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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

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ABSTRACT

This document presents the plan for the closure of the Idaho Nuclear Technology and Engineering Center Tank Farm Facility Tanks WM-182 and WM-183 in accordance with Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act interim status closure requirements. Closure of these two tanks is the first in a series of closures for the final closure of the 15 belowground tanks in the Tank Farm Facility. As such, closure of tanks WM-182 and WM-183 will serve as a proof-of-process demonstration of the waste removal, decontamination, and sampling techniques for the closure of the remaining Tank Farm Facility tanks. Such an approach is required because of the complexity and uniqueness of the Tank Farm Facility closure. This plan describes the closure units, objectives, and compliance strategy as well as the operational history and current status of the tanks. Decontamination, closure activities, and sampling and analysis will be performed with the goal of achieving clean closure of the tanks. Coordination with other regulatory requirements, such as U.S. Department of Energy closure requirements, also is discussed.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPP	Idaho Chemical Processing Plant
DEQ	Idaho Department of Environmental Quality
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
DVB	diversion valve box
EPA	Environmental Protection Agency
FFA/CO	Federal Facility Agreement and Consent Order
FR	Federal Register
HEPA	high-efficiency particulate air
HLW	high-level waste
HWMA	Hazardous Waste Management Act
IDAPA	Idaho Administrative Procedures Act
IDHW	Idaho Department of Health and Welfare
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IWTS	Integrated Waste Tracking System
M	Molar
NWCF	New Waste Calcining Facility
OU	operable unit
PCB	polychlorinated biphenyl
PE	professional engineer
PEW	process equipment waste
RCRA	Resource Conservation and Recovery Act

RI/FS	remedial investigation/feasibility study
ROVER	Space Nuclear Propulsion Program
RWMC	Radioactive Waste Management Complex
TFF	Tank Farm Facility
WAG	waste area group
WINCO	Westinghouse Idaho Nuclear Company
WIR	waste incidental to reprocessing

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

1. INTRODUCTION

Under the terms of the 1992 Consent Order (and subsequent modifications) between the Idaho Department of Health and Welfare[a] (IDHW) and the U.S. Department of Energy (DOE) (IDHW 1992), DOE must permanently cease use of tanks in its Tank Farm Facility (TFF) at the Idaho National Engineering and Environmental Laboratory (INEEL) or bring the tanks into compliance with secondary containment requirements as set forth by Idaho Administrative Procedures Act (IDAPA) 58.01.05.009 (2001) (40 Code of Federal Regulations [CFR] 265.193 (2001)). The Consent Order (IDHW 1992) further specifies that this compliance cannot be achieved through an equivalency demonstration or by obtaining a variance as provided by IDAPA 58.01.05.009 [40 CFR 265.193(d)(4) and (h)]. DOE has decided to close the TFF tanks because high radiation fields would make compliance with secondary containment requirements impractical (because of high radiation dose to workers and cost).

The TFF includes eleven belowground 300,000-gal and 318,000-gal tanks (hereafter referred to in this plan as 300,000-gal tanks) and four 30,000-gal tanks. The 300,000-gal tanks are numbered WM-180 through WM-190. The second modification to the Consent Order specifies that DOE must cease use of Tanks WM-182, WM-183, WM-184, WM-185[b], and WM-186 by June 30, 2003, and the remaining tanks by December 31, 2012. Ceasing use of the tanks, as defined in the Consent Order, means that DOE must empty the tanks down to their heels (that is, the liquid level remaining in each tank must be lowered to the greatest extent possible by the use of existing transfer equipment) (IDHW 1998). According to the Idaho Hazardous Waste Management Act of 1983 (HWMA) and the Resource Conservation and Recovery Act (RCRA), the TFF is an interim status hazardous waste management unit (State of Idaho 1983; 42 USC 6901, 1976). Because of this, the requirements of 40 CFR 265 (2001) apply to the TFF closure (rather than 40 CFR 264 [2001]).

Closure of the TFF tanks will be performed in phases; Tanks WM-182 and WM-183 will be closed in the first phase. The closure of these two tanks will also serve as a proof-of-process demonstration of the waste removal, decontamination, and sampling techniques for the closure of the remaining TFF tanks.

The TFF will continue to operate until 2012 while various parts of the facility are being closed. The final closure of any component of the TFF will not be complete until all the tanks have been closed and the remedial investigation/feasibility study (RI/FS) for operable unit (OU) 3-14 (Tank Farm Soils) is completed. The final closure plan will address closure and any required post-closure care of the TFF. A decision to close the unit as a landfill or as clean closure will be determined during final closure.

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a. On July 1, 2000, the Division of Environmental Quality, a division within the Idaho Department of Health and Welfare, was elevated to the Idaho Department of Environmental Quality (DEQ). This department now oversees the implementation of the Consent Order.

b. The Consent Order allows Tank WM-185 to be used as an emergency spare tank.

Two significant releases from TFF ancillary equipment to surrounding soils have occurred. No releases have occurred from the tanks to environmental media. These releases are subject to investigation and remediation as necessary under the INEEL Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program as described in the *Federal Facility Agreement and Consent Order* (FFA/CO) (IDHW, Environmental Protection Agency [EPA], and DOE Idaho Operations Office [DOE-ID] 1991).

This closure plan addresses closure of Tanks WM-182 and WM-183 and ancillary equipment pursuant to the Idaho HWMA and RCRA only. Because the tanks also contain radioactive constituents regulated by DOE, the tanks also must comply with DOE closure requirements, and a DOE closure plan will be developed separately. These requirements are found in DOE Order 435.1, “Radioactive Waste Management” (DOE 2001a) and its associated manual and guidance (DOE 2001b; DOE 1999a). DOE orders are discussed further in Section 5.1. All closure activities will be closely coordinated to ensure compliance with Idaho HWMA/RCRA and DOE orders.

This document is a plan for the closure of TFF Tanks WM-182 and WM-183 as required by IDAPA 58.01.05.009 and 40 CFR Part 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.” This plan describes a strategy for clean closure (removal or decontamination of all waste residues) of the tanks to site-specific action levels. In addition, IDAPA 58.01.05.009 [40 CFR 265.197(c)(1) (2001)] specifies that both a closure plan for clean closure and a contingent closure plan for closure of the tanks as a landfill must be prepared for tank systems that do not have adequate secondary containment. The contingent landfill closure plan is presented in *Contingent Landfill Closure and Post-Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183* (DOE-ID 2001a).

1.1 Tank Farm Description

The TFF is part of the INEEL’s Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (CPP). The TFF includes eleven belowground 300,000-gal and four belowgrade 30,000-gal stainless-steel tanks. Aboveground structures in the TFF include the TFF Control House (building CPP-628), the Computer Interface Building (CPP-618), condenser pits (CPP-721 and CPP-722), valve boxes, and tank and vault sump riser covers. A perimeter fence encloses the TFF on the west, north, and east sides. Buildings border the east side. Gates are located on the west and north sides of the fence (INEEL 1998).

A description of the INTEC TFF and a general description of the hydrogeologic conditions are provided in Appendix A. The Computer Interface Building is not associated with any closure activities. The TFF Control House contains piping that is associated with the TFF. Portions of the piping associated with WM-182 and WM-183 will be decontaminated and capped or otherwise sealed during this closure. The condenser pits (CPP-721 and CPP-722), valve boxes, and tank and vault sump riser covers will be closed during closure of WM-182 and WM-183.

The TFF was used to store liquid wastes generated by spent nuclear fuel reprocessing operations and decontamination wastes from reprocessing facilities at INTEC. Construction of the TFF began in 1951 with Tanks WM-180 and WM-181. Tanks WM-182 through WM-184 were completed in 1955, Tanks WM-185 and WM-186 were completed in 1957, and Tanks WM-187 and WM-188 were completed in 1959. The last tanks, WM-189 and WM-190, were constructed in 1964. Construction of the four 30,000-gal tanks was completed in 1955. The 30,000-gal tanks were taken out of service in 1983, and the tank inlets have been cut and capped (DOE-ID 2001a).

Eight of the tanks (WM-180, WM-182, WM-183, WM-185, and WM-187 through WM-190) contain stainless-steel cooling coils to minimize tank corrosion. Risers provide access to each tank. Each tank has four or five 12-in. diameter risers. Tanks WM-184 through WM-190 also have two 18-in. diameter risers. Most risers also have installed equipment, such as radio frequency probes for level measurement, corrosion coupons, or waste transfer equipment (steam jets and airlifts). Two steam jets are located inside each tank, except for Tanks WM-189 and WM-190. These two tanks each have one steam jet and one airlift pump. A single steam jet can transfer waste out of a tank at approximately 50 gpm, and an airlift can transfer waste out of a tank at approximately 35 gpm (INEEL 2000a).

Each 300,000-gal tank is contained in a concrete vault. The vaults are approximately 45 ft belowground and are configured in one of three basic designs: monolithic octagonal, pillar and panel octagonal, or monolithic square. The 6-in. thick concrete vault roofs are covered with approximately 10 ft of soil to provide radiation shielding. Tanks WM-182 and WM-183 are contained in pillar and panel octagonal vaults. Because vaults of this design were constructed with prefabricated components, these vaults are not considered as robust as vaults of monolithic design (INEEL 2000a).

Liquid waste transfers to, from, and among the tanks are managed through a system of piping, valves, and diversion boxes. The liquid waste is routed through waste transfer valves located in underground, stainless steel-lined concrete boxes, referred to as valve boxes. Liquids resulting from decontamination efforts or leakage of valve boxes and piping encasements (secondary containment for piping) are drained to tanks or diversion boxes (INEEL 1998).

1.2 Waste Description

Wastes stored in the TFF tanks exhibit the hazardous characteristics of corrosivity (Hazardous Waste Number D002) (40 CFR 261 Subpart D, 2001). Baseline data were collected from Tanks WM-182 and WM-183 in 1999 and 2000 (data presented in Appendix B). Baseline data from Tank WM-182 waste sampling indicate the waste exhibits the characteristic of toxicity for lead (D008) and mercury (D009). Baseline data from Tank WM-183 waste sampling indicate the waste exhibits the toxicity characteristic for cadmium (D006), chromium (D007), lead (D008), and mercury (D009). Also associated with the waste are four RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999):

- F001 (carbon tetrachloride; 1,1,1-trichloroethane; trichloroethylene)
- F002 (carbon tetrachloride; tetrachloroethylene; 1,1,1-trichloroethane; trichloroethylene)
- F005 (benzene, carbon disulfide, pyridine, toluene)
- U134 (hydrofluoric acid).

1.3 Tank Farm Status

The TFF is currently used to store sodium-bearing waste from previous reprocessing and decontamination activities and to receive newly generated liquid waste from INTEC plant operations and decontamination activities. To meet the language of the Settlement Agreement and subsequent court order with the State of Idaho, all non-sodium-bearing-waste liquid HLW was converted to calcine by February 1998[c]. Table 1 summarizes the volume of waste in the 300,000-gal tanks as of August 31, 2001.

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c. DOE 1999b, *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement*, DOE/EIS-0287D, (expected release January 2002).

Table 1. Tank volumes as of August 31, 2001.

Tank	Volume (gal)[a]	Tank	Volume (gal)[a]
WM-180	276,000	WM-186	20,300
WM-181	80,500	WM-187	92,700
WM-182	10,800	WM-188	158,200
WM-183	12,100	WM-189	171,200
WM-184	131,200	WM-190	500
WM-185	43,100		

a. Keith Quigley, INEEL, e-mail to Nick Stanisich, Portage Environmental, “Tank Volumes as of August 2001,” October 3, 2001.

1.4 Maximum Inventory of Wastes

The provisions in IDAPA 58.01.05.009 (State of Idaho 1983) [40 CFR 265.112(3) (2001)] require that a closure plan include an estimate of the maximum inventory of hazardous wastes ever onsite over the active life of the facility. This section discusses the reprocessing operation and wastes generated, tank usage, history of operations, and the maximum inventory in each of Tanks WM-182 and WM-183. The maximum inventory in each tank was administratively controlled at 285,000 gal. Details about waste composition and historical use of Tanks WM-182 and WM-183 are located in Section 1.4.4.

1.4.1 Reprocessing Operations and Wastes Generated

Reprocessing operations at INTEC took place from 1952 until 1991. These operations used a three-cycle solvent extraction process to recover enriched uranium from spent nuclear fuel. The spent nuclear fuel was dissolved in hydrofluoric or nitric acid to form a uranyl nitrate solution suitable for solvent extraction. The fuel types included aluminum, zirconium, stainless steel, graphite, and custom. The fuel dissolution process varied depending on the type of fuel to be reprocessed. The enriched uranium was then extracted using a three-step solvent extraction process. The solution remaining after the first extraction cycle was considered high-level waste (HLW) and was stored in the TFF. The liquid remaining from the second and third extraction cycles, as well as solutions resulting from decontamination activities, were first concentrated by evaporation and then stored separately in the TFF. This waste is generally referred to as sodium-bearing waste because of its high sodium content resulting from decontamination activities. Although reprocessing operations have ceased, the TFF continues to receive waste from INTEC plant operations and decontamination activities. This waste is referred to as newly generated liquid waste (see footnote c, page 3).

1.4.2 Fuel Dissolution

Generally, five types of dissolution processes were used during reprocessing: aluminum, zirconium, stainless steel, graphite, and custom. In the aluminum dissolution process, aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Zirconium-based fuels were dissolved using the fluorinel dissolution process. This process used hydrofluoric and nitric acids, aluminum nitrate, and the soluble nuclear poisons of cadmium and boron. Stainless-steel fuels were dissolved in nitric acid while a direct electrical current passed through the fuel in the electrolytic dissolution process. The Space Nuclear Propulsion Program (ROVER) dissolution process was used to dissolve graphite fuels. ROVER fuels were composed of either an uncoated or pyrolytic-carbon-coated graphite matrix that contained uranium dispersed throughout as uranium dicarbide fuel particles. These fuels were first burned in oxygen to remove the graphite. The uranium materials were then dissolved in hydrofluoric and nitric acids. Custom processing in specially designed pilot-plant-type equipment with material-specific dissolvents was used for nuclear material that was incompatible with established dissolution processes. For example, those fuels with nontraditional cladding materials, material impurities, excessively high radiation levels, or small amounts of recoverable fissile material required custom fuel processing methods (Westinghouse Idaho Nuclear Company [WINCO] 1986).

1.4.3 Fuel Extraction

In the first-cycle extraction process, uranium was extracted from the uranyl nitrate solution into a solution of tributyl phosphate in dodecane. The aqueous raffinate stream from this extraction, which included the fission products, was sent to the TFF waste tanks unless the uranium concentration remained high enough for further extraction (WINCO 1986).

The second- and third-cycle extraction processes used the hexone extraction process to purify the uranium product from the first-cycle extraction. The process used the solvent methyl isobutyl ketone (hexone) to separate the uranium from residual fission products and transuranic elements such as neptunium and plutonium. The waste material containing the transuranics and fission products was generally evaporated to reduce its volume before being sent to the TFF for calcination (WINCO 1986).

1.4.4 Waste Types and Composition

The types of radioactive liquid waste generated at INTEC can be separated into eight basic categories, as listed below. Table 2 summarizes the typical chemical compositions of these waste types.

- Aluminum waste from the dissolution of aluminum fuels in nitric acid
- Zirconium fluoride waste from the dissolution of zirconium fuels in hydrofluoric acid
- Coprocessing waste that results when dissolver product from aluminum fuel dissolution is used as the complexing agent for zirconium dissolver product before introduction to the extraction system
- Fluorinel waste from the dissolution of zirconium fuels in hydrofluoric acid and nitric acid
- Stainless steel waste from the electrolytic dissolution of stainless steel fuels in nitric acid
- ROVER waste from the dissolution of graphite-type fuels in hydrofluoric acid and nitric acid
- Custom-processing wastes that are the second- and third-cycle raffinates resulting from processing custom fuels
- Sodium-bearing waste that results from process equipment waste (PEW) evaporator bottoms and sodium-bearing decontamination solutions.

All first-cycle raffinates were acidic, with a hydrogen-ion concentration between 1 and 3 molar (*M*). Radionuclides in the first-cycle raffinates produced a typical radioactivity level in the stored wastes from 5 to 40 Ci/gal (INEEL 1998). The raffinates from zirconium dissolution and coprocessed zirconium and aluminum dissolution were fluoride-bearing wastes. The first-cycle raffinates from the dissolution of aluminum and stainless steel fuel were non-fluoride bearing (WINCO 1986).

Table 2. Typical chemical composition of various waste types.[a]

Waste Type	Aluminum (*M*)	Zirconium (*M*)	Fluorinel (*M*)	Stainless Steel (*M*)	Sodium (*M*)
Acid (H+)	1	1.5	1.9	2.5	1.2
Nitrate	4.6	2.6	2.3	3	4.6
Fluoride	0	2.5	2.7	0	0.05
Aluminum	1.3	0.6	0.3	0.65	0.6
Zirconium	0	0.4	0.4	0.01	0.0
Boron	0.01	0.15	0.2	0	0.01
Cadmium	0	0	0.13	0	0.0
Sulfate	0.01	0	0.08	0.06	0.06
Sodium	0.04	0.04	0.03	0.01	1.6
Potassium	0.003	0.007	0.001	0	0.2
Iron	0.01	0.01	0.01	0.06	0.02
Chromium	0	0	0	0.01	0.003
Calcium	0.06	0.02	0.02	0.005	0.04

a. From *Idaho Nuclear Technology and Engineering Center Safety Analysis Report* (INEEL 1999).

The chemical and radiochemical composition of the wastes and the amount of heat generated vary with the type of fuel being processed, decay time before processing, and fuel burnup. Chemicals in concentrations up to 4*M* and large quantities of fission products are present. The major chemicals present are aluminum and nitrate in the non-fluoride waste, and aluminum, zirconium, fluoride, and nitrate in the fluoride waste (INEEL 1998).

The composition of second- and third-cycle raffinates is essentially the same for all fuel types processed. The fission product activity in these wastes is low enough that little heat is generated, making cooling unnecessary. The principal nuclides present are ^{137}Cs, ^{90}Sr, and ^{238}Pu. The predominant chemicals in the second- and third-cycle combined waste are aluminum and nitrate. The waste is acidic, with hydrogen ion concentration between 0.1 and 1.6*M* (INEEL 1998).

Each of the two tanks (WM-182 and WM-183) has a different waste storage history. The maximum inventory of each tank was administratively limited to 285,000 gal. Tank WM-182 became operational in 1955 to primarily store high-level liquid waste. Tank WM-183 became operational in 1958 and has stored high-level liquid waste during much of its lifetime (interdepartmental communication[d]; Palmer et al. 1998). Figures 1 and 2 show the historical volumes in Tanks WM-182 and WM-183, respectively. Sodium-bearing waste found in Tanks WM-182 and WM-183, shown in Table 2, is a combination of the various waste types described in Section 1.4.1.

d. Interdepartmental communication, from W. B. Palmer, INEEL, to J. T. Beck, INEEL, "Removing HLW from the Tank Farm," WBP-07-98, December 1998.

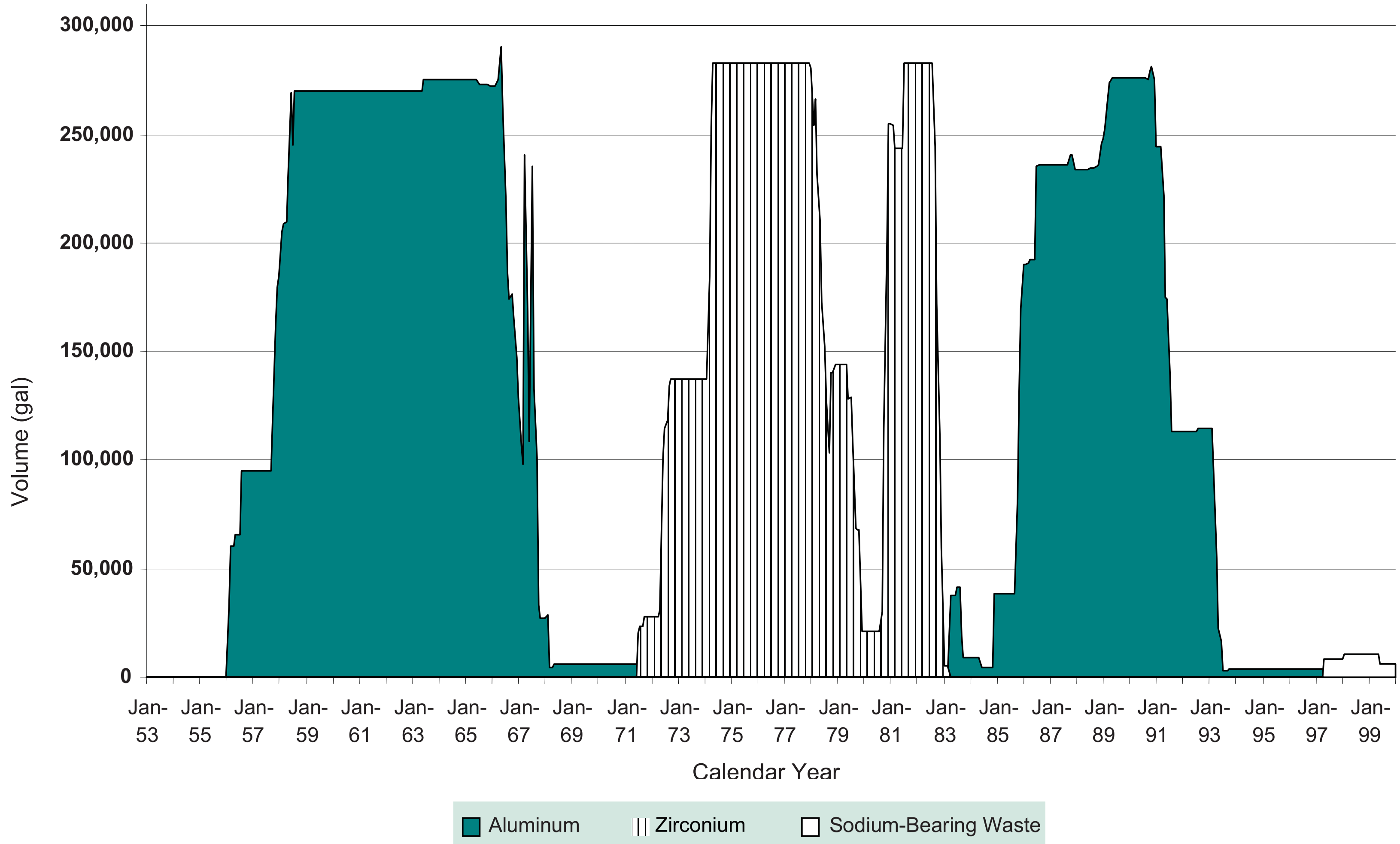

Figure 1. Volumes of waste contained in WM-182.

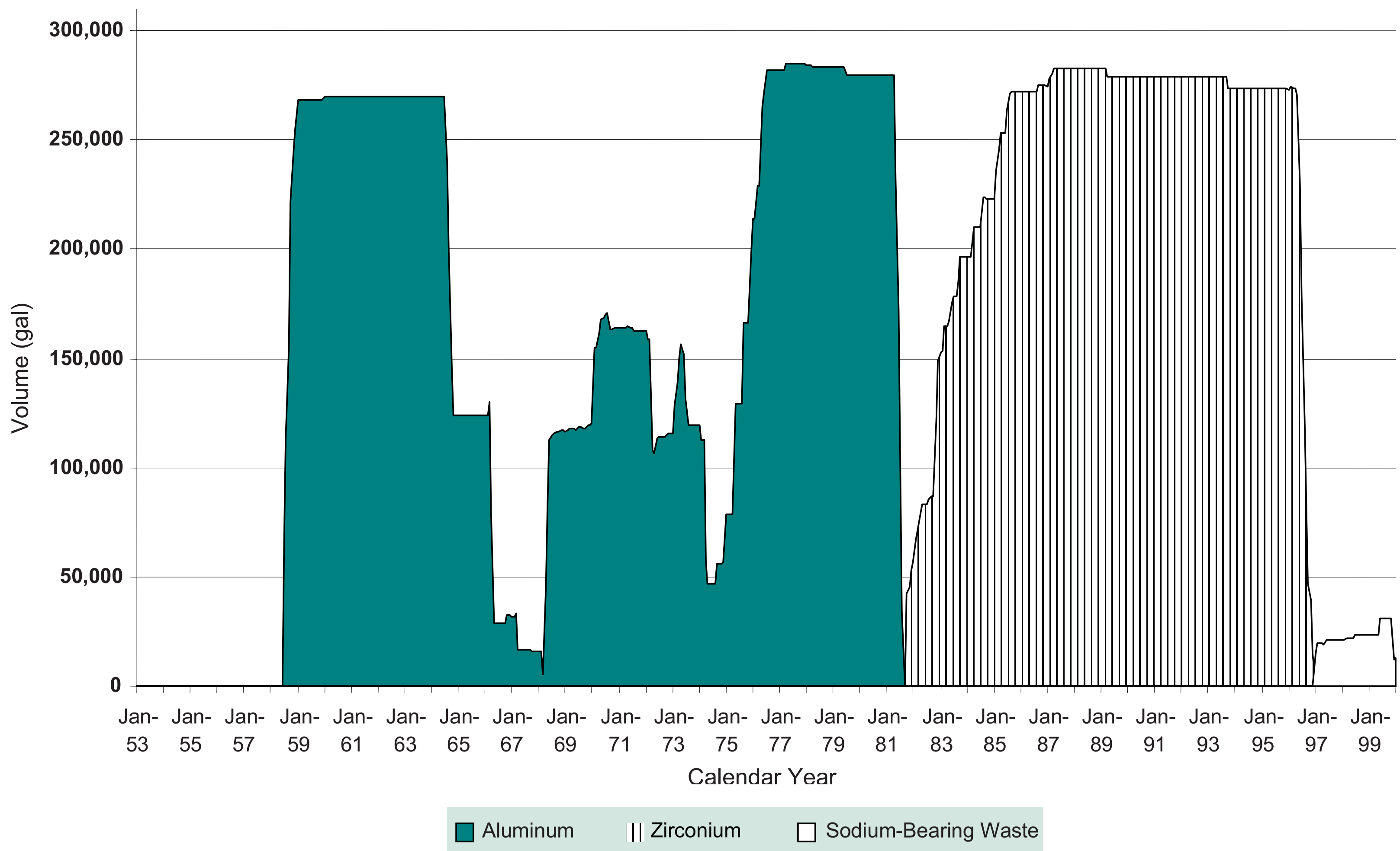

Figure 2. Volumes of waste contained in WM-183.

2. CLOSURE OBJECTIVES

This closure plan presents the strategy for clean closure of Tanks WM-182 and WM-183 to meet the HWMA/RCRA requirements for cleanup of hazardous constituents only. However, as noted previously, the closure of Tanks WM-182 and WM-183 also must meet the requirements for cleanup of radionuclides to meet the intent of DOE orders for HLW systems, specifically DOE Order 435.1. A separate DOE closure plan (the DOE Tier-1 Closure Plan[e]) will provide the necessary information for removal of radionuclides. In addition, the closure of Tanks WM-182 and WM-183 serves as part of continuing research and development into techniques for closing HLW tanks. This is the third primary objective of the tank closure. Each of these objectives is discussed in greater detail below.

2.1 HWMA/RCRA Clean Closure Objectives

Closure of Tanks WM-182 and WM-183 will be performed to meet requirements of HWMA and RCRA, specifically IDAPA 58.01.05.009 (2001) and 40 CFR 265 (2001). IDAPA 58.01.05.009 incorporates 40 CFR 265 and all subparts (excluding Subpart R, "Underground Injection," 40 CFR 265.149, "State Assumption of Responsibility," and 265.150, "Use of State-Required Mechanisms") by reference. The objective will be to achieve clean closure of the tanks and tank system components in accordance with 40 CFR 265.110, 40 CFR 265.111, 40 CFR 265.112, and 40 CFR 265.197 (all 2001).

Clean closure is the removal or decontamination of all hazardous wastes from the tank system. It is widely recognized that, except for hazardous waste and liners, the regulations do not require complete removal of all contamination for clean closure. Rather, some limited quantity of hazardous constituents may remain in the tanks after clean closure, provided the concentrations of hazardous constituents are below site-specific action levels. Tanks WM-182 and WM-183 are intended to be clean closed.

Section 3 describes compliance with the performance standards in 40 CFR 265.111 and 40 CFR 265.197. Figure 3 shows the steps for HWMA/RCRA closure for Tanks WM-182 and WM-183.

Although RCRA closure of a tank system requires investigation and removal or decontamination of associated contaminated soils, the contaminated soils investigation and remediation associated with the WM-182 and WM-183 closure will be performed in accordance with CERCLA requirements as described by the FFA/CO (IDHW, EPA, and DOE-ID 1991). The entire TFF will be investigated as part of OU 3-14. The investigation is described in the *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan*.[f]

To define the clean closure standard, calculation procedures are used to develop site-specific action levels. The methodology for establishing action levels is found in Appendix C. Clean closure is achieved by performing all of the following steps:

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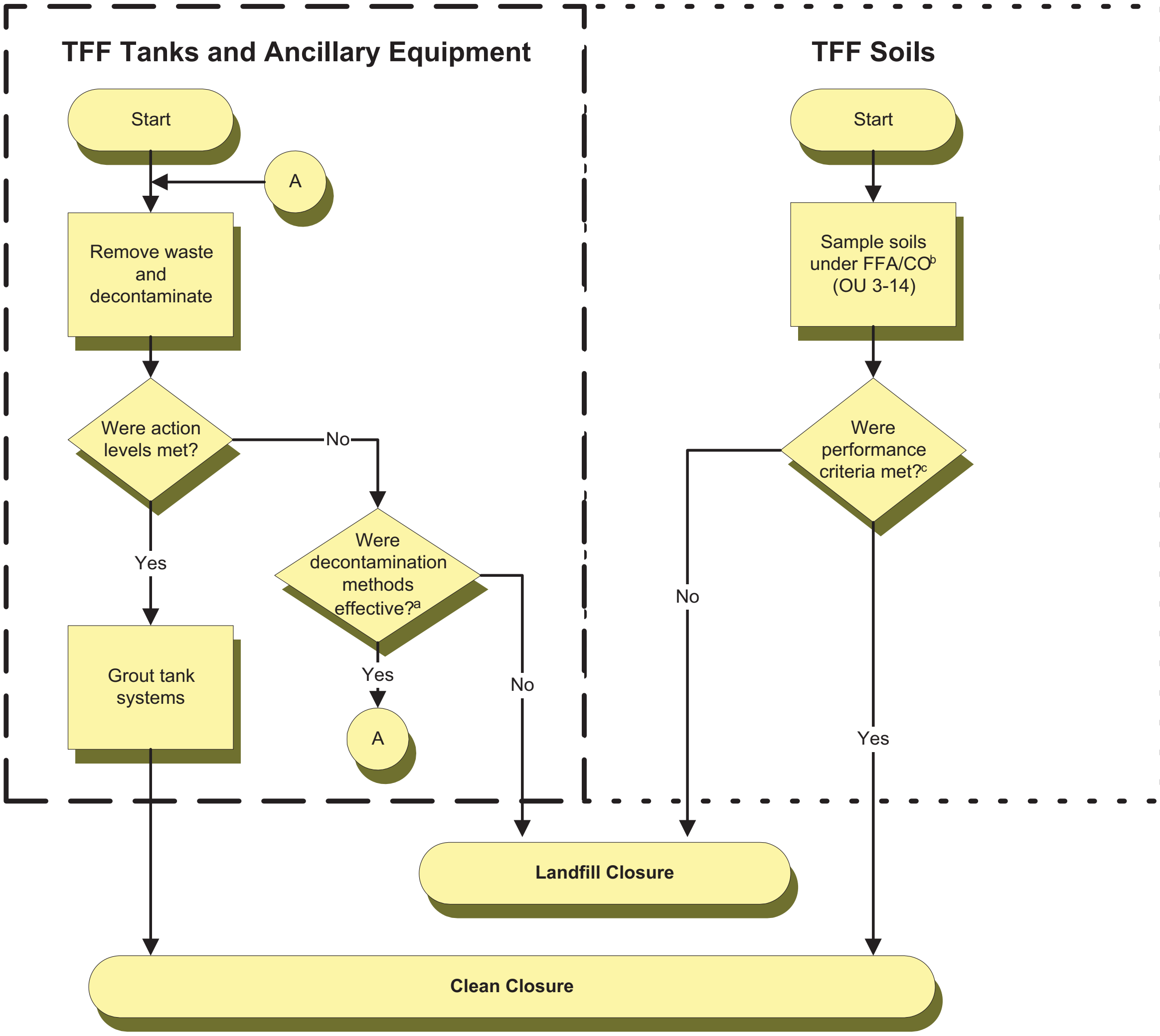
e. Portage Environmental, 2001a, *Tier 1 Closure Plan for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility at the INEEL*, INEEL/EXT-01-00576, for the Idaho National Engineering and Environmental Laboratory (expected release January 2002).

f. DOE-ID, 2000a, *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan*, DOE/ID-10676, Revision 0, Department of Energy Idaho Operations Office , Idaho Falls, Idaho (expected release early 2002).



a. This decision will be made after all tanks and ancillary equipment have been closed.

b. Federal Facility Agreement and Consent Order (IDHW, EPA, and DOE-ID 1991)

c. Performance criteria will be based on a risk assessment to determine whether the contaminated component or soil poses a threat to human health or the environment.

Figure 3. Steps for HWMA/RCRA closure for INTEC Tank Farm Facility tanks ancillary equipment and soils.

- Removing all hazardous waste. All constituents will be decontaminated to less than the toxicity characteristic threshold concentrations (40 CFR 261.24, Table 1 [2001]) and the characteristic of corrosivity (40 CFR 261.22 [2001]) and will not exhibit the toxicity characteristic. The pH of the residual will be greater than 2 and less than 12.5, as described in 40 CFR 261.22. Threshold concentrations are not used as action levels but, rather, to demonstrate that waste does not remain in the tanks.

- Meeting the performance standards of 40 CFR 265.111 (2001). Grouting of the pipes, tanks, vaults, and sumps will meet these performance standards to eliminate need for further maintenance and preclude post-closure escape of contaminants during the post-closure period.

- Meeting the site-specific action levels described in Section 3.2.

2.2 DOE Closure Objectives

The second objective of WM-182 and WM-183 closure is to meet the closure criteria of DOE Order 435.1, "Radioactive Waste Management" (DOE 2001a). This DOE closure is designed to remove radionuclides to the extent technically and economically practical. The quantity of radionuclides that can remain as residual in the tank system is based on a performance assessment (dose assessment)[g]. The results of the performance assessment will be provided in the Tier 1 DOE closure plan (see footnote e, page 9). The Tier 1 DOE closure plan will be reviewed by DOE Headquarters. If the Tier 1 DOE closure plan will be found to be satisfactory, DOE Headquarters will issue an Authorization to Proceed. DOE closure requirements are discussed further in Section 5.1. The proposed methods for hazardous waste, hazardous constituent, and radionuclide removal from the tank systems are the same as described in Section 4.3.

2.3 Research and Development

The third objective of the closure of Tanks WM-182 and WM-183 is the research and development (demonstration) project for HLW systems. The closure of Tanks WM-182 and WM-183 is intended to serve as a proof-of-process demonstration of the waste removal, decontamination, and sampling techniques for the closure of the remaining TFF tanks. This demonstration is necessary because of the uniqueness and complexity of the TFF closure. The closure is unique because similar tanks have not been closed previously at the INEEL. It is complex because of the nature of the waste and the configuration of the tanks (e.g., number of risers and presence of cooling coils). High radiation fields in the tanks and associated equipment preclude manual decontamination of most areas so remote-handling techniques must be used. Furthermore, tank and vault access is available only through risers, which prevents the use of routine decontamination and sampling procedures. Therefore, the closure strategy may be refined for subsequent TFF closure phases based on information obtained during the closure of Tanks WM-182 and WM-183.

Two cold mockups (using surrogates for hazardous constituents) were performed to demonstrate the decontamination and waste removal operations that are proposed for the tanks. The description of the mockups is included in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a).

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g. DOE-ID, 2001b, *Performance Assessment for the Tank Farm Facility at the Idaho National Engineering and Environmental Laboratory*, DOE/ID-10966, (expected release December 2001).

3. CLOSURE REQUIREMENTS AND PERFORMANCE STANDARDS

Closure requirements are specified by HWMA/RCRA as implemented by IDAPA 58.01.05.009 (2001) and 40 CFR Part 265 (2001). The matrix in the following section summarizes closure requirements and the strategy for complying with the requirements.

3.1 Compliance Matrix

Table 3 provides a summary of HWMA/RCRA closure requirements for this closure plan, organized by regulatory citation. The table includes a description of how the compliance strategy will meet the requirement and a reference to the section in this closure plan where the strategy is described in more detail. A contingent landfill closure plan has been prepared and will be submitted with this closure plan (DOE-ID 2001a).

3.2 Action Levels

The action levels established for WM-182 and WM-183 will be compared to data gathered after final decontamination of the tanks and ancillary equipment. Final sample results collected from residuals of the tanks and vaults will be used as the concentration term. The concentration term will be established as the 95% upper confidence limit of the mean of samples collected after decontamination. Residuals from the tanks, tank vaults, and valve boxes will be sampled. During the course of closure, the data from these samples will be analyzed by statistical methods to determine if the data from the various locations are from the same population. The statistics tests used will be the Student's t Test and/or analysis of variance (ANOVA). Radionuclide residuals are addressed in a separate DOE Performance Assessment (see footnote g, page 11). The action levels for RCRA/HWMA closure are presented in Table 4. Hazardous constituents other than those shown in Table 4, which are detected during confirmation sampling (post-decontamination sampling) will be assigned action levels using methodology consistent with that shown in Appendix C.

The action levels were developed by back calculating concentrations of constituents using a risk-based methodology. The concentrations of action levels are shown in mg/L because it is anticipated that the solid removal will be very effective, and representative samples of remaining residual could not be collected for HWMA/RCRA closure. The action level calculation methodology is discussed in detail in Appendix C.

If closure performance standards are met for all but three or fewer constituents of concern and the cumulative cancer risk and the cumulative hazard index remain below 1.0E–06 and 1, respectively, then clean closure will be granted for the INTEC WM-182 and WM-183 tank systems. If repeated decontamination attempts fail to reduce the volume of solids remaining in the tanks to less than 15% of the total residual volume, the solid portion of the sample will be analyzed and compared with the action levels listed in Table 4. In such case, the action levels concentrations will be shown in mg/kg.

3.3 Soils Strategy

Soil contamination is present at the TFF due to leaks from ancillary equipment, although the tanks never leaked contents to the environment. RCRA closure of a tank system requires investigation and removal or decontamination of associated contaminated soils. Contaminated soils are included as part of a CERCLA project. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The investigation is described in the *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan* (see footnote f, page 9).

The alternate strategy for removal and decontamination of the tank systems, which includes soils investigation and decontamination, is proposed because the FFA/CO has established that investigations of Solid Waste Management Unit releases would be the responsibility of the CERCLA program (IDHW, EPA, and DOE-ID 1991). The investigation and remediation plans must be final before closure of the entire TFF. The INEEL Environmental Restoration Program will plan the soil investigation, with input from the INEEL HLW and HWMA/RCRA regulatory programs.

Table 3. HWMA/RCRA closure plan compliance matrix.

