EXECUTIVE SUMMARY

The Savannah River Site (SRS) is owned by the United States Department of Energy (DOE) and is currently operated and managed by the Westinghouse Savannah River Company (WSRC). Since beginning operations in the early 1950s, uranium and plutonium recovery processes have generated liquid high-level radioactive waste, which currently amounts to ~~34~~ 37 million gallons stored in underground tanks in the F- and H-Areas at the site. DOE intends to remove from service the high-level waste (HLW) tanks that do not meet the standards established in Appendix B of the SRS Federal Facility Agreement (FFA; EPA 1993) entered into pursuant to Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). After the wastes are removed from the tanks, the residual contaminants will be stabilized and the tanks closed under the industrial wastewater permits that regulate their operation. This plan establishes the general protocol by which DOE intends to close F- and H-Area HLW tank systems at SRS to prevent health hazards and promote safety in and around the tank systems in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities." In addition, closure of the HLW tanks by this process is intended to be consistent with the requirements of the Resource Conservation and Recovery Act and CERCLA, which will control the overall remediation of the F- and H-Area Tank Farms.

The F- and H-Area Tank Farms are located in the central portion of the SRS. The F-Area Tank Farm is located on 22 acres with 22 HLW tank systems (including 2 that have already been closed), and the H-Area Tank Farm is located on 45 acres and contains 29 HLW tank systems. The tank systems include the tank structure and ancillary components such as transfer pipelines, evaporators, diversion boxes, pump pits, and stripper columns. The tanks are of four basic types, designated I, II, III, and IV, and are constructed of carbon steel and concrete with waste capacities ranging from 750,000 to 1,300,000 gallons. Type I and II tanks have 5-foot-high annular pans (secondary containment), while Type IV tanks have single-wall designs. The newest design (Type III) has a full-height secondary containment tank. Nine of the Type I and II tanks are known to have experienced leaks from primary to secondary containment; one tank (Tank 16) leaked a small amount into the surrounding soil. ~~As described in the *High-Level Waste Tank Closure Program Plan* (DOE 1996),~~ DOE intends to remove from service ~~by 2022~~ and close the 24 tanks (Types I, II, and IV) that do not meet the standards set forth in Appendix B of the FFA. Removal from service and closure will be in accordance with the schedule presented in Appendix E (which currently has all of these tanks being closed by 2022). Summary information on the F- and H-Area HLW tanks is presented in Table ES-1.

This plan describes the environmental setting for the HLW tanks and the human and environmental receptors potentially affected by the tank closures (i.e., land use and demographics, local geology, ground and surface waters, biota, and air quality). Most of the information was compiled from existing SRS documents (environmental impact statements, safety analysis reports, hydrogeologic studies, etc.) that address the F- and H-Areas.

DOE identified environmental requirements and guidance considered pertinent to closure of the F- and H-Area HLW tank systems and derived performance objectives from them to ensure protection of human health and the environment and consistency with potential remedial actions in the F- and H-Area Tank Farms. In establishing the performance objectives for HLW tank system closure, DOE has assumed that the residual waste material remaining in the tank at closure will not be managed as high-level waste.

Before initiating the closure process for a tank, DOE will remove the HLW (salt, sludge, and supernate) by mechanical agitation or other means.

Table ES-1. Summary of high-level waste tanks.

