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2. BACKGROUND AND OPERATIONAL HISTORY

This section addresses INTEC's general background, mission, and operational history as they pertain to the tank farm facility.

In the 1950s, construction began on INTEC (then called the Chemical Processing Plant [CPP]). Nuclear fuel storage operations began in 1952, and reprocessing of SNF was conducted at INTEC from 1953 to 1992. Tanks within the INTEC tank farm were constructed from 1951 through 1964 and were used to support INTEC SNF reprocessing operations and other incidental liquid waste streams.

2.1 Physical Setting

This subsection presents only an overview of the INEEL's physiography, ecology, surface hydrology, meteorology, climatology, demography, and land use, because these topics have been addressed at length in past INEEL WAG 3 and WAG 7 CERCLA reports (DOE-ID 1997a, 1997b, 1998b, 1999a, 2003a). However, the latest information on the geology and hydrogeology are discussed in detail in the following subsections because of their importance to groundwater movement. The specific INTEC geology/hydrogeology is discussed in Subsection 4.1 with the hydrogeologic conceptual model. The latest land use defined by the NE-ID is discussed in Subsection 5.1.3.

The INEEL Site is located in southeastern Idaho near the northeast end of the Snake River Plain. This plain is a large topographic depression that extends from the Oregon border across Idaho to Yellowstone National Park and northwestern Wyoming (DOE-ID 1998b). The INEEL Site occupies 890 mi². It is nearly 39 mi long from north to south and about 36 mi wide in its broadest southern portion. The Lost River Range, the Lemhi Range, and the Beaverhead Mountains border the INEEL on the north and west (see Figure 2-1). The lands that surround the INEEL are managed as rangeland, agricultural lands, U.S. Forest Service lands, and U.S. Bureau of Land Management lands.

The surface of the INEEL is a relatively flat, semiarid, sagebrush desert. Predominant relief is manifested either as volcanic buttes jutting up from the desert floor or as uneven surface expressions of basalt flows or flow vents and fissures. Elevations on the INEEL range from 4,790 ft in the south to 5,913 ft in the northeast, with an average elevation of 5,000 ft above sea level (Irving 1993). The elevation at INTEC, located in the south-central portion of the INEEL, averages 4,917 ft.

In the western portion of the INEEL, intermittently flowing waters from the Big Lost River flow to the Lost River Sinks in the northwest portion of the INEEL. Water either evaporates or infiltrates into the SRPA at the sinks. Normally, water is diverted for irrigation before reaching the INEEL and only flows onto the INEEL Site when sufficient snowpack occurs to provide spring runoff (DOE-ID 1998b).

Meteorological and climatological data for the INEEL and the surrounding region are collected and compiled from several meteorological stations operated by the National Oceanic and Atmospheric Administration field office in Idaho Falls, Idaho. Three stations are located on the INEEL: one at the Central Facilities Area, one at Test Area North, and one at the Radioactive Waste Management Complex. Average annual precipitation at the INEEL is 8.7 in., with the highest amounts occurring during the months of May and June and the lowest in July. Normal winter snowfall occurs from November through April, though occasional snowstorms occur in May, June, and October. Annual snowfall at the INEEL ranges from a low of about 6.8 in. to a high of about 59.7 in., and the annual average is 27.6 in. The average summer daytime maximum temperature is 83°F, while the average winter daytime maximum temperature is 31°F (Clawson, Start, and Ricks 1989).

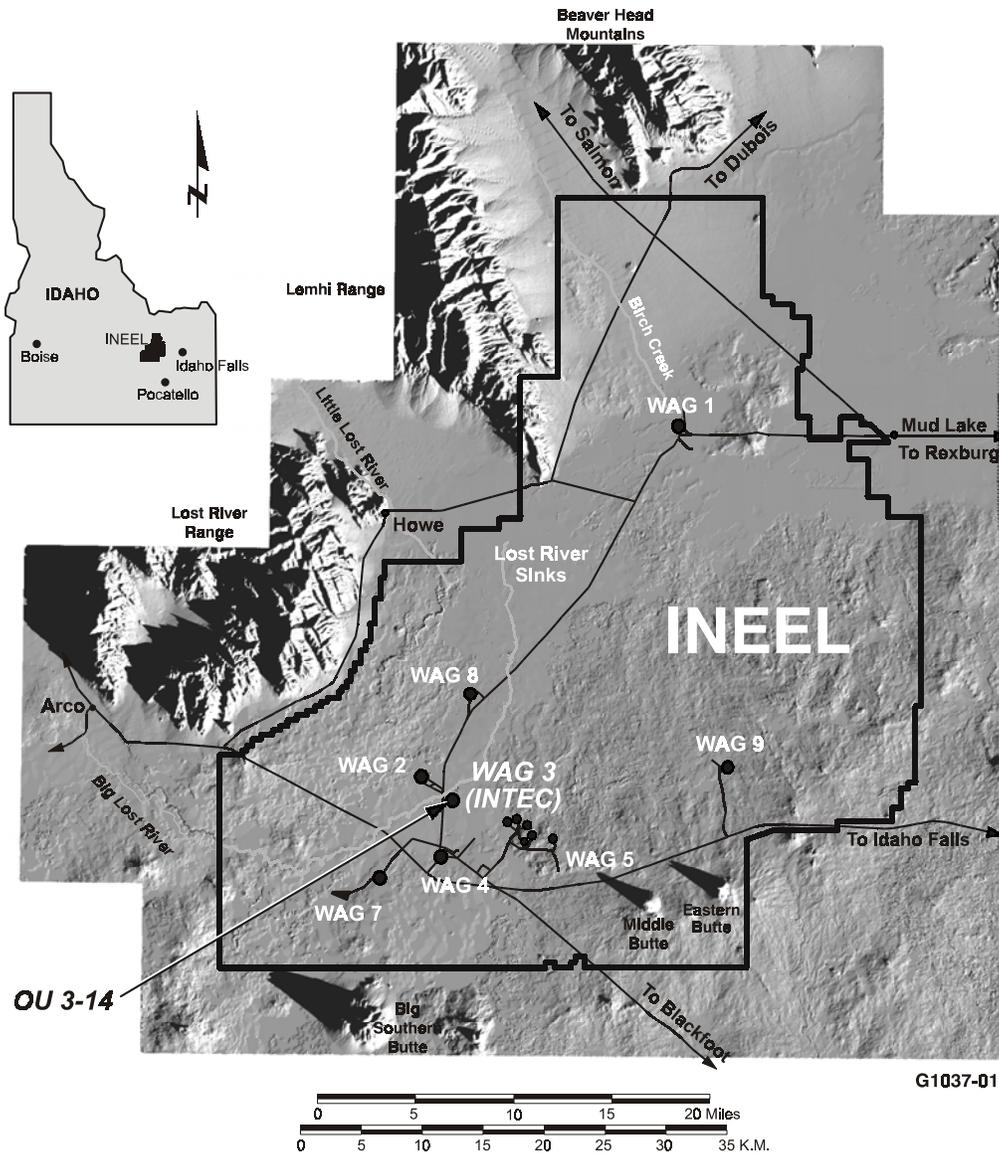


Figure 2-1. Aerial view of the INEEL, showing the bordering mountain ranges.

Regionally, the INEEL is nearest to the major population centers of Idaho Falls and Pocatello and to U.S. Interstate Highways I-15 and I-86. The INEEL Site occupies portions of five southeast Idaho counties: Butte, Bingham, Bonneville, Jefferson, and Clark. Most of the INEEL lies within Butte County. Approximately 95% of the INEEL has been withdrawn from the public domain. The remaining 5% includes public highways (U.S. 20 and 26 and Idaho 22, 28, and 33) and the Experimental Breeder Reactor I, which is a national historic landmark (Irving 1993; DOE-ID 1998b).

2.1.1 INEEL Geology

This subsection is an overview of the regional geology to aid in understanding the subsurface stratigraphy at INTEC and the features that control the subsurface movement of water in the vadose zone and the SRPA. The complexity of the Eastern Snake River Plain (ESRP) geology necessitates a reasonable understanding of how and why it was formed. Included in this subsection is a general

description of the important components that control the fate and transport of contamination from the tank farm at INTEC.

2.1.1.1 Snake River Plain. The INEEL is located in south-central Idaho on the Snake River Plain. The Snake River Plain is commonly divided into two regions: a western region, which is a northwest-trending depositional basin, and an eastern region, which is a northeast-trending volcanic plain (Malde 1991). The INEEL is located in the eastern region of the Snake River Plain. This volcanic plain is composed of approximately 3,000 ft of layered late-Cenozoic basalt flows over a rhyolitic basement that extends to a depth of 10,000 ft, but its total thickness is unknown (Malde 1991).

The ESRP is approximately 200 mi long and ranges between 50 and 70 mi in width (Anderson 1991). It is bounded on the west by the north-flowing reach of the Snake River through the Hagerman Valley and on the east by the Island Park rhyolite deposits. The northern and southern boundaries consist of the basin and range mountains of south-central Idaho (Malde 1991).

2.1.1.2 Origin of the Snake River Plain Volcanics. The crustal structure of the Snake River Plain volcanics, although not completely understood, is believed to include the entire thickness of the crust that was significantly modified by a subsurface heat source known as the “Yellowstone hot spot” (Malde 1991). The track of the Yellowstone hot spot is represented by a systematic northeast-trending, linear belt of silicic-forming volcanism that arrived at Yellowstone approximately 2 million years ago. The hot-spot-induced vulcanism started about 16 million years ago near the Nevada-Oregon-Idaho border and progressed N54°E toward Yellowstone at approximately 1.18 in./yr (Pierce and Morgan 1990).

The hot spot caused two types of large-scale melting to occur. The first melting involved the generation of basaltic magmas from hot mantle material that migrated to mid-crustal depths (5 to 12.4 mi). This melting was due to a decrease in pressure as the hot mantle material migrated upward. The second type of melting was due to heating of mid-crustal rocks by the much hotter basaltic magmas that rose from the mantle plume. The melting of mid-crustal rock produced granitic melts that migrated upward to form near-surface reservoirs and caused widespread explosive and effusive rhyolitic volcanism. The melting processes associated with the hot spot created a lens of anomalously dense basalt roughly 6.2 mi thick in the mid-crust. The addition of this weight to the crust, coupled with the material cooling after passing over the hot spot, has caused the ESRP to subside approximately 1.2 mi during the past 4 million years (SAR-II-8.4 2001).

2.1.1.3 Basalt Flow Structure. The ESRP is a product of plains-style volcanism, which is typified by low shield volcanoes located on volcanic rift zones having slopes of about 1° dip (Greeley 1982). The shields form in an overlapping manner, with minor fissure-fed flows often filling in low areas between shields, producing a subdued topography. The volcanism in the ESRP has been episodic, emplacing lava flows over relatively short periods (a few hundred to a few thousand years), with long periods of volcanic quiescence (tens of thousands to millions of years). During the quiescent periods, loess, alluvial silt, sand, gravel, and lacustrine clays and silt are deposited on top of the basalt, often in topographic lows.

Two types of basalt are commonly erupted on the ESRP: (1) a form known as *pahoehoe*, which is a very fluid, low-viscosity lava that produces thin tongues and lobes, and (2) *aa*, which is a high-viscosity lava that results in blocky angular flows. A third “hybrid” type of basalt is also found among the lava flows of the ESRP. Malde (1991) suggests that this hybrid basalt was formed by magma interacting with crustal rocks at depths of about 19 mi. As suggested by Greeley (1982), *pahoehoe* is the dominant type of basalt that erupted on the Snake River Plain and forms the long, low-angle flanks of the low shield volcanoes.

A typical basalt flow can be divided into four layered elements (Knutson et al. 1990). The lowest layer is the substratum, consisting of a ropy pahoehoe surface, fracture and fissured surfaces, and rubble zones (see Figure 2-2). This layer accounts for about 5% of the flow thickness. Above the substratum is a lower vesicular zone that contributes an average of 11% of the flow thickness. Vesicles form by degassing of the lava, and polygonal fracturing is common in this layer. The massive central element, or nonvesicular zone, of the flow composes about 49% of the thickness. The central element is dense, with few fractures except for vertical columnar jointing. The uppermost element of the flow is the upper vesicular element, accounting for about 35% of the thickness of the flow. This element may have a parting parallel to the upper surface as well as fissures and broken basalt.

The saturated hydraulic properties of basalt are very anisotropic. The most important portions of the basalt flow contributing to the horizontal transmission of water for saturated conditions are the rubble zones between basalt flows in which the lower rubble zone from one flow lies on top of the upper vesicular element of the flow beneath it. Layered basalt flows, therefore, have a high horizontal saturated permeability.

Fractures in subsurface basalt lava flows commonly contain fine-grained sediment infilling and fracture wall coatings because of downward percolation from the overlying sediments. The sediment infilling of the fractures should cause a decrease in the permeability of fractured basalt below the interbeds, though the effects of sediment infilling have not been measured. Where the top of a flow has been covered and fractures have been filled with fine-grained sediment, a low-permeability layer can form. The massive central element of a flow can also have very low permeability, depending on the extent of fracturing.