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
§ 265.110 Applicability		
(a) Sections 265.111 through 265.115 (closure) apply to the owners and operators of all hazardous waste management facilities.	These sections are applicable to this closure.	See citation in matrix below
(b) Sections 265.116 through 265.120 (post-closure care) apply to owners and operators of hazardous waste disposal facilities, waste piles and surface impoundments as required by Sections 265.228 or 265.258, tank systems that are required under Section 265.197 to meet requirements for landfills, and containment buildings as required by Section 265.1102.	Not applicable for clean closure. These sections are addressed in the contingent landfill closure plan (DOE-ID 2001a).	See citation in matrix below
(c) Section 265.121 applies to owners and operators of units that are subject to the requirements of 40 CFR 270.1(c)(7).	Not applicable for clean closure. This section is addressed in the contingent landfill closure plan (DOE-ID 2001a).	See citation in matrix below
(d) The Regional Administrator may replace all or part of the requirements of this subpart with alternative requirements for closure.	Not applicable.	N/A
§ 265.111 Closure Performance Standard		
(a) Facility must be closed in a manner that minimizes the need for further maintenance.	The closure strategy results in waste removal and decontamination of Tanks WM-182 and WM-183 to action levels to meet clean closure standards, minimizing the need for further maintenance.	2.1, 3.2, Table 4, 4.3, 4.4
(b) Facility must be closed in a manner that controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.	Waste will be removed and the system decontaminated. Only residue that does not exceed the clean closure criteria (action levels) will remain in the tank system. Grouting of the tank system will minimize post-closure escape of hazardous constituents, leachate, or hazardous waste decomposition products to the groundwater or to the atmosphere.	4.3, 4.4

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
(c) Facility must be closed in a manner that complies with the closure requirements of this subpart, including § 265.197 (tank systems).	The closure performance standard will be met as described above. The requirements of § 265.197 will be met as described later in this matrix.	4.3, 4.4
§ 265.112 Closure Plan; Amendment of Plan		
(a) Written plan. This section specifies the conditions under which a written closure plan must be maintained.	DOE is required under the Second Modification to Consent Order (IDHW 1998) to submit a closure plan to DEQ under the requirements of IDAPA 16(now 58).01.05.009 (40 CFR Part 265, Subpart G) for at least one of these (WM-182 through WM-186) tanks on or before December 31, 2000. The plan will be maintained until closure certification of the facility is provided to the Director.	9
(b) Content of plan. This section specifies requirements for the content of the closure plan:		
(1) A description of how each hazardous waste management unit at the facility will be closed in accordance with § 265.111.	(1) This closure plan identifies steps necessary to close Tanks WM-182 and WM-183, which is a partial closure of the TFF and INTEC. The general strategy is ▪ Isolate Tanks WM-182 and WM-183 from the rest of the TFF by decontaminating valve boxes, pipe encasements, and vault sumps; isolating process lines and the vessel off-gas system ▪ Remove selected steam jet assemblies and corrosion coupons ▪ Wash tank walls and agitate tank heels using high-pressure water from a wash ball or similar high-pressure nozzle or nozzle arrangement simultaneously removing liquids and solids using remaining or newly installed steam jets ▪ Decontaminate the vault floor ▪ Sample and analyze tank residuals after decontamination to determine whether decontamination is complete or whether additional decontamination is required and is economical and practical ▪ Sample and analyze tank and vault residuals for comparison to action levels	4.3, 4.4

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
	▪ Isolate non-process waste lines ▪ Perform final heel management and grout tank and components.	
(2) A description of how final closure of the facility will be conducted in accordance with § 265.111, including the maximum extent of the operation, which will be unclosed during the active life of the facility.	(2) Final closure of INTEC will be performed in accordance with approved interim status or HWMA/RCRA closure plans. A discussion of the maximum extent of operation unclosed is provided in Section 7. A summary of recently collected data is provided in Appendix B.	6.5
(3) An estimate of the maximum inventory of hazardous wastes ever onsite over the active life of the facility and a detailed description of the methods to be used during partial and final closure, including waste removal methods.	(3) The maximum inventory of hazardous waste ever in the tank system is discussed in this closure plan. Liquids and solids, including the tank heels, removed from Tanks WM-182 and WM-183 will be transferred to another TFF tank for storage before treatment.	0, 4.3
(4) A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils.	(4) Ancillary equipment will be triple-flushed with decontamination solution. The tanks will be flushed iteratively with decontamination solution, and residuals will be compared to action levels to ensure that clean closure criteria will be met. Soil contamination is present at the TFF due to leaks from ancillary equipment, although contents never leaked to the environment from the tanks. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The FFA/CO has established that investigations of Solid Waste Management Unit releases would be the responsibility of the CERCLA program (IDHW, EPA, and DOE-ID 1991).	0, 4.3, 5.2
(5) A detailed description of other activities necessary during the partial and final closure period to ensure that all partial closures and final closure satisfy the closure performance standards.	(5) No other closure activities have been identified at this time.	NA
(6) A schedule for closure of each hazardous waste management unit and for final closure of the facility.	(6) Closure Schedule:	8

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
	<table><tr><th>Activity</th><th>Time for Completion</th></tr><tr><td>Approval of partial closure plan and DOE Authorization to Proceed</td><td>Day 0</td></tr><tr><td>Remove waste and decontaminate WM-182</td><td>328 days</td></tr><tr><td>Evaluate results, grout and close WM-182</td><td>339 days</td></tr><tr><td>Remove waste and decontaminate WM-183</td><td>328 days</td></tr><tr><td>Evaluate results, grout and close WM-183</td><td>339 days</td></tr><tr><td>Submit professional 60 days engineer certification (time is in addition to the 1,334 days for closure)</td><td>60 days</td></tr></table>	
(7) An estimate of the expected year of final closure for facilities without approved closure plans.	(7) Use of the remaining tanks at the TFF must cease by December 31, 2012. The INTEC facility is estimated to be closed no sooner than 2045.	4.1
(8) This section applies to facilities where the Regional Administrator has applied alternative requirements at a regulated unit.	(8) Not applicable.	N/A
(c) Amendment of plan. This section specifies requirements for amending the closure plan and includes conditions under which the closure plan must be amended, timeframes for providing the amendment, procedures for submitting the amended plan, and procedures for responding to a request for amendment by the regulatory agency.	The closure plan will be amended as necessary in accordance with the requirements of this section.	9
(d) Notification of partial closure and final closure. This section specifies when the closure plan must be submitted, the date when closure is expected to begin, and how opportunities for public comment on the closure plan will be provided.	As required by the 1992 Consent Order (and subsequent modifications) between IDHW and DOE (IDHW 1992; IDHW 1998), this closure plan was submitted to IDEQ by December 31, 2000.	8

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
(e) Removal of wastes and decontamination or dismantling of equipment. Nothing in this section shall preclude the owner or operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure.	Closure activities will be performed in accordance with this closure plan.	N/A
§ 265.113 Closure; Time Allowed for Closure		
(a) This section specifies when closure activities must begin. The Regional Administrator may approve a longer period under certain conditions, including demonstration that closure activities will, of necessity, take longer than 90 days to complete, and demonstration that all steps have been taken and will continue to be taken to prevent threats to human health and the environment, including compliance with all applicable interim status requirements.	DOE is requesting an extension to the 90-day waste removal period. An extension is required because waste removal activities will, of necessity, require longer than 90 days. Complicating factors include ▪ The highly radioactive wastes stored in the tanks will require that much of the sampling and waste removal work be performed using remote handling technology, which will require significant lead times to set up and conduct ▪ The approach for partial closure of TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in INTEC waste treatment systems for the wastes generated; operational problems in these systems could result in delays in the closure process ▪ Closure to action levels will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination. Tanks WM-182 and WM-183 are to be closed because they do not meet all applicable interim status requirements; however, all steps have been taken and will continue to be taken to prevent threats to human health and the environment.	8

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
(b) This section specifies when partial and final closure activities must be completed. The Regional Administrator may approve a longer period under certain conditions, including demonstration that partial or final closure activities will, of necessity, take longer than 180 days to complete, and demonstration that all steps have been taken and will continue to be taken to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable interim status requirements.	DOE is requesting an extension to the 180-day closure period to 1,334 days. An extension is required because closure activities will, of necessity, require longer than 180 days. Complicating factors include ▪ The highly radioactive wastes stored in the tanks will require that much of the sampling and waste removal work be performed using remote handling technology, which will require significant lead times to set up and conduct. ▪ The approach for partial closure of TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in INTEC waste treatment systems for the wastes generated; operational problems in these systems could result in delays in the closure process. ▪ Closure to action levels will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination. Tanks WM-182 and WM-183 are to be closed because they do not meet all applicable interim status requirements. However, all steps have been taken and will continue to be taken to prevent threats to human health and the environment.	8
(c) This section specifies when demonstration of conditions requiring an extension must be made.	The demonstrations necessary for extension of the closure periods requested are being submitted in this closure plan.	8
(d) This section specifies when the Regional Administrator may allow an owner or operator to receive non-hazardous wastes in a landfill, land treatment, or surface impoundment.	Not applicable.	N/A
(e) This section imposes additional requirements on the owner or operator of a hazardous waste surface impoundment that is not in compliance with the liner and leachate collection system requirements.	Not applicable.	N/A

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
§ 265.114 Disposal or Decontamination of Equipment, Structures, and Soils		
During the partial and final closure periods, all contaminated equipment, structures, and soil must be properly disposed of or decontaminated unless specified otherwise in 40 CFR 265.197, 265.228, 265.258, 265.280, or 265.310. By removing all hazardous wastes or hazardous constituents during partial and final closure, the owner or operator may become a generator of hazardous waste and must handle that hazardous waste in accordance with all applicable requirements of 40 CFR 262.	All contaminated equipment, structures, and soils generated during closure of the tank system will be characterized, stored, and treated in accordance with applicable IDAPA 58.01.05.006 (40 CFR Part 262) requirements.	6
§ 265.115 Certification of Closure		
This section specifies the schedule and procedure for submitting the closure certification. The certification must be signed by the owner or operator and by an independent registered professional engineer.	Within 60 days of completing closure of the tank system, a certification that the tank system was closed in accordance with the specified activities and closure performance standards of the approved closure plan will be submitted to the Director.	10
§ 265.197 Closure and Post-closure Care		
(a) At closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous waste. In addition, the requirements of 40 CFR Part 265, Subpart G (Closure and Post-Closure) and Subpart H, (Financial Requirements) must be met.	The closure strategy developed for the tank system will meet this regulatory requirement. Subpart G requirements are discussed in detail earlier in this matrix. Pursuant to Section 265.140(c), the federal government, as owner of Tanks WM-182 and WM-183, is exempt from Subpart H requirements. Soil contamination is present at the TFF due to leaks from ancillary equipment, although contents never leaked to the environment from the tanks. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The FFA/CO has established that investigations of Solid Waste Management Unit releases would be the responsibility of the CERCLA program.	4, 11

Table 3. (continued).

40 CFR, Part 265, Subpart G (2001) Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure		
Regulatory Requirement Summary	Compliance Strategy	Section in Plan
(b) This section specifies when closure and post-closure care must be performed in accordance with requirements for landfills. If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in Section 265.197(a) above, then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (40 CFR 265.310).	This section applies to the closure of WM-182 and WM-183. This requirement is addressed in the contingent landfill closure plan (DOE-ID 2001a).	Contingent Landfill Closure Plan
(c) This section imposes additional requirements for a tank system that does not have secondary containment that meets the requirements of 40 CFR 265.193 (containment and detection of releases), including the preparation of a contingent plan for complying with 40 CFR 265.197(b) above.	This section applies to the closure of WM-182 and WM-183. This requirement is addressed in the contingent landfill closure plan (DOE-ID 2001a).	Contingent Landfill Closure Plan

Table 4. Clean closure action levels for Tanks WM-182 and WM-183.

Constituent of Concern (Inorganic)	Action Level (mg/L)	Constituent of Concern (Organic)	Action Level (mg/L)
Aluminum	3.1E+03	Acetone	9.9E+02
Antimony	6.3E+01	Benzene	3.7E-01
Arsenic	4.2E-01	Bromomethane	1.2E+02
Barium	8.3E+01	Carbon disulfide	9.9E+02
Beryllium	5.3E+00	Carbon tetrachloride	2.9E-01
Cadmium	6.1E-01	Chloroethane	9.6E+00
Chromium	9.0E-01	Chloromethane	5.2E+00
Cobalt	7.7E+02	Cyclohexane	7.5E+03
Copper	6.0E+02	Cyclohexanone	7.0E+03
Fluoride	7.7E+02	2,4-dinitrophenol	1.4E+02
Iron	1.7E+03	Ethyl acetate	3.0E+03
Lead	4.0E+00	Ethyl benzene	9.9E+02
Manganese	4.9E+02	2-hexanone	6.3E+02
Mercury	1.6E-01	Methanol	2.2E+03
Nickel	4.4E+02	Methylene chloride	6.0E+00
Selenium	8.9E-01	Methyl ethyl ketone	1.6E+02
Silver	3.0E+00	Methyl isobutyl ketone	8.9E+02
Thallium	2.6E+01	N-nitrosodimethylamine	7.3E-02
Vanadium	2.6E+02	Polychlorinated biphenyl (Aroclor 1260)	3.7E-01
Zinc	1.7E+03	Pyridine	3.7E+00
		Tetrachloroethylene	4.5E-01
		Toluene	1.4E+03
		1,1,1-trichloroethane	4.4E+02
		Trichloroethylene	4.1E-01
		Xylene	4.4E+03

4. CLOSURE STRATEGY

The closure strategy is designed to meet the clean closure requirements described in Section 3. The waste will be removed from the tanks, piping, and vaults. The tanks, vaults, and piping will then be decontaminated. Waste removal and decontamination will begin in one tank, and will commence at the second tank when decontamination of the first tank is complete. Following decontamination, sampling and analysis will be performed, followed by data validation, data evaluation, and comparison to action levels. Grouting of the tank, tank vault, valve box vaults, and piping will occur when the data indicates that hazardous waste is not left in place and concentrations of hazardous constituents are below action levels.

As required by 40 CFR 265.111, "Closure Performance Standard," decontamination of the tanks and ancillary equipment, and grouting of the tanks, vaults, and piping will minimize post-closure escape of hazardous constituents by stabilizing the residuals in a solid matrix. Furthermore, process piping will also be capped (thus sealing any residues in the pipes) to minimize escape of hazardous constituents. The tank vaults will be decontaminated during decontamination of the pipe encasement, and samples from the vault sumps will be collected.

The closure of tanks WM-182 and WM-183 is a proof-of-process closure demonstration of highly radioactive waste tanks. The demonstration includes evaluation of results from two mockups (cold) decontamination and grouting studies. Closure activities include decontamination and removal of waste and residues, sampling and analysis of residuals, comparison to action levels, and grouting. The simplified closure sequence is shown in Figure 4. During closure, an independently registered Idaho professional engineer (PE) will review activities, data, closure methodologies, and waste management practices.

The second modification to the Consent Order (IDHW 1998) specifies that DOE must cease use of pillar and panel tanks, includingWM-182 and WM-183, by June 30, 2003, and must cease use of the remaining tanks by December 31, 2012. Ceasing use of the tanks is defined as "emptying the tanks to their heels, i.e. the liquid level remaining in each will be lowered to the greatest extent possible by the use of existing transfer equipment." Cease use activities are the final stage of operations and precede the closure activities specified in this plan.

Waste removal under closure will begin when additional water is added (flushing water) then removed in conjunction with full-scale decontamination. The steam jets may be lowered to within approximately 1.0 in. of the tank floor to enhance waste removal. The remaining residual will be decontaminated by spraying high-pressure water to clean the tank walls, agitate the heel, and to pump the resulting liquid and solid (to await further treatment) to another tank. Grout placement, which is not a part of the residual removal process, is being done to stabilize residuals and remove free liquids. The grouting will minimize the escape of hazardous constituents as described above.

The remainder of this section identifies the closure unit boundaries, the closure strategy, and the closure demonstration, including the methods and equipment to be used to decontaminate hazardous waste residues, contaminated containment system components, and contaminated structures and equipment for closure of Tanks WM-182 and WM-183. The engineering concept of closure are described in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a). Final engineering design will be completed during the during the Title II design phase.

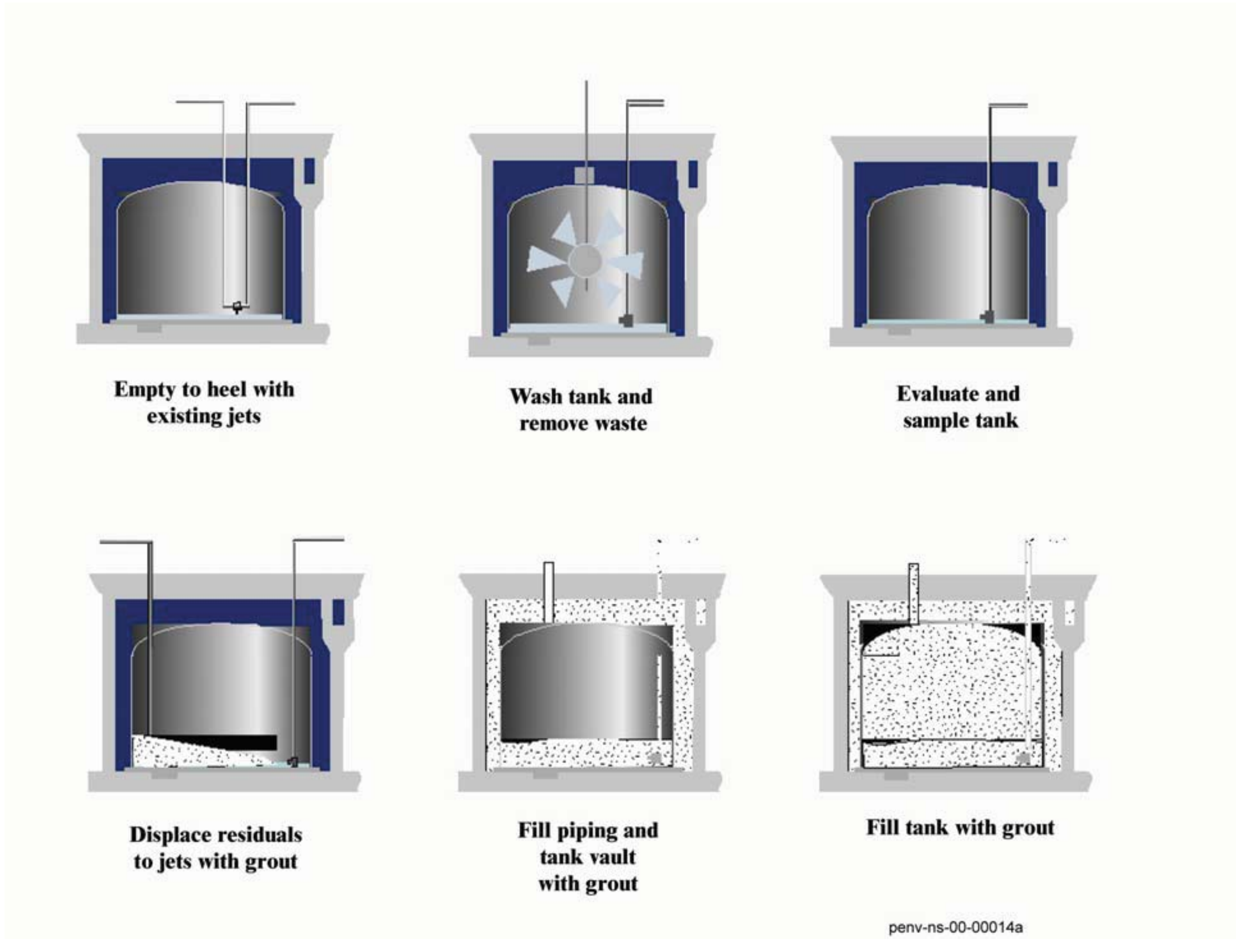


Figure 4. Simplified closure sequence.

4.1 Facility Closure

IDAPA 58.01.05.009 and 40 CFR 265.112(b)(7) (2001) state that an estimate of the expected year of final closure for facilities without approved closure plans should be provided. The HWMA/RCRA facility is the TFF, which must cease use of the remaining tanks by December 31, 2012. The INTEC is a facility that has a future use projection, "…that in 50 years the INTEC would be approaching the end of useful life if no new mission is identified" (DOE-ID 1995). It is estimated that the INTEC facilities will be closed no sooner than 2045. The following paragraphs provide a description of the closure unit boundaries.

Closure of Tanks WM-182 and WM-183 constitutes a partial closure of the TFF. The remainder of the TFF will continue to operate during the closure actions. Because Tanks WM-182 and WM-183 may share associated piping and ancillary equipment with other tanks in the TFF, definition of the tanks and related components or, more specifically, the tank systems being closed is necessary.

For the purposes of this closure, the WM-182 tank system comprises Tank WM-182 (VES-WM-182), Vault CPP-782, and ancillary equipment such as piping, pumps, valve boxes, and associated Tank WM-182 piping and valves within the TFF Control House (CPP-628). The control house contains the steam, water, air, cooling, and instrumentation lines for Tank WM-182. This building also contains similar equipment for other TFF tanks, which will not be closed as a part of this closure plan.

Piping and valves associated with Tank WM-182 will be isolated. Isolation will be accomplished by one of several methods including, but not limited to, closing and locking valves, cutting, capping, or grouting. Other ancillary equipment isolation points included in the WM-182 tank system closure are the condenser pit (CPP-721) and Valve Boxes A5 (DVB-WM-PL-A5), and A6 (DVB-WM-PL-A6). Figure 5 shows the WM-182 and WM-183 tank systems to be decontaminated for closure. Figure 6 shows ancillary equipment that will be taken out of service during closure but will not require decontamination because it has not contacted hazardous waste. Examples of ancillary equipment that did not contact hazardous waste include equipment installed but never used, the supplied air or steam supply to the tank system, and the equipment used for instrumentation connections.

The following line and equipment designators are used in Figures 5 and 6: CA and DCN – decontamination line; DVB – valve box; HAS – high pressure steam; INST – instrumentation; LAA – low pressure air; PLA, PUA, PWA – process waste lines; SR – sump riser; TR – tank riser; WRA – cooling solution return line; and WSA – cooling solution supply line.

The WM-183 tank system includes Tank WM-183 (VES-WM-183), Vault CPP-783, and ancillary equipment (i.e., piping, pumps, valve boxes, and associated Tank WM-183 piping and valves within the TFF Control House). Piping will be isolated. Other ancillary equipment isolation points included in the WM-183 tank system closure are the condenser pit (CPP-722) and Valve Boxes A5 (DVB-WM-PL-A5) and A6 (DVB-WM-PL-A6). Some valve boxes are included in both closures because either they contain piping that service both tanks or piping is routed through the valve box to the storage tanks. As in the WM-182 tank system, the ancillary equipment for other TFF tanks will not be closed as a part of this closure plan. Appendix D contains a piping list for closure of Tanks WM-182 and WM-183. Tables D-3 and D-4 show piping and conduit that do not require decontamination or closure.

4.2 Initial Decontamination and Mockup Studies

Two separate activities took place during calendar year 2000 that tested the decontamination and removal techniques for tank closure. At TFF, decontamination studies in the tanks determined the effectiveness of wash nozzles; at the mockup facility, tank decontamination, steam jet testing, and remote video camera testing were conducted.

Initial wash ball decontamination studies at TFF were conducted in fiscal years 2001 and 2002. The wash ball device delivers high-pressure water to nozzles that move in a pattern. The nozzle orifice and movement were evaluated and adjusted to improve surface contact. The wash ball was lowered into the tank through one of the tank risers (openings). High-pressure water from the wash ball impacted the tank walls and roof and agitated the tank heel. The resulting wash and waste-filled fluid was pumped to another TFF tank to await treatment. A video camera and lighting was installed to monitor and record the decontamination efforts. The decontamination efforts were of short duration but demonstrated the effectiveness of the system.

A tank mockup was constructed at an offsite industrial-use building to duplicate the specific TFF tanks being closed, though building size constraints limited the mockup to a half-circumference tank with a 25-ft radius and 20-ft height. The mockup tank included cameras, stainless-steel panels, piping to simulate cooling coils, and steam jets. In the tank mockup, the wash ball testing included changing water pressure, nozzle orifice, and nozzle type to test variations on the effectiveness of waste removal and decontamination of the tank. Steam jet testing was evaluated for removal of solids and liquids from the tank heel. In 1999, a mockup was performed to determine the effectiveness of grout to displace the tank heel.

These studies were used to determine whether the decontamination methods selected would be sufficient for removing residual material from the sides of the tanks and for agitating the tank heels to allow the solid heel to be removed. Video of the testing was taken to enable a visual evaluation of the effectiveness of the decontamination. These three mockups demonstrated that the waste removal and decontamination designs would be successful in the TFF tanks.

4.3 Closure

4.3.1 General Closure Activities

The high-pressure water from a wash ball (or similar high pressure nozzle or nozzle arrangement to wash the tank walls and agitate the tank heels) will be used to remove waste and decontaminate the tank. The decontamination fluid for WM-182 and WM-183 closure will be demineralized water. Water will be obtained from water sources near the TFF. Liquids and solids will be removed using the steam jets (or other types of pumps) simultaneously with wall decontamination and heel agitation. The liquids and solids removed from Tanks WM-182 and WM-183 will be stored in an existing TFF tank to await treatment. A video camera and lighting will be installed to monitor and record removal and decontamination efforts. For activities where hazardous constituent contamination may exist, confinement (e.g., temporary enclosures and high-efficiency particulate air [HEPA] filter structures) will be placed to minimize risk of contamination spread.

The ancillary equipment to the tanks consists of valve boxes, piping, trenches, and condenser pits. The following paragraphs and Table 5 describe the piping associated with each of the valve boxes and condenser pits. This provides an overview of the ancillary equipment associated with the closure of WM-182 and WM-183. Not all the ancillary equipment in the following description will be closed (decontaminated and grouted) during this phase of closure. Some equipment has never contacted hazardous waste, while other equipment is not scheduled to be closed during this phase of closure. The instrumentation conduit shown in Figure 6 contains wiring. The conduit has been sealed at both ends to prevent entry of hazardous constituents. Ancillary equipment such as Condenser Pit CPP-722 cannot be closed because it is important to other TFF tank closures.

TFF tank systems WM-182 and WM-183 use numerous piping routes to transfer waste solutions, vessel off-gas, and high-pressure steam to and from each tank. Valves housed in diversion valve boxes (DVBs) or condenser pits are used to manipulate all piping transfer routes to and from the TFF tanks. Valve Boxes and Condenser Pits directly associated with Tank WM-182 and WM-183 closure are Valve Boxes A5, A6, C1, C2, C5, C6, C15, C40, CPP-721, and CPP-722. Only Valve Boxes A5 and A6 will be decontaminated and grouted (closed) during this first phase of closure. Valve boxes C2 and C5 will be decontaminated. The descriptions of the valve boxes below are included to list piping associated with each valve box. Only the piping and valve boxes shown in green on Figure 5 are to be closed during this phase of the TFF closure.

DVB-A5 houses valves and process waste piping used to transfer waste from DVB-A6 to tanks WM-182 and WM-183. Two 3-in. lines (PWA-601 and PWA-602) transfer waste from DVB-A6 to DVB-A5. In DVB-A5, waste is diverted to tank WM-182 via 3-in. process waste lines PWA-601 and PWA-602, and to tank WM-183 via 3-in. lines PWA-609 and PWA-610. Liquids present in DVB-A5 drain into tank WM-183 via 1-in. process waste line PWA-653.

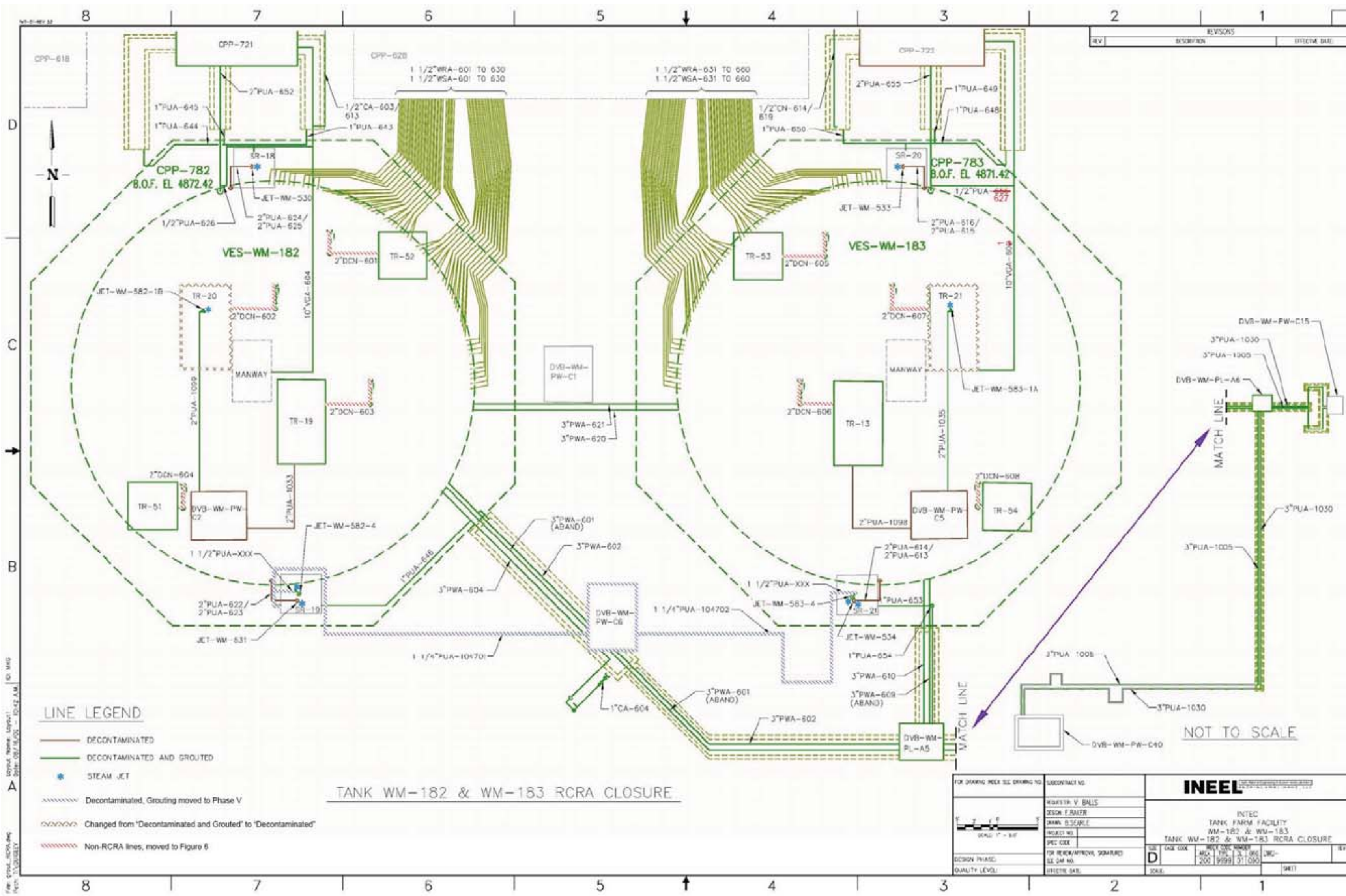


Figure 5. Tank WM-182 and WM-183 systems to be decontaminated during closure.

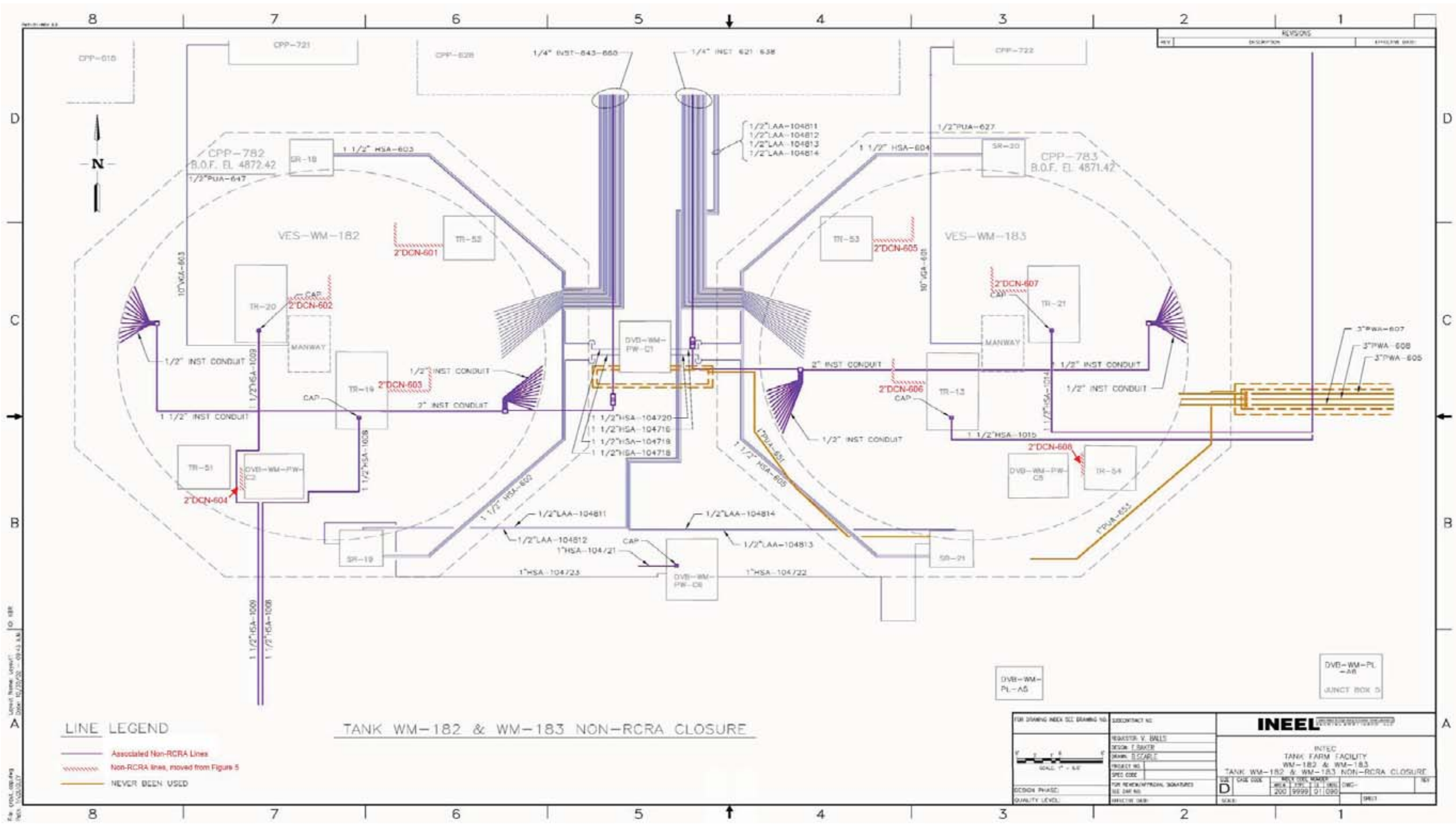


Figure 6. Tank systems that do not require decontamination.

Table 5. Equipment associated with WM-182 and WM-183.

Ancillary Equipment	Description	Comments
SR-18	North vault sump riser for WM-182	Jet WM-530 in sump for transfers to Tank WM-182
SR-19	South vault sump riser for WM-182	Jet WM-531 uses Jet-WM-582-4 to transfer to sump jet header to PEW evaporator
SR-20	North vault sump riser for WM-183	Jet WM-533 in sump for transfers to Tank WM-183
SR-21	South vault sump riser for WM-183	Jet WM-534 uses Jet-WM-583-4 to transfer to sump jet header to PEW evaporator
TR-13	Tank riser for WM-183	Jet WM-583-1A will be removed to install wash ball and video camera
TR-19	Tank riser for WM-182	Jet WM-582-1A will be removed to install wash ball and video camera
TR-20	Tank riser for WM-182	Jet WM-582-1B will be replaced with jet closer to tank bottom
TR-21	Tank riser for WM-183	Jet WM-583-1B will be replaced with jet closer to tank bottom
TR-51	Tank riser for WM-182	Held corrosion coupons; will use directional nozzles and grout mast in this riser and obtain samples with light-duty utility arm
TR-52	Tank riser for WM-182	Instrumentation for tanks will be removed and directional nozzle and grout mast will be used during closure
TR-53	Tank riser for WM-183	Instrumentation for tanks will be removed and directional nozzle and grout mast will be used during closure
TR-54	Tank riser for WM-183	Held corrosion coupons; will use directional nozzles and grout mast in this riser and obtain samples with light-duty utility arm
DWB-WM-PW-C1*	Valve box	Supplies steam for WM-182 and WM-183 vault steam jets
DWB-WM-PW-C2	Valve box for WM-182 waste transfer lines	Receives waste from two jets in WM-182 and transfers to Tank Farm waste header
DWB-WM-PW-C5	Valve box for WM-183 waste transfer lines	Receives waste from two jets in WM-183 and transfers to Tank Farm waste header
DWB-WM-PW-C6 (grouting will be performed during Phase V)	Valve box for WM-182 and WM-183 south sump waste transfer lines	Receives waste from jets in vaults WM-182 (Jet WM-582-4) and WM-183 (Jet WM-583-4) and transfers to Tank Farm sump header

Table 5. (continued).

Ancillary Equipment	Description	Comments
DWB-WM-PW-A5	Valve box for WM-182 and WM-183	Transfers waste from Valve Box A6 to WM-182 and WM-183
DWB-WM-PW-A6	Valve box for WM-182 and WM-183	Transfers waste from Tank Farm to Valve Box A5 from WM-182 and WM-183 to Tank Farm
CPP-721	Ventilation pit for WM-182	Contains pressure/vacuum relief valves and an out of service vent line condenser
CPP-722*	Ventilation pit for WM-183 and WM-185	Contains pressure/vacuum relief valves and an out-of-service vent line condenser
CPP-628*	TFF Control House	Control building for Tank Farm instrumentation and transfer valves

* The equipment or buildings will not be closed during closure of WM-182 and WM-183.

DVB-A6 houses valves and process waste piping used to transfer waste to DVB-A5. Waste enters DVB-A6 via 3-in. process waste lines PWA-1005 and PWA-1030. In DVB-A6, the process waste lines converge into 3-in. process waste line PWA-602, which transfers waste to DVB-A5 or to DVB-C15 (line transitions to 3-in. PWA-1030 for routing to DVB-C15). Liquids present in DVB-A6 drain to DVB-A5 via 1-in. process waste line PUA-654.

DVB-C1 houses valves and high-pressure steam piping used to operate steam jets located in the WM-182 and WM-183 vault sumps. Steam is transferred from CPP-628 to DVB-C1, where it is routed to steam jets located in the WM-182 and WM-183 vault sumps. The 1½-in. steam lines HSA-602 and HAS-603 transfer high-pressure steam to the WM-182 south and north vault sump jets, respectively. The1½-in. steam lines HSA-604 and HAS-605 transfer high-pressure steam to the WM-183 north and south vault sump jets, respectively. All piping in DVB-C1 has not been in contact with hazardous waste and is not part of the WM-182 and WM-183 tank closure. DVB-C1 may be grouted as an activity coincidental to closure.

DVB-C2 houses valves and process waste piping used to transfer waste from WM-182. Process waste is transferred from WM-182 via steam jet through 2-in. process waste lines PUA-1033 and PUA-1099 to DVB-C2 where they converge into 3-in. process waste line PUA-1033 (not included in the closure). All piping beyond PVV-WM-115/116 (the junction inside of DVB-C2) is not included in the closure.

DVB-C5 houses valves and process waste piping used to transfer waste from WM-183. Process waste is transferred from WM-183 via steam jet through 2-in. lines PUA-1035 and PUA-1098 to DVB-C5, where they converge into 3-in. line PUA-1035 (not included in the closure). The 3-in. process waste line then is routed to DVB-C3 and on to DVB-C7 or CPP-780 as stated in the previous paragraph.

Liquids that may be inside DVB-C5 are drained via 1-in. line PLA-104771 to DVB-C12. All piping beyond PVV-WM-121/122 (the junction inside of DVB-C5) is not included in the closure.

DVB-C6 houses valves and high-pressure steam piping used to operate steam jets located in the WM-182 and WM-183 vault sumps. Steam is transferred from CPP-628 to DVB-C6 where it is routed to jets located in the WM-182 and WM-183 south vault sumps via 1-in. steam lines HSA-104723 and

HAS-104722, respectively. Liquids transferred from the WM-182 and WM-183 vault sumps are routed back through DVB-C6 via 1¼-in. waste lines PLA-104701 and PLA-104702, respectively. In DVB-C6, the two waste lines converge into 1½-in. process waste line PLA-104701, which is routed to DVB-C10. Liquids that may be inside DVB-C6 are drained via 1-in. line PLA-104770 to DVB-C12.