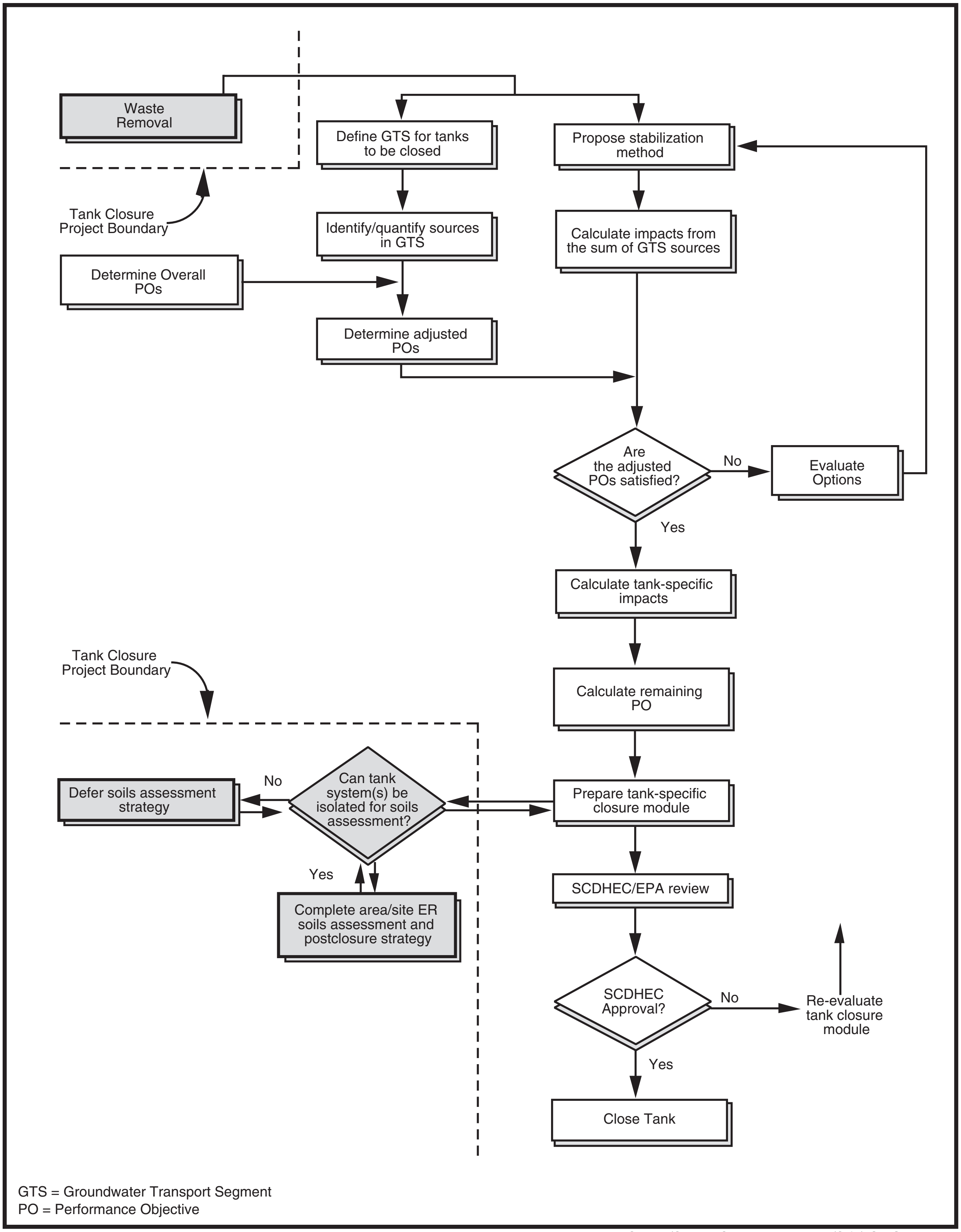
Tank type	Number of tanks	Volume (gallons)	Area	Tank numbers	Year constructed	Year first used
I[a]	12	750,000	F	1 - 8	1952	1954-64
			H	9 - 12	1953	1955-56
II[a]	4	1,030,000	H	13 - 16	19560	1957-60
III	27	1,300,000	F	25 - 28	1978	1980
				33 - 34	1969, 1972	1969, 1972
				44 - 47	1980	1980-82
			H	29 - 32	1970	1971-74
				35 - 43	1976-79	1977-86
				48 - 51	1981	1983-86
IV[a]	8	1,300,000	F	17 - 20[b]	1958	1958-61
			H	21 - 24	1961-62	1961-65

a. Twenty-four Type I, II, and IV HLW tanks will be removed from service ~~by 2022~~.
b. As of publication of this revision of the General Closure Plan, two tanks (Tanks 17 and 20) have been closed.

Any waste not removed will be residual waste. DOE will then determine the inventory of contaminants (radiological and nonradiological) remaining in the tank. The closure process described in this plan and shown in Figure ES-1 will be initiated with the following sequence of activities:

1. DOE will propose a method of stabilizing the residual contaminants in the tanks.
2. The closure configuration (i.e., the combination of residual tank source terms and stabilization method) will be subjected to fate and transport modeling to evaluate compliance with the overall performance objectives determined from the applicable environmental regulations. Contributions from other nearby tanks and nontank sources will also be calculated and accounted for in comparison with the overall performance objectives.
3. As tanks are closed, an accounting of closure impacts against the performance objectives will be maintained to ensure ultimate conformance when the last tank is closed. Chapter 6 provides a more complete explanation of the accounting methods.