2.1.1.4 Flows, Flow Units, Flow Groups. A basalt flow, commonly referred to as a lava flow, is generally defined as an individual molten body of rock that has been extruded out horizontally across the earth's surface from a fissure or vent. The molten rock subsequently cools and solidifies, resulting in a unique flow that can generally be distinguished from surrounding flows. The term "basalt flow" is used somewhat loosely in the context of ESRP geology to describe individual flows, groups of flows, or flow subsets. In some cases, a basalt flow may refer to a flow group, which is a group of petrographically similar flows that erupted from the same magma chamber (Anderson and Lewis 1989). In other cases, a flow will refer to a separate distinct lobe that issued out from a parent flow.

2.1.2 INEEL Hydrogeology

Subsurface hydrology at the INEEL is discussed as three components: the vadose zone, perched water, and the SRPA. The vadose zone, also referred to as the unsaturated zone, extends from the land surface down to the water table. The water content of the geologic materials in the vadose zone is commonly less than saturation, and water is held under negative pressure. Perched water in the subsurface forms as discontinuous saturated lenses with unsaturated conditions existing both above and below the lenses. Perched water bodies are formed by vertical and, to a lesser extent, lateral migration of water moving away from a source until an impeding sedimentary layer is encountered. The SRPA, also referred to as the saturated zone, occurs at various depths beneath the ESRP. About 9% of the SRPA lies beneath the INEEL (DOE-ID 1996). The depth to the water table ranges from approximately 200 ft in the northern part of the INEEL to more than 900 ft in the southern part (Irving 1993). The SRPA, which consists of basalt and sediments and the groundwater stored in these materials, is one of the largest aquifers in the United States (Irving 1993).

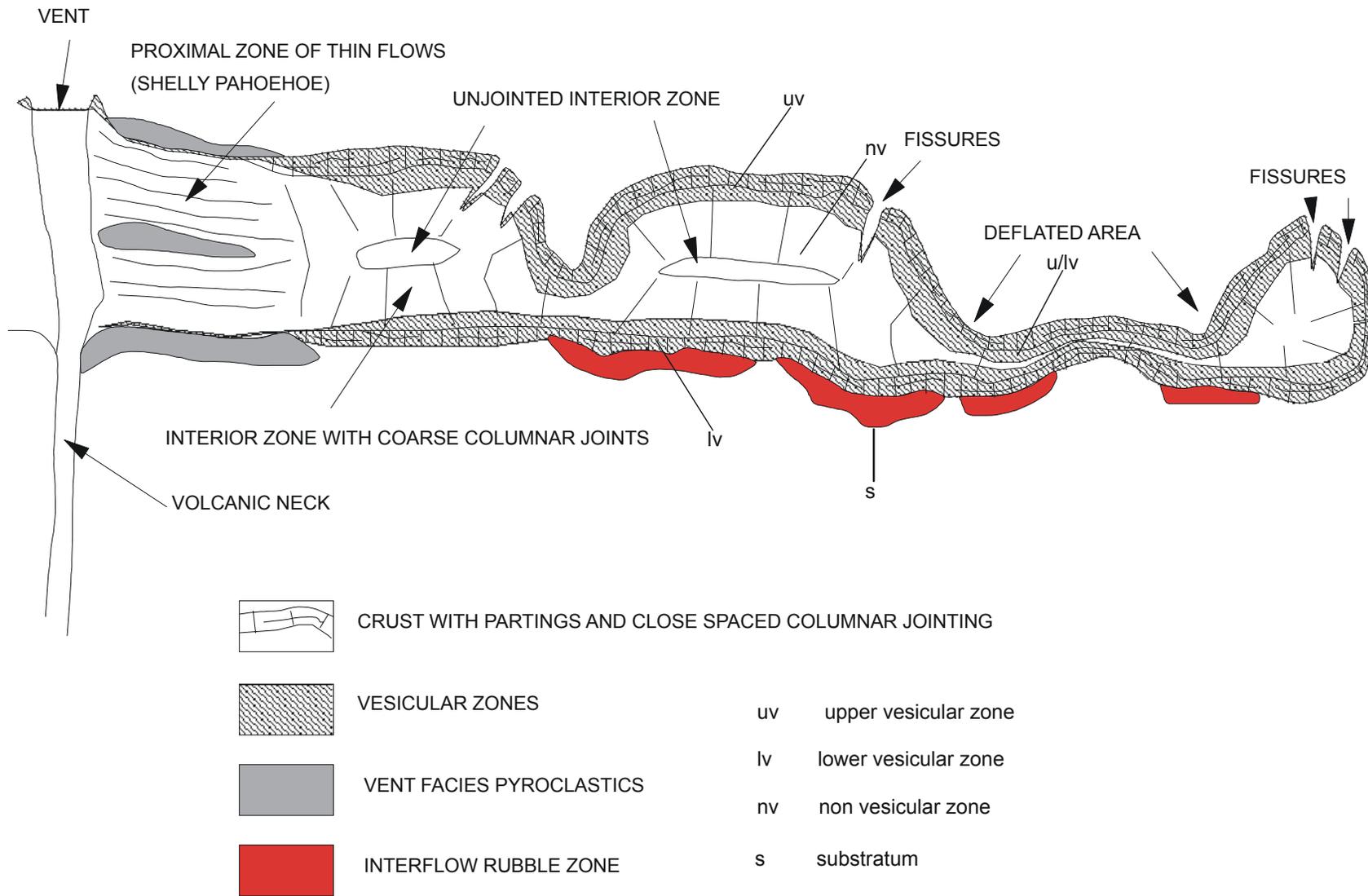


Figure 2-2. Typical vertical cross-section structure of a basalt flow in the ESRP (modified from Knutson et al. 1990).

The vadose zone is a particularly important component of the INEEL hydraulic system. First, the thick vadose zone affords protection to groundwater by acting as a filter and prevents many contaminants from reaching the SRPA. Second, the vadose zone acts as a buffer by providing storage for liquid or dissolved contaminants that have spilled on the ground, have migrated from disposal pits and ponds, or have otherwise been released to the environment. Finally, the vadose zone is important because transport of contaminants through the thick, mostly unsaturated materials can be slow if low-infiltration conditions prevail.

An extensive vadose zone exists at the INEEL and consists of surficial sediments, relatively thin basalt flows, and occasional interbedded sediments (Irving 1993). Surficial sediments include clays, silts, sands, and some gravel. Thick surficial deposits of clays and silts are found in the northern part of the INEEL, but the deposits decrease in thickness to the south, where some basalt is exposed at the topographic surface. Approximately 90% of the vadose zone comprises thick sequences of interfingering basalt flows. These sequences are characterized by large void spaces resulting from fissures, rubble zones, lava tubes, undulatory basalt-flow surfaces, and fractures. Sedimentary interbeds found in the vadose zone consist of sands, silts, and clays and are generally thin and discontinuous. Sediments may be compacted because of original deposition and subsequent overburden pressures.

Perched water at the INEEL forms when a layer of dense basalt or fine sedimentary materials occurs with a hydraulic conductivity that is low enough to restrict vertical movement of the water. Once perched water develops, lateral movement of the water can occur, perhaps by up to hundreds of yards. When perched water accumulates, the hydraulic pressure head increases, resulting in more rapid flow of water through or around the less permeable perching layer. If another low-permeability zone is encountered, perching may occur again. The process can continue, resulting in the formation of several perched water bodies between the land surface and water table. The volume of water contained in perched bodies fluctuates with the amount of recharge available from precipitation, surface water, and anthropogenic sources. Perching behavior tends to slow the downward migration of percolating fluids that may be flowing rapidly under transient, near-saturated conditions through the vadose zone. Historically, perched water has been found beneath INTEC, the Radioactive Waste Management Complex, Argonne National Laboratory–West, and the Test Reactor Area.

The SRPA is defined as the saturated portion of a series of basalt flows and interlayered pyroclastic and sedimentary materials that underlie the ESRP. The lateral boundaries of the SRPA are formed at points of contact with less permeable rocks at the margins of the plain. The total area of the SRPA is estimated at 9,600 mi². The SRPA contains numerous, relatively thin basalt flows extending to depths of 3,500 ft below ground surface (bgs). In addition, the SRPA contains sedimentary interbeds that are typically discontinuous. The SRPA has been estimated to hold 8.8E+13 ft³ of water, which is approximately equivalent to the amount of water contained in Lake Erie, or enough water to cover all of Idaho to a depth of 4 ft (Hackett, Pelton, and Brockway 1986). Water is pumped from the SRPA primarily for human consumption and irrigation (Irving 1993). Compared to such demands, the INEEL's use of less than 1% of the SRPA underflow is minor (Robertson et al. 1974).

SRPA permeability is controlled by the distribution of highly fractured basalt flow tops, interflow zones, lava tubes, fractures, vesicles, and intergranular pore spaces. The variety and degree of interconnected water-bearing zones complicate the direction of groundwater movement locally throughout the SRPA. The permeability of the SRPA varies considerably over short distances, but generally, a series of basalt flows will include several excellent water-bearing zones.

The SRPA is recharged primarily by infiltration from rain and snowfall that occur within the drainage basins surrounding the ESRP and from deep percolation of irrigation water. Annual recharge rates depend on precipitation, especially snowfall. Regional groundwater flows to the south-southwest,

but locally, the flow direction can be affected by recharge from rivers, surface water spreading areas, and heterogeneities in the SRPA. Estimates of flow velocities within the SRPA range from 5 to 20 ft/day (Irving 1993). Flow in the SRPA is primarily through fractures, interflow zones in the basalt, and the highly permeable rubble zones located at flow tops. The SRPA is considered heterogenous and anisotropic (having properties that differ, depending on the direction of measurement) because of the permeability variations that are caused by basalt irregularities, fractures, void spaces, rubble zones, and sedimentary interbeds. The heterogeneity is responsible for the variability in transmissivity (which is a measure of the ability of the aquifer to transmit water) through the SRPA. Transmissivities measured in wells on the INEEL range from 1.1E+00 to 1.2E+07 ft²/day (Wylie et al. 1995).

2.2 Tank Farm Historical Summary

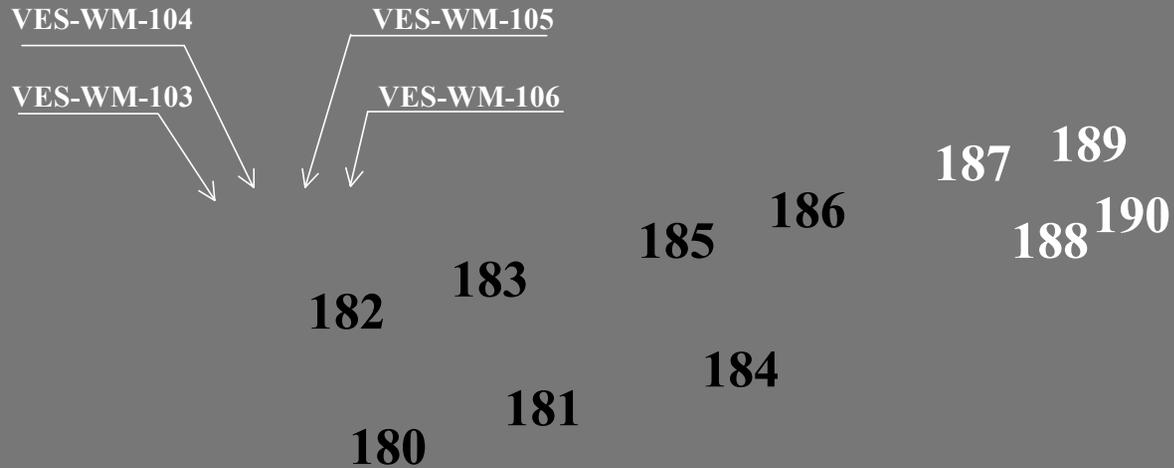
The tanks located at the tank farm were constructed from 1951 through 1964 and were used to support INTEC SNF reprocessing operations and other incidental liquid waste streams. The tanks include 11 stainless-steel tanks, WM-182 through -190 (300,000-gal) and WM-180 and -181 (318,000-gal), all referred to as 300,000-gal tanks. Each 300,000-gal tank is contained within a concrete vault. The vault base rests on basalt about 45 ft below grade. Subsection 2.4 provides a detailed physical description of the tanks and their usage over the years. In addition, four inactive 30,000-gal tanks (VES-WM-103 through -106), are situated on concrete pads, also below grade. A conceptual view of these tanks is presented in Figure 2-3.

Primarily, the tank farm handled radioactive liquid waste streams generated during SNF reprocessing. These waste streams were mostly acidic (i.e., nitric acid) (see Subsection 2.5) and were generated in the first-cycle extraction stage that operated from 1953 to 1992; in second- and third-cycle extraction stages, which operated from 1953 to 1994; and from INTEC plant operations (e.g., off-gas treatment, facility and equipment decontamination, process equipment waste [PEW] evaporation [concentrates or “bottoms”], and laboratory operations). These liquid wastes were stored and treated in the same manner; the liquid waste was accumulated and then transferred to the old Waste Calcine Facility (WCF; CPP-663) for solidification (calcining) until 1981, when the New Waste Calcine Facility (NWCF; CPP-659) began operation (Palmer et al. 1998; Wichmann, Brooks, and Heiser 1996) (see Subsection 2.2.1).

In 1977, a 20-mil-thick Dupont Polyolefin 3110 membrane was placed over the graded surface of the tank farm to prevent water infiltration from the surface. The membrane was reportedly sandwiched between two 3-in. sand layers at the time of installation. The sand-Polyolefin-sand layers were then covered with 3 in. of gravel. More recent descriptions from Track 2 reports indicate that the membrane is sandwiched between two soil layers, that is, 2 ft of soil beneath the membrane, the 20-mil-thick membrane liner, and an additional 6 in. of soil to prevent the membrane liner from blowing away.