Valve Boxes C40 and C15 contact 3" PUA 1030 and 3" PUA 1005. These valve boxes will be termination points for closure activities; therefore, they will not be closed during the closure of Tanks WM-182 and WM-183.

Historical records indicate that the process waste lines 3" PWA-607, 3" PWA-608, 3" PWA-605, and their secondary containment have never been connected to process waste lines and, therefore, were never used. The 1" PUA-653 is the decontamination line from the trench, which contains lines PWA-607, PWA-608, and PWA-605 (see Figure 6). Since the pipes have never been attached, the trench has never been used and, consequently, the decontamination line PUA-653 has never been used.

The drain line 1" PUA 651 is the drain for the secondary containment of the overflow lines (3" PUA 620 and 3" PUA 621) for tanks WM-182 and WM-183. Therefore, it has never been used because the drain lines are above the administratively controlled tank level of 285,000 gallons. Based on operating records, the administrative level has never been exceeded. Lines 3" PUA 620 and 3" PUA 621 will be decontaminated using the wash ball and directional nozzles. The lines will be grouted as tanks WM-182 and WM-183 are filled with grout.

4.3.2 Tank Isolation and Decontamination of Ancillary Systems

The following discussion outlines the steps required to isolate Tanks WM-182 and WM-183 from the rest of the TFF to allow closure activities to take place. Isolation of the tanks and process lines will be accomplished by one of several methods including, but not limited to, closing and locking valves, cutting, capping, or grouting. The remainder of this section also describes the decontamination of ancillary systems associated with Tanks WM-182 and WM-183. The steps are taken from information on the isolation activities developed by the INEEL High-Level Waste Program. Details on the tank isolation activities are presented in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a). Generally, the activities include

- Valve box decontamination
- Process line isolation
- Pipe encasement decontamination
- Vault sump decontamination
- Vessel off-gas system isolation
- Tank access
- Non-process waste line isolation
- Tank decontamination.

Table 6 outlines the washing and cleaning sequence for TFF piping and equipment associated with closure of WM-182 and WM-183. The activities have been segregated into stages based on construction logic following the previously stated closure sequence. The decontamination sequence may change based on field conditions. Care would be taken to ensure that closure performance standards would not be jeopardized. These decontamination sequence changes would not jeopardize the closure performance standards, would be considered minor deviations, and would be noted by the independent PE during certification. Therefore, sequence changes would not require an amendment to the closure plan.

Cleaning operations will begin with the valve boxes and end with the two steam jet lines required to remove decontamination fluids displaced during the initial grout placements in the waste tanks. This logical progression through lines and equipment ensures that cleaned areas will not be re-contaminated as cleaning operations continue within the closure boundaries. Figures 5 and 6 show the closure equipment and piping.

4.3.2.1 Valve Box Decontamination. Isolation of Tanks WM-182 and WM-183 will begin with decontamination of selected valve boxes. Decontamination equipment will be used in the valve boxes and connected to a water source. The inside surfaces of each valve box will be decontaminated. The decontamination fluids will be allowed to drain through existing drains in the valve boxes to the vault sumps, flushing the drain lines and vault, the vault sump, and vault floor. The existing steam jet pumps in each tank vault sump (one jet in the north sump, two jets in the south sump of both tanks) will be used to pump out the decontamination fluid. Samples of decontamination solution will be collected from the vault sumps. Valve Boxes A5 and A6 drain to the tank vault sump, but the C6 valve box drains to Valve Box C12, which is not part of the closure of WM-182 and WM-183.

The data obtained from final decontamination will be included in the comparison to action levels. Samples of decontamination solution will be collected prior to grouting. Only one sample will be collected from each tank vault sump. A sample will be collected from C6 following decontamination. Final decontamination water will be collected from the bottom of C6 before it is allowed to drain to Valve Box C12.

4.3.2.2 Pipe Encasement Decontamination. The stainless-steel-lined concrete encasements that provide secondary containment for process waste lines will be decontaminated. Each encasement will be triple rinsed with decontamination solution. The decontamination fluids will be allowed to drain through existing 1-in. drain lines to the south vault sumps to decontaminate the drain lines. The residual remaining in the tank vault sumps will be sampled and analyzed for comparison to action levels (Portage Environmental 2001b). Decontamination fluids that accumulated in the sumps of each vault will be transferred using existing steam jets to the PEW evaporator after samples have been collected.

The north sump collects waste from the sumps in the condenser pits. These condenser pits contain the vessel off-gas lines that are leaving Tanks WM-182 and WM-183. The north sump does not collect process waste and divert it to the vault.

Condenser Pit CPP-721 houses valves, vessel off-gas piping, process waste piping, air supply piping, and Condenser HE-WM-382. Off-gas is routed from Tank WM-182 to Condenser Pit CPP-721 via 10-in. off-gas line VGA-604, where it passes through HE-WM-382 to remove any condensable liquids in the gas stream. The off-gas then is routed from CPP-721 to CPP-604 through 4-in. off-gas line VGN-601 (not included in the closure). Condensed liquids drain from HE-WM-382 back into tank WM-182 via 2-in. waste line PUA-652. Ventilation is supplied to Tank WM-182 via 10-in. air supply line VGA-603 from CPP-721. Liquids that may be inside CPP-721 are collected in a sump and are jetted to CPP-628 via 1-in. waste line PLA-663 (not included in the closure).

Table 6. Washing and cleaning sequence for piping and equipment associated with closure of Tanks WM-182 and WM-183.

Tank Component	Component Description
Stage 1	
2” PUA-1033 (vertical section)	Steam jet WM-582-1A
2” PUA-1033 (horizontal section)	Process waste line
Stage 2	
3” PWA-602	Process waste line
3” PUA-604 with 1” CA-604	PUA-604 process waste line (spare)
	CA-604 decontamination line
3” PUA-610	Process waste line
2” PUA-1098	Steam jet WM-583-1A
3” PUA-1005 from Valve Box C40 and C15 to A6	Process waste line
3” PUA-1030 from Valve Box C40 and C15 to A6	Process waste line
Stage 3	
3” PWA-601 (operationally abandoned)	Process waste line
3” PWA-609 (operationally abandoned)	Process waste line
Stage 4	
A6 (Valve Box)	
A5 (Valve Box)	
C6 (Valve Box)	
C2 (Valve Box)	
C5 (Valve Box)	
Trench between Valve Box A5 and A6	
Trench between Valve Box A5 and WM-182/WM-183	
Secondary containment from C15 to A6	
Secondary containment from C40 to A6	
Vault floor and vault sumps (Tanks WM-182 and WM-183)	
1” PUA-646	Process drain line
1” PUA-654	Process drain line
1” PUA-653	Process drain line
Stage 5	
CPP-721 and trenches	
1” PUA-643	Process drain line
1” PUA-644	Process drain line

Table 6. (continued).

Tank Component	Component Description
1" PUA-645	Process drain line
CPP-722 and trenches	
1" PUA-648	Process drain line
1" PUA-649	Process drain line
1" PUA-650	Process drain line
Stage 6	
2" PUA-624	Steam jet WM-530
2" PUA-622	Steam jet WM-531
2" PUA-616	Steam jet WM-533
2"PUA-614	Steam jet WM-534
2"PUA-623	Steam jet WM-531
2" PUA-625	Process waste line
2" PUA-615	Process waste line
2" PUA-613	Process waste line
1-1/4" PUA-104701	Process drain line
1-1/2" PUA-XXX (SR-19 jet)	Process waste line
1-1/4" PUA-104702	Process waste line
1-1/2" PUA-XXX (SR-21 jet)	Process waste line
Stage 7	
2" DCN-601	Decontamination line
2" DCN-602	Decontamination line
2" DCN-603	Decontamination line
2" DCN-604	Decontamination line
2" DCN-605	Decontamination line
2" DCN-606	Decontamination line
2" DCN-607	Decontamination line
2" DCN-608	Decontamination line
Stage 8	
VES-WM-182 (tank)	
10" VGA-604	Vessel off-gas line
1/2" PUA-626	Process drain line
2" PUA-652 (2" PWA-652)	Process waste line
3" PWA-620	Process waste overflow line

Table 6. (continued).

Tank Component	Component Description
3” PWA-621	Process waste overflow line
1/2” CA-603/613	Decontamination line
Stage 9	
TR-52	WM-182 tank riser
TR-20	WM-182 tank riser
TR-19	WM-182 tank riser
TR-51	WM-182 tank riser
Stage 10	
VES-WM-183 (tank)	
10” VGA-601	Vessel off-gas line
1/2” PUA-656	Process drain line
2” PUA-655 (2” PWA-655)	Process waste line
1/2” CN-614/619	Decontamination line
Stage 11	
TR-53	WM-183 tank riser
TR-13	WM-183 tank riser
TR-21	WM-183 tank riser
TR-54	WM-183 tank riser
Stage 12[a]	
1-1/2” WSA-601 through WSA-660	Cooling solution supply line
1-1/2” WRA-601 through WRA-660	Cooling solution return line
Stage 13	
2” PUA-1099	Steam jet WM-582-1B
2” PUA-1035	Steam jet WM-583-1B

a. The cooling coil lines may be cleaned at any stage of the process.

Condenser Pit CPP-722 houses valves, vessel off-gas piping, process waste piping, air supply piping, and Condenser HE-WM-383. Off-gas is routed from Tank WM-183 and Tank WM-185 to Condenser Pit CPP-722 via 10-in. off-gas lines VGA-601 and VGA-1002 (not included in the closure), respectively. In CPP-722, off-gas is passed through HE-WM-383 to remove any condensable liquids in the gas stream. The off-gas then is routed from CPP-722 to CPP-604 through 4-in. off-gas line VGN-603. Condensed liquids drain from HE-WM-383 back into Tank WM-183 or WM-185 via 2-in. waste line PUA-655 or 1½-in. waste line PUA-1022 (not included in the closure), respectively. Ventilation is supplied to Tank WM-183 via 10-in. air supply line VGA-602. Liquids that may be inside CPP-722 are collected in a sump and are jetted to CPP-628 via 1-in. waste line PLA-676 (not included in the closure).

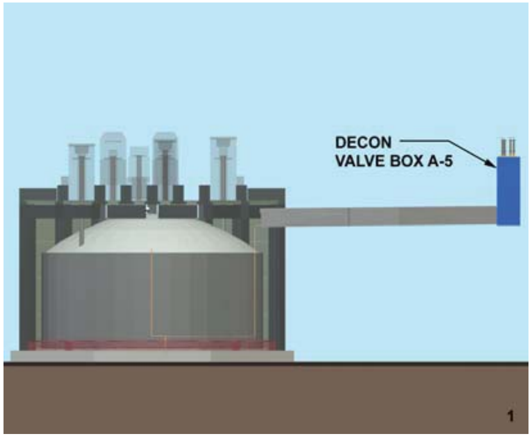
The pipe encasement decontamination also will allow for decontamination of the tank vault floor. Historically, the only method that waste could have entered the vaults is from valve or pipe leaks, which were collected in the encasements that drain to the vault sump. The volume of liquid released to the vault sump and, subsequently, to the vault floor was minimal. Radiation detection instrumentation located in the vault sump alerted operators to a leak. Infiltration of water during spring runoff and during significant precipitation events has covered the vault floor. This water likely has served to help remove any waste that had been discharged to the vaults from the pipe encasements. During closure, decontamination fluid will be introduced into the encasement and will flow into the vault sump and onto the vault floor, following the path by which waste may have previously entered the tank vault. The rinsing sequence will be performed three times with a sufficient volume of demineralized water to ensure adequate vault floor coverage. Figure 7 shows the decontamination flow path. In this way, the flushes will decontaminate both the encasements and the vault floor. The decontamination fluid will be pumped out as described above and samples will be collected. Sampling will be indicative of the residual left in the vault sump from the encasements and the tank vault.

4.3.2.3 Vault Sump. Lines leading from the vault sumps into Tanks WM-182 and WM-183 will be decontaminated using existing steam jets. Waste lines in each of the vault sumps will be flushed with a pre-determined volume and emptied into the respective tanks. The two remaining 1¼-in. lines in the south vault sumps are used to transfer liquids to the PEW evaporator and will be decontaminated later in the TFF closure process. These lines will be terminated at Valve Box C6 as shown in Figure 5. The residual decontamination solution from these sumps will be sampled for comparison to action levels. After decontamination of the vault liquid removal lines is completed, the valves on the steam supply lines to the sump jets in Valve Box C1 will be administratively isolated.

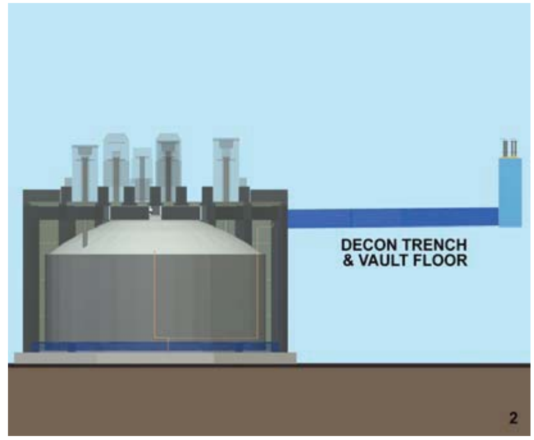
Data from various locations, such as the tank vault sump and the tanks, will be evaluated using statistical techniques. Several different statistical methods will be applied to the TFF closure data. There are two primary objectives with regard to the statistical analysis that will be performed on the data. The first objective is to determine if the constituents of interest are present in levels greater than the specified action level. The second objective is to determine if the contents of the tanks and the vault sumps come from the same population. The description of the proposed statistical analysis is presented in Appendix E.

4.3.2.4 Process Waste Line Isolation. Process waste lines to be closed will be isolated in valve boxes. Split-flow valve cartridges may be installed to replace various valves on process waste lines to enable grout to be placed in the lines leading to the tanks, while allowing decontamination and subsequent grouting of lines leading to other portions of the TFF. Split-flow valve cartridges were designed to isolate pipelines without having to manually and/or remotely cut and remove pipe sections in contaminated areas. Use of these cartridges limits worker exposure and minimizes pipe cutting and welding in hazardous environments. A split-flow valve cartridge replaces the ball valve components with a separating plate.

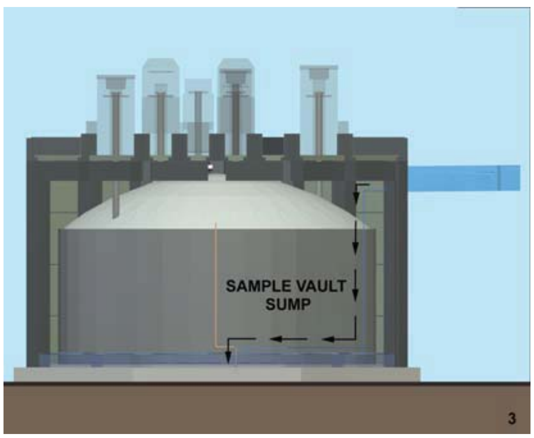
Process waste lines will be triple rinsed with decontamination fluid, which will be drained to Tank WM-182 or Tank WM-183, depending on which system is being decontaminated. Triple flushing with water has been successfully used to decontaminate piping in the TFF to remove residual waste from piping, reduce radiation fields, and limit the potential for airborne radioactivity. Historically, successful decontamination of the lines has been performed during maintenance and repair work on the systems (i.e., valve replacement or repair requiring welding of lines). During the work, lines were decontaminated. The process used water flushing through the lines from a decontamination connection inside the TFF Control House (CPP-628). Water flushing procedures proved effective for the lines as demonstrated by visual inspection of the lines after cutting in preparation for welding. The lines were observed to be free of liquids and loose solids during the inspections (Demmer 1996).



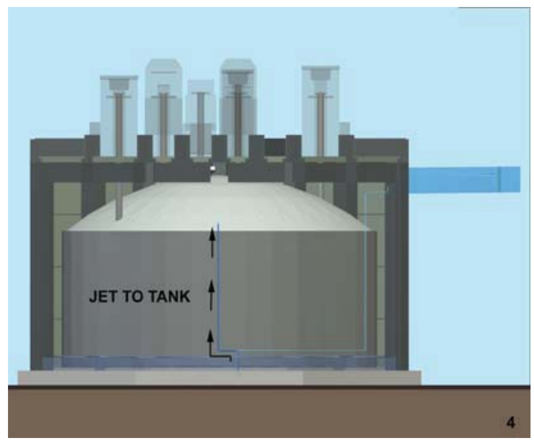
1. The valve box is decontaminated first.



2. Next, the piping trench and vault floor are decontaminated.



3. Samples of the decontamination rinse water are obtained from the vault.



4. Vault steam jets pump the decontamination rinse water into the respective tank.

Figure 7. The valve box, piping trench, and vault floor decontamination flow path.

Aqueous nitric acid also has been used for decontamination during waste transfers through the lines (Demmer 1996). After waste transfers containing solids in solution or suspension were completed, the piping was flushed with water. Nitric acid is the most commonly used decontamination chemical at INTEC. Many of the processes at INTEC contain solid material that is soluble in nitric acid, and the waste itself is nitric acid-based. During transfer, nitric acid transfer solutions remove solids in the lines and valves. The triple water flush of the pipelines is intended to remove liquids and any loose solids remaining from waste transfers.

To further validate the effectiveness of triple rinsing with water, piping removed from WM-182 will be triple rinsed with water. A horizontal and vertical section of line PUA-1033 (2 in. diameter) that transfers process waste from WM-182 will be examined to determine the effectiveness of triple rinsing. PUA-1033 is the outlet line for Steam Jet WM-582-1A. Two pieces of pipe will be visually examined, and the interior surface will be recorded with still and video cameras. Rinsate samples will be collected from the two pieces of pipe by stopping one end, filling with one volume of demineralized water, letting it stand, and then decanting into sample bottles. The analysis will be performed for metals; the results will be compared directly to the action levels shown in Section 3.2. The sampling and analysis is detailed in the *Sampling and Analysis Plan for the Post-Decontamination Characterization Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (Portage Environmental 2001b).

The demonstration of the triple rinse on piping will be followed by 90-day debris treatment methods similar to those used in the past by HLW operations. WM-183 piping will be examined in FY-2002 and rinsate samples collected for determining the effectiveness of triple rinsing.

4.3.2.5 Vessel Off-Gas System Isolation. Closure activities may require a temporary vessel off-gas system to be installed to maintain negative airflow on Tanks WM-182 and WM-183 during some closure or grouting activities. The temporary system will be installed into existing lines connected to the tank risers. The 10-in. line (VGA-601) that vents air from Tank WM-183 will be cut between the tank vault (CPP-783) and the condenser pit (CPP-722). This location was chosen instead of a location inside the condenser pit because the line inside the condenser pit needs to be maintained to service tank WM-185. Cutting into the vessel off-gas line may require excavation. After the line is cut, piping will be installed on both cut ends up to the ground surface for later access. Temporary caps will be installed on the new piping and the excavation will be backfilled. Excavated soil will be managed according to the task-specific soil management plan described in Section 6.4.

The portion of the 10-in. vessel off-gas line connected to Tanks WM-182 and WM-183 will be decontaminated by removing the temporary cap, connecting a low-volume spray nozzle, and spraying the pipe three times with decontamination solution.

4.3.2.6 Removal of System Components. After the covers are removed from the risers using standard INTEC procedures, steam and process waste lines inside the tank risers will be isolated.

Steam jet assemblies WM-582-1A in Tank WM-182 and WM-583-1A in Tank WM-183 will be removed from the tank risers, decontaminated, and bagged for disposal. Liquid level indicators installed in the tanks through TR-52 and TR-53 and corrosion coupons installed in the tanks through TR-51 and TR-54 will be removed and managed in accordance with applicable regulations as discussed in Section 6.3. Tank washing and video surveillance systems will be installed in the tank risers closest to the center of the tanks (TR-13 and TR-19). The remaining steam jets in tanks WM-182 and WM-183 or new steam jets in the same location will be used to remove waste and decontaminate the tanks. These steam jets may require modification to adjust their operating heights. The jets will not be removed, as discussed in the next section.

4.3.3 Tank Decontamination

The steam jets will be used to pump out as much of the tank heels as possible. The washing system will agitate the heels to allow more effective waste removal. The solids will be suspended in liquid by the agitation as demonstrated by the mockup testing. It is expected the steam jets will effectively remove the heel. The steam jets will not be removed at the end of decontamination but will be effectively decontaminated by removing thousands of gallons of decontamination fluid from the tank. If the tank liquid meets specified action levels, the steam jet will be assumed to be decontaminated. Engineering studies prepared for the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a) have indicated the steam jets will effectively remove the tank heel. The tank heel will be sent to another existing tank within the TFF. The tank washing and video systems will be activated to wash the tank walls. The steam jets will be operated during washing to remove waste residues. Video systems will be used to evaluate and record the effectiveness of the tank wall decontamination. The sampling and analysis approach is described in detail in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals* (Portage Environmental 2001c).

The initial tank washing sequence is designed to remove contaminants and provide incidental pH adjustment of the heels. The final pH in the decontaminated tank residuals will be confirmed to be greater than 2.0 but less than 12.5.

After decontamination, the tank residuals will be sampled to determine their final composition. Samples will be obtained using a light-duty utility arm, or other sampling device, to be installed in a tank riser. These samples will be used for comparison to action levels. During tank decontamination, a visual inspection by the remote camera and review of in situ monitoring will provide the information necessary to cease decontamination.

The data collected from sampling the residuals will be used to determine if the decontamination was successful. Successful decontamination is defined as removing hazardous waste and meeting the criteria described in Section 2.1. If the data are conclusive regarding removal of hazardous waste, decontamination efforts will stop and the data will be compared to action levels to determine if clean closure has been achieved. If the concentration of contaminants exceeds the action levels, decontamination will continue until the process is no longer economical or practical. Landfill closure will be determined at final closure of the TFF.

4.3.4 Non-Process Waste Line Isolation

The cooling coil lines for Tanks WM-182 and WM-183 (sixty 1½ -in. lines for each tank) will be decontaminated by decontamination solution flushes. The decontamination solution from the cooling coils will be sampled and disposed of in accordance with applicable regulations. The 6-in. supply and return headers for each tank will be disconnected in the TFF Control House (CPP-628). The active supply and return lines for the cooling system will be temporarily capped. Following flushing, the supply headers for each tank will be connected to a compressed air supply and purged with air. After purging, the cooling coil lines will be disconnected at the headers and both ends will be temporarily capped. Tank instrumentation lines for Tanks WM-182 and WM-183 will be isolated from each line in the TFF Control House. Each pipe will be filled with grout to the maximum extent possible and capped. Grout will be pumped into each pipe until refusal. Two 2-in. electrical conduits that carry 24 thermowell instrumentation lines to each tank will be cut inside the TFF Control House. The portions of these conduits inside the building will be disposed of appropriately, and the portions leading to the tanks will be permanently capped.

4.3.5 Sampling of Tank Residuals and Ancillary Equipment

Both during and at the conclusion of decontamination activities, samples of tank residuals will be collected to determine the concentrations of hazardous constituents remaining in the tanks. During the tank washing, a radiation detection instrument will be used to measure radiation levels of waste removed from the tanks. When the concentrations of radionuclides are reduced and begin to stabilize, the decontamination will cease. The correlation of removal efficiency between radionuclides and metals in the tank will be sufficient to determine when decontamination efficiency has been maximized, indicating that sampling for comparison to action levels may begin. Samples of the residual will be collected to confirm that decontamination has occurred.

The samples will be analyzed for hazardous constituents and radionuclides. The sample data will be used to determine if clean closure objectives have been reached. The sample data for hazardous constituents will be used for comparison to the action levels. If the action levels have not been reached, decontamination may resume if it is determined further efforts are likely to be successful. The sampling and analysis approach is described in detail in the *Sampling and Analysis Plan for the Post-*

Decontamination Characterization of the WM-182 and WM-183 Tank Residuals (Portage Environmental 2001c).

Samples also will be collected in the tank vault sumps, and from Valve Box C6. These samples are described in the sampling plan referenced above. All sample data from the tanks and ancillary equipment will be examined to determine if they are from the same population. The statistical analysis to determine if the data is from the same population is included in Appendix E. The 95% upper confidence level around the mean of each population will be used to compare to the contaminant specific action level. Action levels are shown in Table 4 and the methodology for calculation is explained in Appendix C.

Samples will be collected from a process waste pipe in each of the Tanks WM-182 and WM-183. The pipes will be triple rinsed before they are removed from the tank. A section of the pipe will be prepared to take a rinsate sample of the residual contamination. The rinsate sample data collected only from metals will be compared directly to the contaminant-specific action levels shown in Table C-4. The sampling and analysis is detailed in the *Sampling and Analysis Plan for the Post-Decontamination Characterization Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (Portage Environmental 2001b).

4.4 Grouting Activities

After tank isolation activities are completed, a determination has been made regarding the effectiveness of decontamination, and decisions for DOE closure and HWMA closure have been made, final heel management and tank grouting will begin. At that time, the tank vaults will be isolated and final grouting of the tank system, including the vaults, will be performed. A preliminary description of the heel management and grouting sequence is described in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a). The decision for landfill closure will be based on results from all tanks in the TFF. Physical access to some areas does allow for piping not to be grouted as shown in Figure 5.

4.4.1 Final Heel Management and Tank Grouting

Grout delivery equipment will be installed through tank risers on Tanks WM-182 and WM-183. Video surveillance equipment also will be installed through risers on the tanks. Grout will be placed in each tank in layers following a predetermined sequence. The first grout layer will be placed in a manner that displaces as much of the remaining tank residuals as possible and moves remaining residual toward the steam jet for removal from the tank. As the grout is placed, the remaining tank residual (liquid and solid) will be pumped (using the steam jets remaining in each tank) and transferred through process waste piping to storage in another TFF tank to await further treatment. After the initial grout placements to remove residuals, approximately 4 ft of grout will be placed in the tank to level the large tank void remaining.

4.4.2 Vault Isolation

Grouting of vaults CPP-782 and CPP-783 will isolate them from the rest of the TFF. Decontamination of the piping encasements will allow decontamination fluid to flow onto the vault floor and decontaminate the floor. There has not been a known release of waste to the vaults from either tank. Remaining liquids will be transferred using the remaining steam jets to the PEW evaporator. Sampling of the vault sumps will provide sufficient data to characterize the vaults (the sumps are the lowest points within the vault). Following decontamination, samples will be collected from liquids remaining in the vault sumps. These sample results will be used in the evaluation of action levels. After the vault sumps are emptied and the vault liquid removal lines have been decontaminated, the steam jets and lines for the sumps can be disconnected.

After additional decontamination washes of the valve box, if needed, the decontamination equipment will be removed from the valve box. The vault liquid removal lines in Valve Box C6 will remain open to allow grouting. They will be closed as part of the Phase V closure. Vaults CPP-782 and CPP-783 will be accessed through Vault Risers 18 through 21 (SR-18 through SR-21) by removing the covers to the vault riser access boxes.

4.4.3 Final Grouting

The final grouting will include grouting the pipe encasements between Valve Boxes C15 and A6 and C40 and A6 and the tank vaults. Grout will be pumped through the encasement covers and valve boxes. This process will grout the 1-in. encasement drain lines. Vaults CPP-782 and CPP-783 will be filled with grout from the vault risers. The grout will be placed in lifts. Follow-on activities will be conducted as described in Section 6.5.The process waste lines will be grouted. The 2 in. waste lines in Condenser Pits CPP-721 and CPP 722 also will be grouted. Each grouted line will be considered permanently capped.

The cooling coil lines for each tank will be grouted by connecting the grouting equipment to the cooling coil headers. Grout will be pumped into each line until it comes out of the return end or until the line no longer accepts grout. The supply and return ends of each cooling coil line will then be considered permanently capped.

Steam supply lines have never received hazardous waste. These lines will be grouted during the grouting of the waste transfer lines that they supply. They serve as vents when the waste transfer lines are grouted. During the grouting process, at the first sign of liquid or grout observed in the steam piping, the grouting process will be stopped to ensure that the piping is not over pressurized.

The large tank void remaining after the initial grout placements to remove residuals, will be filled with grout. The grout will be placed in lifts until the tank is full. Video surveillance equipment and lighting will be installed in the center-most tank risers to observe grout placement. The grouting equipment will be reinstalled on the outermost tank risers.

Another grouting sequence will involve the vessel off-gas lines and Condenser Pit CPP-721. The grouting equipment will be connected to the lines and grout will be pumped through these lines until grout enters the tank risers. This action will also grout the ends of PEW lines that connected the two tanks. After the remaining tank voids and the vessel off-gas lines are filled with grout, the lines will be considered permanently capped.

Any remaining voids in the tank risers will be filled with grout. Follow-on activities will be conducted as described in Section 6.5.Finally, Condenser Pit CPP-721 will be filled with grout and the cover will be reinstalled. Condenser Pit CPP-722 will remain operational to support Tank WM-185.

Grouting completion also concludes the closure process for Tanks WM-182 and WM-183. The *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a) describes grouting completion and methods in greater detail. The closure process will be documented and certified as described in Section 10, and closure-generated wastes will be disposed of as described in Section 6.

5. COORDINATION WITH OTHER REGULATORY REQUIREMENTS

As an interim status hazardous waste management unit, the TFF must comply with applicable HWMA/RCRA regulations. However, the TFF is also a HLW facility regulated by DOE, and must meet DOE closure requirements. In addition, other ongoing INTEC and TFF actions may also affect the TFF HWMA/RCRA closure activities. These actions include the CERCLA cleanup of the TFF soils and decisions made pursuant to the *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement* (see footnote c, page 3). Therefore, this HWMA/RCRA closure will need to be carefully coordinated with each of these other requirements to ensure that the objectives of all activities at the TFF are met efficiently and economically.

5.1 DOE Radioactive Waste Management Requirements

Because the TFF is an HLW facility regulated by DOE, this closure must also meet requirements of DOE Order 435.1 (DOE 2001a) and its associated manual and guidance (DOE 2001b; DOE 1999a). Closure requirements for HLW facilities are specified in DOE Manual 435.1 (DOE 2001b). Three closure paths are allowed: decommissioning, the CERCLA process, and closure according to an approved DOE closure plan. The TFF will be closed under an approved DOE closure plan (see footnote c, page 3).

DOE requires a two-tiered approach to closure plan development, review, and approval. The Tier 1 plan, to be approved by DOE Headquarters, may be based on preliminary information and is intended to define and bound the parameters of the closure action. The first-tier plan should include:

- Closure methodology
- Schedules and assumptions
- Closure standards and performance objectives (for the radioactive constituents)
- Strategy for allocating closure standards and performance objectives to individual facilities and units to be closed at the site
- Preliminary assessment of the projected performance of each unit to be closed relative to the allocated performance objectives
- Preliminary assessment of the projected composite performance of all units to be closed at the site
- Alternatives (if any)
- Waste characterization data
- Closure controls plans
- Stakeholder concerns.

After DOE Headquarters reviews and approves the Tier 1 plan and issues an Authorization to Proceed, the second tier of the closure plan may be developed. The Tier 2 closure plan should provide the detailed closure information bounded by the Tier 1 plan. DOE Headquarters approval is not required for the Tier 2 closure plan; rather, DOE Field Office approval is required, provided the conditions defined in the plan are not exceeded.

In addition, DOE Order 435.1 provides for a Waste Incidental to Reprocessing (WIR) Determination for certain waste streams produced during reprocessing operations. This determination allows the waste to be managed as transuranic or low-level waste. For the TFF tanks, residual radioactive material remaining in the tank system is considered HLW unless it meets the low-level or transuranic criteria described in DOE Order 435.1 through a WIR Determination. To meet the WIR criteria, the residuals must satisfy several conditions, including requirements that (a) the waste must have been or will be processed to remove key radionuclides to the maximum extent technically and economically practical, and (b) the waste must be managed pursuant to DOE's authority under the "Atomic Energy Act of 1954," as amended (42 USC 2011, 1954), and in accordance with DOE Order 435.1 and its associated guidance and manual. In addition, for the low-level waste designation, the waste must be managed to meet applicable safety requirements, and the waste must be incorporated in a solid physical form that does not exceed the applicable concentration limits for Class C as specified in 10 CFR 61.55 (2001). In addition to the waste removal and decontamination planned for HWMA/RCRA closure, the grouting activities will be used to meet the WIR requirements for low-level waste under DOE closure.

Actions taken to meet DOE closure requirements will be coordinated with actions needed to meet HWMA/RCRA closure requirements. For example, sampling will be planned so that the effort will support both hazardous and radioactive constituent analysis. In addition, removal and decontamination efforts will be designed to satisfy both HWMA/RCRA and DOE closure requirements.

5.2 Comprehensive Environmental Response, Compensation, and Liability Act Requirements

RCRA closure of a tank system requires investigation of associated contaminated soils. The contaminated soils associated with TFF Tanks WM-182 and WM-183 will be investigated in accordance with CERCLA requirements as governed by the FFA/CO for the entire TFF. An investigation of soils is being planned as part of the OU 3-14 RI/FS as described in the *Operable Unit 3-14, Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan* (see footnote g, page11). This action is described in Section 3. Past releases of hazardous constituents from the TFF are being addressed under CERCLA as described in the FFA/CO (IDHW, EPA 1991).

In November 1989, the INEEL was listed on the National Priorities List (54 Federal Register [FR] 223, 1989). In 1991, the FFA/CO was written to establish a framework for fulfilling CERCLA requirements. Under the FFA/CO, the INEEL is divided into ten waste area groups (WAGs) and then further divided into operable units (OUs). INTEC is designated as WAG 3, with 14 OUs (IDHW, EPA, and DOE 1991).

In October 1999, a final Record of Decision was issued for INTEC OU 3-13 (DOE-ID 1999a). This ROD specifies interim actions for the TFF soils and the Snake River Plain Aquifer sites. Soil investigations and proposed remedies for these sites will be presented in the OU 3-14 RI/FS. The TFF soils include sites located in the TFF area and adjacent to the building that houses the PEW evaporator. The TFF soils sites were contaminated from two significant spills and pipeline leaks of radioactive liquids from plant liquid transfer operations. The principal threats posed by these soils are external radiation exposure, and leaching and transport of contaminants to the perched water or the Snake River Plain Aquifer. An interim action, rather than a final remedy, has been selected pending further characterization and coordination with the *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement* (see footnote c, page 3).

The selected remedy for the Tank Farm Interim Action has been designed to restrict potential exposure to the public from the soils within the Tank Farm and to minimize potential leaching and transport of contaminants to the perched water or Snake River Plain Aquifer [*Remedial Design/Remedial Action Work Plan for Group 1 Tank Farm Interim Action* (DOE-ID 2000b)]. These goals will be accomplished by covering the entire Tank Farm surface and the majority of the 150-ft control zone around the Tank Farm with a polyurea spray-on coating or asphalt and upgrading the associated storm water drainage system.

The Tank Farm Interim Action design is divided into the following three major components (DOE-ID 2000a):

- **Storm Water Drainage System Upgrade.** The storm water drainage system will be upgraded within and around the Tank Farm and out to the discharge point. This upgrade will include constructing, grading, and lining new and existing ditches with concrete; installing a trench drain, lift station, and manholes; and replacing existing culverts with larger culverts to accommodate the expected increase in storm water flow. It will also include constructing concrete headwalls and endwalls, as necessary, throughout the lined drainage system.

- **Storm Water Evaporation Pond.** A lined storm water evaporation pond will be constructed outside of the INTEC fence to collect storm water runoff that currently discharges into environmentally controlled area 37A.

- **Surface Sealing.** Unpaved surfaces within the Tank Farm and the majority of the unpaved surfaces within the 150-ft control zone surrounding the Tank Farm will be sealed with either a polyurea spray-on coating or asphalt.

The interim action specified for the TFF soils consists of institutional controls with runon/runoff controls and the goal of significantly reducing surface water infiltration into TFF soils. The runon/runoff controls will reduce infiltration in the TFF and also in the area of Tanks WM-182 and WM-183.

The diverted runon water is planned to be managed as part of the existing surface water drainage management system. Runoff water from the TFF soils will be collected and managed in a lined evaporation pond with leak detection. The evaporation pond will be constructed and used as a best management practice to reduce infiltration into the INTEC area.

5.3 High-Level Waste and Facilities Disposition Environmental Impact Statement Requirements

Closure of the TFF and Tanks WM-182 and WM-183 also may be affected by the decisions made on the basis of the *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement* (see footnote c, page 3). This environmental impact statement identifies two primary decision-making goals:

- How to treat HLW calcine and sodium-bearing waste into final waste forms ready to leave the State of Idaho by December 2035

- How to conduct the disposition of associated HLW program facilities, including TFF.

The three environmental impact statement general closure alternatives are

- Clean closure

- Closure to landfill standards
- Performance-based closure.

The environmental impact statement is being prepared to fulfill commitments DOE made as part of the terms of a 1995 settlement agreement and court order with the State of Idaho (State of Idaho, DOE, and Department of Navy 1995). Under the agreement and court order, DOE must treat all HLW currently at the INEEL so that the waste is ready for removal from the State of Idaho by 2035. To meet this requirement, DOE must issue a record of decision no later than December 31, 2009, based on an environmental impact statement that analyzes alternatives for treating INEEL HLW. On September 19, 1997, DOE issued a "Notice of Intent to Prepare a High-Level Waste and Facilities Disposition Environmental Impact Statement, Idaho Falls, Idaho" (62 FR 182, 1997). The draft EIS was issued in December 1999 (see footnote c, page 3). Depending on the alternative selected, elements of the TFF closure may need to be modified to meet requirements of the selected alternative.

6. CLOSURE-GENERATED WASTE HANDLING AND DISPOSAL

In accordance with IDAPA 58.01.05.006 (2001) (40 CFR 262.11 [2001]), all solid waste generated during the closure process for Tanks WM-182 and WM-183 is required to be properly characterized to determine if the waste is a hazardous waste. If so, the waste must be managed as a hazardous waste in accordance with all applicable HWMA/RCRA regulations. Circumstances may arise during closure implementation that require removal of equipment and treatment for reuse or disposal rather than leaving the equipment in place as planned. Conversely, leaving some equipment in place may be necessary or desirable to limit personnel radiation exposure.

As stated in more detail in Section 1.2, wastes stored in Tanks WM-182 and WM-183 exhibit the hazardous characteristics of corrosivity (hazardous waste number D002). Tank WM-182 exhibits the characteristic of toxicity for lead (D008) and mercury (D009), while WM-183 exhibits the toxicity characteristic for cadmium (D006), chromium (D007), lead (D008), and mercury (D009). Also associated with the waste are four RCRA listed waste codes: F001, F002, F005, and U134 (Gilbert and Venneman 1999).

6.1 Decontamination and Treatment of Equipment for Disposal

Contaminated equipment from Tanks WM-182 and WM-183 closure activities will be decontaminated or treated for all hazardous constituents present, as indicated by the baseline sampling results and the historical inventory of wastes managed in the tanks. Treatment will consist of subjecting the equipment to one or more existing treatment technologies identified in IDAPA 58.01.05.011 (2001) (40 CFR 268.45 [2001]). The specific technology or technologies will be selected at the time of closure based upon the contaminants subject to treatment, the effectiveness of the selected technology, and the ability of equipment to be effective in a highly radioactive environment. Equipment to be disposed of as solid waste will be disposed of in accordance with applicable local, state, and federal requirements. In some cases, the contaminated equipment may be dismantled, packaged, and transported to an onsite or offsite treatment, storage, and disposal facility. Section 6.3 describes available storage, treatment, and disposal options. Hazardous waste determinations will be performed on waste in accordance with 40 CFR 262.11.

6.2 Equipment and Structures to be Reused

All equipment and structures that have documented RCRA hazardous contamination, visible signs of contamination, or have known contact with waste materials will be decontaminated or disposed of (grouted in place). Also, the contaminated equipment may be dismantled, packaged, and transported to an onsite storage/treatment facility for decontamination prior to reuse (see Section 6.3). For example, grout system piping may require decontamination in the INTEC debris treatment facilities prior to reuse.