DOE will then prepare a detailed tank-specific closure module, which will be submitted to South Carolina Department of Health and Environmental Control (SCDHEC) for review. After SCDHEC approves the module, DOE will stabilize the residual contaminants as the final step of the closure process. Tank Farm soils will be managed by the DOE Environmental Restoration Program according to the requirements of the FFA. Figure ES-1 summarizes the sequence of steps in the closure process.



P: NW Tank Closure/General Closure Plan Update/Grfx/ES-1 Summary.ai

Figure ES-1. Summary of HLW tank closure process.

References

EPA (U.S. Environmental Protection Agency), 1993, Federal Facility Agreement between the U.S. Environmental Protection Agency Region IV, the U.S. Department of Energy, and the South Carolina Department of Health and Environmental Control, Docket No. 89-05-FF, August 16.

CHAPTER 1. INTRODUCTION

The Savannah River Site (SRS) occupies approximately 300 square miles adjacent to the Savannah River, principally in Aiken, Barnwell, and Allendale Counties of South Carolina. The site is owned by the United States Department of Energy (DOE) and is operated by the Westinghouse Savannah River Company (WSRC). Environmental restoration is emphasized in the current site mission. However, since the early 1950s, the primary mission of the site has been to produce nuclear materials for national defense. The process used to recover uranium and plutonium from production reactor fuel and target assemblies in the chemical separations area at SRS generated liquid high-level radioactive waste. This waste, which now amounts to approximately ~~34~~ 37 million gallons, is stored in underground tanks in the F- and H-Areas near the center of the site.

DOE is committed to remove from service ~~by 2022~~ those high-level waste (HLW) tank systems that do not meet the standards set forth in Appendix B of the SRS Federal Facility Agreement (FFA) (EPA 1993). DOE, the U.S. Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control (SCDHEC) signed the FFA pursuant to Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9620) for the comprehensive environmental remediation of SRS; the agreement became effective in August 1993. After wastes are removed from individual tank systems, they will be closed under, then removed from, the industrial wastewater permits that regulate their operation.

1.1 Purpose and Objectives

The purpose of this document is to set forth the general protocol by which DOE intends to close the F- and H-Area HLW tank systems at SRS to protect public health and the environment in accordance with South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities. (SCCOR 2003)" This plan presents the environmental regulatory standards and guidelines pertinent to closure of the tanks and describes the process for evaluating and selecting the closure configuration (i.e., residual source term and method of stabilizing the tank system and residual waste material). The plan also describes the integration of HLW tank system closure activities with existing commitments to remove waste from the tanks before closure and ultimately to remediate the F- and H-Area Tank Farms.

The specific objectives of this plan are as follows:

- Describe the methods DOE could use to remove wastes from the tank systems and stabilize the tank systems and residual waste material.
- Identify the Federal and South Carolina environmental requirements and guidance that apply to the tank closure (e.g., groundwater, surface water, and air emission limits) and describe how DOE will comply with these requirements.
- Describe the process DOE will follow in selecting tank cleaning and stabilization methods for individual tank systems as they are closed.
- Describe the methodology for using fate and transport modeling to calculate potential exposure concentrations or radiological dose rates from residual wastes in the tank systems and from other nearby sources of contamination.
- Provide the methodology for accounting for closure impacts of individual tank systems such that the closure of all F- and H-Area tank systems will comply with environmental standards.

The process outlined in this plan is intended to comply with the requirements of South Carolina R.61-82 and be consistent with the requirements of the Resource Conservation and Recovery Act (RCRA) and CERCLA, under which the F- and H-Area Tank Farms will eventually be remediated. Thus, evaluation and selection of a proposed closure configuration by the process described in this plan will be consistent with evaluation against the following CERCLA criteria [40 CFR 300.430(e)(9)]: (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements (ARARs); (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance. The closure configuration selection process is documented in the *Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement* (DOE 2002). The Record of Decision documented DOE's selection of a closure configuration process (the Fill with Grout Option).

1.2 HLW Tank Systems Closure Plan

SCDHEC has issued three Industrial Wastewater Treatment System construction/operating permits associated with the F- and H-Area Tank Farms. SCDHEC Permit No. 17,424-IW (Sadler 1983) addresses the entire tank farm with the exception of Tanks 16 and 50. Tank 50 is under permit No. 14,520. Tank 16 was taken out of service following waste removal and, therefore, was not included in the wastewater operating permits. However, because the application of a consistent closure methodology is appropriate for all HLW tank systems, Tank 16 will be closed under this plan.