During the mid 1970s, early 1980s, and early 1990s, the tank farm underwent facility upgrades. In 1975, the waste transfer system was upgraded with the installation of the “C” series valve boxes. The project consisted of installing new valve boxes, refurbishing older valves, rerouting waste piping to the new valve boxes, and consolidating valves within the new boxes. The new valve boxes were constructed with drain lines that were designed to drain any leaking liquids to a central location for transfer to the PEW evaporator. Radiation monitors and an enhanced liquid-level monitoring system were also installed in the tank farm during this upgrade. A radiation-monitoring system was installed to detect leaks within valve boxes or other enclosed areas. Liquid-level monitors were installed in each tank to increase the sensitivity (± 200 gal) of tank volumetric changes.

INTEC TANK FARM CLOSURE



Tank Farm Facility

- Octagon Vaults: WM-180, WM-181
- Pillar and Panel Vaults: WM-182, WM-183, WM-184, *WM-185, WM-186
- Square Vaults: WM-187, WM-188, WM-189, WM-190

* WM-185 may be used as an emergency spare tank until closure or until sufficient tank volume is available for emergency use.

GV99 0008

Figure 2-3. Conceptual view of the tank farm looking northeast.

During 1982 and 1983, the Fuel Processing Facility Upgrade Project was undertaken to construct a concrete vault to house waste tanks VES-WL-132 and VES-WL-133 east of the PEW system (see Figure 2-4). The project also provided upgrades to various valve boxes. Excavation was to bedrock (approximately 40 to 45 ft) that completely encompassed the CPP-33 release site and appears to have included the northern edge of the CPP-27 release site (see Figure 1-2). Review of site construction photos indicates that the excavation closely adhered to the excavation plan (INTEC Drawing 162316).

The High Level Waste Tank Farm Upgrade Project began in 1992 and replaced valves in valve boxes with new valves that could be repaired remotely using extension tools, thus reducing worker radiation exposure. The carbon-steel pressure relief discharge header connecting each tank farm tank to the exhaust stack was also replaced due to corrosion holes in the header. The header was disconnected from each tank condenser pit, capped, and abandoned in place. A new stainless-steel pressure-relief discharge line was connected from each tank condenser pit to a new header pipe leading to the atmospheric protection “vent tunnel” ventilation system. As part of this upgrade project, remaining pipelines with inadequate secondary containment were replaced (capped and abandoned in place), and other unnecessary piping was eliminated as needed.

In April 1992, the DOE called for the shutdown of SNF reprocessing facilities at INTEC. Since that time, no more liquid waste from SNF reprocessing has been generated, although decontamination and incidental activities have created additional liquid waste.

In addition, under the terms of a 1992 consent order (DOE-ID 1992) and subsequent modifications discussed in Section 1, NE-ID was required to either permanently stop using the tanks or bring them into compliance with secondary containment requirements. NE-ID decided not bring them into compliance and to close the eleven 300,000-gal and the four 30,000-gal underground tanks within the tank farm by 2012. This decision was made because (1) reprocessing had been terminated, (2) the tanks could not be certified to meet RCRA secondary containment requirements,^a and (3) the high-radiation fields within the tank farm greatly impede the ability to bring the tanks into compliance. The tanks have never leaked, and their estimated remaining life (970 years) far exceeds their remaining use (Palmer et al. 1998) (see Subsection 2.3).

The 1995 *Settlement Agreement* (DOE 1995) required all of the tank farm’s non-SBW^b to be calcined by June 30, 1998 (which was completed by February 1998) and all of the tank farm’s SBW^c to be treated by December 31, 2012. However, because the calciner system in the NWCF building (CPP-569) is undergoing HWMA/RCRA closure, the remaining SBW at the tank farm has no identified treatment (see Figure 2-5). The SBW treatment or series of treatments will be selected and implemented based on the HLW&FD FEIS (DOE-ID 2002a) ROD.

a. The concrete vaults containing the 300,000-gal tanks have no access; therefore, they cannot be readily inspected to certify either compliance with RCRA secondary containment requirements or current seismic standards.

b. Non-SBW is high-level radioactive waste. At INTEC, this waste is defined as first-cycle extraction raffinates, which are from spent fuel is reprocessing.

c. SBW is second- and third-cycle extraction raffinates and other liquid waste generated from INTEC plant operations (e.g., off-gas treatment, facility and equipment decontamination, PEW evaporator concentrates [“bottoms”], and laboratory operations).

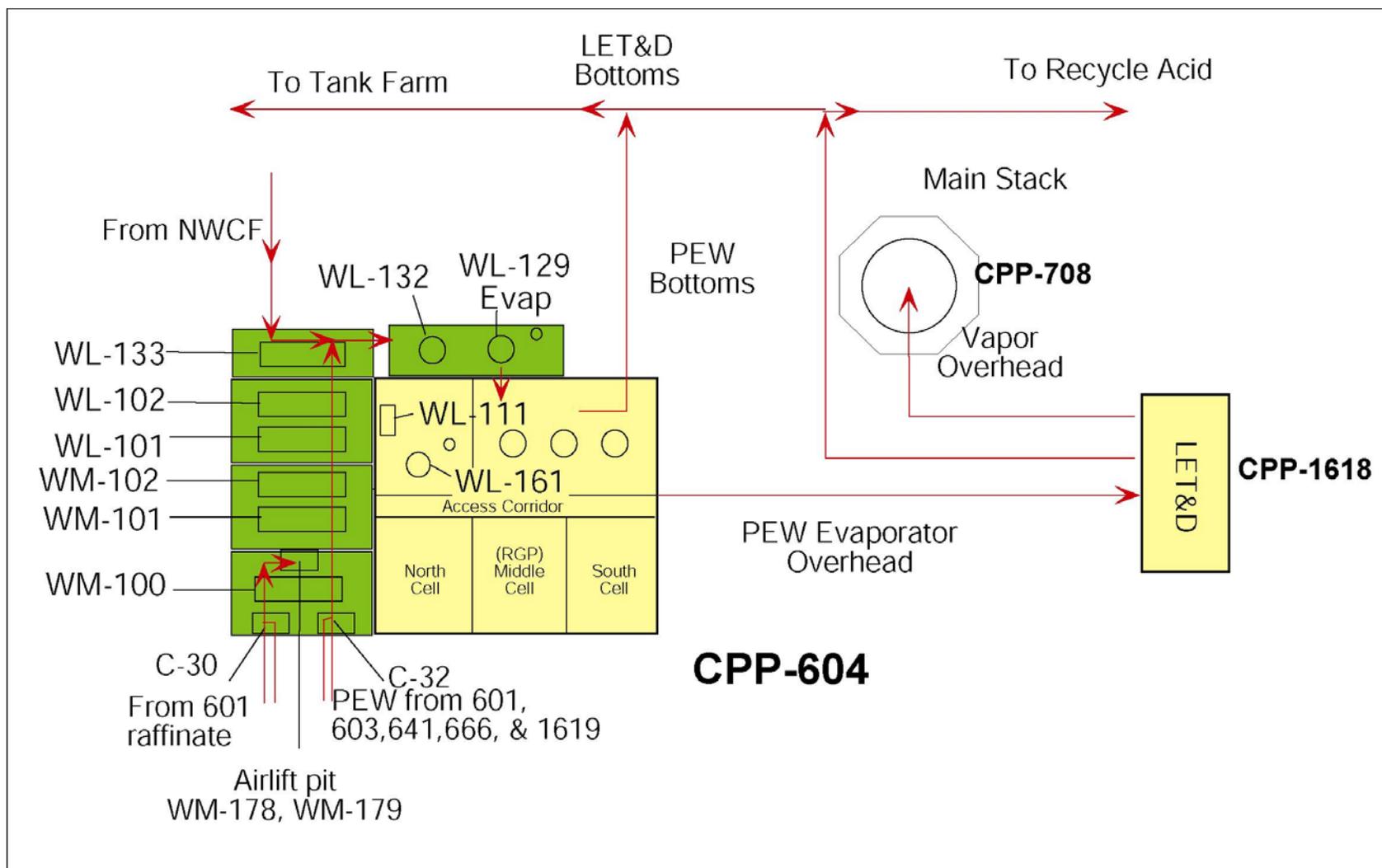
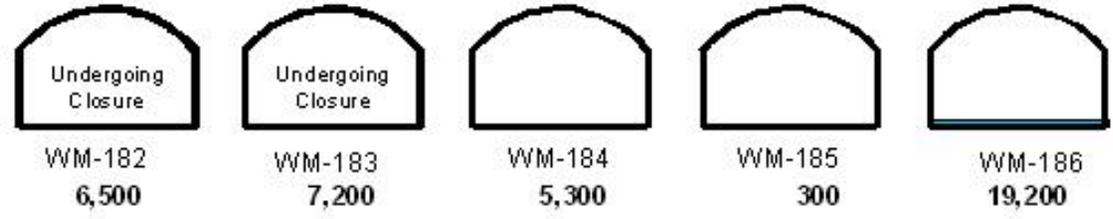


Figure 2-4. Schematic showing the PEW system looking east.

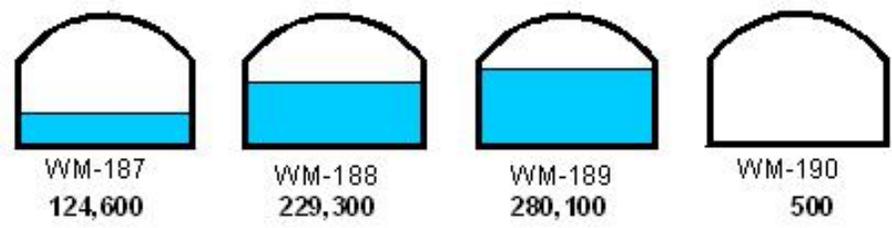
Tank Farm Volumes

(gallons, as of September 30, 2003)

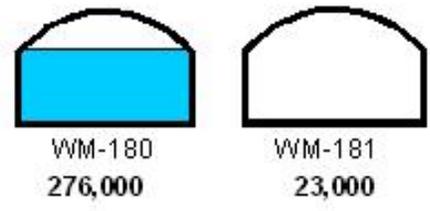
Pillar and Panel



Square Vaults



Octagon Vaults



**Total Liquid in 300,000-gallon Tank Farm Tanks:
972,000 gallons**

Idaho Completion Project

Bechtel BWXT Idaho, LLC

Figure 2-5. September 2003 tank farm waste tank volumes (300,000-gal tanks) (BBWI 2003).

2.2.1 Liquid Waste Calcination

From 1963 until June 2000, liquid waste stored at the tank farm was converted to granular solids using a process known as calcination. The liquid in the radioactive waste (primarily nitric acid) was evaporated, and the dissolved metals and fission products were converted to metal salts and oxides. Each granule is about 0.3 to 0.7 mm in size. The SBW required special handling in order to be calcined; it was concentrated in the liquid waste evaporator or blended with other liquid waste. This was done to (1) prevent the high sodium from forming alkali compounds that would melt and cause the calciner's fluidized bed to agglomerate and (2) prevent high levels of potassium and manganese that would clog the calciner (Palmer et al. 1998; Wichmann, Brooks, and Heiser 1996; WINCO 1986a). The solids were then transferred to stainless-steel bins collectively called the Calcined Solids Storage Facility (CSSF) for interim storage. Calcination typically reduced the volume of non-SBW by two to 10 times^d and reduced the volume of SBW by two to four times. The WCF operated from 1963 until 1981 calcining the liquid waste stored at the tank farm. Closure of the WCF began in 1998 and was completed in 1999. From September 1982 until June 2000, the calcination was performed at the NWCF. The calciner system in the NWCF building (CPP-659) is currently undergoing HWMA/RCRA closure. The liquid SBW will remain in the tanks at the tank farm until a treatment technology is selected and implemented based on the HLW & FD FEIS (DOE-ID 2002a) ROD.

2.2.2 Process Equipment Waste

At one time, three 18,000-gal PEW tanks (WM-100 through -102, as shown on Figure 2-4) located within the Waste Treatment Building (CPP-604) and the associated valve boxes, encasements, and piping (LMITCO 1998, 1999b) were considered part of the tank farm system. These three tanks are no longer considered part of the tank farm system. NE-ID anticipates that the PEW system will continue operating to support INTEC after the tank farm is closed. Waste solutions from NWCF calciner closure activities will be sent to the PEW system. However, once the tank farm is closed, the PEW and the concentrates (i.e., "bottoms") from the Liquid Effluent Treatment and Disposal Facility (CPP-1618) will not be returned to the tank farm. Instead, another storage/treatment facility is anticipated to be available. The three PEW tanks, along with five support tanks (WL-101, -102, -132, -133, and a new tank, WL-111) (Figure 2-4), are being permitted as part of the PEW system (LMITCO 1999b). The PEW system will be closed under RCRA when the system is no longer useful or reaches the end of its life cycle.

2.3 Current Mission of INTEC and the Tank Farm

The current NE-ID mission for INTEC includes management and storage of SNF, treatment and storage of HLW (solidified), liquid radioactive waste (SBW), and newly generated liquid (low-level) waste (NGLW).