The following equipment and structures are designated for potential reuse and will be decontaminated or disposed of (grouted in place) if they become contaminated during WM-182 and WM-183 closure activities:

- Tank closure equipment—grout delivery equipment, the wash ball, heel sampling equipment, video equipment, tank lighting
- Trucks—utility, flat-bed, and dump
- Cranes, backhoes, front-end loaders, excavator

- Temporary vessel off-gas system—blower, filter skids, condensate accumulation receiver tank, and ducting
- Decontamination equipment (line spray and valve box washing systems)
- Grout system—pump and piping
- Radiological protection equipment—shielding and large area containment tents
- Buildings—temporary enclosure and construction trailers
- Miscellaneous—pipe-cutting tools, liquid catches, buckets, brushes, etc.
- Utilities—electrical power (protective devices, conductors, distribution systems), water (pressure regulators, control valves, distribution/delivery systems), steam, and/or air distribution systems as deemed appropriate.
- Light-duty utility arm.

6.3 Closure Waste

INTEC storage and treatment systems (e.g., PEW evaporator and TFF) may be used to store and treat wastes generated from the following sources:

- Valve box covers, valve boxes, and drain lines
- Vaults, vault sumps, and liquid removal lines to tanks and to the PEW evaporator
- Pipe encasements
- Condenser pit covers, pits, vessel off-gas lines, and vessel off-gas drain lines
- Purge liquids and decontamination solutions.

Alternatives for treatment and disposal methods for the liquid sodium-bearing and calcined wastes are being addressed in the *Idaho High-Level Waste and Facility Disposition Environmental Impact Statement* process (see footnote c, page 3). If necessary, decontamination materials and residues (e.g., personal protective equipment, sampling equipment, and high-efficiency particulate air [HEPA] filters) will be placed in containers labeled with the date of accumulation and a barcode identifier, sampled and analyzed, and held within the TFF as mixed, low-level, or transuranic waste. Based on process knowledge and the results of analysis, closure waste will be managed to ensure proper handling, treatment, storage, and disposal. Examples include, but are not limited or restricted to, the following:

- HEPA filters determined to be waste or debris may be transferred to CPP-659 New Waste Calcining Facility (NWCF) HEPA Filter Storage prior to treatment in the CPP-659 NWCF HEPA Filter Leach System and disposal either onsite at the Radioactive Waste Management Complex (RWMC) or offsite. Debris treatment will be necessary prior to disposal at the RWMC.
- Hazardous or mixed waste may be accumulated within the area of closure and either sent offsite for treatment and disposal or sent to CPP-1619 Hazardous Chemical and Radioactive Waste Storage Facility prior to shipment offsite. If hazardous waste generated from the closure activity is

maintained within the boundaries of the Tank WM-182 and Tank WM-183 closure, the 90-day storage limit will not apply; all other handling, packaging, and inspection rules would apply to protect human health and the environment.

- Low-level radioactive waste can be sent to the Waste Reduction Operations Complex/Power Burst Facility for storage, volume reduction, and stabilization prior to disposal at the RWMC. Mixed LLW may be managed similar to the low-level radioactive waste, except that disposal may include an offsite facility.

If applicable, fluids from decontamination may be contained within a work/closure area or collected in containers until characterization results are obtained to ensure compliant storage and/or treatment and disposal.

6.4 Management of Excavated Soils

Management of soils excavated during TFF closure activities will be conducted consistent with the approved methods outlined in the INTEC C40 Valve Box Soil Work Plan (INEEL 2000b). Soil excavated during TFF closure activities either will be returned to the excavation or managed in accordance with applicable HWMA requirements within the 24-month timeframe. TFF closure actions, which may include soil excavation, are expected to require a typical construction season, but may be delayed by unexpected circumstances. The project will require excavation of about 20 yd^3 of soil. Soil excavated during TFF closure activities will be used as backfill for this project only.

6.4.1 Excavation

One or more construction piles will be established immediately adjacent to the excavation where excavated soil will be held temporarily prior to transfer to a staging pile. Transfer will be accomplished using TFF-approved equipment (e.g., backhoe, front-end loader, hand shovels, vacuum, excavator). These temporary construction piles are separate from the soil staging piles. Soil from the construction piles will be removed (down to approximately the last 6 in.) at the end of each day and then covered to prevent spread of loose soil.

6.4.2 Staging

Staging piles, as used for this project, will provide temporary staging of soil (no longer than 24 months) prior to reuse as a backfill for the TFF closure project and placement of excess soil into containers for long-term management. Use of staging piles will provide a reliable, effective, and protective option for staging soil prior to use as backfill. Soil contaminated at levels above 50 mr/hr (on or near contact) will not be put directly into staging piles, but will be placed into containers (probably metal boxes or industrial-duty sacks or bags) to prevent possible spread of radiological contamination. Each container will be marked to indicate the location and depth at which the soil originated. This soil also will be placed back into the excavation near the depth and location of origination.

The staging piles will be placed on a double layer of an impermeable liner to prevent contamination of underlying soil or asphalt. The piles will be covered with impermeable material to prevent windblown spread of radionuclides and hazardous constituents. The covers also will prevent intrusion and percolation of precipitation through the soil. The covers will be secured to the liner and to each other using standard methods such as timbers and sandbags. Netting will be placed over the covers to aid in preventing wind damage. Precipitation run-off from the covers will be diverted away from the piles and then away from the TFF area through the existing storm water diversion system. The same diversion system will prevent precipitation runon. The covers will be lifted or removed to allow working access to the staging pile as required. The staging pile will be re-covered and the cover secured at the end of each day.

Soil, potentially contaminated with hazardous waste, which has been placed into containers will not be staged in a HWMA/RCRA regulated treatment, storage, or disposal facility such as CPP-1617. The containers will be managed within the area of contamination as if they are in a less-than-90-day storage area until the soil is returned to the excavation as backfill. Excess soil, if any, will be managed in accordance with a formal hazardous waste determination and any applicable no-longer-contained-in determination. For the purpose of the TFF closure project, soil placed into containers for the purpose of radiological control will be deemed no different than soil placed into staging piles; that is, Land Disposal Restriction requirements will not be violated.

6.4.3 Soil Emplacement as Backfill

Soil will be used as backfill in a way that does not significantly increase risk at the TFF either through direct exposure to radiation or by migration of contaminants. Soil will generally be placed back into the excavation in reverse order of removal (last-out, first-in). Soil emplacement in the excavation will be completed such that the site profile/condition prior to and after the project is consistent.

6.4.4 Soil Tracking

A single one-time-only waste stream will be established for tracking the management of the soil associated with closure of each TFF tank. The INEEL Integrated Waste Tracking System (IWTS) material profile will track excess soil placed into containers for long-term management. For soil used as backfill, only the volume will be tracked via the IWTS under a single-container profile tied back to the waste stream.

Several steps will be used to track soil during excavation, staging, and backfill activities. Radiological control personnel will complete necessary surveys during all soil movement.

Log sheets will be completed during initial excavation and when soil is used as backfill. These forms allow tracking of soil from the excavation to a staging pile; from the staging pile to backfill; placement into containers for radiological control; and use of containerized soil as backfill. The log sheets also provide a means to initially identify containers used for long-term storage of excess soil. These log sheets will be retained as part of the operating record.

6.5 Integration with Deactivation and Decontamination and CERCLA Waste Management

After it has been determined that the closure performance standards have been met for the tanks and ancillary equipment, inactive structures may be removed by the Deactivation and Decontamination activities that support the CERCLA OU 3-14 remedy. In accordance with the *Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater Remedial Design/Remedial Action Work Plan* (DOE-ID 2008):

> *D&D activities support the OU 3-14 remedy, and debris generated during the D&D of surface structures and components on the TFF will be classified as CERCLA waste to be disposed of in the ICDF upon meeting the Waste Acceptance Criteria (WAC). Contaminated soil and media that are disturbed and removed during or in support of the CERCLA remediation activities will be managed based on the actual radioactive and chemical characteristics and concentrations of the media.*

7. MAXIMUM EXTENT OF THE OPERATION UNCLOSED

Closure of Tanks WM-182 and WM-183 and the final closure of the TFF represent a partial closure of the INEEL facility. Final closure of the remaining HWMA/RCRA-regulated operational units at the INEEL will be conducted in accordance with applicable interim status or approved HWMA/RCRA Part B closure plans. In accordance with the information required under IDAPA 58.01.05.009 (2001) [40 CFR 265.112(b)(2) (2001)], "the maximum extent of the operation which will be unclosed during the active life of the facility" must be identified. Therefore, an estimate of the maximum extent of operations that will remain unclosed (open) at the INEEL after closure of Tanks WM-182 and WM-183 is to be determined. An estimate of the maximum extent of operations that will remain unclosed on the INEEL facility is available in the *HWMA/RCRA Part A Permit Application for the Idaho National Engineering and Environmental Laboratory* (DOE-ID 2000c) and other approved HWMA/RCRA Part B permits for INEEL.

8. TIME ALLOWED FOR CLOSURE/EXTENSION

IDAPA 58.01.05.009 (2001) (40 CFR 265.113, "Closure, Time Allowed for Closure" [2001]) requires that closure of the TFF must commence within 90 days after receiving the final volume of hazardous wastes or within 90 days after approval of the closure plan, whichever is later. The regulations allow DEQ to approve a longer period to commence closure, provided

- "The activities required to comply with this paragraph will, of necessity, take longer than 90 days to complete; and"

- The operator "has taken and will continue to take all steps to prevent threats to human health and the environment, including compliance with all applicable interim status requirements."

The second modification to the Consent Order (IDHW 1998) specifies that DOE must cease use of Tanks WM-182 through WM-186 by June 30, 2003, and the remaining tanks by December 31, 2012. Ceasing use of the tanks means that DOE must empty the tanks to their heels, that is, the liquid level remaining in each tank must be lowered to the greatest extent possible by the use of existing transfer equipment. As described in Section 0, closure of the TFF will be conducted in phases, with partial closures of groups of tanks leading to final closure of the TFF. IDAPA 58.01.05.009 and 40 CFR 265.113 also require that closure activities be completed in accordance with the approved closure plan "within 180 days after receiving the final volume of hazardous wastes" or "within 180 days after approval of the closure plan, if that is later." The director of DEQ may approve an extension to the closure period provided it is demonstrated that

- "The activities required to comply with this paragraph will, of necessity, take longer than 180 days to complete; and"

- The operator "has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable interim status requirements."

Closure activities for the TFF tanks are anticipated to take longer than 180 days to complete for the following reasons:

- The highly radioactive wastes stored in the tanks will require much of the sampling and waste removal work to be performed using remote handling technology, which will require significant lead times to set up and conduct

- The approach for partial closure of TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in the INTEC waste treatment systems for the wastes generated; operational problems in these systems could result in delays in the closure process

- Closure to performance-based standards will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination.

For these reasons, the closure of each set of tanks in the TFF is likely to require much longer than 180 days. Current planning estimates suggest each partial closure phase will require 3 to 5 years. An extension to the 180-day period for Tanks WM-182 and WM-183 is requested to 1,334 days.

Quarterly reports will be provided for the closure of Tanks WM-182 and WM-183. The reports will be provided to DEQ within 30 days of the end of each quarter of the fiscal year. The reports will identify the status of the closure activities, identify the status of the entire closure schedule, and outline any issues or concerns relative to the milestone of completing partial closure. Reporting will begin at the end of the first quarter, after approval of the closure plan and receipt of the DOE Authorization to Proceed. The reports will be submitted no later than January 31, April 30, July 31, and October 31 of each year, and will continue until closure is complete. Table 7 lists the durations and descriptions of the planned activities for closure of Tanks WM-182 and WM-183.

Finally, IDAPA 58 and 40 CFR 265.112(a) (2001) require that by May 19, 1981, or by six months after the effective date of the rule that first subjects a facility to provisions of this section, the owner or operator of a hazardous waste management facility must have a written closure plan. This closure plan is being submitted in accordance with the consent order, which requires submittal of the first closure plan on or before December 31, 2000, as described in the second modification to the Consent Order (IDHW 1998).

The integration of HWMA/RCRA closure and DOE closure is vital to success of the TFF closure. Review and approval of the DOE closure plan by DOE must be coordinated with the review and approval of the HWMA/RCRA closure plan by DEQ. Both a DOE Authorization to Proceed and State of Idaho approval must be obtained before closure of the tanks may begin.

Prior to receiving approval of this closure plan, research and development of tank decontamination and waste removal system components will be occurring in Tank WM-182 and/or Tank WM-183. These activities will not include any types of irreversible activities that may affect waste removal and decontamination activities during closure.

Table 7. Durations and descriptions of planned activities scheduled for WM-182 and WM-183 closure.

Duration	Description
0 day	Approval of partial closure plan and receive DOE Authorization to Proceed
328 days	Remove waste and decontaminate Tank WM-182
339 days	Evaluate results, grout, and close
328 days	Remove waste and decontaminate Tank WM-183
339 days	Evaluate results, grout, and close
60 days	Submit PE supporting documentation (this time is in addition to the 1,334 days for closure)

9. CLOSURE PLAN MAINTENANCE AND AMENDMENTS

In accordance with IDAPA 58.01.05.009 (2001) [40 CFR 265.112(a) (2001)], a copy of the most current version of the closure plan will be maintained by the facility until closure is certified. The plan will be furnished to the Director, upon request, any time prior to closure certification. This closure plan will be modified, as necessary, in accordance with IDAPA 58.01.05.009 [40 CFR 265.112(c)] and as follows:

- Whenever changes in operating plans or facility design affect the closure plan
- If there is a change in the expected year of closure
- If, in conducting closure activities, unexpected events require a modification
- If a change in state or federal laws or regulations require a change in the closure plan
- If the regulatory authority requests modification of the closure plan in accordance with IDAPA 58.01.05.009 [40 CFR 265.112(c)(4)]
- At the time of closure to address the schedule for closure, changes to regulatory standards for cleanup, biased sampling based on the operating record, specific decontamination methods/technologies to be employed, changes to how and where disposal of equipment and structures will take place, and other changes necessary to accomplish the “clean closure” performance standard.

Written notifications or requests for amendment or modification of this closure plan will be submitted, along with a copy of the amended plan, to the appropriate regulating agency

- 60 days before a proposed changed in operating plans or design of the waste management unit or facility; or
- No later than 60 days after an unexpected event occurs that affects the closure plan; or
- No later than 30 days after an unexpected event occurs during closure (IDAPA 58.01.05.009 and 40 CFR 265.112(c).

10. CERTIFICATION OF CLOSURE

Certification of closure will be provided by an independent Idaho-registered PE and the facility contractor and/or DOE-ID, in accordance with IDAPA 58.01.05.009 (2001) (40 CFR 265.115 [2001]) at final closure of the TFF system. It is not required to certify partial closures (NTIS: SUB-9224-98-002, EPA: 530-R-98-005b). The TFF tanks will not be certified closed until all the tanks have been decontaminated and the waste removed.

Within 60 days of completion of final closure of the TFF, the owner or operator must submit to the Director of DEQ, by registered mail, a certification that the hazardous waste management unit has been closed in accordance with the specifications in the approved closure plan. The certification will be signed by the owner or operator and by the PE. Documentation supporting the PE's certification must and will be furnished to the Director of DEQ. The certification of closure as stated in 40 CFR 265.115 will be met with these actions. PE certification information will be submitted to DEQ 60 days after closure of Tanks WM-182 and WM-183. Records of each partial closure certification will be stored at the INEEL for certification upon final closure.

As data are collected in the partial closures of the TFF, the data will be combined using the statistical methods shown in Appendix E. Final closure options for the TFF will be determined when the data from all the tanks and ancillary equipment is compared to the TFF action levels. The 95% upper confidence of the mean of all samples will be compared to the action levels. There may be two or more upper confidence levels calculated and compared to action levels.

If closure of the TFF systems to the landfill closure standard is necessary, a "Notice in Deed" and survey plat will be submitted to the Butte County Courthouse in accordance with IDAPA 58.01.05.009 (40 CFR 265.119). The survey plat will be prepared and certified by an Idaho professional land surveyor and will indicate the location and dimensions of the tank system that requires closure to the landfill standard. The "Notice in Deed" will state

- That the land has been used to manage hazardous waste
- That land use is restricted under IDAPA 58.01.05.009 (40 CFR 265.119)
- That the facility contractor and/or DOE-ID have an obligatory commitment to restrict disturbance of the closed landfill unit.

Additionally, a record of the type, location, and quantity of hazardous waste disposed of in any and all WM-182 and WM-183 tank system components will be submitted to the appropriate regulatory authorities (e.g., DEQ and Butte County Commissioners [IDAPA 58.01.05.009 (40 CFR 265.119)]).

The PE certification information will document all closure activities so there is adequate information provided for each phase of closure. Closure activities for Tanks WM-182 and WM-183 under this closure plan will be considered complete upon submittal of the supporting documentation from the independent PE to DEQ.

11. COST, FINANCIAL ASSURANCE, AND LIABILITY REQUIREMENTS

The INEEL is owned and operated by the U.S. Government. Therefore, the facility is, in accordance with IDAPA 58.01.05.009 (2001) [40 CFR 265.140(c) (2001)], exempt from the financial requirements of IDAPA 58.01.05.009 (40 CFR Part 265, Subpart H [2001]).

12. REFERENCES

10 CFR 61.55, 2001, "Waste Classification," *Code of Federal Regulations*, Office of the Federal Register, January 1.

40 CFR 261, Subpart D, 2001, "Lists of Hazardous Wastes," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 261.22, 2001, "Characteristic of Corrosivity," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 261.24, 2001, "Toxicity Characteristic," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 262, 2001, "Standards Applicable to Generators of Hazardous Waste," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 262.11, 2001, "Hazardous Waste Determination," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 264, 2001, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265, 2001, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265, Subpart G, 2001, "Closure and Post-closure," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265, Subpart H, 2001, "Financial Requirements," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265, Subpart J, 2001, "Tank Systems," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.110, 2001, "Applicability," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.111, 2001, "Closure Performance Standard," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.112, 2001, "Closure Plan; Amendment of Plan," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.113, 2001, "Closure; Time Allowed for Closure," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.115, 2001, "Certification of Closure," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.119, 2001, "Post-closure Notices," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.140, 2001, "Applicability," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.193, 2001, "Containment and Detection of Releases," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.197, 2001, "Closure and Post-closure Care," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 268.45, 2001, "Treatment Standards for Hazardous Debris," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 761, 2001, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, Office of the Federal Register, July 1.

54 FR 223, 1989, "National Priorities List for Uncontrolled Hazardous Waste Sites," *Federal Register*, Environmental Protection Agency, pp. 48184–48200, April 2.

62 FR 182, 1997, "Notice of Intent to Prepare a High-Level Waste and Facilities Disposition Environmental Impact Statement, Idaho Falls, Idaho," *Federal Register,* Department of Energy, pp. 49209–49212, September 19.

63 FR 124, 1998, "Disposal of Polychlorinated Biphenyls (PCBs) Final Rule," *Federal Register*, Environmental Protection Agency, pp. 35383–35474, June 29.

42 USC 2011 et seq., 1954, "Atomic Energy Act of 1954."

42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

Demmer, R. L., 1996, *Testing and Comparison of Seventeen Decontamination Chemicals*, INEL-96/0361, September.

DOE O 435.1, 2001a, "Radioactive Waste Management," Change 1, Department of Energy, August 28.

DOE M 435.1-1, 2001b, "Radioactive Waste Management Manual," Change 1, Department of Energy, June 19.

DOE G 435.1-1, 1999a, "Implementation Guide for Use with DOE M 435.1-1," Department of Energy, July 9.

DOE, 1999b, *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement,* DOE/EIS-0287D, (expected release January 2002).

DOE-ID, 2008, *Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater Remedial Design/Remedial Action Work Plan*, DOE/ID-11333, Revision 0, June.

DOE-ID, 2001a, *Contingent Landfill Closure and Post-Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183,* DOE/ID-10841, Revision 2, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, November 19.

DOE-ID 2001b, *Performance Assessment for the Tank Farm Facility at the Idaho National Engineering and Environmental Laboratory*, DOE/ID-10966 (expected release December 2001).

DOE-ID, 2000a, *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan*, DOE/ID-10676, Revision 0, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, (expected release early 2002).

DOE-ID, 2000b, *Remedial Design/Remedial Action Work Plan for Group 1 Tank Farm Interim Action,* DOE/ID-10772, Revision 0, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, September.

DOE-ID, 2000c, *HWMA/RCRA Part A Permit Application for the Idaho National Engineering and Environmental Laboratory,* DOE-ID-10213, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, April 3.

DOE-ID, 1999, *Final Record of Decision Idaho Nuclear Technology and Engineering Center Operable Unit 3-13*, DOE/ID-10660, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, October.

DOE-ID, 1995, *Long-Term Land Use Future Scenarios for the Idaho National Engineering Laboratory*, DOE/ID-10440, Department of Energy Idaho Operations Office, Idaho Falls, Idaho, August.

Gilbert, Kenneth O., and Timothy E. Venneman, 1999, *A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System*, INEEL/EXT-98-01213, Rev. 1, February.

IDAPA 58.01.05.005, 2001, "Identification and Listing of Hazardous Waste," Idaho Administrative Procedures Act, Department of Environmental Quality, March 30.

IDAPA 58.01.05.009, 2001, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Idaho Administrative Procedures Act, Department of Environmental Quality, March 30.

IDAPA 58.01.05.011, 2001, "Land Disposal Restrictions," Idaho Administrative Procedures Act, Department of Environmental Quality, March 30.

IDHW, 1998, *Second Modification to Consent Order to the Notice of Noncompliance*, Department of Energy Idaho Operations Office; Idaho Department of Health and Welfare, Division of Environmental Quality; Environmental Protection Agency, Region 10, July 31.

IDHW, 1992, *Consent Order to the Notice of Noncompliance*, Department of Energy Idaho Operations Office; Idaho Department of Health and Welfare, Division of Environmental Quality; Environmental Protection Agency, Region 10, April 3.

IDHW, EPA, and DOE-ID, 1991, *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory,* State of Idaho Department of Health and Welfare; Environmental Protection Agency, Region 10; Department of Energy, Idaho Field Office; December 4.

INEEL, 2000a, *Conceptual Design Report, INTEC Tank Farm Facility Closure,* Project File No. 015722, Revision 0, Idaho National Engineering and Environmental Laboratory, September 29.

INEEL, 2000b, *Soil Work Plan for the Idaho Nuclear Technology and Engineering Center (INTEC), C40 Valve Box Project, at the Idaho National Engineering and Environmental Laboratory*, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.

INEEL, 1999a, *Idaho Nuclear Technology and Engineering Center Safety Analysis Report,* Part II, "Facility-Specific Safety Analyses," Section 5.1, "New Waste Calcining Facility," INEL-94/022, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.

INEEL, 1998, *Idaho Chemical Processing Plant Safety Document,* Section 4.2, "Aqueous Liquid Waste Management," PSD-4.2, Rev. 10, Idaho National Engineering and Environmental Laboratory, February 19.

Palmer, W. B., C. B. Millet, M. D. Staiger, and F. S. Ward, 1998, *ICPP Tank Farm Planning through 2012,* INEEL/EXT-98-00339, Idaho National Engineering Laboratory, Idaho Falls, Idaho, April.

Portage Environmental, 2001a, *Tier 1 Closure Plan for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility at the INEEL*, INEEL/EXT-01-00576, for the Idaho National Engineering and Environmental Laboratory (expected release January 2002).

Portage Environmental, 2001b, *Sampling and Analysis Plan for the Post-Decontamination Characterization Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183*, INEEL/EXT-01-015343, for the Idaho National Engineering and Environmental Laboratory, November.

Portage Environmental, 2001c, *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*, INEEL/EXT-01-00666, for the Idaho National Engineering and Environmental Laboratory, November.

State of Idaho, 1983, "Hazardous Waste Management," Idaho Statute, Title 39, "Health and Safety," Chapter 44, "Hazardous Waste Management" (also known as the Hazardous Waste Management Act of 1983).

State of Idaho, DOE, and Department of the Navy, 1995, "Settlement Agreement," to resolve all issues in the actions <u>Public Service Co. of Colorado v. Batt</u>, No. CV91-0035-S-EJL (D. Id.) and <u>United States v. Batt</u>, No. CV-91-0065-S-EJL (D. I.), October 16.

WINCO, 1986, *ICPP Integrated Plant Manual Volume XII, ICPP Major Systems and Operation*, Westinghouse Idaho Nuclear Company, Inc., Idaho National Engineering Laboratory, June. (This manual is classified as "inactive/information only" and contains unclassified controlled nuclear information.)

Appendix A

Detailed INTEC Facility Description

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Detailed INTEC Facility Description

This appendix provides a detailed description of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) to provide information to further support the closure plan. The facilities within the TFF and associated equipment and processes are described.

A-1. INTEC AND TANK FARM FACILITY DESCRIPTION

INTEC, formerly known as the Idaho Chemical Processing Plant, is located in the south-central portion of the Idaho National Engineering and Environmental Laboratory (INEEL). INTEC began operations in 1953 and was historically a fuel reprocessing facility for defense projects, research, and storage of spent nuclear fuel. The high-level radioactive liquid wastes (HLLW) generated from fuel reprocessing operations were stored in stainless-steel storage tanks contained in concrete vaults at the TFF. In 1992, the Department of Energy (DOE) decided to end the fuel reprocessing mission at INTEC. This decision led to the phase-out of fuel dissolution, solvent extraction, product denitration, and other processes. The current mission of INTEC is to receive and store spent nuclear fuels and radioactive wastes, treat and convert wastes, and develop new technologies for waste and waste management for DOE. Employees are to do this in a cost-effective manner that protects the safety of INEEL employees, the public, and the environment.

The INTEC facility is situated on 210 acres that lie within a perimeter fence. Located outside the INTEC perimeter fence are parking areas, a helicopter landing pad, the waste water treatment lagoon, various pits and percolation ponds, and the Tank Farm Project Support Facility. These areas occupy approximately 55 acres.

A-2. TFF TANK CONTENTS AND CONSTRUCTION INFORMATION

The TFF is comprised of

- Nine 300,000-gallon and two 318,000-gallon active stainless steel tanks (hereafter referred to as 300,000-gallon tanks), each of which is contained within a concrete vault
- Four inactive 30,000-gallon stainless steel tanks
- Valve boxes, encasements, and various process and instrumentation piping associated with the tanks (INEEL 2000).

The physical layout of INTEC and the TFF is depicted in Figure A-1. A conceptual view of the TFF is depicted in Figure A-2.

A-2.1 300,000-Gallon Tanks

The 300,000-gallon storage tanks, WM-180 through WM-190, are contained in belowground, unlined, octagonal (WM-180 through WM-186) or square (WM-187 through WM-190) concrete vaults. A diagram of Tank WM-182 is shown in Figure A-3 as an example of the construction and design of the tanks. The tanks are stand-alone, stainless steel, cylindrically-shaped vessels. Each tank is administratively limited to storing 285,000 gallons of liquid waste. The inside tank diameter and wall

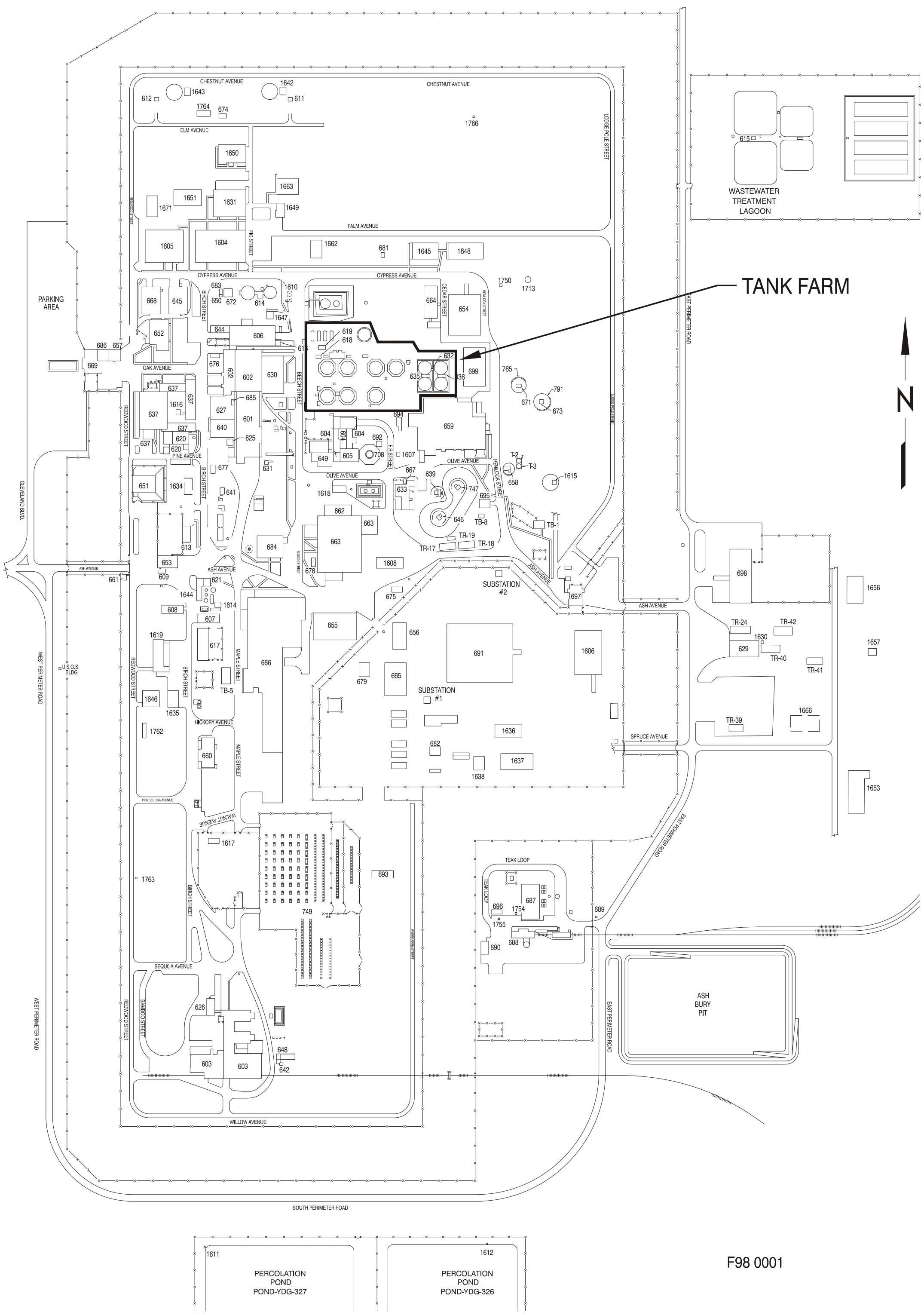

Figure A-1. Location of the TFF at the Idaho Nuclear Technology and Engineering Center.

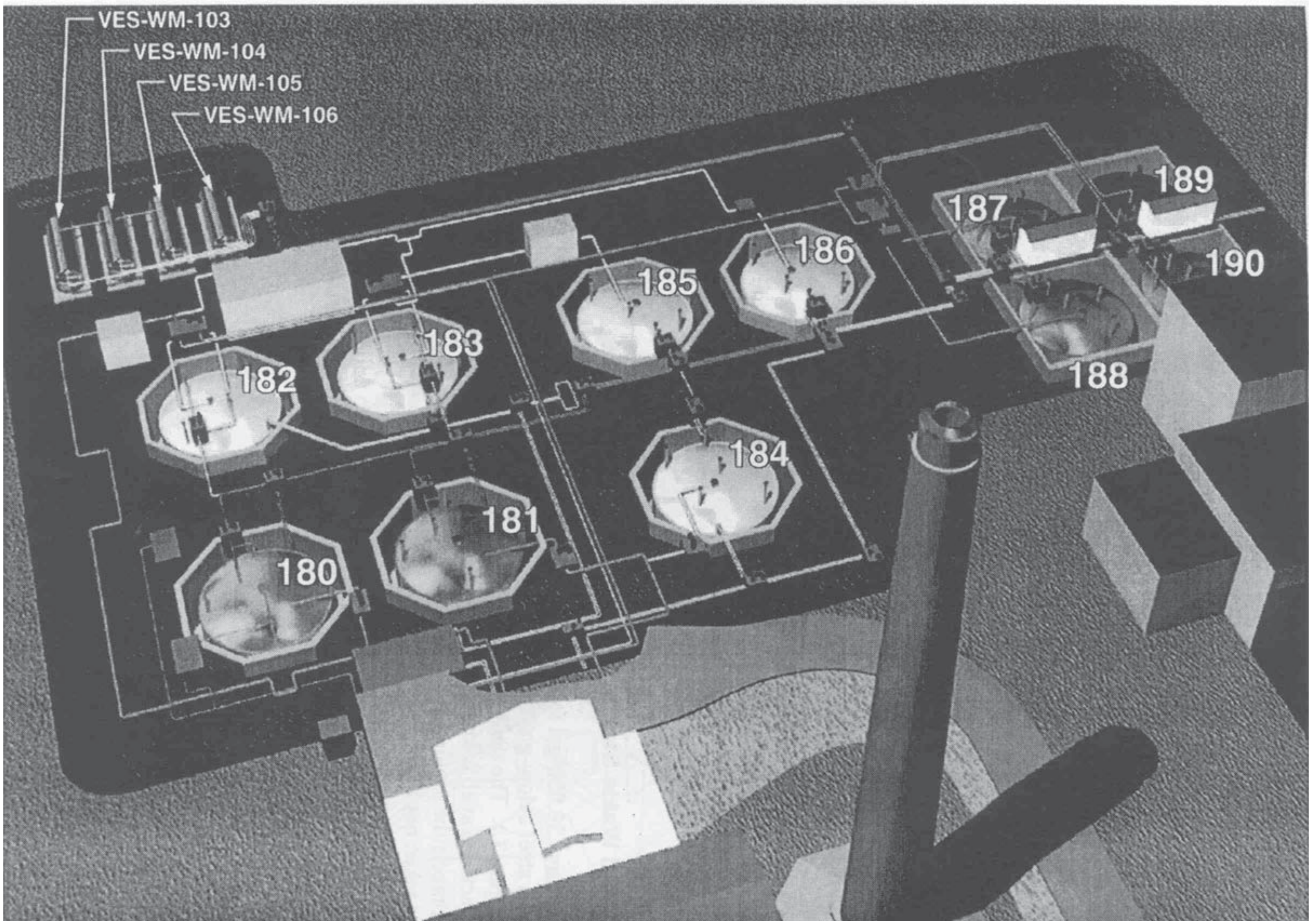

Figure A-2. Conceptual overview of the TFF.

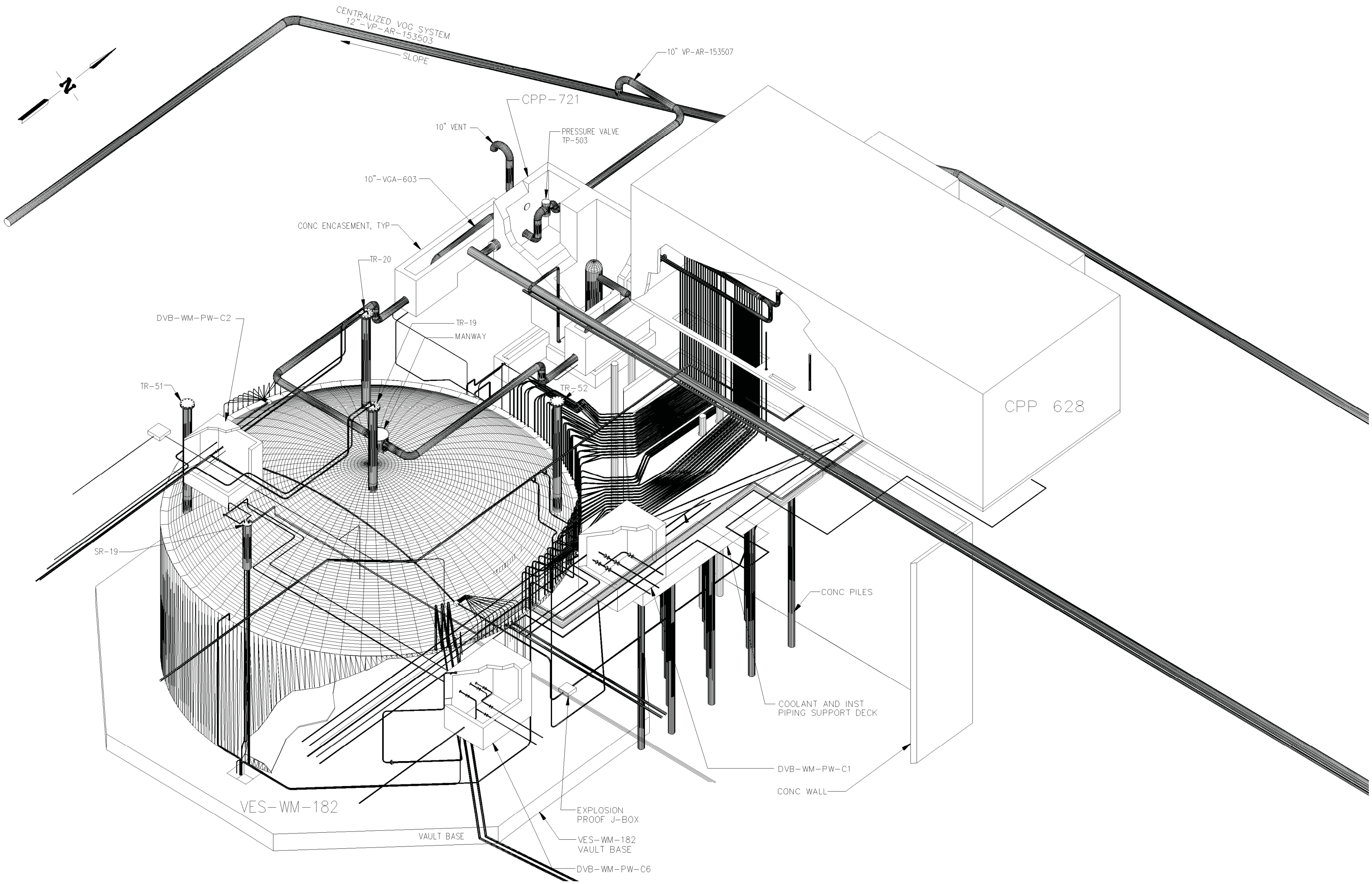

Figure A-3. Cutaway view of Tank WM-182.

height are 50 ft and 21 ft, respectively, with the exception of the 23-ft high walls for WM-180 and WM-181. The higher walls for these two tanks provide a storage capacity of 318,000 gallons for each tank.

Tanks WM-182 through WM-190 are constructed with an 11-in. wide horizontal plate that connects the tank wall top to the dome. This horizontal plate provides a flat surface for process and instrumentation pipelines to penetrate the tank. Equally spaced gussets support the plate from underneath. Tanks WM-180 and WM-181 have no horizontal plate because the dome edge connects directly to the tank wall top. Tank domes are spherical in shape and rise above the tank wall from 8.5 to 8.7 ft.

Eight of the eleven tanks contain stainless steel cooling coils (all except WM-181, -184, and –186). The cooling coils maintain the liquid waste temperature below 95°F for fluoride-containing waste and below 131°F for nonfluoride-containing waste. The liquid waste is maintained below these temperatures to minimize tank corrosion. The lower tank temperature also reduces the liquid surface evaporation rate. Demineralized water in the cooling coils, along with chromate additives, circulates through a closed system and is cooled by secondary cooling water.

Access to the 300,000-gallon tanks is provided through risers. Each tank has four to five 12-in. diameter risers. Tanks WM-184 through WM-190 also have two 18-in. diameter risers. Most risers have equipment installed in them, such as radio frequency probes for level measurement, corrosion coupons, or waste transfer equipment (steam jets and airlifts). Two steam jets are located inside each tank, with the exception of WM-189 and WM-190; these two tanks have one steam jet and one air lift pump. A single steam jet can transfer waste out of a tank at approximately 50 gal/min. An airlift can transfer waste out of a tank at approximately 35 gal/min. Table A-1 provides general construction information on the 300,000-gallon tanks.