Before closure of any tanks, two prerequisite steps must be accomplished. First, DOE has prepared an environmental impact statement (EIS) to evaluate the environmental impacts of DOE's tank closure activities. DOE completed the EIS and issued a Record of Decision in 2002 (67 FR 53784; August 19, 2002).

Secondly, DOE must present the general regulatory framework under which all the tanks would be closed. This closure plan is that framework and will guide SRS and its regulators through the closure process. The specific objectives of this plan have already been listed.

The sequence of steps in the closure process for an individual tank system is depicted in Figure 1-1. Chapters 4 and 6 provide explanations of the process steps. Although removal of the bulk waste from the tank is an operational activity, not part of tank closure, it is an essential precursor to closure. The waste removal process is described in Chapter 4 and Appendix A.

A key element of the process is the preparation of individual tank closure modules as tanks are selected for closure. Because the HLW tanks will be closed over decades, the tank-specific modules allow DOE the opportunity to address and evaluate evolving technologies for waste removal and tank stabilization. The tank closure modules also provide a mechanism for regulatory approval of each closure and present a running account of cumulative tank closure impacts against closure performance objectives for the F- and H-Area Tank Farms.

The remainder of this plan is organized as follows:

- Chapter 2 describes the F- and H-Area Tank Farm components of the HLW system and