The tank farm provides interim storage for past and present SBW. The SBW includes (1) second- and third-cycle raffinates generated during former INTEC SNF operations and (2) decontamination waste streams from INTEC operations (e.g., laboratories, the fuel basins, and plant closure activities). SBW from past operations is stored in the 300,000-gal tanks with the NGLW. Currently, SBW and NGLW waste streams are not segregated. The NGLW (10 CFR 61.55) includes INTEC waste streams from the fuel storage basins, water runoff, evaporation and off-gas cleanup operations, analytical laboratories, and equipment decontamination. As long as INTEC is in operation, newly generated liquid SBW will be generated by ongoing processes such as decontamination and off-gas cleanup.

d. Interdepartmental correspondence from W. B. Palmer to J. T. Beck, "Removing HLW from the Tank Farm," WBP-07-98, Lockheed Martin Idaho Technologies Company, December 11, 1998.

The total volume of SBW in storage at the tank farm at any given time is dependent on the quantity and type of work done at INTEC. The SBW is sent either directly to the SBW tanks or is sent through the PEW evaporator first and then to the tanks. Reduction of the liquid waste volume is accomplished through continued evaporation with the PEW evaporator. Figure 2-5 illustrates (in blue) recent SBW and heel volumes for the tank farm.

2.3.1 Closure of the Tank Farm System

The tank farm systems are being closed in accordance with a 1992 consent order (DOE-ID 1992) and the second modification to the consent order (DOE-ID 1998a). The closure will follow the HWMA/RCRA closure performance standards identified in IDEQ-approved HWMA/RCRA closure plans. These closure plans recognize that the contaminated soils in the tank farm are undergoing investigation by the CERCLA program, and the plans will not duplicate the efforts of the CERCLA investigation and any follow-on remediation actions for the contaminated soils. The closure plans must also meet the requirements of DOE O 435.1, "Radioactive Waste Management" (see Section 1 for regulatory discussion on tank closure).

The strategy that NE-ID provided to IDEQ identified the general approach for closure of the tank farm system. The planned approach begins with removing the waste (heel) from the tanks and ancillary system, decontaminating the system components, and sampling the decontamination residuals. The sample data from the decontamination rinsate will be compared to site-specific action levels.

When all of the tanks are decontaminated (tank and ancillaries), final tank farm facility closure and closure certification will occur. The tank farm facility will be closed as an HWMA/RCRA interim status unit (IDAPA 58.01.05.009 [40 CFR 265]), and the closed tank system will be evaluated in accordance with the OU 3-13 ROD and the Agency-approved OU 3-13 Group 2 – Soils under Buildings and Structures Closure Evaluation Criteria and Checklist. The closed system will then be added to OU 3-14. Upon meeting the performance criteria for waste removal and system decontamination, documentation will be provided to IDEQ certifying the performance of partial closure.

Phase I of the tank farm closure began in 2001 with pillar and panel vaulted tanks WM-182 and -183 (DOE-ID 2001a). In 2003, Phase II closure of pillar and panel vaulted tanks WM-184, -185, and -186 began (DOE-ID 2003b). The waste (heel) has been removed from tanks WM-182, -183, -185, and -186. The performance assessment (DOE-ID 2003c) and the composite analysis (DOE-ID 2002b) calculated risk values assuming the residual tank heel after cleaning would be 1 in. or less. Experience has shown the residual tank heel remaining after cleaning to be no more than 0.25 in.^e This equates to an estimated 2,500 gal of heel for all of the 300,000-gal tanks. Figure 2-5 shows September 2003 volumes of liquid SBW and heels remaining in the tanks.

Preliminary sample results indicate tanks WM-182 and -183 have been cleaned successfully and meet the performance criteria.^f The ancillary system and system components are currently being cleaned. Phase I will include isolating the closed system to eliminate any future inflow to the tanks, ancillary equipment, or secondary containment. The approved closure plan for WM-182 and -183 (DOE-ID 2001a) calls for using grout to isolate systems and fill void spaces. However, grouting was suspended with the court's ruling in *Natural Resources Defense Council vs. Abrahams*. Per the closure plan (DOE-ID 2001a), Phase I will not be completed until the tanks are grouted. In the interim, Phase II closure of pillar and

e. Personal communication between C. Klassy, MSE Technology Applications, Inc., and K. Quigley, Bechtel BWXT Idaho, LLC, November 18, 2003.

f. Preliminary sample results for WM-182 and -183 will be reported in a data quality assessment report for each tank. Comparison of the sample results with the performance criteria will be documented in the Tier 2 closure plan for Phase I.

panel vaulted tanks WM-184, -185, and -186 (DOE-ID 2003b) continues. It is anticipated that these tanks will be cleaned by the end of December 2003.

Information pertaining to tank closure can be found in the following documents:

- *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, DOE/ID-10802, November 2001.
- *Tier 1 Closure Plan for Idaho Nuclear Technology and Engineering Center Tank Farm Facility at INEEL (Draft)*, DOE/ID-10975, March 2002.
- *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-184, WM-185, and WM-186 (Draft)*, DOE/ID-11067, April 2003.

Two issues must be resolved before complete closure of the tank farm can be accomplished. The first issue is the reclassification of SBW/tank heels as waste incidental to reprocessing (WIR). A WIR determination was issued in October 2002 on the SBW/tank heels, and it was ruled invalid by the court in *Natural Resources Defense Council vs. Abrahams* in July 2003. The court ruled that the WIR evaluation process in DOE O 435.1 was invalid. NE-ID is currently considering its options on how to proceed. The second issue is the selection of a technology to treat the remaining liquid radioactive waste (SBW) stored in the tank farm. At this time, the treatment is undecided and remains under review. Until a decision is made and a treatment facility is built and operational, the remaining tanks containing liquid SBW (see Figure 2-5) cannot be cleaned. The second issue is discussed in Subsection 1.2.

2.3.2 Tank Farm Soil Remedial Investigation

The rationale for this tank farm soil remedial investigation work plan and the RI/FS study tasks are presented in Sections 5 and 6, respectively.

2.4 Physical Description of Tanks

The design characteristics and specific past use of the individual underground storage tanks at the tank farm are presented in this subsection. The tanks include:

- Eleven active tanks with a capacity of about 300,000 gal each. The tanks include nine 300,000-gal tanks (WM-182 through -190) and two 318,000-gal tanks (WM-180 and -181). These 11 tanks are referred to collectively as the 300,000-gal tanks.
- Four inactive tanks with a capacity of 31,000 gal each (VES-WM-103 through -106). As shown in Figure 2-4, the four tanks are located north of WM-182. These four tanks are referred to collectively as the 30,000-gal tanks.

2.4.1 300,000-gal Tank Design

The 300,000-gal tanks are similar in design. Each has a diameter of 50 ft, has an overall height of 30 to 32 ft, and is contained in an unlined underground concrete vault. The vault floors are about 45 ft below grade. The three basic designs of the vaults are described below:

- Monolithic octagon. The two oldest tanks at the tank farm (WM-180 and -181) were constructed from 1950 to 1953 and are contained in poured-in-place, monolithic, octagonal, concrete vaults. A photograph of the vault for WM-180 is provided in Figure 2-6.

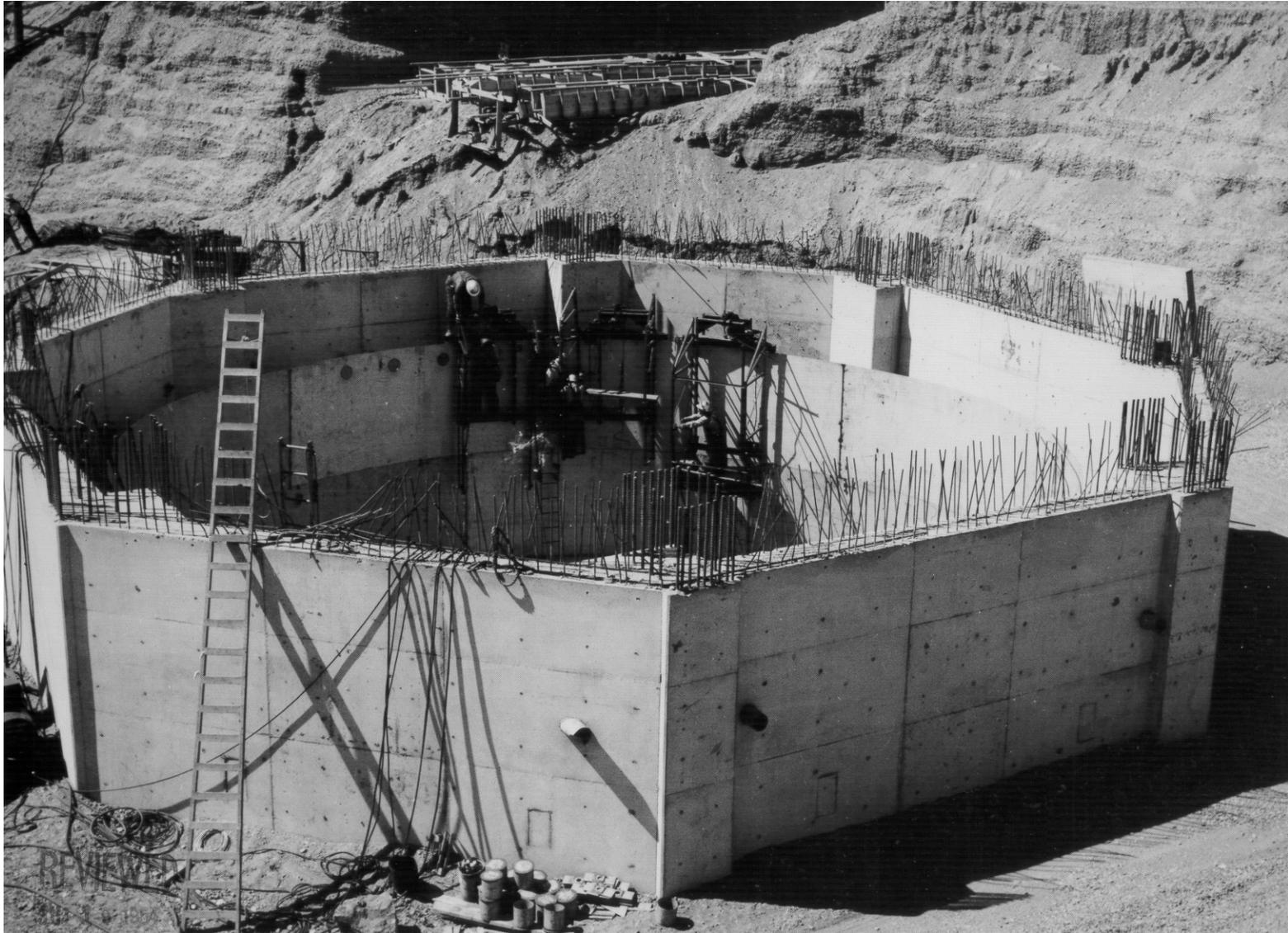


Figure 2-6. Monolithic octagonal vault for WM-180.

- Pillar and panel octagon. The five tanks contained in vaults of pillar and panel construction, WM-182 through -186, were constructed from 1953 to 1957. A photograph of the vault for tank WM-182 is provided in Figure 2-7. A photograph of the vault and dome of tank WM-185, showing the pre-cast concrete beams and concrete risers on top, is provided in Figure 2-8. Also octagonal, the pillar and panel vaults are of prefabricated construction. The pillar and panel design is considered the least structurally sound of the three basic designs, and, therefore, tanks with this design must be closed first, with the exception of tank WM-185, which has been designated as an emergency spare.
- Monolithic square. The four tanks contained in reinforced, poured-in-place, monolithic-square, four-sectioned (or “four-pack”), concrete vaults (WM-187 through -190) were constructed from 1959 to 1965 (see Figure 2-9).

2.4.2 Composition, Past Usage, and Closure Status

The non-SBW inventory that was in the 300,000-gal tanks in 1998 was sampled, and the general chemical and radionuclide compositions were determined (Palmer et al. 1998). Only WM-182, -183, and -188 were sampled for RCRA characteristics at that time. The non-SBW was typically 1 to 3 M nitric acid-containing fission products, transuranic (TRU; beyond uranium on the periodic table) elements, and metals such as mercury and cadmium. The maximum radioactive concentration in the 300,000-gal tanks was in the range of 10 to 20 Ci/L. Concentrations of chemicals and radionuclides measured in 1988 in each of the 300,000-gal tanks are provided in Tables 2-1 and 2-2. The makeup and volumes of the tanks have changed since 1998 (see Figure 2-5 and Subsection 2.3).

In March 2001, a composite summary of the chemical and radionuclide inventory for each 300,000-gal tank was prepared (see Table 22, *Tank Farm Facility, Tank and Waste Data*, EDF-1598, Rev. 0) to produce the best estimate of the current composition. The composite summary for the entire tank farm was developed from the averages of individual tank analyses. For detailed information on the composite summary see EDF-1598. Radionuclides of interest are summarized in Table 2-3.