A-2.2 30,000-Gallon Tanks

The four, inactive 30,000-gallon tanks are stainless steel belowground tanks on reinforced concrete pads. The tanks have a diameter of about 11.5 ft, are 38 ft long, and are covered by compacted gravel. Tanks WM-103, -104, -105, and -106 were buried at depths of 28.5, 29.0, 29.5, and 29.5 ft, respectively. Like the 300,000-gallon tanks, the 30,000-gallon tanks do not have secondary containment that can be certified to meet Hazardous Waste Management Act (HWMA) (1983)/Resource Conservation and Recovery Act (RCRA) (1976) requirements. Unlike the 300,000-gallon tanks, the 30,000-gallon tanks do not have vaults.

The tanks rest on concrete slabs that are 47.5 ft long × 17 ft wide × 1.25 ft thick. These slabs were constructed with a 0.75 × 1 ft high curb surrounding the slab perimeter to contain leaking waste. A gravel pad was placed inside the curb. Sumps 2 × 2 × 2 ft deep were cast into the northeast corner of each concrete slab.

Each tank has a total volume of 30,750 gal. The tanks are horizontal cylinders with American Society of Mechanical Engineers (ASME) dished heads attached on both ends. Generalized information and tank dimensions can be found in Table A-2.

Underground pillars anchored to bedrock support the concrete pipe encasements associated with the 30,000-gallon tanks. The base slabs, which the tanks rest on, sit on undisturbed soil.

All four tanks contain stainless steel, closed loop, re-circulating cooling coils to control liquid waste temperature, evaporation rate, and condensation accumulation. Base slab sump access is provided by a 2-ft diameter concrete riser that extends to grade level. A permanently installed sump jet pump obstructs the sump access riser interior.

Table A-1. Design information summary for the 300,000-gallon tanks at the TFF.[a]

	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Design organization	Foster-Wheeler	Foster-Wheeler	Blaw-Knox	Blaw-Knox	Blaw-Knox	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.
Tank subcontractor	Chicago Bridge and Iron	Chicago Bridge and Iron	Chicago Bridge and Iron	Chicago Bridge and Iron	Chicago Bridge and Iron	Chicago Bridge and Iron	Chicago Bridge and Iron	Hammond Iron	Hammond Iron	Industrial Contractors	Industrial Contractors
Years constructed	1951–1952	1951–1952	1954–1955	1954–1955	1954–1955	1957	1955–1957	1958–1959	1958–1959	1964	1964
Initial service date	1954	1953	1955	1958	1958	1959	1962	1959	1963	1966	Spare
Design codes	Unknown	Unknown	API-12C	API-12C	API-12C	API-12C	API-12C	API-12C	API-12C	API-650	API-650
Cooling coils	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Tank diameter (ft)	50	50	50	50	50	50	50	50	50	50	50
Tank height to springline (ft)	23	23	21	21	21	21	21	21	21	21	21
Tank capacity (gal)	318,000	318,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Lower tank thickness (in.)	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125
Upper tank thickness (in.)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Corrosion allowance (mils)	Unknown	Unknown	125	125	125	125	125	125	125	125	125
Type of stainless steel	347	347	304 L	304 L	304 L	304 L	304 L	304 L	304 L	304 L	304 L
Design specific gravity	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Physical characteristic		Dimension									
Dome height		8.7 ft (WM-180 and WM-181)[b]				8.5 ft (WM-182 through WM-190)[b]					
Approximate total tank volume		2,000 yd^3 (WM-180 and WM-181)[b,c]				1,825 yd^3 (WM-182 through WM-190)[b,c]					
Approximate dome volume		330 yd^3 (WM-180 and WM-181)[b,d]				300 yd^3 (WM-182 through WM-190)[b,d]					

a. Data taken from *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach* (INEEL 2000).

b. Values shown in the table are approximations to aid in cost estimation and provide a general tank description.

c. Estimated volume is based on the physical tank volume, not the tank capacity.

d. Volume calculated using standard spherical cap equation, a diameter of 50 ft, and appropriate dome height.

Table A-2. Design information summary for the 30,000 gallon tanks at the TFF.

Tank Identification Number	WM-103	WM-104	WM-105	WM-106
Design organization	Blaw-Knox Company	Blaw-Knox Company	Blaw-Knox Company	Blaw-Knox Company
Vendor	Alloy Fabricators	Alloy Fabricators	Alloy Fabricators	Alloy Fabricators
Years constructed	1954–1955	1954–1955	1954–1955	1954–1955
Total tank volume (gal)	30,750	30,750	30,750	30,750
Tank cylindrical length (ft)	38	38	38	38
Spherical heads (two per column)	ASME standard flanged and dished heads (≈2 ft deep)	ASME standard flanged and dished heads (≈2 ft deep)	ASME standard flanged and dished heads (≈2 ft deep)	ASME standard flanged and dished heads (≈2 ft deep)
Total tank length (ft)	42	42	42	42
Tank inner diameter (ft)	11.5	11.5	11.5	11.5
Tank wall thickness (in.)	11/16	11/16	11/16	11/16
Tank supporting base slab size (ft)	47.5 × 17 × 1.25 thick	47.5 × 17 × 1.25 ft thick	47.5 × 17 × 1.25 thick	47.5 × 17 × 1.25 ft thick
Liquid containment perimeter curb size (in.)	12 high × 9 wide	12 high × 9 wide	12 high × 9 wide	12 high × 9 wide
Tank access risers	Three 6-in. diameter	Three 6-in. diameter	Three 6-in. diameter	Three 6-in. diameter
	One 3-in. diameter	One 3-in. diameter	One 3-in. diameter	One 3-in. diameter
Sump riser (concrete pipe)	24-in. diameter	24-in. diameter	24-in. diameter	24-in. diameter
	Pipe wall is 3 in. thick	Pipe wall is 3 in. thick	Pipe wall is 3 in. thick	Pipe wall is 3 in. thick
Sump dimensions (ft)	2 × 2 × 2	2 × 2 × 2	2 × 2 × 2	2 × 2 × 2
Buried tank depths (dimensions to tank bottom) (ft)	28.5	28.5	28.5	28.5

Access to the 30,000 gallon tanks is provided by three 6-in. and one 3-in. diameter risers that reach to grade level. Tank jets are connected through the tank personnel access and extend underground to the other TFF locations. Tanks WM-103 and WM-104 are installed with four steam jets, while tanks WM-105 and WM-106 are installed with two steam jets for liquid removal.

A-2.3 Vaults

The vault floors are approximately 45 ft belowground. The vaults containing the tanks are of three basic designs: monolithic octagonal, pillar and panel octagonal, or monolithic square. The vault roofs are covered with approximately 10 ft of soil to provide radiation shielding. The vault roofs are 6-in. thick concrete. Details of the various vaults are provided in Table A-3.

A-2.3.1 Monolithic Octagonal Vaults

The two oldest tanks at TFF, Tanks WM-180 and WM-181, were constructed from 1950 to 1952 and are contained in poured-in-place monolithic octagonal concrete vaults. These are the only vaults that have been qualified through analytical modeling to meet Performance Category (PC) -4 seismic criteria. The vault floors are octagonal and were poured on bedrock. They are flat with sump areas cast within the vault floor for liquid drainage. Vault CPP-180 (Tank WM-180) was installed with two sump areas: 2 × 2 × 4 ft deep in the southeast corner and 2.5 × 2.5 × 2 ft deep in the northeast corner. Vault CPP-781 (Tank WM-181) was installed with one sump area 2 × 2 × 4 ft deep in the southwest corner. The concrete vault walls were cast once the vault floors were poured. The concrete vault roof was cast in place. The vault roof was constructed to rise at an angle from the vault walls and flatten toward the middle. Concrete platforms, supported by vertical concrete pillars, were constructed between the vaults for WM-182 and WM-183. This platform supports the cooling coils, instrumentation pipelines, process waste pipelines, and their respective encasements.

A-2.3.2 Pillar and Panel Octagonal Vaults

The five tanks contained in vaults of pillar and panel octagonal construction, Tanks WM-182 through WM-186, were constructed from 1954 to 1957. Also in octagonal vaults, the tanks contained in the pillar and panel vaults are of prefabricated construction and, therefore, are not considered as robust as the tanks contained in monolithic vaults (Palmer et al. 1998). The pillar and panel vaults were not analyzed for and probably would not qualify for PC-4 seismic criteria.[a] A diagram of the pillar and panel vault design is presented in Figure A-4. The octagonal concrete floors were poured on bedrock. Each floor has a 4-in. slope, beginning at the floor center and tapering to the slab edge. This slope creates a conical shaped floor. Sump areas, 1 × 1 × 1 ft deep, located on the north and south side of each vault, were cast within the vault floor. There is a 6 × 6-in. curb cast 6 ft in from the concrete base slab. The curb encloses an octagonal area 51 ft wide, encircling a sand pad.

The vault walls are constructed of concrete pillars and panels. A diagram of a pillar and panel vault can be seen in Figure A-4. The roofs are constructed of similar materials.

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a. M.C. Swenson, INEEL, e-mail to P.A. Tucker, INEEL, "Seismic Qualification of 300,000-gal Tanks," April 1999.

Table A-3. Design information summary for Vaults CPP-780 through CPP-786 and CPP-713.

	CPP-780	CPP-781	CPP-782	CPP-783	CPP-784	CPP-785	CPP-786	CPP-713			
	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Design organization	Foster-Wheeler	Foster-Wheeler	Blaw-Knox	Blaw-Knox	Blaw-Knox	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.	Fluor Corp.
Years Constructed	1951-1952	1951-1952	1954-1955	1954-1955	1954-1955	1957	1955-1957	1958-1959	1958-1959	1964	1964
Vault type	Monolithic octagonal [a]	Monolithic octagonal [a]	Pillar and panel octagonal	Pillar and panel octagonal	Pillar and panel octagonal	Pillar and panel octagonal	Pillar and panel octagonal	Monolithic square [a]	Monolithic square [a]	Monolithic square [a]	Monolithic square [a]
Inside width (ft)	56	56	58.9	58.9	58.9	58.8	58.8	56	56	56	56
Wall thickness (ft)	2.33 or 1.75	2.33 or 1.75	0.5	0.5	0.5	0.542	0.542	N = 3.5 S = 3.5 W = 1.5 E = 3.5	N = 3.5 S = 3.5 W = 1.5 E = 3.5	N = 3.5 S = 3.5 W = 3.5 E = 1.5	N = 3.5 S = 3.5 W = 3.5 E = 1.5
Inside vault wall height (ft)	27.33	27.33	32	32	32	29.5	29.5	32.6	32.6	32.6	32.6
No. of vault risers and sumps	1	1	2	2	2	2	2	2	2	2	2
Maximum roof thickness (ft)	5.75	5.75	3.66	3.66	3.66	3.5	3.5	4.5	4.5	4.0	4.0
Minimum roof thickness (ft)	1.25	1.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vault top to grade (ft)	6.75	6.75	8.5 to 9	9 to 9.5	9	9	9	9	9	9	9
Total vault volume (yd^3)	3,386	3,386	3,229	3,229	3,229	3,229	3,229	3,737	3,737	3,737	3,737
Vault volume with tank in vault (yd^3)	1,384	1,384	1,404	1,404	1,404	1,404	1,404	1,911	1,911	1,911	1,911

a. Cast-in-place.

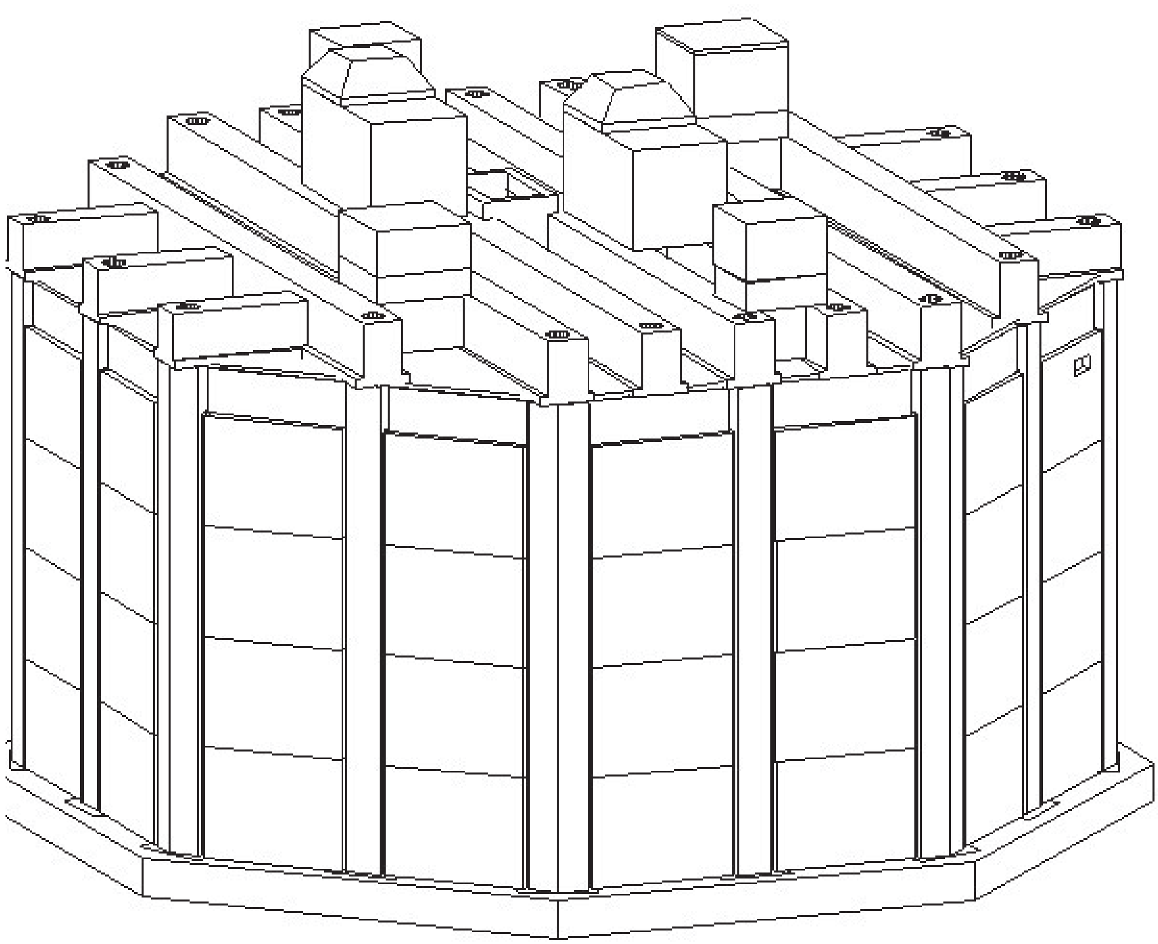

Figure A-4. Pillar and panel vault design at the INTEC Tank Farm Facility.

A-2.3.3 Monolithic Square Vaults

The four tanks contained in reinforced, poured-in-place, monolithic square, four-sectioned ("four pack") concrete vaults, Tanks WM-187 through WM-190, were constructed from 1958 to 1964. The vaults of these tanks are believed to meet PC-4 criteria, but the analysis for qualification was not performed (Palmer et al. 1998; footnote a, page 9). The square concrete vault floors were poured side by side on bedrock. The floors are constructed with a 4-in. slope, beginning at the floor center and tapering to the slab edge. The slope creates a conical-shaped floor similar to the pillar and panel vaults. Two sump areas, 12 × 12 × 12 in., are cast within the vault floor. The sumps are located in the northwest and southeast corners for the WM-187 and WM-189 vaults and the northeast and southwest corners for the WM-188 and WM-190 vaults. A 6 × 6-in. octagonal curb was installed inside the square vault. The curb creates an octagonal area 51 ft wide, encircling a sand pad.

A-2.4 Transfer Equipment

Waste transfer, cooling, decontamination, instrumentation, and vessel off-gas pipelines are plumbed to individual tanks and vaults. The waste transfer pipe running from the valve boxes to just outside the vault walls is encased in concrete enclosures with stainless steel liners to prevent radioactive waste from escaping. The concrete enclosures do not penetrate the vault. Pipes penetrate the vault via a pipe-in-pipe sleeve. Drains in each concrete encasement allow liquid from a leaking pipe or water infiltration to flow back to the nearest tank vault. Sump jets are installed in the sumps on the north and south sides of each tank. A portable high-pressure steam hose connected aboveground energizes these pumps. The sump jets transfer liquid from the vaults to the respective tanks.

Jet pumps are installed to remove liquid from the tanks. These jet pumps are located 3 to 9.5 in. above the tank floor. Permanent steam lines are connected to each jet pump and routed through underground piping to steam sources within the TFF Control House (CPP-628). Double contained process waste lines are routed underground from the jet pumps to the main transfer/filling system.

All lines that transport waste within the TFF are buried and enclosed in pipe encasements known as secondary containment. The four main types of TFF secondary containment are

1. Split tile (ceramic cast pipe with concrete joints)

2. Stainless-steel-lined concrete troughs

3. Direct-buried pipes in concrete

4. Double-walled stainless-steel pipe.

During recent TFF upgrades, most pipe sections encased in ceramic tile were replaced or abandoned in place. Short sections of ceramic pipe still remain on the active line list that serves WM-180 and WM-181. These lines cannot be used unless authorized by upper management. Any fluid leaking from a process line drains into an encasement and then into a valve box or vault sump. Leaking fluid is detected by radiation and/or level detection instrumentation. A leaking line is immediately taken out of service and is not reused until it has been repaired. Waste collected in the valve box or vault sumps is jetted to Tank WL-133 or drained to Valve Box C12. Wastes collected in Valve Box C12 also are jetted to WL-133. All wastes are then transferred to the process equipment waste (PEW) evaporator for processing.

A-2.4.1 Transfer Equipment for Tanks WM-187 through WM-190

Waste transfer, cooling, decontamination, instrumentation, and vessel off-gas pipelines are plumbed to individual tanks and vaults. The waste transfer pipe running from the valve boxes to just outside the vault walls are encased in stainless-steel pipe enclosures to prevent escape of radioactive waste. Process line leaks are routed to the nearest valve box sump. Sump jets with permanently attached steam source and transfer lines are installed into each vault sump to allow liquid removal. Liquid transfer jets are permanently installed inside the storage tanks through the tank risers to allow liquid waste removal.

A-2.4.2 30,000-Gallon Tank Liquid Transfer Equipment

There are permanent sump jet pumps installed in each of the four sumps associated with these tanks. Liquid removal jet pumps are installed in each tank, with lines penetrating through the tank personnel access. The inlets to these tanks are currently disconnected, but the outlets are still tied to the TFF piping system.

A-2.4.3 C-Series Valve Boxes

Valve boxes, located where pipe runs change directions, were constructed to provide protection for pipe joints, improve valve access, increase protection to workers from contaminated soils, and reduce valve repair costs by minimizing ground excavation. Valve boxes were installed with sumps and attached drain lines to transfer liquid waste to vault sumps or PEW evaporator in the event pipe encasement draining or process valve leaking occurs.

Each concrete valve box is reinforced and lined with stainless steel. The interior surfaces of C-series valve boxes are painted. Americoat 33, an enamel-based paint, was used to paint C-series valve boxes. Bitumastic #50, a material similar to tar thatch, was used as filler around pipe sleeves or on carbon steel piping. The approximate valve box dimensions are 6 ft long × 6 ft wide × 6.5 ft high with a wall thickness of 6 in. Typically, valve boxes extend approximately 1 ft aboveground.

A-2.4.4 Process Waste Pipelines

During recent TFF upgrades, most pipe sections encased in split tile were either replaced or abandoned in place (footnote a, page A-1). Process waste lines and respective secondary containment are generally covered with 10 to 15 ft of soil.

Any fluid leaking from a process line drains into an encasement and then into a valve box or vault sump. Leaking liquid is detected by radiation and level detection instrumentation. Waste collected in a valve box or vault sump is jetted to Tank WL-133 (located in building CPP-604) or drained to Valve Box C12. Waste collected in Valve Box C12 is also jetted to Tank WL-133. Waste from WL-133 is sent to the PEW evaporator for processing.

A-3. REFERENCES

42 USC 6901 et seq., 1976, “Resource Conservation and Recovery Act of 1976.”

INEEL, 2000, *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE HWMA/RCRA Closure Approach*, INEEL/EXT-99-01066, Idaho National Engineering and Environmental Laboratory, June.

Palmer, W. B., C. B. Millet, M. D. Staiger, and F. S. Ward, 1998, *ICPP Tank Farm Planning through 2012*, INEEL/EXT-98-00339, Idaho National Engineering and Environmental Laboratory, April.

State of Idaho, 1983, “Hazardous Waste Management,” Idaho Statute, Title 39, “Health and Safety,” Chapter 44, “Hazardous Waste Management,” (also known as the Hazardous Waste Management Act of 1983).

Appendix B

Data Summary for Tanks WM-182 and WM-183

Appendix B
Data Summary for Tanks WM-182 and WM-183

B-1. HISTORY OF TANKS WM-182 AND WM-183

Tank WM-182 was built between 1954 and 1955. It was put into service in 1955, and was used primarily to store first-cycle raffinate wastes resulting from the processing of aluminum and zirconium nuclear fuels. Approximately 1,604,100 gal of waste from Tank WM-182 were calcined during five calcination campaigns.

Tank WM-183 was built between 1954 and 1955, and was put into service in 1958. Tank WM-183 has been filled and emptied to heel-level three times and has contained aluminum- and stainless steel-clad fuel reprocessing raffinates.

Wastes other than high-level waste and sodium-bearing waste have been introduced to the TFF (including Tanks WM-182 and WM-183). Mixed low-level waste and low-level waste were sent to the process equipment waste evaporator, and the bottoms were subsequently discharged to the TFF. Of the two tanks, WM-183 has contained the greatest variety of waste, and its heel will likely have the most precipitated solids. Tanks WM-182 and WM-183 now contain 10,800 gal and 12,100 gal of sodium-bearing waste, respectively.[a]

B-2. SAMPLING ACTIVITIES

The light-duty utility arm (LDUA), a remote sampling device, was used to collect samples directly from Tanks WM-182, WM-183, and WM-188. The liquid level in the tanks was reduced to approximately 6 to 10 inches, which allowed samples to be collected of the solids and liquids in the tank bottoms. The LDUA uses a canister-sampling device that is lowered into the waste. Drawing a vacuum on the canister collects liquid and solid samples.

The tank solids had not previously been sampled, measured, or viewed. The LDUA sampling included video of each sampling event. At the time of each sampling event for Tanks WM-182 and WM-183, the liquid levels were different and the undissolved solids were found to vary significantly. Table B-1 shows the estimated solid level and measured liquid amount in WM-182 and WM-183 at the time of sampling. These values are reported in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000).

Table B-1. Liquid and solids in tanks at sampling.

Tank	Solid level (in.)	Liquid amount (gal)
WM-182	4	6,400
WM-183	8	12,800

a. Keith Quigley, INEEL, e-mail to Nick Stanisich, Portage Environmental, "Tank Volumes as of August 2001," October 3, 2001.

The collection of characterization samples from Tanks WM-182 and WM-183 provided initial information about tank heel constituents. The chemical/radiochemical composition of both solid and liquid residuals is better understood because of this effort. In addition, this effort provided users of the LDUA the opportunity to determine its relative effectiveness in remote sampling.

The objective of tank heel characterization is to produce data suitable for meeting the closure requirements as defined by RCRA (42 U.S. Code [USC] 6901, 1976) and DOE (DOE 2001). Quality assurance (QA) objectives are those specifications that data must meet to comply with project requirements. The specific QA parameters of interest are defined as quantitative QA parameters (precision, accuracy, method detection limit, and completeness), and qualitative QA parameters (representativeness and comparability).

Sampling efforts during the initial characterization effort used the LDUA sampling device to obtain both liquid and solid samples from the heels of Tanks WM-182 and WM-183. Although there were some QA/QC problems, many of these problems were associated with performing analysis on samples with high radiation fields. Following data collection, the data were evaluated using Environmental Protection Agency functional guidelines for inorganic and organic data review.

The data collected were generally usable for decision-making. However, some data were rejected (flagged “R”) because some QA/quality control (QC) parameters were not within control limits. The characterization effort for Tanks WM-182 and WM-183 is the first characterization of the tank heels. These efforts were the first to acquire data of known quality using standard Environmental Protection Agency or equivalent protocols. A significant amount of operations data has been gathered over the years. However, strict QA/QC controls on sample collection and analysis were not in place. The operations data were collected during the life of the TFF. Because of the time difference, direct comparison of operations data with the data from initial characterization efforts is not advised.

B-3. INITIAL CHARACTERIZATION DATA

B-3.1 Summary of Organic Compound Detections

Several organic compounds were detected in the heels of both tanks. Table B-2 summarizes all organic compounds detected in the tank heel residuals. Most of the organic compounds detected are generally consistent with the waste materials that were expected to contribute contaminants of concern to the tank heels.

Several liquid samples and one solid sample were taken from Tank WM-182, and several liquid and several solid samples were taken from Tank WM-183. Due to the natural breakdown of hexanone, all the detected ketones must be considered when evaluating potential contaminants of concern for closure purposes. Detections of the ketones 2-hexanone, 2-butanone, 4-methyl-2-pentanone, and acetone correlate to the extensive usage of hexanone as a process solvent/extractant and its degradation within both tanks.

In the samples taken from Tank WM-182, all four ketones were detected. 2-hexanone was detected in the solid sample. From the liquid samples, acetone was detected five times, 2-butanone was detected three times, 4-methyl-2-pentanone was detected two times, and 2-hexanone was detected once. Of the four ketones of concern, acetone was detected most often and was found with concentrations above 100 μg/L (see Table B-2). In Tank WM-183, however, the only ketone detected was acetone, with one detection in the liquid samples and two in the solid samples.

Table B-2. Organic results for samples.

Tank ID (WM-###)	Sample ID #	Matrix Type	Analyte	Concentration	Concentration Units	Validation Flag [a]
182	9910262-SV-LIQ RE	Water	2,4-dinitrophenol	260	µg/L	J
182	9910272-SV-LIQ	Water	2,4-dinitrophenol	66	µg/L	J
182	9911081-SV-LIQ	Water	2,4-dinitrophenol	52	µg/L	J
182	9910262-SV-LIQ	Water	2,4-dinitrophenol	260	µg/L	R
182	9910262-VOA-LIQ	Water	2-butanone	10	µg/L	J
182	9911014-VOA-LIQRE	Water	2-butanone	9	µg/L	J
182	WM182- SOLID COMP DL	Water	2-butanone	180	µg/L	R
182	WM:182 SOL COMP	Soil	2-hexanone	34	µg/kg	R
182	WM182- SOLID COMP DL	Water	2-hexanone	140	µg/L	R
182	WM182- SOLID COMP	Water	4-methyl-2-pentanone	14	µg/L	R
182	WM182- SOLID COMP DL	Water	4-methyl-2-pentanone	59	µg/L	R
182	9910262-VOA-LIQ	Water	Acetone	110	µg/L	J
182	9910272-VOA-LIQRE	Water	Acetone	230	µg/L	EJ
182	9910272-VOA-LIQDL	Water	Acetone	120	µg/L	J
182	9911014-VOA-LIQDL5	Water	Acetone	110	µg/L	J
182	9911014-VOA-LIQRE	Water	Acetone	97	µg/L	J
183	WM183-SOLID-TOTAL	Solid	Acetone	78	µg/kg	J
183	WM183-SOLID-TOTALDL10	Solid	Acetone	170	µg/kg	J
183	WM183-011700-PROTO	Water	Acetone	49	µg/L	
183	WM: 183 SOL-TOT	Soil	Aroclor-1260	1600	µg/kg	R
183	WM: 183 SOL-TOT B	Soil	Aroclor-1260	1400	µg/kg	R
183	0001175-PCB-LIQ	Water	Aroclor-1260	2.8	µg/L	J
183	0001175-PCB-LIQB	Water	Aroclor-1260	2.5	µg/L	J
182	9910262-VOA-LIQ-TB	Water	Benzene	5	µg/L	J
182	9910272-VOA-LIQRE	Water	Benzene	11	µg/L	
182	9910272-VOA-LIQDL	Water	Benzene	84	µg/L	J
182	9911014-VOA-LIQDL5	Water	Bromomethane	98	µg/L	J
182	9911014-VOA-LIQRE	Water	Chloroethane	8	µg/L	J
182	9910272-VOA-LIQDL	Water	Chloromethane	34	µg/L	J
182	9911014-VOA-LIQDL5	Water	Chloromethane	220	µg/L	J
182	9911014-VOA-LIQRE	Water	Chloromethane	530	µg/L	EJ
182	WM182- SOLID COMP DL	Water	Chloromethane	27	µg/L	R
183	WM183-011700-PROTO	Water	Chloromethane	42	µg/L	J
182	9910262-VOA-LIQ	Water	Ethylbenzene	4	µg/L	J
182	9910272-VOA-LIQRE	Water	Methylene chloride	3	µg/L	J
183	WM183-SOLID-TOTAL	Solid	Methylene chloride	80	µg/kg	J
183	WM183-SOLID-TOTALDL10	Solid	Methylene chloride	130	µg/kg	J
182	9910262-VOA-LIQ	Water	m-xylene and p-xylene	14	µg/L	J
182	9910262-SV-LIQ RE	Water	N-nitrosodimethylamine	31	µg/L	J
182	9910272-SV-LIQ	Water	N-nitrosodimethylamine	16	µg/L	J

Table B-2. (continued).

Tank ID (WM-###)	Sample ID #	Matrix Type	Analyte	Concentration	Concentration Units	Validation Flag [a]
182	WM182- SOLID COMP	Water	Toluene	8	µg/L	R
182	WM182- SOLID COMP DL	Water	Toluene	22	µg/L	R
182	9910262-SV-LIQ RE	Water	Tri-n-butylphosphate	50	µg/L	J
183	WM: 183 SOLID-TOTAL	Soil	Tri-n-butylphosphate	8,600	µg/kg	R

a. E = exceeds instrument calibration range
J = estimated concentration
R = concentration is rejected quantitatively.

Chlorinated organic compounds were also detected in the samples taken from both tanks. Detections of chlorinated compounds such as chloromethane, chloroethane, and methylene chloride are consistent with process information, which indicates that chlorinated solvents such as carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene were likely present in the process stream. The detection of lower-order chlorinated materials may have resulted from the degradation of process solvents, and they must be considered as possible contaminants of concern because carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene are constituents for which the TFF wastes have been assigned RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999).

Because detections of other, similar chlorinated organic compounds were made within the tank heel materials, methylene chloride also must be considered as a possible contaminant of concern. Based on process information, the semivolatile organic compound N-nitosodimethylamine also is consistent when considered as a possible degradation product of pyridine. From Tank WM-182 liquid samples, there was one detection each of methylene chloride and chloroethane, two detections of N-nitosodimethylamine, and four detections of chloromethane. From Tank WM-183, there were two detections of methylene chloride in the solid samples and one detection of chloromethane in the liquid samples. Most concentrations detected were below 100 µg/L. Two detections of chloromethane from Tank WM-182 samples and for methylene chloride from the Tank WM-183 samples were above 100 µg/L.

Additional volatile organic compounds such as benzene, ethylbenzene, and toluene were also identified by the TFF process evaluation as likely contaminants of concern in the tank heels. Benzene, ethyl benzene, xylene, and toluene were all detected in tank WM-182 residuals. Benzene and toluene are associated with RCRA-listed hazardous wastes that are included in the RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999). Therefore, their presence along with other aromatics, must be considered as potential contaminants of concern.

Related to the detections of these aromatics were the detections of 2,4-dinitrophenol in WM-182 liquids. Because of the excessive concentration of nitrate ions available in the residual liquids, the mechanism exists for the formation of 2,4-Dinitrophenol from the existing benzene, ethylbenzene, and toluene in Tank WM-182. Therefore, its presence also must be considered significant, and it should be evaluated as a contaminant of concern.

Aroclor-1260 was detected in WM-183 solids samples and in liquids in that tank. The reported concentrations in solid materials far exceed the levels in the liquid residuals.

Two detections of tri-n-butylphosphate were noted, one for WM-182 liquids and one for WM-183 solids. This compound was historically used as a chelating agent in decontamination solvents; therefore, its presence is consistent with past practices at INTEC, and the compound must be considered a viable contaminant of concern in the tank heel system.

Finally, a single detection in WM-182 liquids for bromomethane is consistent with historical data collected from TFF. Bromomethane is likely a degradation product, which falls between two compounds during normal degradation. Although bromide was not analyzed as part of the initial characterization sampling and analysis effort, historical data indicate the presence of bromide within the system and parent compounds from which bromomethane would have been formed.

B-3.2 Inorganic Detections and Physical Parameters

A significant number of detections were made for target metals measured in tank heel residuals for both WM-182 and WM-183. Table B-3 summarizes the positive metals detections found in tank heel residual solids and liquids. Table B-4 summarizes detectable concentrations for anion analyses performed in support of the initial characterization effort.

The metals detected in Tanks WM-182 and WM-183 are consistent with process knowledge. Chromium (24 mg/L), lead (6 mg/L), cadmium (5 mg/L), and mercury (17 mg/L) in Tank WM-183 solids were detected in concentrations that exceed maximum concentrations of contaminants for the toxicity characteristic (40 CFR 261.24, 2001). The mercury toxicity characteristic leaching procedure (TCLP) concentration was rejected during data validation and is, therefore, considered questionable.

In Tank WM-182 solids, only mercury (3 mg/L) and cadmium (2 mg/L) exceeded the concentrations of the toxicity characteristic standards. The RCRA toxicity characteristic regulatory concentration levels are 0.2 mg/L for mercury, 1.0 mg/L for cadmium, 5.0 mg/L for chromium, and 5.0 mg/L for lead.

The concentrations of metals in solution are generally greater in WM-183. The metals concentrations in the liquid phase and the possible inability to remove all liquids may account for the higher TCLP values and the more frequent detections above the toxicity characteristic limits. Concentrations of metals in solids were generally 2 to 3 orders of magnitude greater than the concentrations in solution.

The detectable anions in the WM-182 and WM-183 tank heels are chloride, fluoride, nitrate, sulfate, and phosphate (see Table B-4). Five samples were taken from WM-183; only one sample was taken from WM-182. In the WM-183 tank heel, phosphate was detected in the solid sample and B-acid was detected in the liquid samples.

B-3.3 Statistical Analysis of Initial Characterization Data

Statistical analysis was performed on the data to investigate the properties of the contents of WM-182 and WM-183 using various methods. The primary goal of the analysis was to determine the sample size required to meet the data quality objective requirements for each analyte. The secondary goal of the analysis was to examine how the concentrations of the tested constituents varied between tanks. Ratios also were calculated to analyze the difference in concentrations of analytes between the solid matrix and the liquid matrix for the metals in each tank. This section provides information on the type of statistical analysis that was performed, as well as a summary of results from this analysis. There was insufficient organic data to perform a statistical analysis for those analytes.

Table B-3. Inorganic results for samples.