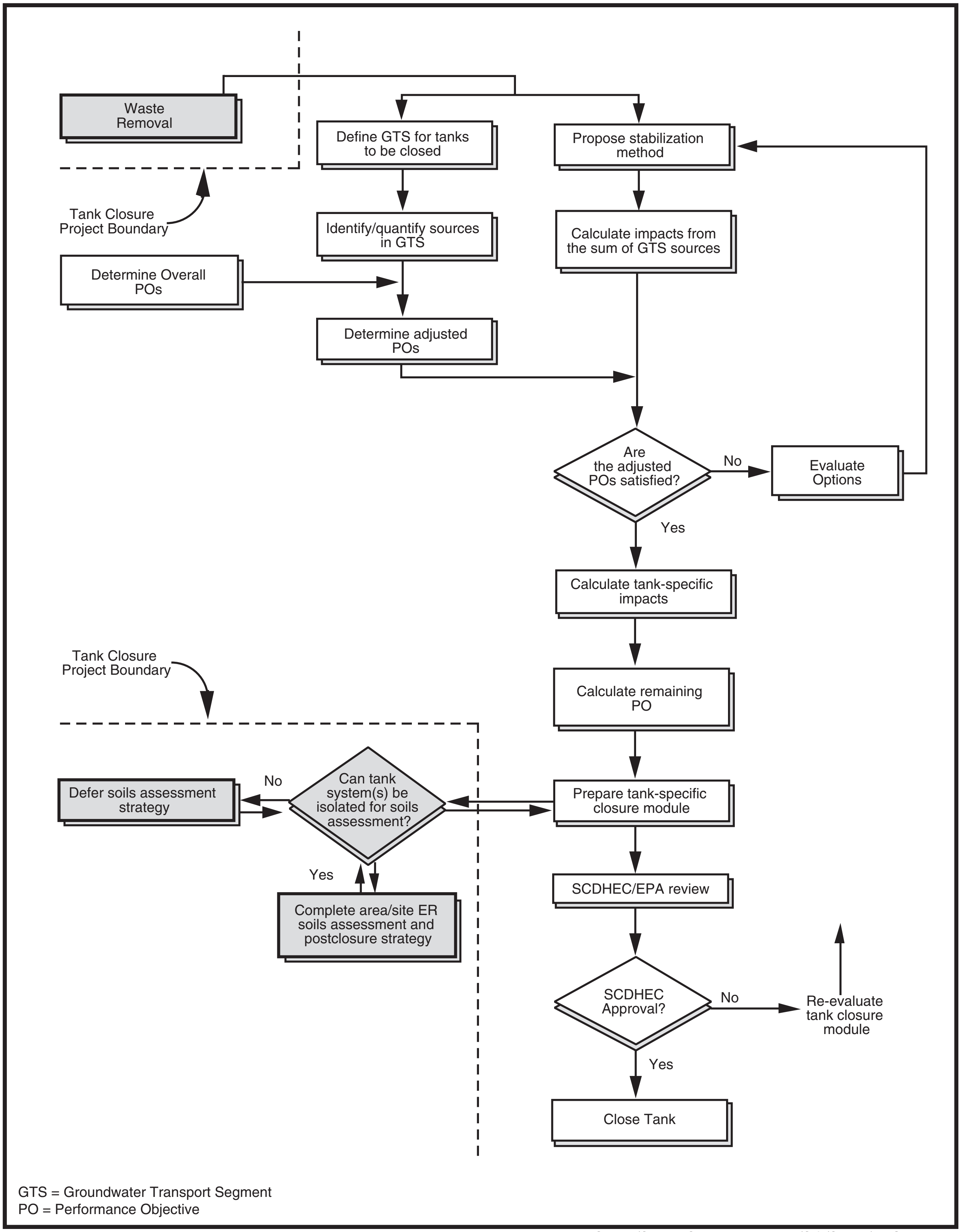


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Figure 1-1. Summary of HLW tank closure process.

identifies the elements of the tank farms that this closure plan covers.

- Chapter 3 describes the environmental setting of the tank systems.

- Chapter 4 describes the waste removal and stabilization processes for the tank systems and the methods by which DOE will use tank-specific impacts and other factors (e.g., other environmental requirements, technical feasibility, cost) to select an appropriate closure option.

- Chapter 5 identifies the regulatory standards and guidance applicable to closure of the tank systems.

- Chapter 6 describes the methodology for using fate and transport modeling to account for tank-specific closure impacts against overall closure performance objectives.

- Appendix A describes the methods DOE could employ for removing wastes from the HLW tank systems and for stabilizing the tank systems and associated residual wastes.

- Appendix B summarizes the process to identify pertinent environmental regulatory requirements and guidance and the resulting overall performance objectives for HLW tank system closures.

- Appendix C provides an example of the fate and transport modeling that could be used to determine tank-specific closure impacts and accounting against the performance objectives.

- Appendix D presents an example of the process of accounting for closure impacts against overall performance objectives.

- Appendix E presents DOE’s schedule for closing the tanks.

References

42 U.S.C. §9620, The Public Health and Welfare, "Comprehensive Environmental Response, Compensation and Liability," *United States Code*, Title 42, Chapter 103, Subchapter I, Section 9620, Federal facilities.

DOE (U.S. Department of Energy), 2002, *Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement*, DOE/EIS-0303 Savannah River Operations Office, Aiken, South Carolina, May.

EPA (U.S. Environmental Protection Agency), 1993, Federal Facility Agreement between the U.S. Environmental Protection Agency Region IV, the U.S. Department of Energy, and the South Carolina Department of Health and Environmental Control, Docket No. 89-05-FF, August 16.

Sadler, M.F., 1993, Letter to W.D. Dunaway, "Re: Construction Permit *17, 424-IW," South Carolina Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division, Columbia, SC, January 25.

SCCOR (South Carolina Code of Regulations), 2003, SC R.61-82, South Carolina Code of Regulations, Chapter 61, Section 82, "Proper Closeout of Wastewater Treatment Facilities," Department of Health and Environmental Control.

CHAPTER 2. HIGH-LEVEL WASTE SYSTEM

A legacy of the SRS mission was the generation of high-level radioactive waste. Since the beginning of SRS operations, an integrated management system, the "High-Level Waste System," consisting of several facilities designed for the overall processing of liquid high-level radioactive waste has evolved. Two of the major components of this system are the F- and H-Area High-Level Waste (HLW) Tank Farms, which are near the center of the site (Figure 2-1) F- and H-Areas are where plutonium, uranium, and other radionuclides were separated from irradiated fuel and target assemblies using chemical separations processes. The tank farms, which store and process HLW from the chemical separations process, include the following facilities and structures: tank systems, evaporators, transfer systems, the In-Tank Precipitation (ITP) Facility, and sludge processing tanks.

The tank farm sites were chosen because of their favorable terrain, proximity to the F- and H-Area Separations Facilities (the major waste generating sources), and isolation distance (at least approximately 5.5 miles) from the SRS boundaries. Figure 2-2 shows the setting of the F- and H-Areas and associated tank farms.

The F-Area Tank Farm is a 22-acre site consisting of 22 waste tanks, 2 evaporator systems, transfer pipelines, 6 diversion boxes, and 3 pump pits. Figure 2-3 shows the general layout of F-Area Tank Farm.

The H-Area Tank Farm is a 45-acre site consisting of 29 waste tanks, 2 evaporator systems and the Replacement High Level Waste Evaporator (RHLWE), the ITP process building and associated equipment, transfer pipelines, 8 diversion boxes, and 10 pump pits. Figure 2-4 shows the general layout of the H-Area Tank Farm.