Each 300,000-gal tank has a different waste storage history that has impacted or may impact the removal of the remaining waste. A brief summary of each tank compiled from information contained in Palmer (footnote d) and Palmer et al. (1998) is provided below:

- WM-180 was put in service in 1954 and stored non-SBW from reprocessing aluminum-clad SNF. The non-SBW in the tank was calcined in 1966 and 1967. The tank has been used only for storing SBW waste since 1972. WM-180 and -181 are the two oldest tanks at the tank farm.
- WM-181 became operational in 1953 and was used as a service waste diversion tank until 1975. Since then, the tank has been used to store SBW. This tank has never been used to store first-cycle raffinate liquid waste (non-SBW).
- WM-182 became operational in 1956 to store non-SBW from reprocessing aluminum- and zirconium-clad SNF. The non-SBW heel of this tank was evaluated for RCRA constituents in late 1999. This tank and ancillary equipment are undergoing HWMA/RCRA closure. In September 2002, the final rinse of the tank was performed. The heel was sampled, and the residual contamination levels were verified to meet the performance criteria.



Figure 2-7. Pillar and panel octagonal vault for WM-182.



Figure 2-8. Vault and dome of WM-185, with the concrete beams and concrete risers on top.



Figure 2-9. Monolithic square vault for WM-190 (forefront) and WM-189.

Table 2-1. The 1998 estimated chemical properties and concentrations in 300,000-gal tanks (from Palmer et al. 1998).

Analyte or Constituent	Unit	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Density	g/mL	1.28	1.16	1.23	1.24	1.27	1.28	1.18	1.16	1.32	1.31	NR ^a
Acid [H ⁺]	M	1.20	1.89	0.85	2.03	0.45	1.61	1.57	1.98	2.79	2.62	0.02
Nitrate	g/L	298.65	239.98	264.16	342.30	301.99	328.03	190.99	208.97	3.82	401.20	1.24
Aluminum	g/L	17.81	6.21	33.99	17.54	22.93	19.43	9.98	14.57	23.47	28.06	NR
Boron	g/L	0.12	0.17	0.10	0.15	0.08	0.19	0.23	0.14	0.42	0.29	NR
Cadmium	g/L	0.09	0.62	0.023	0.17	0.02	0.22	0.20	0.58	1.07	0.67	NR
Calcium	g/L	1.44	1.84	NR	1.76	0.48	2.85	2.65	1.72	6.25	3.85	NR
Chloride	g/L	1.16	0.57	0.037	0.41	1.61	1.12	0.75	0.08	0.55	0.78	0.01
Chromium	g/L	0.21	0.16	0.05	0.88	0.10	0.26	NR	0.10	0.68	0.31	NR
Fluoride	g/L	0.08	1.79	1.60	1.06	0.80	3.19	0.80	4.41	6.04	6.65	0.13
Iron	g/L	1.06	0.73	1.17	3.41	1.17	1.23	1.06	1.12	3.13	1.95	NR
Lead	g/L	0.31	0.23	NR	0.33	0.25	0.21	NR	NR	0.25	NR	NR
Manganese	g/L	NR	0.77	NR	0.77	0.49	1.10	NR	NR	NR	NR	NR
Mercury	g/L	0.21	0.10	NR	0.56	0.32	0.82	NR	0.16	1.56	0.72	NR
Molybdenum	g/L	NR	0.05	NR	0.07	0.05	0.05	NR	NR	NR	NR	NR
Nickel	g/L	0.10	0.08	NR	0.43	0.08	0.09	NR	NR	0.33	NR	NR
Phosphate	g/L	NR	0.57	NR	NR	2.37	0.28	NR	NR	0.04	NR	NR
Potassium	g/L	7.43	5.87	0.12	3.91	5.47	7.82	6.65	0.78	5.87	5.87	NR
Sodium	g/L	48.51	21.84	0.46	18.62	48.51	33.80	23.22	4.14	17.93	26.21	NR
Sulfate	g/L	3.27	2.40	2.79	6.63	7.20	4.32	3.36	1.06	3.55	2.98	NR
Zirconium	g/L	<0.11	0.46	1.00	<0.15	NR	0.91	NR	2.19	2.46	2.92	NR

a. NR means not reported.

Table 2-2. The 1998 estimated radionuclide concentrations (Ci/L) in 300,000-gal tanks (Palmer et al. 1998).

Radionuclide	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Am-241	5.59E-04	2.08E-04	5.02E-04	7.48E-04	2.20E-04	5.59E-04	2.10E-04	4.58E-04	1.42E-03	9.14E-04	NR ^a
Ce-144	NR	1.80E-06	2.01E-05	9.26E-07	NR	1.81E-06	1.11E-06	NR	NR	NR	4.52E-11
Co-60	NR	2.61E-04	1.22E-04	1.45E-04	NR	3.79E-05	5.02E-05	4.59E-05	3.52E-04	1.10E-04	NR
Cs-134	9.03E-04	2.33E-04	2.22E-03	3.43E-04	1.66E-06	1.16E-04	1.16E-04	1.72E-04	1.23E-03	5.40E-04	9.80E-07
Cs-137	2.85E-02	2.94E-02	5.67E-01	2.28E-01	2.02E-02	1.08E-01	3.25E-02	7.40E-02	3.74E-01	1.61E-01	1.06E-02
Eu-154	5.59E-05	2.99E-04	4.44E-03	9.26E-04	NR	2.48E-04	1.38E-04	3.66E-04	1.83E-03	7.30E-04	2.94E-05
Eu-155	NR	9.49E-05	1.14E-03	4.29E-04	NR	NR	NR	1.04E-04	6.36E-04	1.30E-04	4.08E-06
H-3	2.35E-05	2.11E-05	7.76E-04	4.82E-04	NR	3.58E-05	NR	NR	NR	NR	NR
I-129	<1.4E-08	<3.3E-07	NR	<1.2E-05	5.72E-06	<3.9E-05	NR	NR	NR	NR	NR
Ni-63	2.67E-05	6.22E-05	NR								
Np-237	4.34E-07	1.93E-07	2.16E-06	7.72E-07	4.60E-07	1.44E-05	2.90E-07	5.67E-07	1.61E-06	1.11E-05	NR
Pu-238	3.47E-04	6.15E-04	2.57E-03	6.59E-04	6.59E-04	8.39E-04	2.32E-04	1.99E-03	3.77E-03	2.82E-03	NR
Pu-239	5.65E-05	1.30E-05	2.85E-04	2.40E-04	8.30E-05	7.52E-05	3.99E-05	1.04E-05	2.39E-0	6.62E-05	NR
Pu-240	1.69E-05	3.65E-06	1.64E-05	1.88E-05	3.40E-05	2.05E-05	9.86E-06	2.34E-06	2.11E-05	1.75E-05	NR
Pu-241	3.18E-04	2.75E-04	6.10E-04	5.61E-04	4.47E-04	9.08E-04	1.75E-04	8.69E-04	1.90E-03	1.63E-03	NR
Pu-242	1.27E-08	8.63E-09	1.94E-08	5.53E-08	1.00E-08	2.44E-08	4.17E-09	5.93E-09	6.05E-08	2.43E-08	NR
Ru-106	NR	5.58E-06	2.81E-05	NR	NR	1.67E-06	2.12E-06	NR	NR	NR	NR
Sb-125	NR	8.96E-05	NR	NR	NR	NR	3.09E-05	NR	NR	NR	NR
Sr-90	2.30E-02	2.82E-02	5.51E-01	1.75E-01	1.56E-02	9.59E-02	3.03E-02	NR	2.84E-01	NR	NR
Tc-99	NR										
U-234	5.61E-07	8.53E-07	1.98E-06	6.28E-07	8.23E-07	1.31E-06	9.77E-07	3.16E-08	6.39E-07	9.85E-07	NR
U-235	1.54E-08	2.14E-08	5.73E-08	2.65E-08	2.26E-08	2.74E-08	2.27E-08	7.11E-10	2.59E-08	2.07E-08	NR
U-236	7.36E-09	7.56E-08	2.13E-07	2.57E-08	1.43E-08	6.09E-08	5.85E-08	3.18E-09	2.97E-08	4.77E-08	NR
U-238	9.37E-09	2.11E-08	1.08E-09	3.00E-08	9.16E-09	2.47E-08	5.15E-08	2.08E-12	2.77E-08	1.80E-08	NR

a. NR means not reported.

Table 2-3. March 2001 radionuclides of interest from composite summary of tank farm tanks.

Element (species)	Tank Farm Average (Ci/L)
U-235	1.5E-08
U-238	1.2E-08
Np-237	2.1E-06
Am-241	5.6E-05
Sr-90	3.6E-02
Tc-99	7.9E-06
Cs-134	2.3E-05
Cs-137	4.1E-02
Eu-154	1.7E-04
Eu-155	1.4E-04
Co-60	5.0E-05
Ni-63	3.5E-05
I-129	9.9E-09 ^a ; 1.6E-07 ^a
C-14	8.4E-07

a. This is the lowest and the highest individual tank average. A composite average for I-129 could not be determined, because there was no average I-129 value for each tank.

- WM-183 became operational in 1958 and was originally used to store non-SBW from reprocessing aluminum- and stainless-steel-clad SNF, high-fluoride decontamination solutions, and the PEW evaporator and evaporator bottoms from the WCF. The radioactive non-SBW was transferred from the tank in 1981, after which the tank was filled with SBW. The heel of this tank was evaluated for RCRA constituents in January 2000. Of all the tanks, WM-183 has contained the greatest variety of waste. This tank and ancillary equipment are undergoing HWMA/RCRA closure. In 2003, the final rinse of the tank was performed. The heel was sampled and the residual contamination levels verified.
- WM-184 became operational in 1958 and has contained only SBW composed of PEW evaporator bottoms. It has never contained first-cycle raffinate HLW (non-SBW). The HWMA/RCRA closure of this tank is being initiated.
- WM-185 became operational in 1959 and has stored non-SBW from aluminum and zirconium fuel reprocessing as well as high-fluoride decontamination waste and PEW evaporator bottoms. After it is emptied, the tank is expected to be used as a spare tank for emergency waste storage (LMITCO 1998; DOE-ID 1998a). The HWMA/RCRA closure of this tank is being initiated.
- WM-186 was put into service in 1962 and contained non-SBW from reprocessing aluminum-clad SNF until 1967, when the waste was transferred out of the tank. The HWMA/RCRA closure of this tank is being initiated.
- WM-187 was put into service in 1959 and stored non-SBW from reprocessing of aluminum- and zirconium-clad SNF, high-fluoride decontamination waste, and PEW evaporator bottoms.
- WM-188 became operational in 1963 and has contained non-SBW from zirconium fuel reprocessing as well as high-fluoride decontamination waste and PEW evaporator bottoms. The heel of this tank was sampled for RCRA constituents in 1999. This tank now contains SBW.

- WM-189 became operational in 1964 and contained non-SBW from reprocessing zirconium-clad SNF and waste from decontamination and bed dissolutions at the WCF and NWCF until 1996. This tank now contains SBW.
- WM-190 was never placed in service after it was constructed in 1964, but it was retained as the designated spare tank for use in emergencies. It contains about 500 gal of liquid waste (see Figure 2-5) remaining from approximately 7,000 gal of accumulated meteoric (i.e., rainwater and snowmelt) vault sump water and liquid waste that leaked through closed valves and collected in the tank over time. The meteoric waste was pumped from the tank in 1982 using a sump pump that emptied the tank as much as possible without personnel entry, leaving the 500-gal heel.

A summary of the fuel processed and tank usage history is provided in Table 2-4.

2.4.3 30,000-gal Tanks

The four inactive 30,000-gal tanks (VES-WM-103 through -106) were constructed in 1954 and are stainless-steel belowground tanks on reinforced-concrete pads. Unlike the 300,000-gal tanks, the 30,000-gal tanks have no vaults. These tanks were normally empty, because they have no containment vaults. From 1957 to 1965, these tanks were used to temporarily store specific processing waste, such as zirconium and stainless-steel waste from the CPP-601 E cell, until compatibility of the waste with that in the 300,000-gal tanks was determined. Then the waste was transferred to one of the 300,000-gal tanks.

The tanks are about 11.5 ft in diameter, about 38 ft long, and covered with compacted gravel. The 30,000-gal tanks were emptied to their heels and taken out of service in 1983. Raw water was added to the tanks in 1990 to provide enough solution to sample for RCRA characteristics and radionuclides. The tanks were tested for pH, metals, and organic compounds. The pH results ranged from 3.4 to 7.9 (WINCO 1990a, 1990b, 1990c, 1990d), the RCRA characteristics were determined to be nonhazardous,^g and the radiation readings ranged from 6 to 35 mrem/hr.^{h,i} The tanks were then emptied to their heels, and the contents were used to flush lines from the tank farm to the PEW in CPP-604. These tanks are scheduled for closure with accordance with RCRA standards.

2.4.4 Tank Farm Piping and Secondary Containment

The primary piping for transferring waste at the tank farm was constructed with stainless steel to withstand the corrosive nature of the waste. Four principal types of secondary containment (encasement) surrounding the primary piping were used historically. The four types of encasement were as follows:

1. Split-clay tile
2. Split steel
3. Stainless-steel-lined concrete troughs
4. Stainless-steel pipe within a pipe.

g. Interdepartmental correspondence from A. J. Matule to D. C. Machovec, "Solids Sampling of WM-103 through -106," AJM-20-90, Westinghouse Idaho Nuclear Company, Inc., September 26, 1990.

h. Interdepartmental correspondence from D. C. Machovec to A. J. Matule, "WM-103/106 Solids Sample," DCM-08-90, Westinghouse Idaho Nuclear Company, Inc., August 28, 1990.

i. Interdepartmental e-mail from D. C. Machovec to P. A. Tucker, "Results of Sampling of the 30,000-gal Tanks," Lockheed Martin Idaho Technologies Company, April 26, 1999.