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
182	WM182 SOLID COMP TOTALS	Solid	Aluminum	2.19E+04	mg/kg	J
182	9910262 LIQUID	Water	Aluminum	8.05E+06	µg/L	
182	9910272 LIQUID	Water	Aluminum	7.68E+06	µg/L	
182	9911081 LIQUID	Water	Aluminum	7.52E+06	µg/L	
182	9911082 LIQUID	Water	Aluminum	8.03E+06	µg/L	
183	WM183-SOLID-TOTAL	Solid	Aluminum	2.49E+04	mg/kg	
183	0001125-LIQUID	Water	Aluminum	1.19E+07	µg/L	
183	0001175-LIQUID	Water	Aluminum	1.06E+07	µg/L	
183	0001191-LIQUID	Water	Aluminum	1.44E+07	µg/L	
183	0001192-LIQUID	Water	Aluminum	9.47E+06	µg/L	
183	WM183-SOLID-TOTAL	Solid	Antimony	3.20E+01	mg/kg	J
183	0001125-LIQUID	Water	Antimony	4.70E+02	µg/L	
183	0001175-LIQUID	Water	Antimony	6.70E+02	µg/L	
183	0001191-LIQUID	Water	Antimony	3.40E+02	µg/L	
183	0001192-LIQUID	Water	Antimony	4.70E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Arsenic	2.81E+02	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Arsenic	5.56E+01	mg/kg	J
183	0001125-LIQUID	Water	Arsenic	7.90E+02	µg/L	
183	0001191-LIQUID	Water	Arsenic	4.80E+02	µg/L	
183	0001192-LIQUID	Water	Arsenic	4.70E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Barium	1.27E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Barium	2.44E+02	µg/L	
182	9910262 LIQUID	Water	Barium	3.49E+03	µg/L	
182	9910272 LIQUID	Water	Barium	3.33E+03	µg/L	
182	9911081 LIQUID	Water	Barium	3.47E+03	µg/L	
182	9911082 LIQUID	Water	Barium	3.52E+03	µg/L	
183	WM183-SOLID-TOTAL	Solid	Barium	2.36E+01	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Barium	7.76E+02	µg/L	
183	WM: 183 LIQ	Water	Barium	5.15E+03	µg/L	
183	0001125-LIQUID	Water	Barium	6.92E+03	µg/L	
183	0001175-LIQUID	Water	Barium	6.53E+03	µg/L	
183	0001191-LIQUID	Water	Barium	8.39E+03	µg/L	
183	0001192-LIQUID	Water	Barium	5.85E+03	µg/L	
182	9910262 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9910272 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9911081 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9911082 LIQUID	Water	Beryllium	3.03E+01	µg/L	
183	0001125-LIQUID	Water	Beryllium	6.00E+01	µg/L	
183	0001175-LIQUID	Water	Beryllium	5.00E+01	µg/L	
183	0001191-LIQUID	Water	Beryllium	7.00E+01	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	0001192-LIQUID	Water	Beryllium	5.00E+01	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Cadmium	3.25E+02	mg/kg	J
182	WM182 SOLID COMP	TCLP	Cadmium	2.19E+03	µg/L	
182	9910262 LIQUID	Water	Cadmium	6.09E+04	µg/L	
182	9910272 LIQUID	Water	Cadmium	5.97E+04	µg/L	
182	9911081 LIQUID	Water	Cadmium	6.02E+04	µg/L	
182	9911082 LIQUID	Water	Cadmium	6.08E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Cadmium	1.42E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Cadmium	5.85E+03	µg/L	
183	WM: 183 LIQ	Water	Cadmium	7.29E+04	µg/L	
183	0001125-LIQUID	Water	Cadmium	8.31E+04	µg/L	
183	0001175-LIQUID	Water	Cadmium	7.50E+04	µg/L	
183	0001191-LIQUID	Water	Cadmium	9.29E+04	µg/L	
183	0001192-LIQUID	Water	Cadmium	7.00E+04	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Calcium	1.76E+03	mg/kg	J
182	9910262 LIQUID	Water	Calcium	5.24E+05	µg/L	
182	9910272 LIQUID	Water	Calcium	5.02E+05	µg/L	
182	9911081 LIQUID	Water	Calcium	5.02E+05	µg/L	
182	9911082 LIQUID	Water	Calcium	5.13E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Calcium	1.87E+03	mg/kg	
183	0001125-LIQUID	Water	Calcium	1.09E+06	µg/L	
183	0001175-LIQUID	Water	Calcium	9.46E+05	µg/L	
183	0001191-LIQUID	Water	Calcium	1.29E+06	µg/L	
183	0001192-LIQUID	Water	Calcium	8.36E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Chromium	5.52E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Chromium	1.87E+03	µg/L	
182	9910262 LIQUID	Water	Chromium	1.01E+05	µg/L	
182	9910272 LIQUID	Water	Chromium	9.66E+04	µg/L	
182	9911081 LIQUID	Water	Chromium	9.82E+04	µg/L	
182	9911082 LIQUID	Water	Chromium	1.00E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Chromium	9.49E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Chromium	2.46E+04	µg/L	
183	WM: 183 LIQ	Water	Chromium	2.61E+05	µg/L	J
183	0001125-LIQUID	Water	Chromium	4.48E+05	µg/L	
183	0001175-LIQUID	Water	Chromium	3.88E+05	µg/L	
183	0001191-LIQUID	Water	Chromium	5.99E+05	µg/L	
183	0001192-LIQUID	Water	Chromium	3.33E+05	µg/L	
182	9910262 LIQUID	Water	Cobalt	8.68E+02	µg/L	
182	9910272 LIQUID	Water	Cobalt	8.78E+02	µg/L	
182	9911081 LIQUID	Water	Cobalt	8.37E+02	µg/L	
182	9911082 LIQUID	Water	Cobalt	8.78E+02	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	WM183-SOLID-TOTAL	Solid	Cobalt	9.30E+00	mg/kg	
183	0001125-LIQUID	Water	Cobalt	5.35E+03	μg/L	
183	0001175-LIQUID	Water	Cobalt	4.75E+03	μg/L	
183	0001191-LIQUID	Water	Cobalt	6.49E+03	μg/L	
183	0001192-LIQUID	Water	Cobalt	4.38E+03	μg/L	
182	9910262 LIQUID	Water	Copper	1.29E+04	μg/L	J
182	9910272 LIQUID	Water	Copper	1.68E+04	μg/L	J
182	9911081 LIQUID	Water	Copper	1.33E+04	μg/L	J
182	9911082 LIQUID	Water	Copper	1.24E+04	μg/L	J
183	WM183-SOLID-TOTAL	Solid	Copper	1.66E+02	mg/kg	
183	0001125-LIQUID	Water	Copper	1.10E+05	μg/L	
183	0001175-LIQUID	Water	Copper	7.86E+04	μg/L	
183	0001191-LIQUID	Water	Copper	6.82E+04	μg/L	
183	0001192-LIQUID	Water	Copper	3.80E+04	μg/L	
182	WM182 SOLID COMP TOTALS	Solid	Iron	4.48E+03	mg/kg	
182	9910262 LIQUID	Water	Iron	6.25E+05	μg/L	
182	9910272 LIQUID	Water	Iron	5.95E+05	μg/L	
182	9911081 LIQUID	Water	Iron	6.32E+05	μg/L	
182	9911082 LIQUID	Water	Iron	6.48E+05	μg/L	
183	WM183-SOLID-TOTAL	Solid	Iron	1.80E+04	mg/kg	
183	0001125-LIQUID	Water	Iron	1.95E+06	μg/L	
183	0001175-LIQUID	Water	Iron	1.68E+06	μg/L	
183	0001191-LIQUID	Water	Iron	2.48E+06	μg/L	
183	0001192-LIQUID	Water	Iron	1.52E+06	μg/L	
182	WM182 SOLID COMP TOTALS	Solid	Lead	3.69E+02	mg/kg	
182	9910262 LIQUID	Water	Lead	7.28E+04	μg/L	
182	9910272 LIQUID	Water	Lead	7.07E+04	μg/L	
182	9911081 LIQUID	Water	Lead	7.32E+04	μg/L	
182	9911082 LIQUID	Water	Lead	7.40E+04	μg/L	
183	WM183-SOLID-TOTAL	Solid	Lead	2.74E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Lead	6.75E+03	μg/L	
183	WM: 183 LIQ	Water	Lead	1.22E+05	μg/L	
183	0001125-LIQUID	Water	Lead	1.58E+05	μg/L	
183	0001175-LIQUID	Water	Lead	1.35E+05	μg/L	
183	0001191-LIQUID	Water	Lead	1.80E+05	μg/L	
183	0001192-LIQUID	Water	Lead	1.17E+05	μg/L	
182	WM182 SOLID COMP TOTALS	Solid	Magnesium	4.10E+02	mg/kg	
182	9910262 LIQUID	Water	Magnesium	1.01E+05	μg/L	
182	9910272 LIQUID	Water	Magnesium	9.59E+04	μg/L	
182	9911081 LIQUID	Water	Magnesium	9.44E+04	μg/L	
182	9911082 LIQUID	Water	Magnesium	9.39E+04	μg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	WM183-SOLID-TOTAL	Solid	Magnesium	4.34E+02	mg/kg	
183	0001125-LIQUID	Water	Magnesium	2.08E+05	µg/L	
183	0001175-LIQUID	Water	Magnesium	1.81E+05	µg/L	
183	0001191-LIQUID	Water	Magnesium	2.33E+05	µg/L	
183	0001192-LIQUID	Water	Magnesium	1.60E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Manganese	5.65E+02	mg/kg	
182	9910262 LIQUID	Water	Manganese	2.39E+05	µg/L	
182	9910272 LIQUID	Water	Manganese	2.28E+05	µg/L	
182	9911081 LIQUID	Water	Manganese	2.23E+05	µg/L	
182	9911082 LIQUID	Water	Manganese	2.29E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Manganese	7.40E+02	mg/kg	
183	0001125-LIQUID	Water	Manganese	4.67E+05	µg/L	
183	0001175-LIQUID	Water	Manganese	3.96E+05	µg/L	
183	0001191-LIQUID	Water	Manganese	5.72E+05	µg/L	
183	0001192-LIQUID	Water	Manganese	3.65E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Mercury	3.10E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Mercury	3.13E+03	µg/L	J
182	WM182-SOLID-COMPR	TCLP	Mercury	3.16E+03	µg/L	J
182	9910262 LIQUID	Water	Mercury	1.78E+05	µg/L	
182	9910272 LIQUID	Water	Mercury	1.59E+05	µg/L	
182	9911081 LIQUID	Water	Mercury	1.72E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Mercury	3.24E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Mercury	1.73E+04	µg/L	R
183	WM: 183 LIQ	Water	Mercury	3.30E+05	µg/L	J
183	0001125-LIQUID	Water	Mercury	4.40E+05	µg/L	
183	0001175-LIQUID	Water	Mercury	2.68E+05	µg/L	
183	0001191-LIQUID	Water	Mercury	3.78E+05	µg/L	
183	0001192-LIQUID	Water	Mercury	3.04E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Nickel	3.09E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Nickel	2.89E+03	µg/L	
182	9910262 LIQUID	Water	Nickel	5.05E+04	µg/L	
182	9910272 LIQUID	Water	Nickel	5.00E+04	µg/L	
182	9911081 LIQUID	Water	Nickel	4.88E+04	µg/L	
182	9911082 LIQUID	Water	Nickel	5.09E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Nickel	4.17E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Nickel	1.70E+04	µg/L	
183	WM: 183 LIQ	Water	Nickel	1.46E+05	µg/L	
183	0001125-LIQUID	Water	Nickel	2.33E+05	µg/L	
183	0001175-LIQUID	Water	Nickel	1.90E+05	µg/L	
183	0001191-LIQUID	Water	Nickel	2.66E+05	µg/L	
183	0001192-LIQUID	Water	Nickel	1.83E+05	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
182	WM182 SOLID COMP TOTALS	Solid	Selenium	9.11E+01	mg/kg	J
183	0001192-LIQUID	Water	Selenium	2.80E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Silver	6.47E+01	mg/kg	J
182	WM182 SOLID COMP	TCLP	Silver	4.60E+01	µg/L	J
182	9911082 LIQUID	Water	Silver	2.32E+02	µg/L	
183	WM183-SOLID-TOTAL	Solid	Silver	2.20E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Silver	6.96E+02	µg/L	
183	WM: 183 LIQ	Water	Silver	2.22E+02	µg/L	J
183	0001125-LIQUID	Water	Silver	6.10E+02	µg/L	
183	0001175-LIQUID	Water	Silver	3.60E+02	µg/L	
183	0001191-LIQUID	Water	Silver	8.10E+02	µg/L	
183	0001192-LIQUID	Water	Silver	4.20E+02	µg/L	
183	0001125-LIQUID	Water	Thallium	1.16E+03	µg/L	
183	0001175-LIQUID	Water	Thallium	3.90E+02	µg/L	
183	0001191-LIQUID	Water	Thallium	1.11E+03	µg/L	
183	0001192-LIQUID	Water	Thallium	7.60E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Vanadium	1.33E+01	mg/kg	
182	9910262 LIQUID	Water	Vanadium	4.84E+02	µg/L	
182	9910272 LIQUID	Water	Vanadium	5.25E+02	µg/L	
182	9911081 LIQUID	Water	Vanadium	4.94E+02	µg/L	
182	9911082 LIQUID	Water	Vanadium	4.54E+02	µg/L	
183	WM183-SOLID-TOTAL	Solid	Vanadium	1.07E+01	mg/kg	
183	0001125-LIQUID	Water	Vanadium	1.76E+03	µg/L	
183	0001175-LIQUID	Water	Vanadium	1.53E+03	µg/L	
183	0001191-LIQUID	Water	Vanadium	2.04E+03	µg/L	
183	0001192-LIQUID	Water	Vanadium	1.34E+03	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Zinc	1.79E+02	mg/kg	
182	9910262 LIQUID	Water	Zinc	2.32E+04	µg/L	
182	9910272 LIQUID	Water	Zinc	3.60E+04	µg/L	
182	9911081 LIQUID	Water	Zinc	2.58E+04	µg/L	
182	9911082 LIQUID	Water	Zinc	2.25E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Zinc	1.48E+02	mg/kg	
183	0001125-LIQUID	Water	Zinc	9.52E+04	µg/L	
183	0001175-LIQUID	Water	Zinc	7.59E+04	µg/L	
183	0001191-LIQUID	Water	Zinc	7.04E+04	µg/L	
183	0001192-LIQUID	Water	Zinc	4.64E+04	µg/L	

a. J = estimated concentration

R = concentration is rejected quantitatively

Table B-4. Detectable anion results.

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	0001125-LIQUID	Water	B-Acid	2.50E+00	mg/L	
183	0001175-LIQUID	Water	B-Acid	2.40E+00	mg/L	
183	0001191-LIQUID	Water	B-Acid	2.50E+00	mg/L	
183	0001192-LIQUID	Water	B-Acid	2.40E+00	mg/L	
182	WM182 SOLID COMP	Water Extract	Chloride	2.02E+03	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Chloride	1.31E+03	mg/kg	
183	0001125-LIQUID	Water	Chloride	3.11E+02	mg/L	
183	0001175-LIQUID	Water	Chloride	2.93E+02	mg/L	
183	0001191-LIQUID	Water	Chloride	3.08E+02	mg/L	
183	0001192-LIQUID	Water	Chloride	2.52E+02	mg/L	
182	WM182 SOLID COMP	Water Extract	Fluoride	1.49E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Fluoride	4.37E+03	mg/kg	
183	0001125-LIQUID	Water	Fluoride	8.27E+02	mg/L	
183	0001175-LIQUID	Water	Fluoride	7.32E+02	mg/L	
183	0001191-LIQUID	Water	Fluoride	6.62E+02	mg/L	
183	0001192-LIQUID	Water	Fluoride	6.03E+02	mg/L	
182	WM182 SOLID COMP	Water Extract	Nitrate	7.07E+04	mg/kg	R
183	WM183-SOLID-TOTAL	Solid	Nitrate	1.75E+05	mg/kg	
183	0001125-LIQUID	Water	Nitrate	1.09E+05	mg/L	
183	0001175-LIQUID	Water	Nitrate	1.91E+05	mg/L	
183	0001191-LIQUID	Water	Nitrate	2.01E+05	mg/L	
183	0001192-LIQUID	Water	Nitrate	1.83E+05	mg/L	
182	WM182 SOLID COMP	Water Extract	Phosphate	6.84E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Phosphate	1.26E+05	mg/kg	
182	WM182 SOLID COMP	Water Extract	Sulfate	3.32E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Sulfate	1.36E+04	mg/kg	
183	0001125-LIQUID	Water	Sulfate	1.44E+03	mg/L	
183	0001175-LIQUID	Water	Sulfate	2.36E+03	mg/L	
183	0001191-LIQUID	Water	Sulfate	2.58E+03	mg/L	
183	0001192-LIQUID	Water	Sulfate	2.25E+03	mg/L	

a. J = estimated concentration
R = concentration is rejected quantitatively

B-3.3.1 Tank Comparison

This section provides a description of the statistical methods that were applied to the data to compare WM-182 and WM-183 and the justification for each method. Data were analyzed separately for each tank and in some instances for both tanks combined. Data from the liquid matrix was always analyzed separately from the data for the solid matrix.

B-3.3.1.1 Histograms. A histogram is a graphic representation of the quantitative data that separates the data from various intervals or bins and plots the frequency of the data in each bin. This type of graph displays the overall distribution or shape of the data, which can point out many trends or irregularities, such as outliers. The histogram also is one of the first steps in assessing whether the data follow a normal distribution. The graph points out any obvious departures from normality.

Histograms were constructed for each of the metals, anions, and radionuclides that was analyzed, detected, or had two or more observations in a given tank. Histograms were not generated from measurements taken from the solid matrix since there was no more than one measurement per tank for any analyte. If sufficient data were available for both tanks for a particular analyte, three histograms were made for that analyte. These histograms were made from the data for each tank, as well as a third histogram for the combined data from both tanks. If sufficient data were only available from one tank, only one histogram was made for that analyte.

The histograms consistently show a trend for the metal analyses between the tanks. The data for WM-182 had a different range and spread than the data for WM-183 and in every case the data for WM-182 show lower concentrations and a smaller range of values than the data for WM-183. Examination of the histograms showed that none of the analytes appeared to follow a normal distribution for either tank or for the combined data.

Only enough anion data was available to construct histograms for WM-183 since there was only one measurement per analyte in WM-182. The histograms were constructed primarily to determine if the data followed a normal distribution; none of the data exhibited a normal distribution.

B-3.3.1.2 Normal Probability Plots. A normal probability plot was used to assess the normality of the data. The normal probability plot is a graph of the quantiles of a data set against the quantiles of the normal distribution. If the points on the graph follow a straight line, the data are considered to follow the normal distribution. If the data varies from a straight line, the data are considered non-normal in distribution.

Normal probability plots were made for each data set for which a histogram had previously been constructed. None of the metals or anions demonstrated a normal distribution for either tank or for the combined data from both tanks.

B-3.3.1.3 Summary Statistics. One of the primary goals of this statistical evaluation is the comparison of WM-182 and WM-183 against each other with respect to analyte concentration. To examine the differences and similarities between the tanks more closely, each tank was compared by analyte and by matrix (liquid or solid). This was done by calculating summary statistics for each analyte by tank. If two or more observations were measured and detected for a particular analyte in a certain tank, the mean, median, standard deviation, range, minimum concentration, and maximum concentration were calculated. If only one measurement was recorded, this was the value used for comparison. Tables B-5, B-6, and B-7 contain the summary statistics.

Table B-5. Summary statistics for Tanks WM-182 and WM-183.

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Aluminum	Mean	7,820	11,592.5
	Standard Deviation	262	1,059.35
	Median	7,855	11,250
	Range	530	4,930
	Minimum	7,520	9,470
	Maximum	8,050	14,400
Antimony	Mean	Undetected	0.49
	Standard Deviation	Undetected	0.14
	Median	Undetected	0.47
	Range	Undetected	0.33
	Minimum	Undetected	0.34
	Maximum	Undetected	0.67
Arsenic	Mean	Undetected	0.39
	Standard Deviation	Undetected	0.28
	Median	Undetected	0.47
	Range	Undetected	0.68
	Minimum	Undetected	0.11
	Maximum	Undetected	0.79
Barium	Mean	3.45	6.57
	Standard Deviation	0.08	1.07
	Median	3.48	6.53
	Range	0.19	3.24
	Minimum	3.33	5.15
	Maximum	3.52	8.39
Beryllium	Mean	0.0303	0.0575
	Standard Deviation	0.00	0.01
	Median	0.0303	0.055
	Range	0.0303	0.02
	Minimum	0.00	0.05
	Maximum	0.0303	0.07
Cadmium	Mean	60.4	78.78
	Standard Deviation	0.56	10.01
	Median	60.5	75.0
	Range	1.2	22.9
	Minimum	59.7	70.0
	Maximum	60.9	92.9

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Calcium	Mean	510.25	1,040.5
	Standard Deviation	10.53	196.2
	Median	507.5	1,018
	Range	22	454
	Minimum	502	836
	Maximum	524	1,290
Chromium	Mean	98.95	405.8
	Standard Deviation	1.95	115.0
	Median	99.1	388
	Range	4.4	338
	Minimum	96.6	261
	Maximum	101	599
Cobalt	Mean	0.865	5.243
	Standard Deviation	0.02	0.92
	Median	0.873	5.050
	Range	0.041	2.110
	Minimum	0.837	4.380
	Maximum	0.878	6.490
Copper	Mean	13.85	73.7
	Standard Deviation	2.00	29.7
	Median	13.1	73.4
	Range	4.4	72
	Minimum	12.4	38
	Maximum	16.8	110
Iron	Mean	625	1,907.5
	Standard Deviation	22.2	420.9
	Median	628.5	1815
	Range	53	960
	Minimum	595	1,520
	Maximum	648	2,480
Lead	Mean	72.681	142.4
	Standard Deviation	1.41	27.4
	Median	73	135
	Range	3.3	63
	Minimum	70.7	117
	Maximum	74	180

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Magnesium	Mean	96.3	195.5
	Standard Deviation	3.25	31.8
	Median	95.15	194.5
	Range	7.1	73
	Minimum	93.9	160
	Maximum	101	233
Manganese	Mean	229.75	450
	Standard Deviation	6.70	91.9
	Median	228.5	431.5
	Range	16	207
	Minimum	223	365
	Maximum	239	572
Mercury	Mean	169.67	344
	Standard Deviation	9.71	76.8
	Median	172	330
	Range	19	172
	Minimum	159	268
	Maximum	178	440
Nickel	Mean	50.05	203.6
	Standard Deviation	0.91	38.9
	Median	50.25	190
	Range	2.1	120
	Minimum	48.8	146
	Maximum	50.9	266
Selenium	Mean	Undetected	0.14
	Standard Deviation	Undetected	0.10
	Median	Undetected	0.09
	Range	Undetected	0.19
	Minimum	Undetected	0.09
	Maximum	Undetected	0.28
Silver	Mean	0.126	0.484
	Standard Deviation	0.07	0.20
	Median	0.091	0.42
	Range	0.141	0.588
	Minimum	0.091	0.222
	Maximum	0.232	0.81

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Thallium	Mean	Undetected	0.855
	Standard Deviation	Undetected	0.36
	Median	Undetected	0.935
	Range	Undetected	0.77
	Minimum	Undetected	0.39
	Maximum	Undetected	1.16
Vanadium	Mean	0.489	1.668
	Standard Deviation	0.03	0.30
	Median	0.489	1.645
	Range	0.071	0.700
	Minimum	0.454	1.340
	Maximum	0.525	2.040
Zinc	Mean	26.875	71.975
	Standard Deviation	6.25	20.09
	Median	24.5	73.15
	Range	13.5	48.8
	Minimum	22.5	46.4
	Maximum	36	95.2

Table B-6. Comparison of TCLP metal concentrations in the solid matrix.

Analyte	WM-182 (mg/L) [a]	WM-183 (mg/L) [a]
Arsenic	ND	ND
Barium	0.24	0.78
Cadmium	2.2	5.8
Chromium	1.9	24
Lead	ND	6.7
Mercury	3.1	17 (R)
Nickel	2.9	17
Selenium	ND	ND
Silver	0.046	0.70

a. ND = not detected

R = rejected during data validation

Table B-7. Comparison of metal concentrations in the solid matrix.

Analyte	WM-182 (mg/kg) [a]	WM-183 (mg/kg) [a]
Aluminum	21,900	24,900
Antimony	ND	32
Beryllium	ND	ND
Calcium	1,760	1,870
Cobalt	ND	9.3
Copper	ND	166
Iron	4,480	18,000
Magnesium	410	434
Manganese	565	740
Thallium	ND	ND
Vanadium	13.3	10.7
Zinc	179	148

a. ND = not detected

The metals in the liquid matrix demonstrated a trend that the average concentration in WM-182 was consistently less than the average concentration in WM-183. The difference was so extreme for each of the metals, with the exception of silver, that the maximum measured concentration in WM-182 was less than the minimum measured concentration in WM-183. (The maximum measured concentration for silver in WM-182 was 0.232 mg/L and the minimum measured concentration in WM-183 was 0.222 mg/L.) By examining the full set of summary statistics for silver, on average the concentration of silver is higher in WM-183 than in WM-182. Hypothesis tests were not performed on the difference between the means, because the data did not exhibit sufficient normality to justify doing so.

A trend is also shown in the spread of the data between the two tanks. The standard deviation and the range both demonstrate that there is much larger variation in the concentration measurements in WM-183 than in WM-182. The range and standard deviation were larger in WM-183 than in WM-182 for every metal measured. The summary statistics for metals in the liquid matrix can be found in Table B-5.

The metals in the solid matrix did not exhibit any trend. Since only one measurement was taken in the solid matrix per tank there is no way to analyze the difference in variation in the concentrations of the metals between tanks. However, higher concentrations of arsenic, barium, cadmium, lead, selenium, vanadium, and zinc were found in WM-182. Higher concentrations of aluminum, antimony, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, silver, and thallium were measured in WM-183. Beryllium was not detected in either measurement, and the copper measurement in WM-182 was rejected so no comparisons can be made for either analyte. The summary statistics for the metals in the solid matrix can be found in Tables B-6 and B-7.

A comparison of anions measured in the liquid matrix for each tank could only be performed on chloride, fluoride, nitrate, and sulfate since these were the only anions detected in both tanks. One measurement was taken in WM-182 and four measurements were taken in WM-183 for each of these analytes. There appears to be a much higher concentration of nitrate in WM-183 than in WM-182, and notably higher concentrations of chloride and sulfate in WM-183 as opposed to WM-182. There was not much difference between the concentration of fluoride in the two tanks, but WM-182 had a slightly higher mean concentration than WM-183. There was no comparison of anions for b-acid phosphate because of lack of data. There was also no analysis done on anion concentrations in the solid matrix because no measurements were taken in WM-182 and only one measurement was taken in WM-183. The summary statistics for anion analyses in the liquids can be found in Table B-8.

B-3.3.1.4 Detection Levels. This section provides a summary of the measured concentration of the constituents of interest before WM-182 and WM-183 were decontaminated and how those measurements relate to the TCLP regulatory limit of each constituent. Of particular interest is identifying the analytes that were not detected in a particular tank or whose measured concentration was far below the TCLP regulatory limit. The anions had high concentrations in both tanks so only the metals will be analyzed in this section. The results for this section are based on the information in Tables B-3, B-5, B-6, and B-7. TCLP maximum concentration limits are reported in parentheses after discussed analytes where pertinent.

This information is based on four measurements per analyte per tank at most and sometimes as few as one measurement per analyte per tank.

Table B-5 shows that if an analyte had a low concentration in one of the tanks, that same analyte had a low concentration in the other tank. However, with the exception of selenium, if one analyte was not detected in one tank it was not necessarily detected in the other tank. This was evident for metals in both the liquid matrix and the solid matrix.

In Tank WM-182 for the metals in the liquid matrix, antimony, arsenic, selenium, and thallium were not detected. Beryllium, cobalt, silver, and vanadium all had concentration measures less than 1 mg/L. All of the measurements for barium were below the TCLP maximum concentration limit (100 mg/L). Where direct TCLP measurements on samples of tank solids were not available, total constituent analysis data were compared to the TCLP regulatory limits by dividing the total analysis result (mg/kg) by 20 to obtain the maximum possible TCLP results in mg/L. Antimony, beryllium, cobalt, and thallium were not detected in the WM-182 solids. Vanadium had a concentration measurement less than 1 mg/L, and selenium was measured below the TCLP maximum concentration limit (5 mg/L).

In Tank WM-183 for the metals in the liquid matrix, all metals analyzed were detected. Antimony, arsenic, barium, beryllium, selenium, silver, thallium, and vanadium were all measured at relatively small concentrations. All of the measurements for arsenic, barium, and silver were below their TCLP maximum concentration limits (5 mg/L, 100 mg/L, and 1 mg/L respectively). As with the Tank WM-182 solids, total constituent analysis data were used to calculate maximum TCLP concentrations when an analyte was not measured in the TCLP extract produced from the solid sample. Beryllium, selenium, and vanadium were not detected. The measured concentrations for antimony, arsenic, barium, cobalt, and thallium were relatively small. All of the measurements for arsenic and barium were below their TCLP maximum detection limits (5 mg/L and 100 mg/L, respectively).

Table B-8. Summary statistics for anions in liquids.

Anion	WM-182	WM-183 Minimum (mg/L)	WM-183 Mean (mg/L)
Chloride	101	252	291
Fluoride	745	603	706
Nitrate	3,535	10,900	171,000
Sulfate	1,660	1,440	2,157.2
	Median of anions:	5.76E+05	7.73E+05
	Range of anions:	1.78E+05	3.46E+05

B-4. REFERENCES

40 CFR 261.24, 2001, "Toxicity Characteristic," *Code of Federal Regulations*, Office of the Federal Register, July 1.

42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

DOE O 435.1, 2001, "Radioactive Waste Management," Change 1, Department of Energy, August 28.

Gilbert, Kenneth O., and Timothy E. Venneman, 1999, *A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System*, INEEL/EXT-98-01213, Rev. 1, February.

INEEL, 2000, *Conceptual Design Report, INTEC Tank Farm Facility Closure,* Project File 015722, Book 3, *Modeling and Animations*, Volume 5, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, August.

Appendix C

Development of Action Levels for the HWMA/RCRA Closure of Tanks WM-182 and WM-183

Appendix C

Development of Action Levels for the HWMA/RCRA Closure of Tanks WM-182 and WM-183

The Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) Tanks WM-182 and WM-183 are to be closed under HWMA/RCRA (State of Idaho 1983; 42 U.S. Code [USC] 6901, 1976) by removal of the waste currently contained in the tanks and decontamination of the internal tank surfaces. Compliance with the performance standard for closure of tank systems (40 CFR 265.111 and 265.197) is to be demonstrated for the tanks by sampling the final rinsate solutions from the decontamination efforts and comparing the resulting analytical data with action levels developed in this appendix. The action levels for the HWMA/RCRA closure of Tanks WM-182 and WM-183 have been developed to ensure that the tanks, subsequent to completion of closure activities, will be left in a state that is protective of human health and the environment. This appendix was prepared to present the methodology used to develop action levels specific to the HWMA/RCRA closure of Tanks WM-182 and WM-183. Action levels were developed by defining the acceptable excess cancer risk and hazard quotient thresholds and calculating corresponding action levels based upon these risk and hazard thresholds. Finally, the excess cancer risk and hazard for all pathways and contaminants at the developed action levels are presented. The technique for calculation of action levels described in this appendix will be applied to any additional COCs identified during the course of closure activities for Tanks WM-182 and WM-183.

This analysis considers two pathways: soil inhalation and soil ingestion to an occupational receptor. Performing the analysis considering these pathways is very conservative. Environmental Protection Agency (EPA) guidance (EPA 1989) states that the soil inhalation and soil ingestion pathways are appropriate for soil contamination not greater than 10 feet in depth. While the potential soil contamination resulting from liquid contacting the internal tank surfaces will be greater than 40 feet in depth, these pathways were retained to ensure the protectiveness of the action level development methodology. In developing the conceptual site model for this risk assessment, the following assumptions were made:

1. Liquid infiltration contacts the internal tank surfaces

2. Contacting liquid then exits the tank system with all COCs present at action level concentrations

3. Each liter of contaminated liquid contaminates 1 kg of soil (thus each part per million of contaminant in the liquid is equivalent to one part per million of contaminant in the soil).

Assumption No. 1 is conservative due to the planned grouting of the tank system. Once the tanks have been grouted, it is highly unlikely that water infiltration will contact the internal tank surfaces. Assumption No. 2 is conservative because it assumes immediate release of liquid contacting the internal tank surfaces from the tank to the soil (should such liquid/tank surface contact be possible, which is unlikely due to grouting). In reality, liquid contacting the internal tank surfaces will remain contained within the stainless steel tanks and concrete vaults. Assumption No. 3 is conservative for three reasons. First, assuming an average bulk soil density of 1.3 kg/L, and an average soil porosity of 0.45, the void volume in a typical kilogram of soil is approximately 350 mL. Thus, although the assumption has been made that each liter of contaminated liquid contaminates 1 kg of soil, in reality, it is only physically possible for 350 mL of the contaminated liquid to contaminate each kilogram of soil. Second, it is assumed that the liquid and soil are in contact for sufficient time to allow mass transfer equilibrium to be reached between the soil column and the liquid, whereas in reality, the water will be flowing through the soil column and equilibrium will not be reached. Finally, it is assumed that 100% of the contaminant is transferred to the soil without regard for partitioning of the contaminant between the soil column and the water. In reality, a fraction of each of the contaminants will remain contained within the contaminated liquid.

Step 1: Define the Total Allowable Excess Cancer Risk and Hazard Quotient to the Future Occupational Receptor

As stated in the assumptions above, the liquid that may come into contact with the closed tank system and subsequently contaminate surrounding soil is assumed to exit the tank system and enter the surrounding soil at the action level concentration. The surrounding soil is then assumed to be contaminated at equivalent parts per million concentrations. Consequently, risk-based media cleanup standards are appropriate to establish the allowable excess cancer risk and hazard quotient. Protective media cleanup standards for human health means constituent concentrations that result in the total residual risk from a medium to an individual exposed over a lifetime falling within a range from 10^{-4} to 10^{-6}, with a cumulative carcinogenic risk range. For noncarcinogenic effects, EPA generally interprets protective cleanup standards to mean constituent concentration that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; the hazard index generally should not exceed 1 (55 FR 46, 1990; 55 FR 145, 1990); 61 FR 85, 1996). To ensure protectiveness of human health, the most conservative threshold for excess cancer risk, 1.0E–06, will be used for Tanks WM-182 and WM-183. Therefore

- Total allowable risk threshold = 1.0E–06
- Total allowable hazard quotient threshold = 1.0.

Step 2: Define Receptors and Pathways

The pathways considered for developing action levels include

- Occupational receptor ingestion of contaminated soil
- Occupational receptor inhalation of contaminated soil.

Step 3: Define Contaminants of Concern and Toxicity Parameters

The contaminant of concern (COC) list was developed by defining all HWMA/RCRA-regulated constituents that meet either of the following criteria:

1. The HWMA/RCRA-regulated constituent was detected during sampling and analysis of the waste currently contained within the tanks ***and*** the constituent is listed in the United States EPA Region 9 Preliminary Remediation Goal (PRG) Table (EPA 2003)[a]
2. The HWMA/RCRA-regulated constituent was determined to be part of the INTEC liquid waste stream as described in *A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Number for Applicability to the INTEC Liquid Waste System* (Gilbert and Venneman 1999).

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a. One constituent, 2-hexanone, while not listed in the EPA Region 9 PRG Table, was listed in the EPA Region III Risk-based Concentration Table (EPA 2002). This constituent was retained in the COC list, and toxicity information from the Region III document was used to determine constituent-specific action levels for 2-hexanone.

Applying the two criteria defined above allows definition of the complete COC list for HWMA/RCRA closure of Tanks WM-182 and WM-183. The complete list of COCs is provided in Table C-1. As stated in criterion No. 1, above, detected constituents that are not listed in the EPA Region 9 PRG Table were excluded from the COC list. Constituents excluded for this reason were calcium, chloride, magnesium, nitrate, phosphate, and sulfate.

Reference doses and slope factors for each of the contaminants of concern are provided in Table C-1. This information was obtained from the United States EPA Region 9 PRG Table (EPA 2003). Toxicity information for 2-hexanone was obtained from the EPA Region III Risk-based Concentration Table (EPA 2002). The EPA Region 9 PRG Table does not include inhalation reference doses for antimony, arsenic, cadmium, and chromium. As requested by the Idaho Department of Environmental Quality (DEQ), the ingestion reference doses for these four metals were used as both ingestion and inhalation reference doses. Toxicity information is available for all COCs listed in Table C-1 with the exception of lead. While there is no specific toxicity information currently available for lead, separate EPA guidance was used to develop the action level for lead (see Step 8).

Table C-1. COCs and toxicity parameters as provided in the EPA Region 9 PRG Table (EPA 2003).

COC	Oral Slope Factor 1/(mg/kg-d)	Oral Reference Dose (mg/kg-d)	Inhalation Slope Factor 1/(mg/kg-d)	Inhalation Reference Dose (mg/kg-d)
1,1,1-trichloroethane	—	0.02	—	0.29
2,4-dinitrophenol	—	0.002	—	0.002
2-hexanone[a]	—	0.04	—	0.0014
Acetone	—	0.1	—	0.1
Aluminum	—	1	—	0.0014
Antimony	—	0.0004	—	0.0004[b]
Aroclor-1260	2	—	2	—
Arsenic	1.5	0.0003	15	0.0003[b]
Barium	—	0.07	—	0.00014
Benzene	0.055	0.003	0.027	0.0017
Beryllium	—	0.002	8.4	0.0000057
Bromomethane	—	0.0014	—	0.0014
Cadmium	—	0.0005	6.3	0.0005[b]
Carbon disulfide	—	0.1	—	0.2
Carbon tetrachloride	0.13	0.0007	0.053	0.0007
Chloroethane	0.0029	0.4	0.0029	2.9
Chloromethane	0.013	—	0.0063	0.086
Chromium	—	0.003	290	0.003[b]
Cobalt	—	0.06	—	—
Copper	—	0.037	—	—
Cyclohexane	—	5.7	—	5.7
Cyclohexanone	—	5	—	5
Ethyl acetate	—	0.9	—	0.9
Ethyl benzene	—	0.1	—	0.29
Fluoride	—	0.06	—	—
Iron	—	0.3	—	—
Lead	—	—	—	—
Manganese	—	0.024	—	0.000014
Mercury	—	0.0003	—	0.000086
Methanol	—	0.5	—	0.5
Methyl ethyl ketone	—	0.6	—	0.29
Methyl isobutyl ketone	—	0.08	—	0.023
Methylene chloride	0.0075	0.06	0.0016	0.86
Nickel	—	0.02	—	—
N-nitrosodimethylamine	51	—	49	—
Phenol	—	0.6	—	0.6
Pyridine	—	0.001	—	0.001
Selenium	—	0.005	—	—
Silver	—	0.005	—	—
Tetrachloroethylene	0.052	0.01	0.002	0.11
Thallium	—	0.000066	—	—
Toluene	—	0.2	—	0.11
Trichloroethylene	0.011	0.006	0.006	0.006
Vanadium	—	0.007	—	—
Xylene	—	2	—	0.2
Zinc	—	0.3	—	—

a. The toxicity information was obtained from the EPA Region III Risk-based Concentration Table (EPA 2002).

b. The ingestion reference dose is used as the inhalation reference dose although no inhalation reference dose is provided in the EPA Region 9 PRG Table (EPA 2003).

Step 4: Define Percentage of Risk and Hazard to be Applied to Ingestion and Inhalation Scenario

The total allowable excess cancer risk and hazard quotient must be split into the fraction that is allowable for the ingestion pathway and the fraction that is allowable for the inhalation pathway. Experience indicates that the ingestion pathway will drive the risk and hazard for the occupational receptor. Consequently, the majority (99.5%) of the allowable risk and hazard defined in Step 1 above was assigned to the ingestion pathway as shown in Table C-2.

Table C-2. Pathway-specific allowable risk and hazard.

	Total	Ingestion (%)	Inhalation (%)	Ingestion Fraction	Inhalation Fraction
Risk	1.00E!06	99.5	0.5	9.95E!07	5.00E!09
Hazard quotient	1.00E+00	99.5	0.5	9.95E!01	5.00E!03

Step 5: Calculate the COC-Specific Allowable Risk and Hazard Quotient for Each Pathway

Back calculation of action levels for COCs requires determination of allowable risk for each COC.[b] The sum of all allowable risks must be less than 1.0E–06. To determine the allowable risk for each COC, the total allowable risk must be apportioned among the COCs. There are several techniques for apportioning allowable risk among COCs.

The simplest technique for apportioning allowable risk is to distribute allowable risk equally among the COCs. Using this technique, the allowable risk is divided by the total number of carcinogenic COCs and the result is used as the allowable risk for each COC. The problem with this approach is that it makes no differentiation among COCs with respect to carcinogenic threat to human health. In the case of the action level determination for the HWMA/RCRA closure of Tanks WM-182 and WM-183, the same allowable risk is assigned to a COC that is extremely carcinogenic (N-nitrosodimethylamine [slope factor 51 $(mg/kg\text{-}d)^{-1}$]) and a contaminant that is minimally carcinogenic (chloroethane [slope factor 0.0029 $(mg/kg\text{-}d)^{-1}$]). Using this approach results in action levels that are extremely low (below detection levels in many instances) for the highly carcinogenic compounds and action levels that are excessively high for minimally carcinogenic compounds. This approach results in decontamination efforts being driven by the need to meet a single action level for the most carcinogenic component. The actual COC concentrations for the less carcinogenic components will be reduced far below action levels, resulting in a total residual risk far below the threshold of 1.0E!06. While extremely conservative, this approach results in action levels that may prove impossible to achieve during closure (particularly those below detection limits).

A second approach uses slope factor normalization to apportion allowable risk among the COCs. The slope factors for all carcinogenic COCs are summed, and the percent slope factor contribution to the total is used to determine the percent of the allowable risk that is apportioned to each COC. In this way, the majority of the allowable risk is assigned to the COCs that are the most highly carcinogenic. This technique is superior to the equal distribution technique described above because it results in action levels for highly-carcinogenic contaminants that are above detection limits and realistically achievable, while

b. While this discussion of apportioning risk among COCs is written with respect to determination of action levels using carcinogenic contaminants and risk-based back-calculation, it applies equally to determination of action levels using non-carcinogenic contaminants and hazard-based back-calculation.

still maintaining the overall allowable risk below the regulatory threshold. The problem with this approach for the purposes of determining action levels for the closure of Tanks WM-182 and WM-183 is the presence of the extremely carcinogenic N-nitrosodimethylamine. This contaminant is extremely carcinogenic with respect to the other COCs present in the tank system. Using the normalization approach, consequently, results in the majority of the allowable risk being assigned to this contaminant. This results in greatly reduced action levels for moderately carcinogenic contaminants such as heavy metals. This approach results in decontamination efforts being driven by the need to meet action levels for the metals. Due to the chemistry associated with the contents of the tanks, and the relative ease of decontaminating organic contaminants versus metals, decontamination to meet the action levels for metals will result in actual concentrations of organic constituents that will be far below the action levels for these constituents. This would result in a total residual risk far below the threshold of 1.0E!06. This approach results in action levels for various metals that may prove impossible to achieve during closure.

While both approaches described above result in action levels that are compliant with the need to reduce risk below 1.0E!06, the first approach results in an impracticable action level for the highly carcinogenic N-nitrosodimethylamine. The second approach results in impracticable action levels for a variety of heavy metals. A compromise approach balancing the action levels for the amine and the metals to achievable, yet protective, levels was developed. This third approach uses logarithmic slope factor normalization to apportion allowable risk among the COCs. A normalizing power of 0.5 was selected via trial and error that resulted in achievable, yet compliant action levels for all COCs. Each of the slope factors was raised to the power of 0.5. These slope factors were then summed, and the percent contribution to this sum of each slope factor was determined. This percent contribution was then used to assign allowable risk to all carcinogenic COCs.

The three approaches above are alternate methods for assigning allowable risk to each COC. The sum of the allowable risk for each approach is the same, at 1.0E!06. Selection of the third technique provides action levels that are technically practicable. The true risk resulting from each COC is calculated in Step 7 of this methodology. This true risk is calculated at 9.2E!07, demonstrating that the selected action levels are compliant with the regulatory threshold of 1.0E!06. The calculation of true residual risk is independent of the apportioning of allowable risk performed in this step.

As discussed above, allowable risk and hazard quotients for each COC for each pathway were normalized logarithmically against their expected percent contribution to the overall risk and hazard for each pathway. For carcinogenic risk, the square root of the slope factor for each COC was determined. The normalized slope factor percentage was determined by dividing the square root of the slope factor for each COC by the sum of the square root of the slope factors for all COCs for a given pathway. This percent contribution was then multiplied by the total pathway-specific allowable risk to calculate the COC- and pathway-specific allowable risk. To increase the conservativeness of the design, correction factors (discussed below) were applied to COCs, as necessary, to reduce the total allowable risk for each COC. The resulting COC pathway-specific allowable risks for ingestion and inhalation are listed in Table C-3.