The F- and H-Area Tank Farms were constructed to receive high-level radioactive waste generated by various SRS production, processing, and laboratory facilities. The use of the tank farms isolates these wastes from the environment, SRS workers, and the public. In addition, the tank farms enable radioactive decay by aging the waste, clarification of waste by gravity settling, and removal of soluble salts from waste by evaporation. The tank farms also pretreat the accumulated sludge and salt solutions (supernate) to enable the management of these wastes at other SRS treatment facilities (i.e., Defense Waste Processing Facility (DWPF) and Z-Area Saltstone Manufacturing and Disposal Facility (SMDF). These treatment facilities convert the sludge and supernate to more stable forms suitable for permanent disposal.

To accomplish the system operational objectives described above, the following units were assembled in the tank farms:

- Fifty-one large underground waste tanks to receive, store, age, and gravity separate the waste
- Five existing evaporator systems to concentrate soluble salts and reduce the waste volume
- Transfer system (i.e., transfer lines, diversion boxes, and pump pits) to transfer supernate, sludge and other waste (e.g., evaporator condensate) between tanks and treatment facilities
- Precipitation/filtration system (i.e., ITP Facility) to separate the salt solution into high- and low-activity fractions for immobilization at the DWPF Vitrification Facility and Z-Area Saltstone Manufacturing and Disposal Facility, respectively [Operation of the ITP Facility was suspended in early 1998.