Table 2-4. Types of fuel dissolution performed at INTEC (based on Wagner 1999).

Dissolution	Process Description	Facility	Campaign Dates	Comments
Aluminum (batch)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Hexone was used as the uranium solvent for first-, second-, and third-cycle extraction.	CPP-601	1953–71	The equipment was removed in 1984.
Aluminum (continuous)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Tributyl phosphate (TBP) was used as the solvent for first-cycle extraction, and hexone was used for second and third cycles.	CPP-601	1957–86	Startup operations were in progress when reprocessing was terminated.
Zirconium	Zirconium-based fuels were dissolved in hydrofluoric acid. TBP was used for first-cycle extraction, and hexone was used for second and third cycles.	CPP-601	1957–81	The system was refurbished in 1986 but not used. To reduce the waste volume, the aluminum and zirconium dissolution processes were run together to eliminate the step of adding cold aluminum nitrate to complex fluoride.
Fluorinel (Fluorinel Dissolution Process [FDP])	Newer types of zirconium-based fuels were dissolved in hydrofluoric acid.	CPP-666	1986–88	Before the termination of reprocessing, FDP was intended to be the major method of dissolution at INTEC. Cadmium nitrate was used as a nuclear poison to prevent criticality.
Stainless Steel (Submarine Intermediate Reactor)	Stainless-steel fuels were dissolved in sulphuric and nitric acid.	CPP-601	1959–65	None.
Stainless Steel (Electrical Dissolution Process)	Stainless-steel fuels were dissolved in nitric acid while a direct electrical current passed through fuel.	CPP-640	1973–81	The run was terminated because of equipment failure.
ROVER	Graphite fuels were first burned in oxygen to reduce the graphite. The uranium materials were dissolved in hydrofluoric acid.	CPP-640	1965–84	Uranium-bearing material recovery was completed at the facility in 1998.
Custom	Other fuels, such as cermet-type, were dissolved in specially designed equipment.	CPP-627	1965–91	The final run was terminated because of equipment damage.

Each encasement type is described below in further detail as well as where and when the style of piping was used and the configuration's strengths and weaknesses. Valve box construction was designed to accept any liquid waste that leaked into the encasement system and direct the waste to a nearby tank sump for collection via valve box drain lines.

2.4.4.1 Split-Clay Tile Encasement. As a part of the original INTEC liquid waste system installed between 1951 and 1952, stainless-steel lines using split-clay tile encasement were installed to transfer waste solutions. Waste solutions generated in the CPP-601 Process Building were transferred through five, 3-in., stainless-steel pipelines to the tanks in the CPP-604 vault (PY-2401Y, PU-2297Y, WB-1009C, WD-1004C, and WC-1019C, all of which are abandoned). Each line was supported inside separate 6-in. split-tile encasements, which were enclosed in a concrete envelope, as shown in Figure 2-10. Concrete sampling boxes were provided at 50-ft intervals along the encasements for leak detection. Each of the pipes and the encasement was sloped and terminated in a sampling box located near the ceiling inside the CPP-604 tank room. Any leakage from the pipelines was designed to flow through the tile encasements to the respective sample box for sampling. Overflow lines from the sample boxes directed flow to the level-alarmed collection sumps in the tank room cells. No leaks were detected between 1951 and 1974 in the five lines.

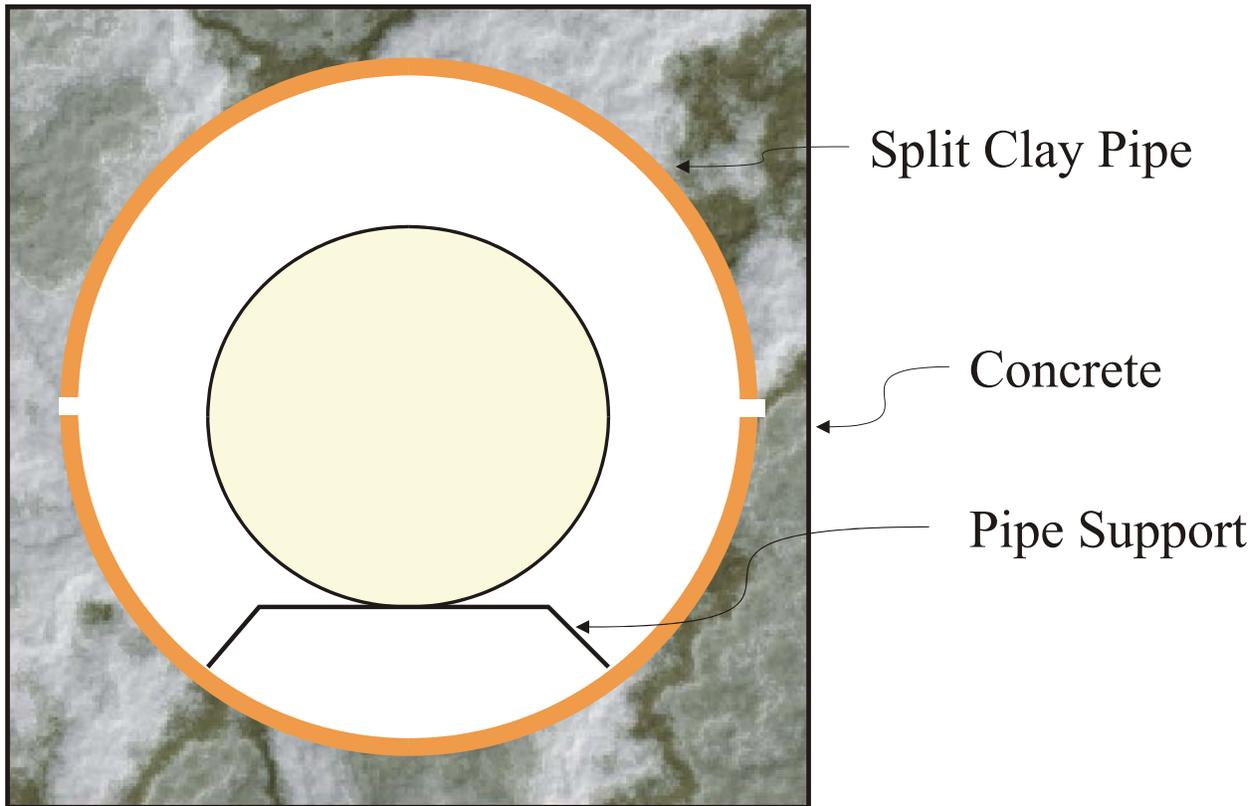


Figure 2-10. Split-clay tile encasement design.

Five additional pipelines were also installed to transfer waste solutions from the CPP-604 tank room to WM-180 and -181 (from WM-100 to -180, PWM-10019Y; from WM-101 to -180, PWM-20028Y; from WM-102 to -180, PWM-3019Y; and two lines from WL-101 to WM-181, PWA-1013, and PWA-1014). Each of these lines was included in the leak-detection system with similar split-tile encasements sloped downward from WM-180 and -181 to sample boxes on the outside of the north wall of the CPP-604 tank room. These sample boxes also had overflow lines that drained to the

CPP-604 tank room floor sumps. Also included in the design of the three waste lines to WM-180 were provisions for tie-ins with future storage tank additions (PWM-2011Y, PWM-1024Y, and 3" PWM-10019Y). This consisted of a vertical loop to a point 2 ft above grade with a flanged valve and a flanged tee connection at the top of the loop. These pipe loops were also separately encased in split tile between lower junction boxes 38.7 ft below grade and an upper diversion valve box (A-3A, A-3B, and A-3C) at the surface. Leakage from the pipeline or the loop, if any occurred, would flow into the lower junction box and flow from there through the encasement into the respective sample boxes. The two waste transfer lines from WL-101 to WM-181 were not originally provided with the future tie-in provisions. Locations of the waste transfer lines using the split-clay pipe encasement are shown in Figure 2-11.

The design of the split-clay tile encasement was not completely compatible with the waste it could contact. The clay pipe itself was compatible with the waste, but leaking acidic waste could eat through the mortar used to attach and seal sections of the split-tile piping, compromising the secondary containment. In addition, the rigid nature of the encasement system may have made it susceptible to cracking due to soil settling and compaction. Most of the tile-encased pipes have been replaced or abandoned.

Figure 2-11 shows two "suspect" split-tile-encased lines, one on WM-180 (4" PWM28004Y) and the other on WM-181 (4" PWM28104Y). These are the only split-tile-encased lines that are operable in the tank farm. These lines are administratively controlled such that they can only be used under special circumstances using strict procedures. No process knowledge or evidence to date indicates these lines have ever leaked. They are labeled "suspect" only because they are encased in the split-clay tile, but if the clay pipe were to ever leak, an acidic waste could damage the mortar of the split-tile encasement.

2.4.4.2 Split-Steel Encasement. In 1955, a major expansion program was started that included the construction of three new waste storage tanks, WM-182, -183, and -184, along with enlarging existing, and installing new, valve boxes and constructing new pipelines, encasements, and supports from the valve boxes to the new tanks. Two completely different pipe encasement designs were used during this phase of the tank farm expansion. Most of the encasement installed used the stainless-steel-lined concrete trough discussed in the following subsection. However, approximately 160 ft of waste-transfer piping used the split-steel encasement design and was installed from valve boxes A3-A and A3-B to where they connected to the stainless-steel-lined concrete trough (Figure 2-11). This design consisted of (1) a lower trough section of welded stainless steel in which the stainless-steel transfer pipeline was supported and (2) an upper cover section of carbon steel that overlapped and was pinned to the lower stainless-steel trough by No. 10 × 3/8-in.-long, hex-head, tapping screws spaced on 1-ft centers along its length (Figure 2-12). The upper 1/8-in.-thick cover was installed in 10-ft sections (maximum), with ends lapped 2-in. in the direction of flow and painted with two coats of bitumastic paint. The encasement rested on undisturbed soil or compacted soil backfill.

This encasement design was not entirely compatible with the waste it was designed to contain. The carbon-steel upper cover was susceptible to corrosion if it came into contact with the acidic waste solution for extended periods. Failure of the top cover would allow soil to collapse into the lower stainless-steel trough, blocking the designed drainage toward connecting valve boxes.

2.4.4.3 Stainless-Steel-Lined Concrete Troughs. As stated in the previous subsection, the 1955 tank farm expansion used the stainless-steel-lined concrete trough design encasements for nearly all of the new waste-transfer lines. This design consisted of a pile-supported, reinforced-concrete trough lined with stainless steel, with sloped drainage to sampling sumps and removable concrete cover plates (Figures 2-13 and 2-14). This secondary containment design has been trouble-free with no known releases.

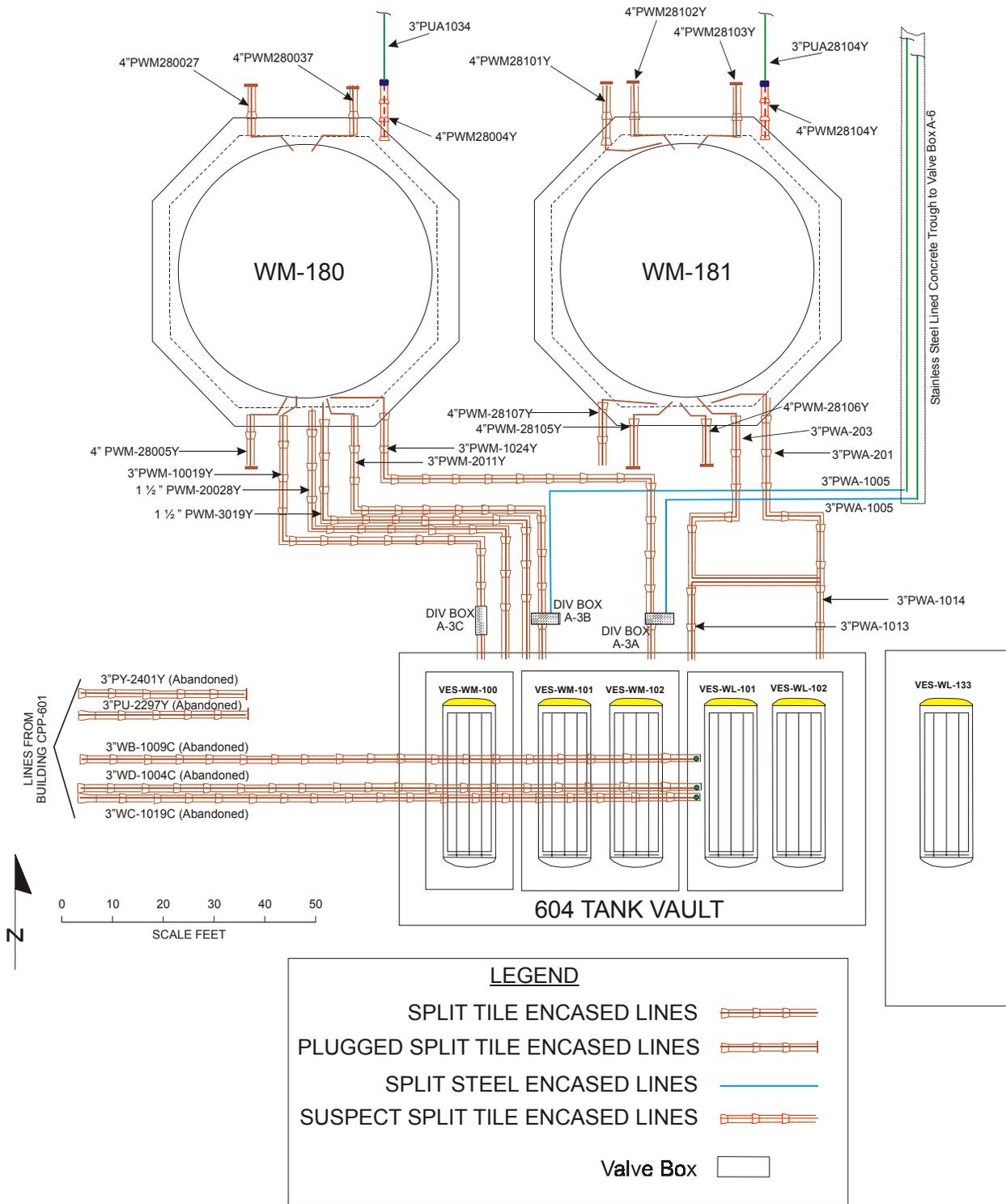


Figure 2-11. Locations of the waste transfer lines using split-clay pipe and split-steel encasement.

