown	Methyl ethyl ketone ☐ Yes ☐ No ☐ Unknown	2,4,6-Trichlorophenol ☐ Yes ☐ No ☐ Unknown
Selenium ☐ Yes ☐ No ☐ Unknown	m-Cresol ☐ Yes ☐ No ☐ Unknown	Endrin ☐ Yes ☐ No ☐ Unknown	Nitrobenzene ☐ Yes ☐ No ☐ Unknown	2,4,5-TP (Silvex) ☐ Yes ☐ No ☐ Unknown
Silver ☐ Yes ☐ No ☐ Unknown	p-Cresol ☐ Yes ☐ No ☐ Unknown	Heptachlor ☐ Yes ☐ No ☐ Unknown	Pentachlorophenol ☐ Yes ☐ No ☐ Unknown	Vinyl Chloride ☐ Yes ☐ No ☐ Unknown

12. Waste Usage Information

A. Was the waste used as a solvent or extractant? ☐ Yes ☐ No ☐ Unknown

A1. If Yes, did the solvent or extractant before use exceed 10% of product composition? ☐ Yes ☐ No ☐ Unknown ☐ NA

A2. If Yes, did the solvent or extractant retain the characteristic of ignitability upon generation as a waste? ☐ Yes ☐ No ☐ Unknown ☐ NA

B. Is the waste an unused chemical or an off-specification commercial chemical product? ☐ Yes ☐ No ☐ Unknown

B1. If Yes, is the waste a combination of unused commercial chemical products? ☐ Yes ☐ No ☐ Unknown ☐ NA

B1.1. If Yes, does the unused commercial chemical product(s) contain only one sole active ingredient? ☐ Yes ☐ No ☐ Unknown ☐ NA

B2. If Yes (Line B), is the waste soil, water, or other media resulting from a spill or release of an unused commercial chemical product? ☐ Yes ☐ No ☐ Unknown ☐ NA

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

13. Is the waste covered by a RCRA closure plan? (If Yes, list the RCRA closure plan number.)	☐ Yes ☐ No
14. Is the waste generated by or governed under a CERCLA activity? (If Yes, list the governing document for waste generation.)	☐ Yes ☐ No

CERTIFICATION

I certify that the information in Section I of this form and the applicable attachments are fully disclosed. A good faith effort has been put forward to acquire and verify the information. Willful or deliberate omissions have not been made, and all known and suspected hazards have, to the best of my knowledge, been identified.

Generator Print/Type Name	Generator Signature	Date

SECTION II: WASTE DETERMINATION AND DISPOSITION (Completed by the WGS Technical Specialist)

A. Waste Determination

1. Is the information provided, other than container specific information (e.g., the container source term, dose rates), adequate for the waste determination, management, transportation, treatment, and disposal of waste? ☐ Yes ☐ No (If No, provide additional information or analysis needed.)

2. Waste Stream Data or Analysis Required (TCLP, EDF, Source Term, etc):	Data Received (Yes / No):	Date:	Adequate (Yes / No):

3. Provide a documented evaluation of the process knowledge sources used for waste characterization that identifies the uncertainties, inconsistencies, limitations, and usefulness of the process knowledge sources (provide attachments as needed).

4. Is this a solid waste (per 40 CFR 261.2)? ☐ Yes ☐ No

5. Is this a hazardous waste (per 40 CFR 261.3)? ☐ Yes ☐ No

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

WDDF Number: _____

Waste Stream: _____ Material Profile Number: _____

5a. Is the waste excluded from regulation under 40 CFR 261.4 or 40 CFR 261.5(g)? ☐ Yes ☐ No ☐ NA

(If Yes, provide the regulatory citation) _____

5b. Is the waste listed in Subpart D of 40 CFR 261? ☐ Yes ☐ No ☐ NA

(If Yes, provide information in C.2.)

5c. Is the waste characteristic per Subpart C of 40 CFR 261? ☐ Yes ☐ No ☐ NA

(If Yes, provide information in C.2.)

5d. Is the waste exempt for recycling in accordance with 40 CFR 261.2(e)(1)? ☐ Yes ☐ No ☐ NA

(If Yes, provide the regulatory citation.)

B. Evaluation of Land Disposal Restrictions

1. Is waste subject to 40 CFR 268 regulations? ☐ Yes ☐ No

If Yes, specify the waste treatability group: ☐ Waste Water ☐ Nonwastewater

1a. Does the waste require evaluation in accordance with 40 CFR 268.48? ☐ Yes ☐ No ☐ NA

(If Yes, provide Information in C.3.)

1b. Is this waste debris per 40 CFR 268.45? ☐ Yes ☐ No ☐ NA

1c. Is this waste a lab pack? ☐ Yes ☐ No ☐ NA

C. Waste Type

1. Based on an evaluation of the process and available data, identify the waste type. (Check all that apply. If mixed low-level, then hazardous and low-level need not be checked.)

☐ Hazardous	☐ Low-level	☐ Mixed low-level	☐ Industrial
☐ High-level	☐ Transuranic	☐ Mixed transuranic	☐ Recyclable
☐ Used oil	☐ Waste regulated as asbestos-containing waste material	☐ Other—Describe:	☐ Waste incidental to reprocessing
☐ Universal waste	☐ Friable or ☐ Nonfriable		
	☐ TSCA regulated as PCBs		

WASTE DETERMINATION & DISPOSITION FORM (WDDF)

(This form is used with MCP-1390, MCP-454, MCP-3811, MCP-9424, & MCP-1396)

2. Applicable EPA Waste Codes (D, F, K, P, and/or U) _____

3. Applicable Underlying Hazardous Constituents: _____

D. Proposed Disposition Plan

1. Will this waste be treated on-site? ☐ Yes ☐ No

   If Yes, provide references: _____

2. Proposed disposition path (e.g., Energy Solutions, RWMC, NTS):

CERTIFICATIONS

I certify that the information in Section II of this form (and the applicable attachments) is fully disclosed and accurate. A good faith effort has been put forward to acquire and verify the information. Willful or deliberate omissions have not been made.

WGS Waste Technical Specialist Print/Type Name	WGS Waste Technical Specialist Signature	Date
WGS Independent Reviewer Print/Type Name	WGS Independent Reviewer Signature	Date

APPROVAL

I approve this WDDF:

WGS Facility Representative Print/Type Name	WGS Facility Representative Signature	Date