For non-carcinogenic hazard, the square root of the inverse of the reference dose for each COC was determined. The normalized inverse reference dose percentage was determined by dividing the square root of the inverse reference dose for each COC by the sum of the square root of the inverse reference doses for all COCs for a given pathway. This percent contribution was then multiplied by the total pathway-specific allowable hazard to calculate the COC- and pathway-specific allowable hazard. To increase the conservativeness of the design, correction factors (discussed below) were applied to COCs, as necessary, to reduce the total allowable hazard for each COC. The resulting COC pathway-specific allowable hazard for ingestion and inhalation are listed in Table C-3.

Table C-3. COC-specific allowable risk and hazard for the soil ingestion and inhalation pathways.

COC	Effective Allowable Ingestion Risk	Effective Allowable Inhalation Risk	Effective Allowable Ingestion Hazard	Effective Allowable Inhalation Hazard
1,1,1-Trichloroethane	—	—	1.08E−02	7.18E−06
2,4-Dinitrophenol	—	—	3.43E−02	8.65E−05
2-Hexanone	—	—	7.67E−03	1.03E−04
Acetone	—	—	4.85E−03	1.22E−05
Aluminum	—	—	1.53E−03	1.03E−04
Antimony	—	—	7.67E−02	1.93E−04
Aroclor-1260	1.28E−07	2.00E−10	1.08E−03	2.74E−06
Arsenic	1.11E−07	5.47E−10	8.85E−02	2.23E−04
Barium	—	—	5.80E−04	3.27E−05
Benzene	3.55E−09	3.87E−12	4.67E−03	1.56E−05
Beryllium	—	4.09E−10	3.43E−02	1.62E−03
Bromomethane	—	—	4.10E−02	1.03E−04
Cadmium	—	3.54E−11	6.86E−03	1.73E−05
Carbon disulfide	—	—	4.85E−03	8.65E−06
Carbon tetrachloride	6.54E−09	6.50E−12	1.16E−02	2.92E−05
Chloroethane	4.89E−09	7.60E−12	2.43E−03	2.27E−06
Chloromethane	1.03E−08	1.12E−11	0.00E+00	1.32E−05
Chromium	—	2.40E−09	2.80E−02	7.06E−05
Cobalt	—	—	6.26E−03	0.00E+00
Copper	—	—	7.97E−03	0.00E+00
Cyclohexane	—	—	6.42E−04	1.62E−06
Cyclohexanone	—	—	6.86E−04	1.73E−06
Ethyl Acetate	—	—	1.62E−03	4.08E−06
Ethyl benzene	—	—	4.85E−03	7.18E−06
Fluoride	—	—	6.26E−03	0.00E+00
Iron	—	—	2.80E−03	0.00E+00
Lead	—	—	0.00E+00	0.00E+00
Manganese	—	—	9.90E−03	1.03E−03
Mercury	—	—	2.53E−04	1.19E−06
Methanol	—	—	2.17E−03	5.47E−06
Methyl ethyl ketone	—	—	1.32E−04	4.79E−07
Methyl isobutyl ketone	—	—	5.42E−03	2.55E−05
Methylene chloride	7.86E−09	5.65E−12	6.26E−03	4.17E−06
Nickel	—	—	1.08E−02	0.00E+00
N-Nitrosodimethylamine	6.48E−07	9.88E−10	0.00E+00	0.00E+00
Pyridine	—	—	2.11E−03	5.32E−06
Selenium	—	—	8.68E−05	0.00E+00
Silver	—	—	2.89E−04	0.00E+00
Tetrachloroethylene	4.14E−09	1.26E−12	3.07E−03	2.33E−06
Thallium	—	—	1.89E−01	0.00E+00
Toluene	—	—	3.43E−03	1.17E−05
Trichloroethylene	7.93E−10	9.11E−13	1.65E−03	4.16E−06
Vanadium	—	—	1.83E−02	0.00E+00
Zinc	—	—	2.80E−03	0.00E+00
Total	**9.26E−07**	**4.62E−09**	**6.48E−01**	**3.76E−03**

Correction factors were used in the risk calculations to lower the action levels of contaminants to meet regulatory thresholds. Risk calculations alone would produce concentrations greater than the maximum concentration of contaminants for the toxicity characteristic. Correction factors, therefore, were used to augment the risk number to ensure hazardous waste is not left in place. Removing hazardous waste is the first criteria for achieving clean closure for the tank system.

In an effort to develop action levels at appropriate concentrations and meet project goals for protection of the public and the environment, correction factors were developed on a case-by-case basis and may vary for different tank systems. Systems that are fairly accessible and with contamination that can be removed to low concentrations will have different correction factors than those used for tanks systems that are not easily accessible and where effective decontamination may be more difficult to achieve. Two important points should be recognized:

- Correction factors are not intended to be the same for all closure actions. Therefore, the Department of Energy can develop action levels as conservative as possible on a project basis.

- Action levels will always be protective of human health and the environment based on the calculated risks and hazard index.

The use of correction factors is performed to lower action levels to concentrations below regulatory thresholds while accounting for project-specific challenges to clean closure. The correction factors are not used to adjust for the uncertainty of any closure project. The difference between the use of correction factors and accounting for uncertainty is clearly established by the following explanation.

Using conservative assumptions when calculating the risk and hazard quotient negates uncertainties associated with meeting the performance standard for clean closure. Examples of the conservative assumptions used in action level calculation are listed below:

- Risk and hazard indices are based on the total number of constituents that may be detected in the unit. Actually, some of these constituents (particularly organic compounds) will not be present after waste removal and decontamination. For example N-nitrosodimethylamine is a significant contributor to risk. However, it is likely that this compound will not be detected during final sampling. The total risk will then be reduced by the amount contributed by N-nitrosodimethylamine. The calculated risk for N-nitrosodimethylamine from soil ingestion and inhalation is 6.48E–07. This is the greatest potential risk contributor in Tanks WM-182 and WM-183.

- The probability of detecting N-nitrosodimethylamine after decontamination is based on the decontamination factor that is necessary to reduce the maximum detected concentration to one that is below the detection limit. This decontamination factor is approximately 15. While the decontamination factor for reducing the concentration of mercury to below the action level is more than 100. The relationship between the two decontamination factors indicates N-nitrosodimethylamine will likely be completely removed.

Step 6: Calculate the COC- and Pathway-Specific Action Levels from Allowable Risk and Hazard Calculated in Step 5

The equations used to relate risk, intake factor, and slope factor or reference dose to excess cancer risk or hazard quotient are given in Step 7. These equations were obtained from EPA guidance (EPA 1989). The risk-based COC-specific action levels were calculated from COC-specific allowable risk by dividing the COC-specific allowable risk (Table C-3) by the intake factor coefficient (see Step 7) and the

COC-specific slope factor (Table C-1). The hazard-based COC-specific action levels were calculated from COC-specific allowable hazard quotients by dividing the COC-specific allowable hazard quotient (Table C-3) by the intake factor coefficient (see Step 7) and multiplying by the reference dose (Table C-1). The COC-specific action levels for the ingestion and inhalation pathways resulting from COC-specific allowable risk and COC-specific allowable hazard are listed in Table C-4. To be conservative, the minimum pathway-specific action level was used as the overall action level. The final effective action levels are provided in the right-hand column of Table C-4.

Table C-4. Pathway-specific and effective action levels for each COC.

COC	Action Level (mg/kg) Ingestion Risk	Action Level (mg/kg) Inhalation Risk	Action Level (mg/kg) Ingestion Hazard	Action Level (mg/kg) Inhalation Hazard	Effective Action Level (mg/kg)
1,1,1-Trichloroethane	—	—	4.4E+02	8.1E+04	4.4E+02
2,4-Dinitrophenol	—	—	1.4E+02	6.7E+03	1.4E+02
2-Hexanone	—	—	6.3E+02	5.6E+03	6.3E+02
Acetone	—	—	9.9E+02	4.8E+04	9.9E+02
Aluminum	—	—	3.1E+03	5.6E+03	3.1E+03
Antimony	—	—	6.3E+01	3.0E+03	6.3E+01
Aroclor-1260	3.7E−01	1.1E+01	1.3E+03	6.4E+04	3.7E−01
Arsenic	4.2E−01	4.0E+00	5.4E+01	2.6E+03	4.2E−01
Barium	—	—	8.3E+01	1.8E+02	8.3E+01
Benzene	3.7E−01	1.6E+01	2.9E+01	1.0E+03	3.7E−01
Beryllium	—	5.3E+00	1.4E+02	3.6E+02	5.3E+00
Bromomethane	—	—	1.2E+02	5.6E+03	1.2E+02
Cadmium	—	6.1E−01	7.0E+00	3.4E+02	6.1E−01
Carbon disulfide	—	—	9.9E+02	6.7E+04	9.9E+02
Carbon tetrachloride	2.9E−01	1.3E+01	1.7E+01	8.0E+02	2.9E−01
Chloroethane	9.6E+00	2.8E+02	2.0E+03	2.6E+05	9.6E+00
Chloromethane	4.5E+00	1.9E+02	—	4.4E+04	4.5E+00
Chromium	—	9.0E−01	1.7E+02	8.2E+03	9.0E−01
Cobalt	—	—	7.7E+02	—	7.7E+02
Copper	—	—	6.0E+02	—	6.0E+02
Cyclohexane	—	—	7.5E+03	3.6E+05	7.5E+03
Cyclohexanone	—	—	7.0E+03	3.4E+05	7.0E+03
Ethyl Acetate	—	—	3.0E+03	1.4E+05	3.0E+03
Ethyl benzene	—	—	9.9E+02	8.1E+04	9.9E+02
Fluoride	—	—	7.7E+02	—	7.7E+02
Iron	—	—	1.7E+03	—	1.7E+03
Lead	—	—	—	—	0.0E+00
Manganese	—	—	4.9E+02	5.6E+02	4.9E+02
Mercury	—	—	1.6E−01	4.0E+00	1.6E−01
Methanol	—	—	2.2E+03	1.1E+05	2.2E+03
Methyl ethyl ketone	—	—	1.6E+02	5.4E+03	1.6E+02
Methyl isobutyl ketone	—	—	8.9E+02	2.3E+04	8.9E+02
Methylene chloride	6.0E+00	3.8E+02	7.7E+02	1.4E+05	6.0E+00
Nickel	—	—	4.4E+02	—	4.4E+02
N-Nitrosodimethylamine	7.3E−02	2.2E+00	—	—	7.3E−02
Pyridine	—	—	4.3E+00	2.1E+02	4.3E+00
Selenium	—	—	8.9E−01	—	8.9E−01
Silver	—	—	3.0E+00	—	3.0E+00
Tetrachloroethylene	4.5E−01	6.9E+01	6.3E+01	1.0E+04	4.5E−01
Thallium	—	—	2.5E+01	—	2.5E+01
Toluene	—	—	1.4E+03	5.0E+04	1.4E+03
Trichloroethylene	4.1E−01	1.7E+01	2.0E+01	9.7E+02	4.1E−01
Vanadium	—	—	2.6E+02	—	2.6E+02
Zinc	—	—	1.7E+03	—	1.7E+03

a. The action level for lead cannot be determined using a risk-based approach, as there are currently no established toxicity parameters for lead. The action level for lead was developed as described in Step 8.

Step 7: Determine the True Excess Cancer Risk and Hazard Quotient Resulting in the Action Levels Calculated in Step 7

Soil concentrations resulting from the calculated action levels were used as a starting point to assess the risk and hazard to the occupational receptor via the soil ingestion and inhalation pathways. The results of this analysis are provided in Table C-5 below. The table also includes the cumulative risk and hazard posed by both pathways. The calculation spreadsheets are shown on the following pages in Equations (C-1) through (C-9) and Tables C-6 through C-9.

Table C-5. Cumulative excess cancer risk resulting from soil ingestion and soil inhalation pathways to an occupational receptor from contaminated soil at the effective action levels presented in Table C-4.

COC	Risk (Ingestion Pathway)	Risk (Inhalation Pathway)	Total Risk	Hazard Quotient (Ingestion Pathway)	Hazard Quotient (Inhalation Pathway)	Total Hazard Quotient
1,1,1-Trichloroethane	—	—	—	1.08E–02	3.93E–08	1.08E–02
2,4-Dinitrophenol	—	—	—	3.43E–02	1.80E–06	3.43E–02
2-Hexanone	—	—	—	—	—	—
Acetone	—	—	—	4.85E–03	2.55E–07	4.85E–03
Aluminum	—	—	—	1.53E–03	5.76E–05	1.59E–03
Antimony	—	—	—	7.67E–02	4.03E–06	7.67E–02
Aroclor-1260	1.28E–07	6.75E–12	1.28E–07	—	1.77E–09	1.77E–09
Arsenic	1.11E–07	5.84E–11	1.11E–07	6.90E–04	3.63E–08	6.90E–04
Barium	—	—	—	5.80E–04	1.52E–05	5.95E–04
Benzene	3.55E–09	9.16E–14	3.55E–09	6.01E–05	5.57E–09	6.01E–05
Beryllium	—	4.09E–10	4.09E–10	1.29E–03	2.39E–05	1.32E–03
Bromomethane	—	—	—	4.10E–02	2.16E–06	4.10E–02
Cadmium	—	3.54E–11	3.54E–11	5.98E–04	3.14E–08	5.98E–04
Carbon disulfide	—	—	—	4.85E–03	1.28E–07	4.85E–03
Carbon tetrachloride	6.54E–09	1.40E–13	6.55E–09	2.01E–04	1.06E–08	2.01E–04
Chloroethane	4.89E–09	2.57E–13	4.89E–09	1.18E–05	8.53E–11	1.18E–05
Chloromethane	1.03E–08	2.64E–13	1.03E–08	—	1.36E–09	1.36E–09
Chromium	—	2.40E–09	2.40E–09	1.47E–04	7.72E–09	1.47E–04
Cobalt	—	—	—	6.26E–03	—	6.26E–03
Copper	—	—	—	7.97E–03	—	7.97E–03
Cyclohexane	—	—	—	6.42E–04	3.38E–08	6.42E–04
Cyclohexanone	—	—	—	6.86E–04	3.61E–08	6.86E–04
Ethyl Acetate	—	—	—	1.62E–03	8.50E–08	1.62E–03
Ethyl benzene	—	—	—	4.85E–03	8.79E–08	4.85E–03
Fluoride	—	—	—	6.26E–03	—	6.26E–03
Iron	—	—	—	2.80E–03	—	2.80E–03
Lead	—	—	—	—	—	—
Manganese	—	—	—	9.90E–03	8.92E–04	1.08E–02
Mercury	—	—	—	2.53E–04	4.64E–08	2.53E–04
Methanol	—	—	—	2.17E–03	1.14E–07	2.17E–03
Methyl ethyl ketone	—	—	—	1.32E–04	1.44E–08	1.32E–04
Methyl isobutyl ketone	—	—	—	5.42E–03	9.92E–07	5.42E–03
Methylene chloride	7.86E–09	8.82E–14	7.86E–09	4.88E–05	1.79E–10	4.88E–05
Nickel	—	—	—	1.08E–02	—	1.08E–02
N-Nitrosodimethylamine	6.48E–07	3.27E–11	6.48E–07	—	—	—
Pyridine	—	—	—	2.11E–03	1.11E–07	2.11E–03
Selenium	—	—	—	8.68E–05	—	8.68E–05
Silver	—	—	—	2.89E–04	—	2.89E–04
Tetrachloroethylene	4.14E–09	8.37E–15	4.14E–09	2.22E–05	1.06E–10	2.22E–05
Thallium	—	—	—	1.89E–01	—	1.89E–01
Toluene	—	—	—	3.43E–03	3.28E–07	3.43E–03
Trichloroethylene	7.93E–10	2.28E–14	7.93E–10	3.36E–05	1.77E–09	3.36E–05
Vanadium	—	—	—	1.83E–02	—	1.83E–02
Zinc	—	—	—	2.80E–03	—	2.80E–03
Total	**9.26E–07**	**2.95E–09**	**9.29E–07**	**4.55E–01**	**1.00E–03**	**4.56E–01**

Occupational Soil Ingestion—Excess Cancer Risk

$$Intake\ Factor = \left(\frac{C \times FI \times EF \times CF}{AT}\right) \times \left(\frac{IR \times ED}{BW}\right) \quad \text{(C-1)}$$

where

C	=	contaminant concentration (mg/kg) (contaminant dependent)
FI	=	fraction ingested from source = 1
EF	=	exposure frequency (day/year) = 250
CF	=	conversion factor (kg/mg) = 1.00E–06
AT	=	averaging time (day) = 2.55E+04
IR	=	ingestion rate (mg/day) = 50
ED	=	exposure duration (year) = 25
BW	=	body weight (kg) = 70.

Assumption: Each liter of leachate contaminates 1 kg of soil.

$$Risk = Intake\ Factor \times Slope\ Factor \quad \text{(C-2)}$$

Table C-6. Calculation of excess cancer risk for an occupational soil ingestion scenario using the action levels provided in Table C-4.

Constituent	C (mg/Kg)	Intake Factor/C (1/day)	Intake Factor (mg/Kg-day)	Slope Factor (Kg-day/mg)	Risk	Risk Percentage
1,1,1-Trichloroethane	4.44E+02	1.75E–07	7.77E–05	0.00E+00	—	—
2,4-Dinitrophenol	1.40E+02	1.75E–07	2.46E–05	0.00E+00	—	—
2-Hexanone	6.27E+02	1.75E–07	1.10E–04	0.00E+00	—	—
Acetone	9.92E+02	1.75E–07	1.74E–04	0.00E+00	—	—
Aluminum	3.14E+03	1.75E–07	5.49E–04	0.00E+00	—	—
Antimony	6.27E+01	1.75E–07	1.10E–05	0.00E+00	—	—
Aroclor-1260	3.67E–01	1.75E–07	6.42E–08	2.00E+00	1.28E–07	13.86
Arsenic	4.23E–01	1.75E–07	7.41E–08	1.50E+00	1.11E–07	12.01
Barium	8.30E+01	1.75E–07	1.45E–05	0.00E+00	—	—
Benzene	3.68E–01	1.75E–07	6.45E–08	5.50E–02	3.55E–09	0.38
Beryllium	5.29E+00	1.75E–07	9.26E–07	0.00E+00	—	—
Bromomethane	1.17E+02	1.75E–07	2.05E–05	0.00E+00	—	—
Cadmium	6.11E–01	1.75E–07	1.07E–07	0.00E+00	—	—
Carbon disulfide	9.92E+02	1.75E–07	1.74E–04	0.00E+00	—	—
Carbon tetrachloride	2.88E–01	1.75E–07	5.03E–08	1.30E–01	6.54E–09	0.71
Chloroethane	9.63E+00	1.75E–07	1.69E–06	2.90E–03	4.89E–09	0.53
Chloromethane	4.55E+00	1.75E–07	7.96E–07	1.30E–02	1.03E–08	1.12
Chromium	9.01E–01	1.75E–07	1.58E–07	0.00E+00	—	—
Cobalt	7.68E+02	1.75E–07	1.35E–04	0.00E+00	—	—
Copper	6.03E+02	1.75E–07	1.06E–04	0.00E+00	—	—
Cyclohexane	7.49E+03	1.75E–07	1.31E–03	0.00E+00	—	—
Cyclohexanone	7.01E+03	1.75E–07	1.23E–03	0.00E+00	—	—
Ethyl Acetate	2.98E+03	1.75E–07	5.21E–04	0.00E+00	—	—
Ethyl benzene	9.92E+02	1.75E–07	1.74E–04	0.00E+00	—	—
Fluoride	7.68E+02	1.75E–07	1.35E–04	0.00E+00	—	—
Iron	1.72E+03	1.75E–07	3.01E–04	0.00E+00	—	—
Lead	0.00E+00	1.75E–07	0.00E+00	0.00E+00	—	—
Manganese	4.86E+02	1.75E–07	8.51E–05	0.00E+00	—	—
Mercury	1.55E–01	1.75E–07	2.72E–08	0.00E+00	—	—
Methanol	2.22E+03	1.75E–07	3.88E–04	0.00E+00	—	—
Methyl ethyl ketone	1.62E+02	1.75E–07	2.84E–05	0.00E+00	—	—
Methyl isobutyl ketone	8.87E+02	1.75E–07	1.55E–04	0.00E+00	—	—
Methylene chloride	5.99E+00	1.75E–07	1.05E–06	7.50E–03	7.86E–09	0.85
Nickel	4.44E+02	1.75E–07	7.77E–05	0.00E+00	—	—
N-Nitrosodimethylamine	7.26E–02	1.75E–07	1.27E–08	5.10E+01	6.48E–07	70.01
Pyridine	4.31E+00	1.75E–07	7.55E–07	0.00E+00	—	—
Selenium	8.87E–01	1.75E–07	1.55E–07	0.00E+00	—	—
Silver	2.96E+00	1.75E–07	5.18E–07	0.00E+00	—	—
Tetrachloroethylene	4.55E–01	1.75E–07	7.96E–08	5.20E–02	4.14E–09	0.45
Thallium	2.55E+01	1.75E–07	4.46E–06	0.00E+00	—	—
Toluene	1.40E+03	1.75E–07	2.46E–04	0.00E+00	—	—
Trichloroethylene	4.12E–01	1.75E–07	7.21E–08	1.10E–02	7.93E–10	0.09
Vanadium	2.62E+02	1.75E–07	4.59E–05	0.00E+00	—	—
Zinc	1.72E+03	1.75E–07	3.01E–04	0.00E+00	—	—
				Total	**9.26E–07**	**100.00**

Occupational Soil Inhalation—Excess Cancer Risk

$$Intake\ Factor = \left(\frac{C \times IR \times EF \times ET \times ED}{BW \times AT \times PEF} \right) \qquad \text{(C-3)}$$

where

C	=	soil contaminant concentration (mg/kg) (contaminant dependent)
IR	=	inhalation rate (m^3/hr) = 0.83
EF	=	exposure frequency (day/year) = 250
ET	=	exposure time (hour/day) = 8
ED	=	exposure duration (year) = 25
BW	=	body weight (kg) = 70
AT	=	averaging time (day) = 2.55E+04
PEF	=	particulate emission factor (m^3/kg) (calculated).

$$PEF = \frac{LS \times 5.8\text{E}+10}{A} \left(\frac{m^4}{kg} \right) \qquad \text{(C-4)}$$

where

LS	=	prevailing wind field dimension (m) = 49.65
A	=	area of contamination (m^2) = 1140.15.

Assumption: Each liter of leachate contaminates 1 kg of soil.

$$Risk = Intake\ Factor \times Slope\ Factor \qquad \text{(C-5)}$$

Table C-7. Calculation of excess cancer risk for an occupational soil inhalation scenario using the action levels provided in Table C-4.

Constituent	C (mg/kg)	Intake Factor/C (1/day)	Intake Factor (mg/kg-day)	Slope Factor (kg-day/mg)	Risk	Risk Percentage
1,1,1-Trichloroethane	4.44E+02	9.21E–12	4.08E–09	0.00E+00	—	—
2,4-Dinitrophenol	1.40E+02	9.21E–12	1.29E–09	0.00E+00	—	—
2-Hexanone	6.27E+02	9.21E–12	5.77E–09	0.00E+00	—	—
Acetone	9.92E+02	9.21E–12	9.13E–09	0.00E+00	—	—
Aluminum	3.14E+03	9.21E–12	2.89E–08	0.00E+00	—	—
Antimony	6.27E+01	9.21E–12	5.77E–10	0.00E+00	—	—
Aroclor-1260	3.67E–01	9.21E–12	3.37E–12	2.00E+00	6.75E–12	0.23
Arsenic	4.23E–01	9.21E–12	3.90E–12	1.50E+01	5.84E–11	1.98
Barium	8.30E+01	9.21E–12	7.64E–10	0.00E+00	—	—
Benzene	3.68E–01	9.21E–12	3.39E–12	2.70E–02	9.16E–14	0.00
Beryllium	5.29E+00	9.21E–12	4.87E–11	8.40E+00	4.09E–10	13.88
Bromomethane	1.17E+02	9.21E–12	1.08E–09	0.00E+00	—	—
Cadmium	6.11E–01	9.21E–12	5.62E–12	6.30E+00	3.54E–11	1.20
Carbon disulfide	9.92E+02	9.21E–12	9.13E–09	0.00E+00	—	—
Carbon tetrachloride	2.88E–01	9.21E–12	2.65E–12	5.30E–02	1.40E–13	0.00
Chloroethane	9.63E+00	9.21E–12	8.86E–11	2.90E–03	2.57E–13	0.01
Chloromethane	4.55E+00	9.21E–12	4.19E–11	6.30E–03	2.64E–13	0.01
Chromium	9.01E–01	9.21E–12	8.29E–12	2.90E+02	2.40E–09	81.56
Cobalt	7.68E+02	9.21E–12	7.07E–09	0.00E+00	—	—
Copper	6.03E+02	9.21E–12	5.55E–09	0.00E+00	—	—
Cyclohexane	7.49E+03	9.21E–12	6.89E–08	0.00E+00	—	—
Cyclohexanone	7.01E+03	9.21E–12	6.46E–08	0.00E+00	—	—
Ethyl acetate	2.98E+03	9.21E–12	2.74E–08	0.00E+00	—	—
Ethyl benzene	9.92E+02	9.21E–12	9.13E–09	0.00E+00	—	—
Fluoride	7.68E+02	9.21E–12	7.07E–09	0.00E+00	—	—
Iron	1.72E+03	9.21E–12	1.58E–08	0.00E+00	—	—
Lead	0.00E+00	9.21E–12	0.00E+00	0.00E+00	—	—
Manganese	4.86E+02	9.21E–12	4.47E–09	0.00E+00	—	—
Mercury	1.55E–01	9.21E–12	1.43E–12	0.00E+00	—	—
Methanol	2.22E+03	9.21E–12	2.04E–08	0.00E+00	—	—
Methyl ethyl ketone	1.62E+02	9.21E–12	1.49E–09	0.00E+00	—	—
Methyl isobutyl ketone	8.87E+02	9.21E–12	8.17E–09	0.00E+00	—	—
Methylene chloride	5.99E+00	9.21E–12	5.51E–11	1.60E–03	8.82E–14	0.00
Nickel	4.44E+02	9.21E–12	4.08E–09	0.00E+00	—	—
N-nitrosodimethylamine	7.26E–02	9.21E–12	6.68E–13	4.90E+01	3.27E–11	1.11
Pyridine	4.31E+00	9.21E–12	3.97E–11	0.00E+00	—	—
Selenium	8.87E–01	9.21E–12	8.17E–12	0.00E+00	—	—
Silver	2.96E+00	9.21E–12	2.72E–11	0.00E+00	—	—
Tetrachloroethylene	4.55E–01	9.21E–12	4.19E–12	2.00E–03	8.37E–15	0.00
Thallium	2.55E+01	9.21E–12	2.35E–10	0.00E+00	—	—
Toluene	1.40E+03	9.21E–12	1.29E–08	0.00E+00	—	—
Trichloroethylene	4.12E–01	9.21E–12	3.79E–12	6.00E–03	2.28E–14	0.00
Vanadium	2.62E+02	9.21E–12	2.42E–09	0.00E+00	—	—
Zinc	1.72E+03	9.21E–12	1.58E–08	0.00E+00	—	—
				Total	**2.95E–09**	**100.00**

Occupational Soil Ingestion—Hazard Quotient

$$Intake\ Factor = \left(\frac{C \times FI \times EF \times CF}{AT}\right) \times \left(\frac{IR \times ED}{BW}\right) \quad \text{(C-6)}$$

where

C = contaminant concentration (mg/kg) (contaminant dependent)

FI = fraction ingested from source = 1

EF = exposure frequency (day/year) = 250

CF = conversion factor (kg/mg) = 1.00E!06

AT = averaging time (day) = 9.13E+03

IR = ingestion rate (mg/day) = 50

ED = exposure duration (year) = 25

BW = body weight (kg) = 70.

Assumption: Each liter of leachate contaminates 1 kg of soil.

$$Hazard = Intake\ Factor/Reference\ Dose \quad \text{(C-7)}$$

Table C-8. Calculation of hazard quotient for an occupational soil ingestion scenario using the action levels provided in Table C-4.

Constituent	C (mg/kg)	Intake Factor/C (1/day)	Intake Factor (mg/kg/day)	Reference Dose (mg/kg/day)	Hazard Quotient	Hazard Quotient (%)
1,1,1-trichloroethane	4.445E+02	4.890E!07	2.173E!04	2.000E!02	1.087E!02	2.35
2,4-dinitrophenol	1.406E+02	4.890E!07	6.873E!05	2.000E!03	3.436E!02	7.42
2-hexanone	6.286E+02	4.890E!07	3.074E!04	4.000E!02	7.684E!03	1.66
Acetone	9.939E+02	4.890E!07	4.860E!04	1.000E!01	4.860E!03	1.05
Aluminum	3.143E+03	4.890E!07	1.537E!03	1.000E+00	1.537E!03	0.33
Antimony	6.286E+01	4.890E!07	3.074E!05	4.000E!04	7.684E!02	16.59
Aroclor-1260	3.67E–01	4.890E!07	8.417E!04	0.000E+00	—	—
Arsenic	4.860E!01	4.890E!07	2.376E!07	3.000E!04	7.921E!04	0.17
Barium	8.315E+01	4.890E!07	4.066E!05	7.000E!02	5.808E!04	0.13
Benzene	4.230E!01	4.890E!07	2.068E!07	3.000E!03	6.894E!05	0.01
Beryllium	5.512E+00	4.890E!07	2.695E!06	2.000E!03	1.348E!03	0.29
Bromomethane	1.176E+02	4.890E!07	5.750E!05	1.400E!03	4.107E!02	8.87
Cadmium	6.365E!01	4.890E!07	3.112E!07	5.000E!04	6.224E!04	0.13
Carbon disulfide	9.939E+02	4.890E!07	4.860E!04	1.000E!01	4.860E!03	1.05
Carbon tetrachloride	3.302E!01	4.890E!07	1.614E!07	7.000E!04	2.306E!04	0.05
Chloroethane	1.105E+01	4.890E!07	5.404E!06	4.000E!01	1.351E!05	0.00
Chloromethane	5.220E+00	4.890E!07	2.553E!06	0.000E+00	—	—
Chromium	9.381E!01	4.890E!07	4.587E!07	3.000E!03	1.529E!04	0.03
Cobalt	7.699E+02	4.890E!07	3.764E!04	6.000E!02	6.274E!03	1.35
Copper	6.045E+02	4.890E!07	2.956E!04	3.700E!02	7.989E!03	1.72
Cyclohexane	7.504E+03	4.890E!07	3.669E!03	5.700E+00	6.437E!04	0.14
Cyclohexanone	7.028E+03	4.890E!07	3.436E!03	5.000E+00	6.873E!04	0.15
Ethyl acetate	2.982E+03	4.890E!07	1.458E!03	9.000E!01	1.620E!03	0.35
Ethyl benzene	9.939E+02	4.890E!07	4.860E!04	1.000E!01	4.860E!03	1.05
Fluoride	7.699E+02	4.890E!07	3.764E!04	6.000E!02	6.274E!03	1.35
Iron	1.721E+03	4.890E!07	8.417E!04	3.000E!01	2.806E!03	0.61
Lead	0.000E+00	4.890E!07	0.000E+00	0.000E+00	—	—
Manganese	4.869E+02	4.890E!07	2.381E!04	2.400E!02	9.920E!03	2.14
Mercury	1.555E!01	4.890E!07	7.605E!08	3.000E!04	2.535E!04	0.05
Methanol	2.222E+03	4.890E!07	1.087E!03	5.000E!01	2.173E!03	0.47
Methyl ethyl ketone	1.623E+02	4.890E!07	7.936E!05	6.000E!01	1.323E!04	0.03
Methyl isobutyl ketone	8.889E+02	4.890E!07	4.347E!04	8.000E!02	5.433E!03	1.17
Methylene chloride	6.873E+00	4.890E!07	3.361E!06	6.000E!02	5.601E!05	0.01
Nickel	4.445E+02	4.890E!07	2.173E!04	2.000E!02	1.087E!02	2.35
N-nitrosodimethylamine	8.335E!02	4.890E!07	4.075E!08	0.000E+00	—	—
Pyridine	4.321E+00	4.890E!07	2.113E!06	1.000E!03	2.113E!03	0.46
Selenium	8.889E!01	4.890E!07	4.347E!07	5.000E!03	8.693E!05	0.02
Silver	2.963E+00	4.890E!07	1.449E!06	5.000E!03	2.898E!04	0.06
Tetrachloroethylene	5.220E!01	4.890E!07	2.553E!07	1.000E!02	2.553E!05	0.01
Thallium	2.553E+01	4.890E!07	1.248E!05	6.600E!05	1.892E!01	40.83
Toluene	1.406E+03	4.890E!07	6.873E!04	2.000E!01	3.436E!03	0.74
Trichloroethylene	4.729E!01	4.890E!07	2.312E!07	6.000E!03	3.854E!05	0.01
Vanadium	2.630E+02	4.890E!07	1.286E!04	7.000E!03	1.837E!02	3.96
Xylene	4.445E+03	4.890E!07	2.173E!03	2.000E+00	1.087E!03	0.23
Zinc	1.721E+03	4.890E!07	8.417E!04	3.000E!01	2.806E!03	0.61
Total					**4.63E!01**	**100.00**

Occupational Soil Inhalation—Hazard Quotient

$$Intake\ Factor = \left(\frac{C \times IR \times EF \times ET \times ED}{BW \times AT \times PEF} \right) \quad \text{(C-8)}$$

where

C	=	soil contaminant concentration (mg/kg) (contaminant dependent)
IR	=	inhalation rate (m^3/hr) = 0.83
EF	=	exposure frequency (day/year) = 250
ET	=	exposure time (hour/day) = 8
ED	=	exposure duration (year) = 25
BW	=	body weight (kg) = 70
AT	=	averaging time (day) = 9.13E+03
PEF	=	particulate emission factor (m^3/kg) (calculated).

$$PEF = \frac{LS \times 5.8\text{E}+10}{A} \left(\frac{m^4}{kg} \right)$$

where

LS	=	prevailing wind field dimension (m) = 49.65
A	=	area of contamination (m^2) = 1140.15.

Assumption: Each liter of leachate contaminates 1 kg of soil.

Hazard = Intake Factor/Reference Dose (C-9)

Table C-9. Calculation of hazard quotient for an occupational soil inhalation scenario using the action levels provided in Table C-4.

Constituent	C (mg/kg)	Intake Factor/C (1/day)	Intake Factor (mg/kg-day)	Reference Dose (mg/kg/day)	Hazard Quotient	Hazard Quotient (%)
1,1,1-trichloroethane	4.445E+02	2.571E!11	1.143E!08	2.900E!01	3.940E!08	0.00
2,4-dinitrophenol	1.406E+02	2.571E!11	3.614E!09	2.000E!03	1.807E!06	0.18
2-hexanone	6.286E+02	2.571E!11	1.616E!08	1.400E!03	1.154E!05	1.14
Acetone	9.939E+02	2.571E!11	2.555E!08	1.000E!01	2.555E!07	0.03
Aluminum	3.143E+03	2.571E!11	8.080E!08	1.400E!03	5.772E!05	5.69
Antimony	6.286E+01	2.571E!11	1.616E!09	4.000E!04	4.040E!06	0.40
Aroclor-1260	3.67E–01	2.571E!11	4.426E!08	0.000E+00	—	—
Arsenic	4.860E!01	2.571E!11	1.249E!11	3.000E!04	4.165E!08	0.00
Barium	8.315E+01	2.571E!11	2.138E!09	1.400E!04	1.527E!05	1.51
Benzene	4.230E!01	2.571E!11	1.088E!11	1.700E!03	6.397E!09	0.00
Beryllium	5.512E+00	2.571E!11	1.417E!10	5.700E!06	2.486E!05	2.45
Bromomethane	1.176E+02	2.571E!11	3.023E!09	1.400E!03	2.160E!06	0.21
Cadmium	6.365E!01	2.571E!11	1.636E!11	5.000E!04	3.273E!08	0.00
Carbon disulfide	9.939E+02	2.571E!11	2.555E!08	2.000E!01	1.278E!07	0.01
Carbon tetrachloride	3.302E!01	2.571E!11	8.488E!12	7.000E!04	1.213E!08	0.00
Chloroethane	1.105E+01	2.571E!11	2.842E!10	2.900E+00	9.799E!11	0.00
Chloromethane	5.220E+00	2.571E!11	1.342E!10	8.600E!02	1.561E!09	0.00
Chromium	9.381E!01	2.571E!11	2.412E!11	3.000E!03	8.040E!09	0.00
Cobalt	7.699E+02	2.571E!11	1.979E!08	0.000E+00	—	—
Copper	6.045E+02	2.571E!11	1.554E!08	0.000E+00	—	—
Cyclohexane	7.504E+03	2.571E!11	1.929E!07	5.700E+00	3.384E!08	0.00
Cyclohexanone	7.028E+03	2.571E!11	1.807E!07	5.000E+00	3.614E!08	0.00
Ethyl acetate	2.982E+03	2.571E!11	7.666E!08	9.000E!01	8.517E!08	0.01
Ethyl benzene	9.939E+02	2.571E!11	2.555E!08	2.900E!01	8.811E!08	0.01
Fluoride	7.699E+02	2.571E!11	1.979E!08	0.000E+00	—	—
Iron	1.721E+03	2.571E!11	4.426E!08	0.000E+00	—	—
Lead	0.000E+00	2.571E!11	0.000E+00	0.000E+00	—	—
Manganese	4.869E+02	2.571E!11	1.252E!08	1.400E!05	8.941E!04	88.14
Mercury	1.555E!01	2.571E!11	3.999E!12	8.600E!05	4.650E!08	0.00
Methanol	2.222E+03	2.571E!11	5.714E!08	5.000E!01	1.143E!07	0.01
Methyl ethyl ketone	1.623E+02	2.571E!11	4.173E!09	2.900E!01	1.439E!08	0.00
Methyl isobutyl ketone	8.889E+02	2.571E!11	2.285E!08	2.300E!02	9.937E!07	0.10
Methylene chloride	6.873E+00	2.571E!11	1.767E!10	8.600E!01	2.055E!10	0.00
Nickel	4.445E+02	2.571E!11	1.143E!08	0.000E+00	—	—
N-nitrosodimethylamine	8.335E!02	2.571E!11	2.143E!12	0.000E+00	—	—
Pyridine	4.321E+00	2.571E!11	1.111E!10	1.000E!03	1.111E!07	0.01
Selenium	8.889E!01	2.571E!11	2.285E!11	0.000E+00	—	—
Silver	2.963E+00	2.571E!11	7.618E!11	0.000E+00	—	—
Tetrachloroethylene	5.220E!01	2.571E!11	1.342E!11	1.100E!01	1.220E!10	0.00
Thallium	2.553E+01	2.571E!11	6.564E!10	0.000E+00	—	—
Toluene	1.406E+03	2.571E!11	3.614E!08	1.100E!01	3.285E!07	0.03
Trichloroethylene	4.729E!01	2.571E!11	1.216E!11	6.000E!03	2.026E!09	0.00
Vanadium	2.630E+02	2.571E!11	6.760E!09	0.000E+00	—	—
Xylene	4.445E+03	2.571E!11	1.143E!07	2.000E!01	5.714E!07	0.06
Zinc	1.721E+03	2.571E!11	4.426E!08	0.000E+00	—	—
Total					**1.014E!03**	**100.00**

Step 8: Determine an Action Level for Lead

Of the COCs currently applicable to Tanks WM-182 and WM-183, only lead does not have a reference dose or a slope factor. The following discussion offers an approach for establishing an action level for lead. Soil screening guidance (EPA 2001) suggests a lead soil concentration of 400 mg/kg based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (EPA 1994). The liquid lead concentration is calculated using the definition of K_d. The K_d value is the ratio of the soil concentration to the liquid concentration. Thus, the action level is calculated by dividing the suggested soil concentration for lead by the $K_{d.}$ The K_d of lead is 100 cm^3/g (EPA 1996). With these values, lead action level is calculated at 4 mg/L.