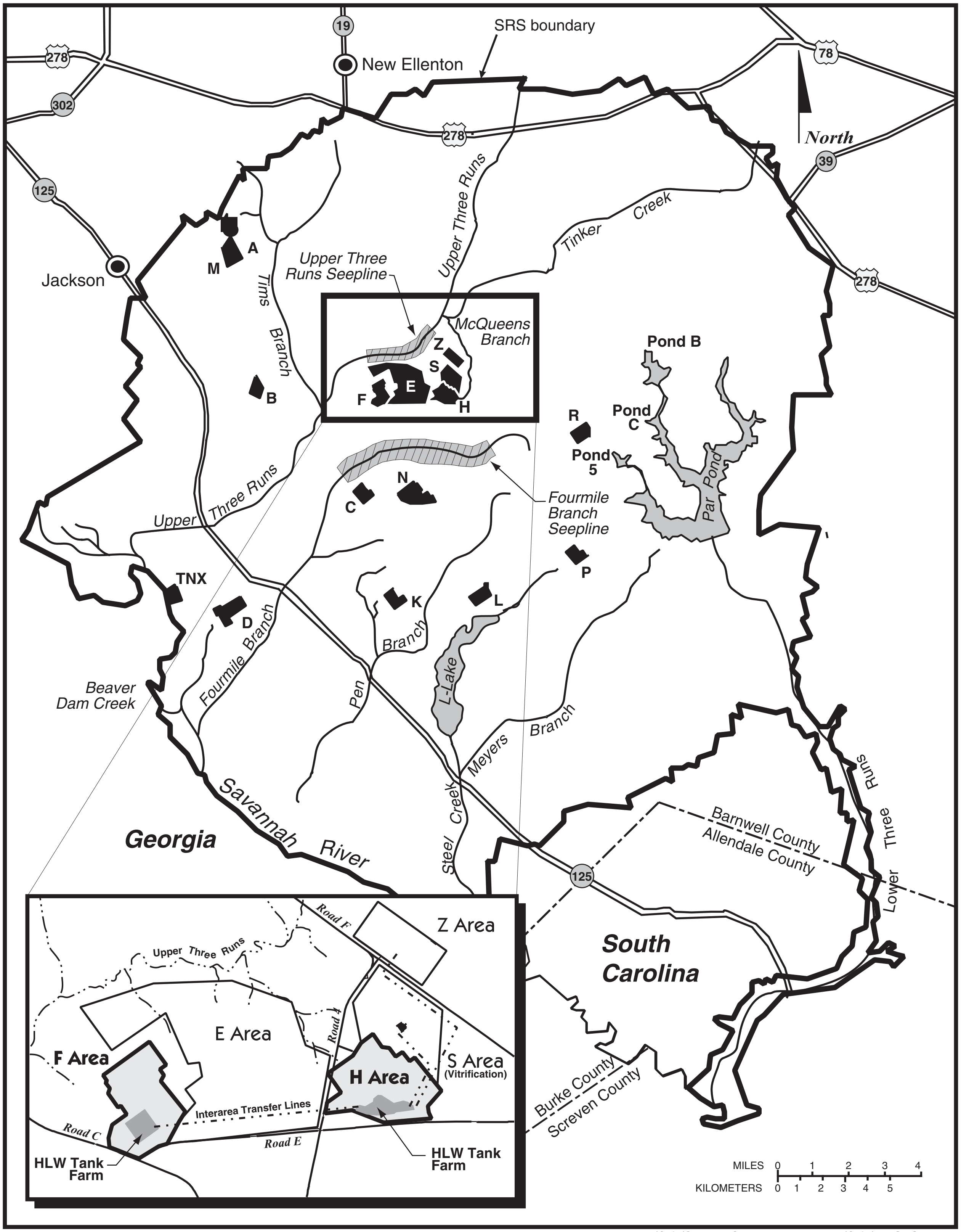
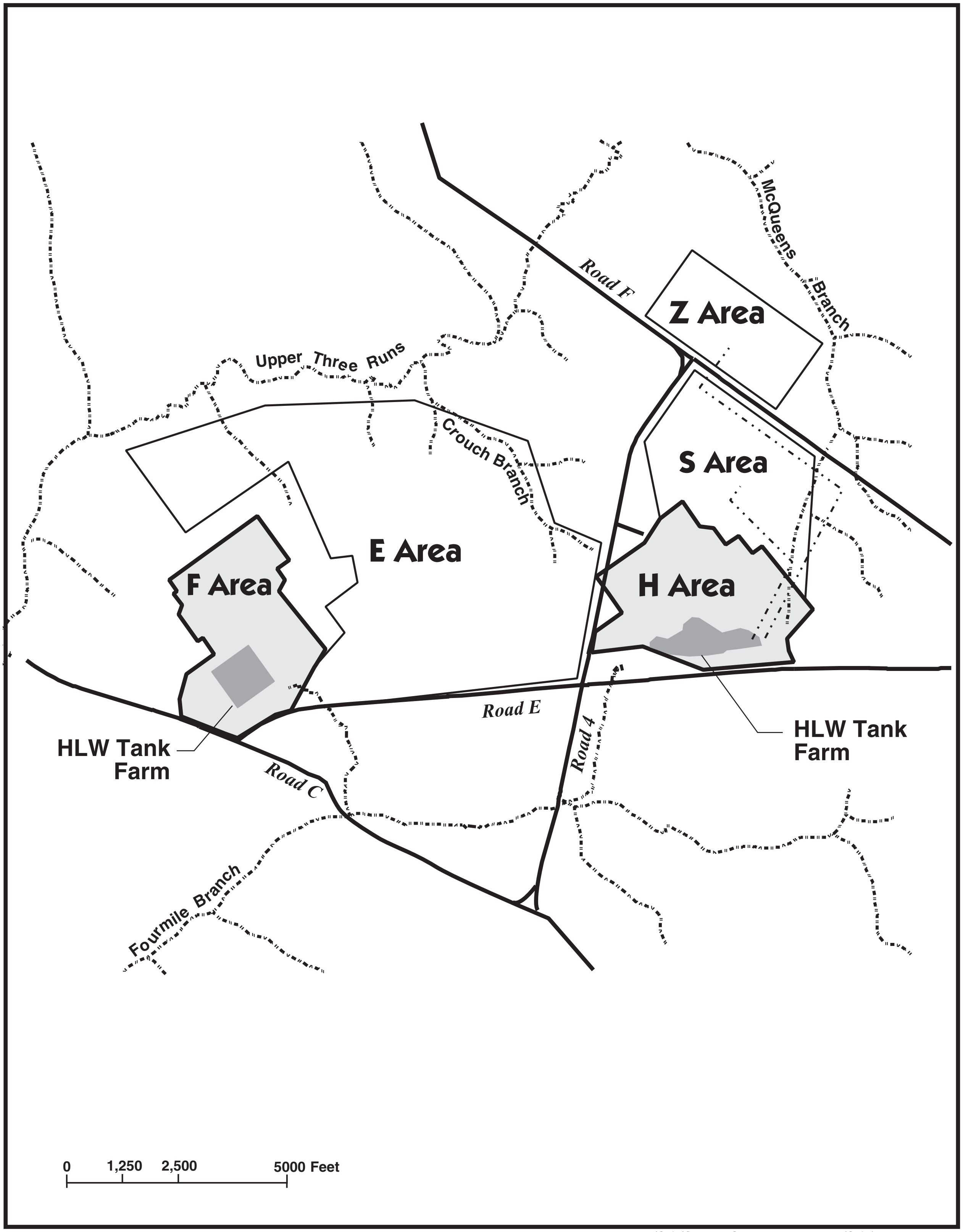


Figure 2-1. Savannah River Site map with F- and H-Areas highlighted.