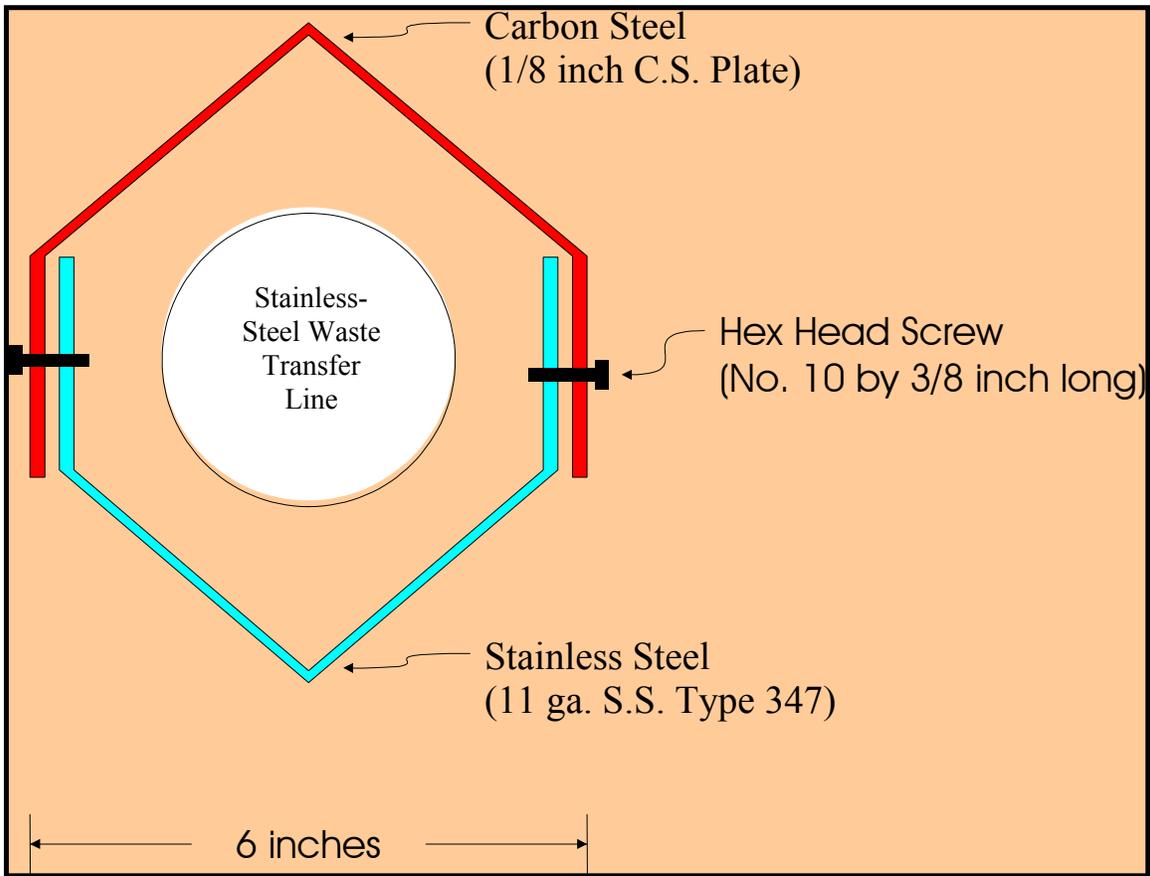


Figure 2-12. Split-steel encasement design.

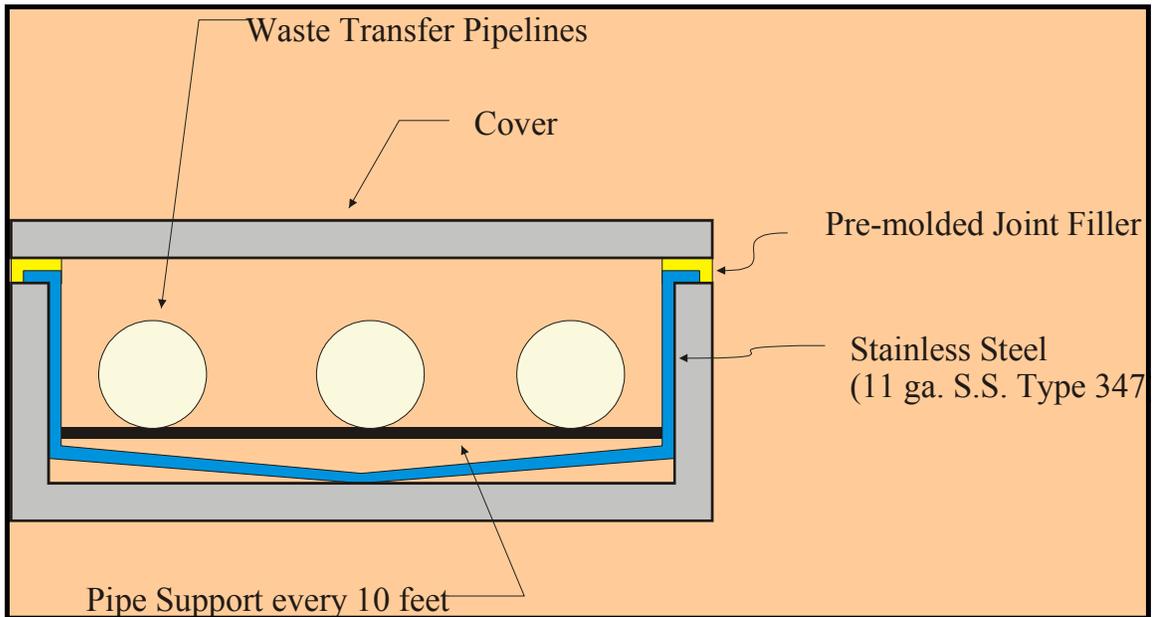


Figure 2-13. Stainless-steel-lined concrete trough encasement design.

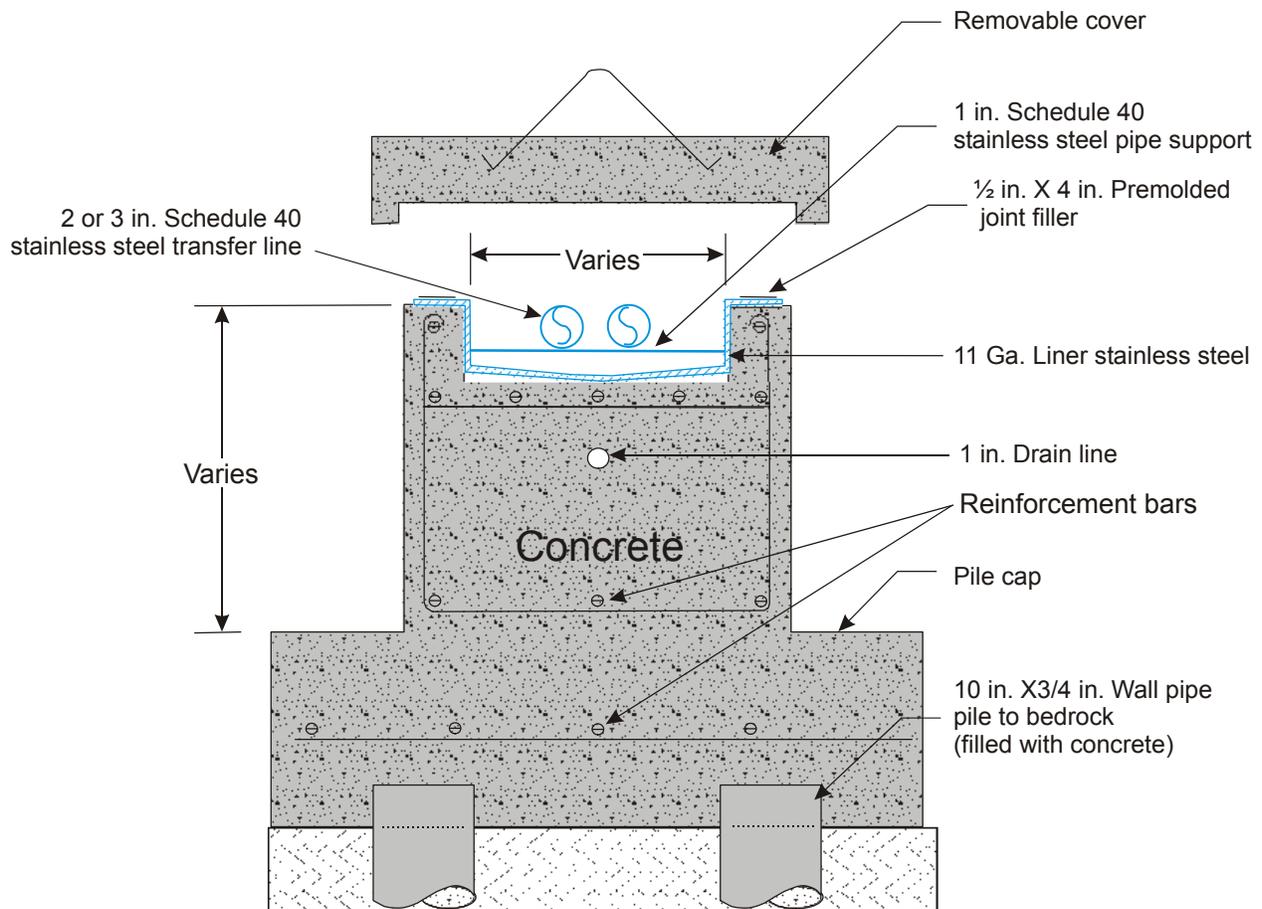


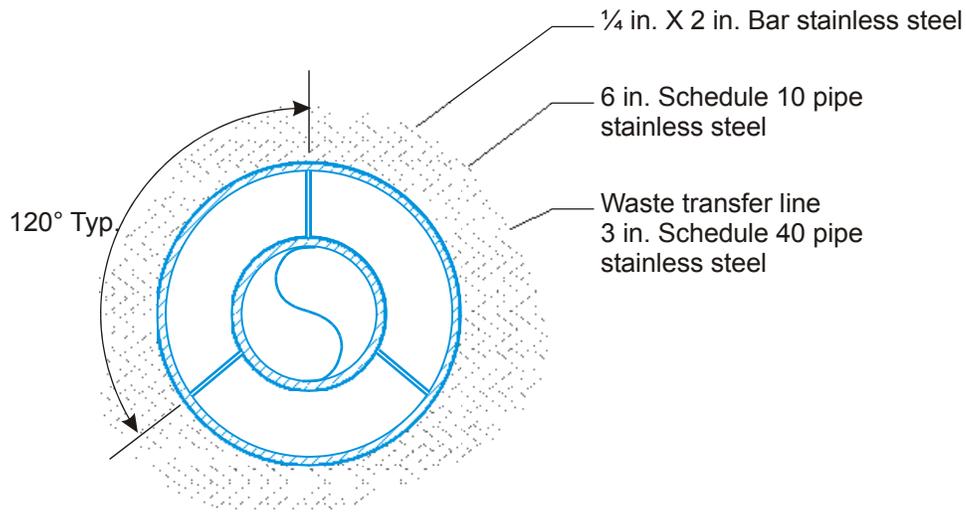
Figure 2-14. Piling and support cap design for the stainless-steel-lined concrete trough encasement design.

2.4.4.4 Stainless-Steel Pipe within a Pipe. Starting in 1957, secondary containment for waste-transfer piping was changed to the stainless-steel pipe-within-a-pipe design, which was used during installation of the new intertank transfer-piping system, allowing the tanks in the tank farm to be filled and emptied as necessary. At the completion of the intertank transfer system, it was possible to transfer waste from any tank to any other tank or to the WCF, which was then under construction. The stainless-steel pipe-within-a-pipe design is shown in Figure 2-15.

Very few problems, if any, have been associated with the pipe-within-a-pipe design. The stainless-steel inner and outer material is compatible with the acidic waste solutions.