REFERENCES

40 CFR 265.111, 2001, "Closure Performance Standard," *Code of Federal Regulations*, Office of the Federal Register, July 1.

40 CFR 265.197, 2001, "Closure and Post-closure Care," *Code of Federal Regulations*, Office of the Federal Register, July 1.

55 FR 46, 1990, "National Oil and Hazardous Substances Pollution Contingency Plan," *Federal Register*, Environmental Protection Agency, pp. 8666-8673, March 8.

55 FR 145, 1990, "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," *Federal Register*, Environmental Protection Agency, pg. 30798, July 27.

61 FR 85, 1996, "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities," *Federal Register*, Environmental Protection Agency, pp. 19432-19464, May 1.

42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

EPA, 2003, *EPA Region 9 PRGs* [Preliminary Remediation Goals] *Table*, online via http://www.epa.gov/Region9/waste/sfund/prg/files/02table.pdf, Web page updated March 4, 2003, Web page visited April 7, 2003.

EPA, 2002, *EPA Region III RBC* [Risk-Based Concentration] *Table*, online via http://www.epa.gov/reg3hwmd/risk/rbc1002.pdf, published October 9, 2002, Web page visited April 7, 2003.

EPA, 2001, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, Peer Draft Review, OSWER 9355.4-24, March.

EPA, 1996, *Soil Screening Guidance: Technical Background Document*, EPA/540/R95/128, NTIS PB96-963502, Office of Emergency and Remedial Response.

EPA, 1994, *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A),* EPA/540/1/1-89/002, December.

Gilbert, Kenneth O., and Timothy E. Venneman, 1999, *A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System*, INEEL/EXT-98-01213, Revision 1, February.

State of Idaho, 1983, "Hazardous Waste Management," Idaho Statute, Title 39, "Health and Safety," Chapter 44, "Hazardous Waste Management" (also known as the Hazardous Waste Management Act of 1983).

Appendix D

Piping List and Associated Equipment

Appendix D
Piping List and Associated Equipment

Tables D-1 through D-4 list the piping associated with Tanks WM-182 and WM-183, and describe past use, point of origin and termination, and function. Tables D-1 and D-2 list the piping that must be decontaminated for Hazardous Waste Management Act/Resource Conservation and Recovery Act closure for Tanks WM-182 and WM-183, respectively. Tables D-3 and D-4 list the piping that has hazardous waste for Tanks WM-182 and WM-183, respectively. These pipes will be taken out of service, but decontamination is unnecessary.

Table D-1. Piping requiring decontamination for Tank WM-182.

Number	Description	Point of Origin	Point of Termination	Material	Comments
2” PUA-652 [2” PWA-652]	Process waste	CPP-721 PIT, From Tank WM-382 through a 4” × 2” eccentric reducer attached to HE-WM-382	VES-WM-182	Schedule 40, seamless or welded, 347 SST or 304L SST	2” PUA-652 comes from Tank WM-382 and goes to a 4” × 2” eccentric reducer located inside CPP-721, then travels in a concrete encasement to CPP-782. After 2” PUA-652 penetrates CPP-782, it rises upward 1' and connects to VES-WM-182. ½” PUA-647 and ½” PUA-626 connect into the top of PUA-652 at WM-182.
½” PUA-626	Process drain	10” VGA-604	2” PUA-652	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties into 2” PUA-652 prior to Tank WM-182.
1” PUA-643	Process drain	Trench for 10” VGA-604	North Sump SR-18 of CPP-782	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench. Line 1” PUA-644 ties into this line prior to sump.
1” PUA-644	Process drain	Trench for 10” VGA-603	1” PUA-643	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench. Line 1” PUA-645 ties into this line prior to 1” PUA-643.
1” PUA-645	Process drain	Trench for 2” PUA-652	1” PUA-644	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench.
3” PUA-602 [PWA-602]	Process waste	Transition to 3” PUA-1030 w/in Valve Box DVB-WM-PW-A6	VES-WM-182	Schedule 40, seamless or welded, 347 SST or 304L SST	Pipeline begins in Valve Box A6 and passes through A5, where 3” PWA-610 connects to it before terminating in VES-WM-182.
3” PUA-601 [PWA-601] Abandoned	Process waste	DVB-WM-PL-A6, capped pipeline end	VES-WM-182	Schedule 40, seamless or welded, 347 SST or 304L SST	This line is capped inside Valve Box A6. 3” PWA-609 from Tank WM-183 is connected to this line in Valve Box A-5.
3” PUA-604 [PWA-604]	Process waste	1” CA-604 (southeast of concrete encasement and South of DVB-WM-PW-C6)	VES-WM-182	Schedule 40, seamless or welded, 347 SST or 304L SST	3” PUA-604 is a spare line that is capped and has a decon stub installed above grade level 1” CA-604 (southeast of VES-WM-182 and south of DVB-WM-PW-C6) to flush out pipe.
1” CA-604	Decontamination line	Above grade hose connection southeast of VES-WM-182	3” PUA-604		Connects to 3” PUA-604 thru Valve DCV-155.

Table D-1. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
3" PUA-621	Carries process waste from tank VES-WM-182 to VES-WM-183 in a concrete enclosure for overflow purposes	VES-WM-182	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	Pipeline encased in concrete as it leaves CPP-782. No valves, tees, etc. in this line. Line is encased in a concrete encasement.
3" PUA-620	Carries process waste from tank VES-WM-182 to VES-WM-183 in a concrete enclosure for overflow purposes	VES-WM-182	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	Pipeline encased in concrete as it leaves CPP-782. No valves, tees, etc. in this line. Line is encased in a concrete encasement.
2" PUA-1033 Encased in 4" pipe	Process waste	Inside VES-WM-182 (Tank Riser 19) Jet WM-582-1A	3" PUA-1033 in DVB-WM-PW-C2, PUV-WM-116	Schedule 40, seamless or welded, 347 SST or 304L SST	
2" PUA-1099 Encased in 4" pipe	Process waste	Inside VES-WM-182 (Tank Riser 20) Jet WM-582-1B	3" PUA-1033 in DVB-WM-PW-C2, PUV-WM-115	Schedule 40, seamless or welded, 347 SST or 304L SST	
1½" WS-A-601 to 630	Cooling solution supply	CPP-628 cooling solution supply manifold 6" WS-N-152735	VES-WM-182 cooling coils	Carbon steel in CPP-628, then changes to stainless steel to VES-WM-182	Supplies cooling solution to Tank WM-182.
1½" WR-A-601 to 630	Cooling solution return	VES-WM-182 cooling coils	CPP-628 cooling solution return manifold 6" WR-N-152735	Stainless steel from VES-WM-182, then changes to carbon steel in CPP-628	Returns cooling solution to CPP-628.
2" PU-A-624	Process waste	CPP-182 north sump SR-18	VES-WM-182	Schedule 40, seamless or welded, 347 SST	Connects to Jet-WM-530 at sump and routes to Tank WM-182.
2" PU-A-625	Process waste	CPP-182 North Sump SR 18	Jet-WM-530	Schedule 40, seamless or welded, 347 SST	Suction line from sump that connects to Jet-WM-530.
2" PU-A-622	Process waste	CPP-182 South Sump SR 19	VES-WM-182	Schedule 40, seamless or welded, 347 SST	Connects to Jet-WM-531 at sump and routes to Tank WM-182.
2" PU-A-623	Process waste	CPP-182 South Sump SR 19	Jet-WM-531	Schedule 40, seamless or welded, 347 SST	Suction line from sump that connects to Jet-WM-531.

Table D-1. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
1¼" PLA-104701 Encased in 3" pipe	Process drain	CPP-782 (sump riser 19), Jet WM-582-4	1½" PLA-104701 in DVB-WM-PW-C6, PLV-WM-1	Schedule 40, seamless or welded, 347 SST or 304L SST	1¼" PLA-104701 was installed after initial CPP-782 construction. 1¼" PLA-104701 is encased with a 3" pipe encasement.
1½" PU-A-xxx	Process waste	CPP-182 South Sump SR 19	Jet-WM-582-4	Schedule 40, seamless or welded, 347 SST	Suction line from sump that connects to Jet-WM-582-4.
1" PU-A-646	Process drain	Sump in pipe trench	CPP-782 South Sump SR 19	Schedule 40, seamless or welded, 347 SST	This line drains sump in pipe trench for line 3" PU-A-601, 602, 604.
½" CA-603/613	Decontamination line	Abovegrade connection	10" VG-A-604	Schedule 40, seamless or welded, 347 SST	Above-grade connection east of CPP-721 that can be used to decontaminate line 604.
10" VG-A-604	Vessel off-gas	VES-WM-182 center manway	HE-WM-382 in CPP-721	Schedule 40, seamless or welded, 347 SST	This line connects to the heat exchanger inside CPP-721.
1" PU-A-653	Process drain	Sump in pipe trench (*Note:* serves both tanks)	CPP-783 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	This line drains sump in pipe trench for line 3" PU-A-605, 607, and 608.

Table D-2. Piping requiring decontamination for Tank WM-183.

Number	Description	Point of Origin	Point of Termination	Material	Comments
2” PUA-655 [2” PWA-655]	Process waste	CPP-722 PIT, from Tank WM-383 through a 4” × 2” eccentric reducer attached to HE-WM-383	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	2” PUA-655 comes from Tank WM-383 and goes to a 4” × 2” eccentric reducer located inside CPP-722, then travels in a concrete encasement to CPP-783 and connects to VES-WM-183. ½” PUA-656 and ½” PUA-627 connect into the top of 655 at Tank WM-183.
½” PUA-627	Process drain	10” VGA-601	2” PUA-655	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties into 2” PUA-655 prior to Tank WM-183
1” PUA-648	Process drain	Trench for 10” VGA-602	CPP-783 North Sump SR-20 JET-WM-533	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench. Line 1” PUA-650 ties into this line prior to sump.
1” PUA-650	Process drain	Trench for 10” VGA-601	1” PUA-648	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench. Line 1” PUA-649 ties into this line prior to 1” PUA-648.
1” PUA-649	Process drain	Trench for 2” PUA-655	1” PUA-650	Schedule 40, seamless or welded, 347 SST or 304L SST	Drain line for trench.
3” PUA-609 [PWA-609] Abandoned	Process waste	3” PU-A-601 (abandoned) w/in Valve Box DVB-WM-PW-A5	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	Pipeline begins in Valve Box A5 as tie to 3” PUA-601 (through Valve PUV-WM-8) before terminating in VES-WM-183.
3” PUA-610 [PWA-610]	Process waste	3” PU-A-602 w/in Valve Box DVB-WM-PW-A5	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	Pipeline begins in Valve Box A5 as tie to 3” PUA-602 (through Valve PUV-WM-8) before terminating in VES-WM-183.
3” PUA-621	Process waste	VES-WM-182	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	No valves, tees, etc., in this line.
3” PUA-620	Process waste	VES-WM-182	VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	No valves, tees, etc., in this line.
2” PUA-1098 Encased in 4” pipe	Process waste	Inside VES-WM-183 Tank Riser 13 Jet-WM-583-1A	3” PUA-1035 in DVB-WM-PW-C5, PUV-WM-122	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties to 3” PUA-1035 in Valve Box C5.

Table D-2. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
2" PUA-1035 Encased in 4" pipe	Process waste	Inside VES-WM-183 Tank Riser 21 Jet-WM-583-1B	3" PUA-1035 in DVB-WM-PW-C5, PUV-WM-121	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties to 3" PUA-1035 in Valve Box C5.
1½" WS-A-631 to A-660	Cooling solution supply	CPP-628 cooling solution supply manifold 6" WS-N-152736	VES-WM-183 cooling coils	Carbon steel in CPP-628, then changes to stainless steel to VES-WM-183	Supplies cooling solution to Tank WM-183.
1½" WR-A-631 to A-660	Cooling solution return	VES-WM-183 cooling coils	CPP-628 cooling solution return manifold 6" WR-N-152736	Stainless steel from VES-WM-183, then changes to carbon steel in CPP-628	Returns cooling solution to CPP-628.
1" PU-A-653	Process drain	Sump in pipe trench	CPP-783 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	This line drains sump in pipe trench for line 3" PU-A-605, 607, and 608.
1" PU-A-654	Process drain	Trench sump east of DVB-WM-PL-A6	1" PU-A-653	Schedule 40, seamless or welded, 347 SST	This line drains sump in pipe trench for line 3" PU-A-609, -610, -1030, and –1005, and for Valve Boxes DVB-WM-PL-A5 and -A6. This line ties to 1" PU-A-653.
½" CN-614/619	Decontamination line	Abovegrade connection	10" VG-A-601	Schedule 40, seamless or welded, 347 SST	Abovegrade connection west of CPP-722 that can be used to decontaminate line 601.
10" VG-A-601	Vent off-gas	VES-WM-183 center manway	HE-WM-383 in CPP-722	Schedule 40, seamless or welded, 347 SST	This line connects to the heat exchanger inside CPP-722.
2" DC-N-605/609	Decontamination solution	Hose connect exterior of VES-WM-183 Tank Riser TR 53 thru DCV-WM-157	Tee to 12" access riser at TR 53	Stainless steel	605 is abovegrade, and 609 is belowgrade.
2" DC-N-606/610	Decontamination solution	Hose connect exterior of VES-WM-183 Tank Riser TR 13 thru DCV-WM-156	Tee to 12" access riser at TR 13	Stainless steel	606 is abovegrade, and 610 is belowgrade.
2" DC-N-607/611	Decontamination solution	Hose connect exterior of VES-WM-183 Tank Riser TR 21 thru DCV-WM-158	Tee to 12" access riser at TR 21	Stainless steel	607 is abovegrade, and 611 is belowgrade.
2" DC-N-608/612	Decontamination solution	Hose connect exterior of VES-WM-183 Tank Riser TR 54 thru DCV-WM-159	Tee to 12" access riser at TR 54	Stainless steel	608 is abovegrade, and 612 is belowgrade.
1½" SAMPLE	Sample line	Top inside of SR 20	CPP-783 North Sump	Stainless steel	Sample line for north sump.
1½" SAMPLE	Sample line	Top inside of SR 21	CPP-783 South Sump	Stainless steel	Sample line for south sump.
2" PUA-614/613	Process Waste	VES-WM-183	CPP-783 South Sump	Schedule 40, seamless or welded, 347 SST	Connects to Jet-WM-534 at sump and routes to Tank WM-183.

Table D-2. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
2” PUA-616/615	Process Waste	VES-WM-183	CPP_783 North Sump	Schedule 40, seamless or welded, 347 SST	Suction line from sump that connects to Jet-WM-534.
3” PUA-1005	Process Waste	DVB-WM-PW-C40	DVB_WM-PL-A6	Schedule 40, seamless or welded, 347 SST or 304L SST	
3” PUA-1030	Process Waste	DVB-WM-PW-C40	DVB_WM-PL-A6	Schedule 40, seamless or welded, 347 SST or 304L SST	

Table D-3. Tank WM-182 non-RCRA piping that will not require decontamination.

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” PUA-647	Process drain	10” VGA-603	2” PUA-652	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties into 2” PUA-652 prior to Tank WM 182. Supply side of vessel off-gas system.
¼” INST-643 to INST-646	Specific gravity indicator	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-647	Level alarm indicator (lower)	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-648	Level alarm indicator (middle)	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-649	Level alarm indicator (upper)	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-650	Pressure alarm indicator	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-651	Level alarm indicator	CPP-182 South Sump SR 19	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from south sump and routes to CPP-628.
¼” INST-652	Level alarm indicator (spare)	CPP-182 South Sump SR 19	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from south sump and routes to CPP-628.
¼” INST-653 to INST-657	Specific gravity indicator	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-658	Level alarm indicator (middle)	VES-WM-182	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on east side and routes to CPP-628.
¼” INST-659	Level alarm indicator	CPP-182 North Sump SR 18	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from north sump and routes to CPP-628.
¼” INST-660	Level alarm indicator	CPP-182 North Sump SR 18	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from north sump and routes to CPP-628.

Table D-3. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” INST-T1	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-1A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T2	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-2A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T3	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-3A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T4	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-4A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T5	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-5A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T6	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-6A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T7	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-7A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T8	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-8A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T9	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-9A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.

Table D-3. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” INST-T10	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-10A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T11	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-11A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T12	Temperature indicator line Thermowell	VES-WM-182 west side	TE-WM-182-12A at JB box in Vault 782 west side		½” conduit with wire inside goes from Tank WM-182 to JB box on west side, then all wires are in 1½” conduit to JB on east side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T13	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-1B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.
½” INST-T14	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-2B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.
½” INST-T15	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-3B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.
½” INST-T16	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-4B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.
½” INST-T17	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-5B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.
½” INST-T18	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-6B at JB box in Vault 782 east side		½” conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2” conduit that routes to CPP-628.

Table D-3. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½" INST-T19	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-7B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
½" INST-T20	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-8B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
½" INST-T21	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-9B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
½" INST-T22	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-10B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
½" INST-T23	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-11B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
½" INST-T24	Temperature indicator line Thermowell	VES-WM-182 east side	TE-WM-182-12B at JB box in Vault 782 east side		½" conduit with wire inside goes from Tank WM-182 to JB box on east side, then all wires including west 12, are in 2" conduit that routes to CPP-628.
1½" HS-A-603	High-pressure steam	1½" HS-A-104718	CPP-782 North Sump SR 18	Schedule 40, seamless or welded, 347 SST	This line connects to 104718 at east outside wall of vault 782 and routes to north sump and connects to Jet WM-530. Steam supply line.
1½" HS-A-104718	High-pressure steam	Valve Box DVB-WM-C1	1½" HS-A-603	Schedule 40, seamless or welded, 347 SST	This line connects to 603 at east outside wall of vault 782. Steam supply line.
1½" HS-A-602	High-pressure steam	1½" HS-A-104719	CPP-782 South Sump SR 19	Schedule 40, seamless or welded, 347 SST	This line connects to 104719 at east outside wall of vault 782 and routes to north sump and connects to Jet WM-531. Steam supply line.
1½" HS-A-104719	High-pressure steam	Valve Box DVB-WM-C1	1½" HS-A-602	Schedule 40, seamless or welded, 347 SST	This line connects to 602 at east outside wall of vault 782. Steam supply line.
10" VG-A-603	Vent off-gas	VES-WM-182 center manway	10" VP-AR-153507 in CPP-721	Schedule 40, seamless or welded, 347 SST	This line connects to 153507 through valve PSV-WM-83 inside CPP-721. Air supply line.
1" HS-A-104723	High-pressure steam	Valve Box DVB-WM-C6 Valve HSV-WM-223	CPP-782 South Sump SR 19 Jet-WM-582-4	Schedule 40, seamless or welded, 347 SST	Steam supply line to south sump.

Table D-3. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
1” HS-A-1008	High-pressure steam	Inside CPP-628 at Valve HSV-WM-146	VES-WM-182 TR 19 Jet-WM-582-1A	Schedule 40, seamless or welded, 347 SST	Steam supply line to the steam jet in Riser 19.
1” HS-A-1009	High-pressure steam	Inside CPP-628 at Valve HSV-WM-145	VES-WM-182 TR 20 Jet-WM-582-1B	Schedule 40, seamless or welded, 347 SST	Steam supply line to the steam jet in Riser 20.
½” LL-A-104811	Low-pressure air line	CPP-628	CPP-782 South Sump SR 19	Schedule 40, seamless or welded, 347 SST	Instrument air supply.
½” LL-A-104812	Low-pressure air line	CPP-628	CPP-782 South Sump SR 19	Schedule 40, seamless or welded, 347 SST	Instrument air supply.
2” DC-N-601/605	Decontamination solution	Hose connect exterior of VES-WM-182 Tank Riser TR 52 thru DCV-WM-153	Tee to 12” access riser at TR 52	Stainless steel	601 is abovegrade and 605 is belowgrade.
2” DC-N-602/606	Decontamination solution	Hose connect exterior of VES-WM-182 Tank Riser TR 20 thru DCV-WM-152	Tee to 12” access riser at TR 20	Stainless steel	602 is abovegrade and 606 is belowgrade.
2” DC-N-603/607	Decontamination solution	Hose connect exterior of VES-WM-182 Tank Riser TR 19 thru DCV-WM-154	Tee to 12” access riser at TR 19	Stainless steel	603 is abovegrade and 607 is belowgrade.
2” DC-N-604/608	Decontamination solution	Hose connect exterior of VES-WM-182 Tank Riser TR 51 thru DCV-WM-151	Tee to 12” access riser at TR 51	Stainless steel	604 is abovegrade and 607 is belowgrade.
1½” SAMPLE	Sample line	Top inside of SR 18	CPP-782 North Sump	Stainless steel	Sample line for north sump.
1½” SAMPLE	Sample line	Top inside of SR 19	CPP-782 South Sump	Stainless steel	Sample line for south sump.

Table D-4. Tank WM-183 non-RCRA piping that will not require decontamination.

Number	Description	Point of Origin	Point of Termination	Material	Comments
½" PUA-656	Process drain	10" VGA-602	2" PUA-655	Schedule 40, seamless or welded, 347 SST or 304L SST	Ties into 2" PUA-655 prior to Tank WM-183. Condensate from vessel off-gas supply.
3" PUA-605 Abandoned and partially encased in 6" pipe	Process waste	VES-WM-183	Capped east side of VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	This line was for a future tank and is now cut 8" outside of vault and filled with 2′ of concrete. Remaining line is in concrete trench extending east of CPP-783. Line then extends 5′ beyond trench and is encased in a 6" pipe.
3" PUA-607 Abandoned and partially encased in 6" pipe	Process waste	VES-WM-183	Capped east side of VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	This line was for a future tank and is now cut 8" outside of vault and filled with 2′ of concrete. Remaining line is in concrete trench extending east of CPP-783. Line then extends 5′ beyond trench and is encased in a 6" pipe.
3" PUA-608 Abandoned and partially encased in 6" pipe	Process waste	VES-WM-183	Capped east side of VES-WM-183	Schedule 40, seamless or welded, 347 SST or 304L SST	This line was for a future tank and is now cut 8" outside of vault and filled with 2′ of concrete. Remaining line is in concrete trench extending east of CPP-783. Line then extends 5′ beyond trench and is encased in a 6" pipe.
¼" INST-621	Level alarm indicator	CPP-183 North Sump SR 20	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from north sump and routes to CPP-628.
¼" INST-622	Level alarm indicator	CPP-183 North Sump SR 20	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from north sump and routes to CPP-628.
¼" INST-623	Level alarm indicator (lower)	VES-WM-183	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on west side and routes to CPP-628.
¼" INST-624 to 629	Level alarm indicator (middle)	VES-WM-183	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on west side and routes to CPP-628.
¼" INST-630	Level alarm indicator (upper)	VES-WM-183	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on west side and routes to CPP-628.

Table D-4. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
¼” INST-631	Level alarm indicator (middle)	VES-WM-183	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on west side and routes to CPP-628.
¼” INST-632 to 636	Level alarm indicator (lower)	VES-WM-183	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line exits top of tank on west side and routes to CPP-628.
¼” INST-637	Level alarm indicator	CPP-183 South Sump SR 21	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from south sump and routes to CPP-628.
¼” INST-638	Level alarm indicator (spare)	CPP-183 South Sump SR 21	CPP-628	Schedule 80, ASTM A312 TP 347 or 304L SST, seamless	Line runs from south sump and routes to CPP-628.
½” INST-T1	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-1A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T2	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-2A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T3	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-3A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T4	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-4A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T5	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-5A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.

Table D-4. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” INST-T6	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-6A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T7	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-7A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T8	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-8A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T9	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-9A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T10	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-10A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T11	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-11A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T12	Temperature indicator line Thermowell	VES-WM-183 east side	TE-WM-183-12A at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on east side, then all wires are in 1½” conduit to JB on west side of vault, then in 2” conduit that routes to CPP-628.
½” INST-T13	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-1B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.

Table D-4. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” INST-T14	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-2B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T15	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-3B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T16	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-4B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T17	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-5B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T18	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-6B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T19	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-7B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T20	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-8B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T21	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-9B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T22	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-10B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
½” INST-T23	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-11B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.

Table D-4. (continued).

Number	Description	Point of Origin	Point of Termination	Material	Comments
½” INST-T24	Temperature indicator line Thermowell	VES-WM-183 west side	TE-WM-183-12B at JB box in Vault 783 east side		½” conduit with wire inside goes from Tank WM-183 to JB box on west side, then all wires including east 12, are in 2” conduit that routes to CPP-628.
1½” HS-A-604	High-pressure steam	1½” HS-A-104717	CPP-783 North Sump SR 20	Schedule 40, seamless or welded, 347 SST	This line connects to 104717 at west outside wall of Vault 783 and routes to north sump and connects to Jet WM-533.
1½” HS-A-104717	High-pressure steam	Valve box DVB-WM-C1	1½” HS-A-604	Schedule 40, seamless or welded, 347 SST	This line connects to 604 at west outside wall of Vault 783.
1½” HS-A-605	High-pressure steam	1½” HS-A-104720	CPP-7823 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	This line connects to 104720 at west outside wall of Vault 783 and routes to north sump and connects to Jet WM-534.
1½” HS-A-104720	High-pressure steam	Valve Box DVB-WM-C1	1½” HS-A-605	Schedule 40, seamless or welded, 347 SST	This line connects to 605 at west outside wall of Vault 783.
1” PU-A-651	Process drain	Sump in pipe trench	CPP-783 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	This line drains sump in pipe trench for line 3” PU-A-620 and 621.
10” VG-A-602	Vent off-gas	VES-WM-183 center manway	10” VP-AR-153504 in CPP-721	Schedule 40, seamless or welded, 347 SST	This line connects to 153507 thru valve PSV-WM-134 inside CPP-721. Steam supply line.
1” HS-A-104722	High-pressure steam	Valve Box DVB-WM-C6 Valve HSV-WM-222	CPP-783 South Sump SR 21 Jet-WM-583-4	Schedule 40, seamless or welded, 347 SST	Steam supply.
1” HS-A-104723	High-pressure steam	Valve Box DVB-WM-C6 Valve HSV-WM-222	CPP-783 South Sump SR 19 Jet-WM-582-4	Schedule 40, seamless or welded, 347 SST	Steam supply.
1” HS-A-104721	High-pressure steam	Valve Box DVB-WM-C6 Valve HSV-WM-222	Steam supply to Valve Box C6	Schedule 40, seamless or welded, 347 SST	Steam supply.
1” HS-A-1014	High-pressure steam	Inside CPP-628 at Valve HSV-WM-144	VES-WM-183 TR 13 Jet-WM-583-1A	Schedule 40, seamless or welded, 347 SST	Steam supply.
1” HS-A-1015	High-pressure steam	Inside CPP-628 at Valve HSV-WM-143	VES-WM-183 TR 21 Jet-WM-583-1B	Schedule 40, seamless or welded, 347 SST	Steam supply.
½” LAA-104813	Low-pressure air line	CPP-628	CPP-783 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	Air supply.
½” LAA-104814	Low-pressure air line	CPP-628	CPP-783 South Sump SR 21	Schedule 40, seamless or welded, 347 SST	Air supply.
1½” SAMPLE	Sample line	Top inside of SR 20	CPP-783 North Sump	Stainless steel	Sample line for north sump.
1½” SAMPLE	Sample line	Top inside of SR 21	CPP-783 South Sump	Stainless steel	Sample line for south sump.

Appendix E

Statistical Analysis for Tank Farm Closure

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Statistical Analysis for Tank Farm Closure

E-1. INTRODUCTION

Several different statistical methods will be applied to the Tank Farm Facility (TFF) closure data. There are two primary objectives with regard to the statistical analysis that will be performed on the data. The first objective is to determine if the constituents of interest are present in levels greater than the specified action level. Confidence intervals will be used for this analysis. The second objective is to determine if the contents of the tanks and the vault sumps came from the same population. This will be done by performing Analysis of Variance (ANOVA) on the data from the samples collected in the vault sumps at Tanks WM-182 and WM-183 and the data from samples collected within the two tanks. ANOVA also will be used when more data are obtained from other tanks. Five samples will be taken from each tank and one sample from each of the two vault sumps for each tank (a total of four samples from the vault sumps). This provides a total of 14 samples from Tanks WM-182 and WM-183.

E-2. CONFIDENCE INTERVALS

Confidence intervals will be used to determine if any of the constituents of concern in the tanks or the vaults exceed the specified action levels. This is done by constructing a 90% confidence interval for the concentration of each constituent in each tank and comparing the upper confidence limit with the specified action level. If the upper confidence limit is less than the action level, then the constituent is considered to be present in levels less than the action level. If the upper confidence limit is greater than the action level, then it is assumed that the constituent is present in concentrations that are greater than the action level and appropriate action will be taken.

E-2.1 Construction of a Confidence Interval

A confidence interval is constructed using the sample mean and standard deviation of the data. For each constituent, the mean concentration, $\overline{X}$, is calculated using the equation

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n} \tag{E-1}$$

where

n	=	the number of observations in the data set
X_i	=	the i^{th} observation in the data set.

The standard deviation, s, is calculated using the equation

$$s^2 = \frac{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)^2}{n-1} \tag{E-2}$$

The confidence interval is calculated using the expression

$$\overline{X} \pm t_{1-\alpha,n-1}\sqrt{\frac{s^2}{n}}$$

where

$t_{1-\alpha,n-1}$ = the *t*-statistic at *1-α* with *n-1* degrees of freedom

So

$$UCL = \overline{X} + t_{1-\alpha,n-1}\sqrt{\frac{s^2}{n}} \tag{E-3}$$

where

UCL = upper confidence limit.

The *t*-statistic can be found on a *t*-table or from a statistical software package. In the case of the analysis for the Tank Farm Facility closure, α=0.05 since the 95% upper confidence limit is being used. This is the significance level of a statistical hypothesis test. Essentially comparing the upper limit of a confidence interval to the action level is comparable to performing a one-sample *t*-test of the sample mean against the action level at the α=0.05 level. (The 95% upper confidence limit is the upper limit of a 90% confidence interval. Since it is only the upper confidence limit that is being compared to the action level, setting α=0.05 gives the test an overall significance level of 0.05.)

E-2.2 Use of the Confidence Interval

Once the confidence interval has been calculated for a given constituent concentration, a comparison can be made against the action level for that constituent. The general rule is if

$$\overline{X} + t_{1-\alpha,n-1}s < AL \tag{E-4}$$

where

AL = action level

then it can be confidently concluded that the constituent concentration is less than the action level. However, if

$$\overline{X} + t_{1-\alpha,n-1}s \geq AL \tag{E-5}$$

then it cannot be concluded that the constituent concentration is less than the action level. In this situation, it is assumed that the constituent concentration exceeds the action level and the appropriate action should be taken.

A confidence interval will be constructed for every constituent of concern in each tank and in the vault sumps for each tank. This means if there are 10 constituents of interest, 40 confidence limits will be calculated and compared to the appropriate action levels.

Let's work through an example calculation to determine the 95% upper confidence limit. If the sample data are $\overline{X} = 0.87$, $s^2 = 0.073$, $t_{0.05,9} = 1.833$, and $UCL = 0.87 \pm 0.1565$, which corresponds to an upper confidence limit at 1.03 mg/L, then the calculation yields the following:

Liquid Arsenic Sample Data (Example)			
Sample No.	Concentration (mg/L)	Sample No.	Concentration (mg/L)
1	0.79	6	0.98
2	0.85	7	0.87
3	0.92	8	0.78
4	0.75	9	0.88
5	0.80	10	1.06

Since the action level for liquid arsenic has been set at 1.05, it can be determined that for these 10 samples, there is 95% confidence that the true mean is less than 1.03 mg/L. This method is adapted from *Test Methods for Evaluating Solid Wastes*, *Physical/Chemical Methods* EPA SW-846 (1998).

E-2.3 Assumptions of Confidence Intervals

When constructing a confidence interval, the data must be approximately normally distributed to meet the assumptions of the confidence interval. Since the *t*-statistic is used to generate the confidence interval, the interval is robust against certain variations from the normal distribution. However, the data still need to be symmetric about the mean and free of outliers. Since the *t*-statistic is robust against slight variations from the normal distribution, performing a hypothesis test to verify the normality of the data is not appropriate. Statistical tests that are used to determine if a data set follows a certain distribution are highly sensitive to variations of the data from the distribution in question. Because of this, data that fail to meet the requirements of the statistical test for normality may still produce a reliable confidence interval. In fact, if a statistical test for determining the normality of the data does show that the data are normal (i.e., the null hypothesis is not rejected), then the *z*-statistic should be used in the confidence interval instead of the *t*-statistic. The normality of the data can be better assessed by examining the summary statistics of the data and through graphical methods such as histograms.

Another assumption that is made when constructing a confidence interval is that the sample mean and the standard deviation are independent. This is always the case if the data are truly normally distributed. Because of this, it is assumed that this assumption is met if the data appear to be approximately normally distributed.

E-2.4 Using the Lognormal Transformation

Since the type of data that will be obtained from the Tank Farm Facility tanks is non-negative, it is likely that the data will be log normally distributed rather than normally distributed. This means that the natural log of the data points have a normal distribution. The traditional method for analyzing lognormal data is to take the log of all of the data points and perform the statistical analysis on the transformed data. Any methods that are appropriate for the normal distribution can be applied to the transformed data. However, this can pose some complications with some analytical methods. For example, a confidence interval that is generated using the transformed data is accurate for estimating the mean of the transformed data, but the interval cannot be transformed back to the scale of the raw data to estimate the mean of the raw data. However, the *t*-test can be accurately performed on the transformed data against a cutoff value such as the action level of a constituent. The test is performed by taking the log of the raw data and calculating the mean and standard deviation using the transformed data. These values are then used to perform a *t*-test against the log of the action level. Because the confidence interval is only being used to conduct a *t*-test for the data from the Tank Farm Facility, the results obtained by comparing the 95% upper confidence limit of log transformed data against the log of the action level is as accurate a test as comparing the 95% upper confidence limit against the action level if the raw data were truly normally distributed.

It is possible that the data that will be obtained from the Tank Farm Facility will be neither normal nor log normally distributed. If this is the case, other transformations will be attempted on the data to see if normality can be achieved with some transformation. The methods described above will be applied to the transformed data. As with the natural log transformation of the data, confidence intervals can be used to perform a *t*-test on the transformed data.

E-3. ANALYSIS OF VARIANCE (ANOVA)

The second type of analysis of interest is the use of one-way ANOVA to determine if the contents of the tanks and vault sumps came from the same population. A separate ANOVA will be performed for each constituent of concern. One-way ANOVA is similar to the *t*-test. In fact, the *t*-test is a special case of one-way ANOVA. ANOVA is a statistical hypothesis test for determining if the means of several groups are different from each other. In the situation of the tanks and vault sumps in the TFF, each tank or vault sump is considered a group. ANOVA is used instead of a *t*-test because many different *t*-tests would need to be performed to make all of the desired comparisons. This will increase the significance level, α. Since multiple tests would be run on the same set of data, the significance level would no longer be 0.05. This is because the significance level applies to the chance of achieving significance in the analysis, not just one test. Although the chance of making a Type I error (rejecting the null hypothesis when it is in fact true) on a single test is only 0.05, the chance of making a Type I error somewhere in at least one of several tests is much greater than 0.05. ANOVA is a more appropriate way to deal with this type of situation.

E-3.1 Use of ANOVA

As stated above, ANOVA is a test of the means between several different groups. The null hypothesis is that there is no difference in analyte concentrations between all of the tanks and vault sumps. This means that the contents of the tanks and vault sumps came from the same population. The alternative hypothesis is that there is a difference in analyte concentration levels between the tanks and vault sumps. This means that the contents of the tanks and vault sumps do not come from the same population. Note that the alternative hypothesis does not specify which tanks or sump vaults are different from each other. It could be that all the tanks and vault sumps have significantly different constituent concentrations or it could be that only one of the tanks or vault sumps has a different mean concentration than one, or all, of the other tanks or vault sumps. If the P-value associated with the ANOVA test indicates that there is a significant difference in concentration levels between the tanks and vault sumps (i.e., $P < 0.05$), then multiple means comparison testing will be used to determine which tanks and/or vault sumps are different from each other. Just because significance is achieved using ANOVA, it does not necessarily mean that there is significant contamination in the tanks or vault sumps. It could be that two of the post-decontamination residuals in the tanks have different mean concentrations from each other, but that none of the tanks or vault sumps have constituent concentrations that are significantly greater than the action level.

The results of the ANOVA test are presented in a table that looks like this:

Model	DF	SS	MS	F	P
Group	DFG	SSG	MSG	F	P
Error	DFE	SSE	MSE		
Total	DFT	SST			

In the table,

DFG = number of tanks and sump vaults –1

DFT = total number of samples –1

DFE = DFT – DFG

$$SSG = n\sum_{groups}(\bar{x}_i - \bar{x})^2$$

$$SST = \sum_{obs}(x_{ij} - \bar{x})^2$$

SSE = SST – SSG

MSG = SSG/DFG

MSE = SSE/DFE

F = MSG/MSE

where

n = the total number of samples taken from each tank

DFX = the degrees of freedom for term X

SSX = the sum of squares for the term X

MSX = the mean square for the term X

F = the F-statistic

P = P-value.

The P-value can be found from an *F*-table. The degrees of freedom in the numerator are DFG and the degrees of freedom in the denominator are DFE (this is only pertinent if you are in fact going to look up the P-value on a table).

The P-value is the number that is of primary interest. If P is less than 0.05, then the null hypothesis is rejected and there is some difference between the analyte concentrations in the tanks and/or sump vaults. If P is greater than or equal to 0.05, then there is not sufficient evidence to reject the null hypothesis and it can be concluded that the contents of the tanks and vault sumps come from the same population.

ANOVA can be used to analyze the data from Tanks WM-182 and WM-183 and the corresponding vault sumps, and can also be used to analyze the data as more data are obtained. A separate ANOVA needs to be generated for each constituent of concern.

One issue with this particular data set is that the data are unbalanced. This means that each group does not have the same number of observations in it. Each of the tanks will consist of 5 observations per tank. Each vault sump group will contain 2 observations. There are two different ways to handle this situation. One way is to analyze the tanks separately from the vault sumps. The benefit of doing this is that the design will be balanced and the mathematics will be simpler. The disadvantage is that a direct comparison between the tanks and the vault sumps cannot be made. The other method is to use type III sums of squares to generate the *F*-statistics instead of the type I sums of squares. The advantage of this method is that all of the tanks and vault sumps can be analyzed in the same design and therefore they all can be compared against each other. The disadvantage is that the equations for the sums of squares for ANOVA that are listed above are no longer applicable, so the mathematics become very complex in generating the sums of squares. However, since a computer will be used to perform all of the calculations, the mathematical complexity does not present a problem. It is recommended that all of the data be analyzed in the same model and that type III sums of squares are used to generate the *F*-statistics.

E-3.2 Assumptions of ANOVA

Several assumptions are made when performing ANOVA on the data. They are as follows:

- The data are approximately normally distributed
- The groups have approximately equal variance
- The group mean and standard deviation are independent.

These assumptions need to be verified before the results of ANOVA can be considered reliable. Since ANOVA is based on the *F*-statistic, the test is robust against small variations from the normal distribution. However, the data do need to be symmetric and free of outliers. As with the confidence interval, the use of a statistical test to determine the normality of the data is not appropriate because it is far more conservative than is necessary for ANOVA (see Section E-2.3).

The normality assumptions can be verified through examining residual plots. Residual plots are generated by plotting the residuals against the predicted values generated from ANOVA and by plotting the residuals against the groups. A residual is calculated by subtracting the value predicted from the ANOVA model from the corresponding observed data value. Residual plots also are the standard method for determining if the groups have approximately equal variance. Normal-quantile plots and symmetry plots also can be used to assess symmetry, the presence of outliers in the data, and how close the data follow a normal distribution. A histogram of the residuals can also be examined to determine the normality of the data. These methods are sufficient for establishing that the normality assumption has been met. As with the confidence intervals, if the data look to be sufficiently normally distributed then it is assumed that the group mean and standard deviation are independent. This is because for data that are truly normal, the sample mean and standard deviation are always independent.

E-4. REFERENCES

EPA, 1998, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, EPA SW-846, Revision 5, April.