2.5 Sources of Tank Farm Waste

Although fuel-reprocessing operations produced most of the liquid waste transferred to the tank farm, other facilities also generated waste that was transferred to the tank farm. A historical summary of the fuel reprocessing operations and waste streams stored at the tank farm is provided in the following subsections.



Typical buried stainless steel encased pipe

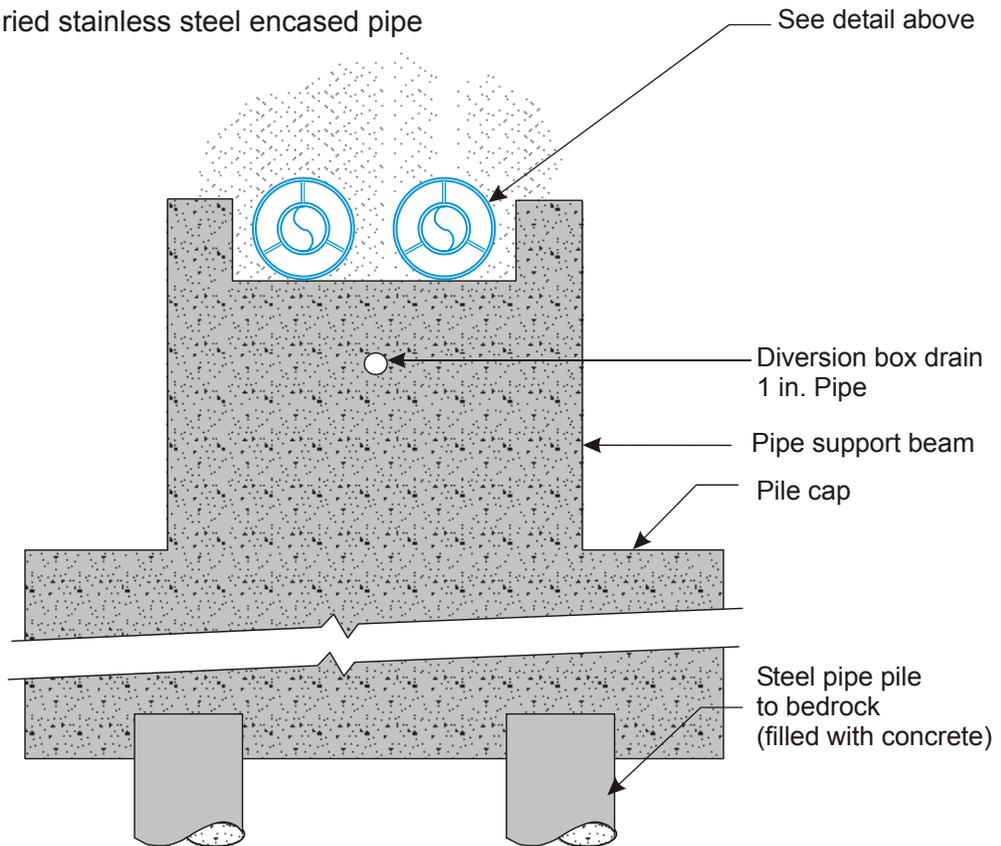


Figure 2-15. Stainless-steel pipe-within-a-pipe encasement design.

2.5.1 Fuel Reprocessing

Reprocessing operations at INTEC took place from 1952 until they were phased out in 1992. These operations used a three-cycle solvent extraction process to recover enriched uranium from SNF. The SNF 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 (see Table 2-4). 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 (raffinate) after the first extraction cycle was considered non-SBW and was stored in the tank farm. The liquid remaining from the second and third extraction cycles, as well as solutions resulting from decontamination activities, was for the most part stored separately in the tank farm. The waste resulting from decontamination activities is generally referred to as SBW because of the relatively high sodium content (when compared to first-cycle wastes). Although reprocessing operations have ceased, the tank farm continues to receive waste from INTEC plant operations and decontamination activities (see Subsection 2.3).

2.5.1.1 Fuel Dissolution. The initial step in reprocessing SNF at INTEC was fuel dissolution, which produced a solution of uranyl nitrate for solvent extraction. The different types of fuel dissolution processes, known as “headend” operations, are shown in Table 2-4.

The fuel dissolution processes produced a liquid uranium-bearing product stream for the solvent extraction process. The stream would sometimes be prepared as a “feed” by (1) clarification by centrifuge to remove particulates, (2) adjustment of the chemical composition by adding aluminum nitrate to drive the U-235 to the organic phase from the aqueous feed stream, or (3) suppression of emulsions by adding gelatin. The gases, xenon and krypton, were completely released during fuel dissolution and were recovered commensurate with the economic demand (WINCO 1986a).

2.5.1.2 Fuel Extraction. In the first-cycle extraction process, uranium was extracted from the uranyl nitrate solution into a solution of TBP and dodecane. The aqueous raffinate stream from this extraction, which included the fission products, was sent to the tank farm waste tanks unless the uranium concentration remained high enough for further extraction (WINCO 1986b).

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 TRU 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 tank farm prior to calcination (WINCO 1986b).

2.5.1.2.1 First-Cycle Raffinates—All first-cycle raffinates were acidic, with a hydrogen-ion concentration between 1 and 3 *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 co-processed 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 1986b).

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 in the non-fluoride waste are aluminum and nitrate; the major chemicals present in the fluoride waste are aluminum, zirconium, fluoride, and nitrate (INEEL 1998).

The primary transfer route for first-cycle waste from the process areas to the tank farm was via two 3-in. lines (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR-104853, and 3"-PUA-2401Y, which was also replaced in 1982 by 2"-PUAR-104854) to the surge transfer tank, WM-178, for possible transfer to eight of the eleven 300,000-gal storage tanks. (After 1967, tanks WM-181 and -184 were reserved exclusively for SBW, and WM-190 was designated the emergency spare). Because the airlift for WM-178 would entrain moisture droplets into the off-gas filter system, the raffinate siphon system was installed in the mid 1980s, which allowed WM-178 to be bypassed. However, the gravity-vacuum system required the addition of wastewater to restart the system when the siphon would shut down. In 1986, the siphon system was replaced by steam jets, which still bypassed WM-178. In 1992, the WM-178 tank lines were capped, and the tank was abandoned in place because of a lack of secondary containment.

The first-cycle extraction waste streams, relatively high in radioactivity, were analyzed for uranium content. (During the early years of extraction, the waste was then evaporated, if possible, to reduce volume. However, the evaporation step was subsequently eliminated to avoid problems associated with clogging of the raffinate waste in the evaporator.) The concentrate was then transferred to an available 300,000-gal storage tank with cooling coils, i.e., WM-180, -182, -183, -185, -187, -188, -189, or -190. All non-SBW was eventually calcined to a solid and stored in underground stainless-steel bins (the CSSF).

2.5.1.2.2 Second- and Third-Cycle Raffinates—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 Cs-137, Sr-90, and Pu-238. The predominant chemicals in the second- and third-cycle combined waste are aluminum and nitrate. The waste is acidic with a hydrogen ion concentration between 0.1 and 1.6 *M* (INEEL 1998).

Second-cycle raffinates were transferred to the tank farm via a 3-in. line (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR 104853). Third-cycle raffinates were transferred to the 300,000-gal storage tank via a 3-in. line (3"- PUA-2401Y, which was also replaced in 1982 by 2"- PUAR 104854).

2.5.2 Waste from Other Sources

While the largest volume of waste originated from fuel reprocessing in CPP-601, waste was shipped to the tank farm from several other facilities. The process flow of historical fuel operations at INTEC is illustrated in Figure 2-16. A map showing the facility sources of waste stored at the tank farm is provided in Figure 2-17.

Intermediate-level waste and low-level waste were sent to the PEW evaporator, and the PEW bottoms were then shipped to the tank farm for storage. The other types of waste shipped to the tank farm through the PEW facility include the following:

- Fluoride- and cadmium-bearing waste from the FDP (from the Fluorinel Dissolution Process and Fuel Storage [FAST] facility at CPP-666 through the Fuel Processing Facility [CPP-601])
- Waste from the fuel storage basins (in FAST and the Fuel Storage Facility in CPP-603)
- Decontamination waste containing fluoride from the waste calcining process (from the WCF at CPP-633 and later the NWCF at CPP-659)

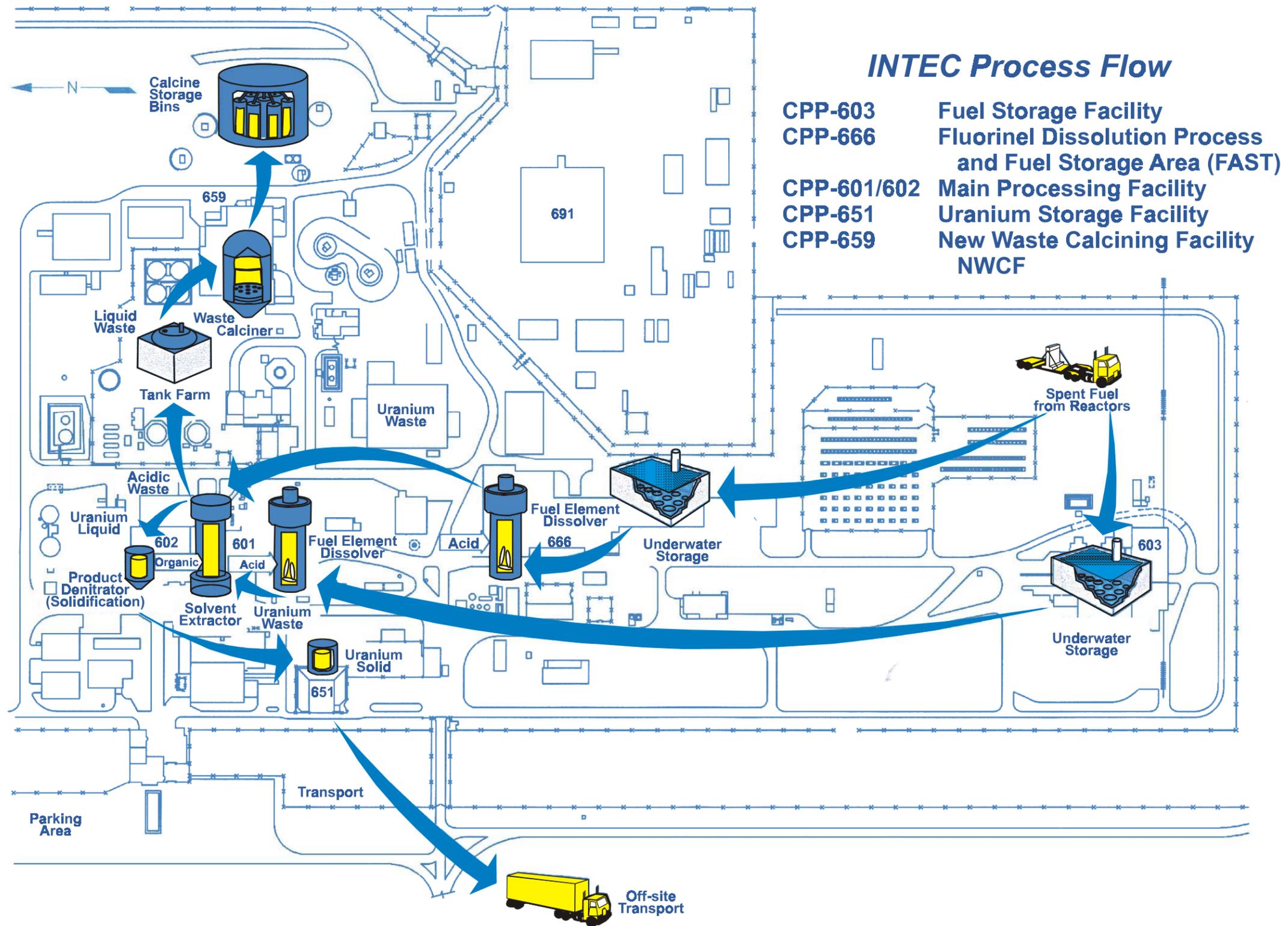


Figure 2-16. The process flow of historical fuel operations at INTEC.

- Waste from occasional transfers from the West Side Holdup Facility in CPP-641 (tanks WL-104 and -105), the Pilot Plant in CPP-637, and the Headend Process Plant in CPP-640
- Waste generated at the Remote Analytical Laboratory (CPP-684) and the Analytical Laboratory located in the Main Processing Facility (CPP-601/602)
- Chlorinated solvents used for degreasing from maintenance operations from the Maintenance Hot Shop in CPP-663
- Non-INTEC waste such as from Test Area North or the Test Reactor Area through the numerous truck unloading stations such as CPP-1619 at INTEC
- Decontamination and other incidental waste from the Liquid Effluent Treatment and Disposal Facility in CPP-1618.

Of the facilities mentioned in the bullets above, FAST (CPP-666), the Fuel Processing Building (CPP-601), the WCF (CPP-633), the NWCF (CPP-659), the Pilot Plant (CPP-637), the Headend Process Plant (CPP-640), the Remote Analytical Facility (CPP-627), and the Hot Shop (CPP-663) are inactive. These facilities are, or will be, decontaminated, dismantled, and closed.

To ensure compatibility with equipment in the raffinate streams, all hazardous waste was analyzed for the analytes of concern (i.e., not for RCRA characterization) before it was processed. Liquid waste was segregated according to chemical composition and stored in separate vessels. When space was limited, waste was combined if analysis determined an undesirable chemical reaction would not occur.