NW TANK/Grfx/General Closure Plan Update/Grfx/2-2 F&H Tank.ai

Figure 2-2. F- and H-Tank Farm areas.

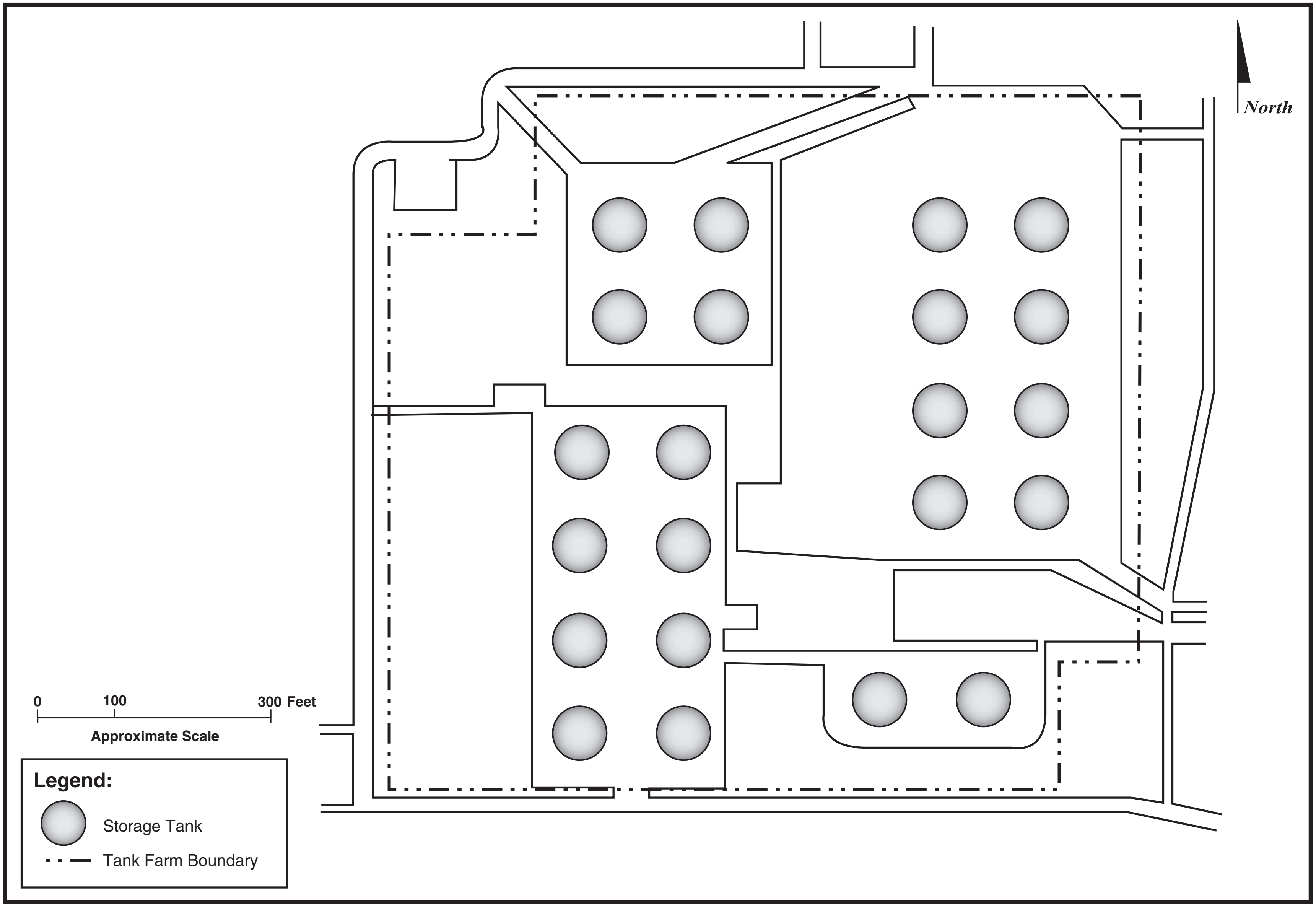


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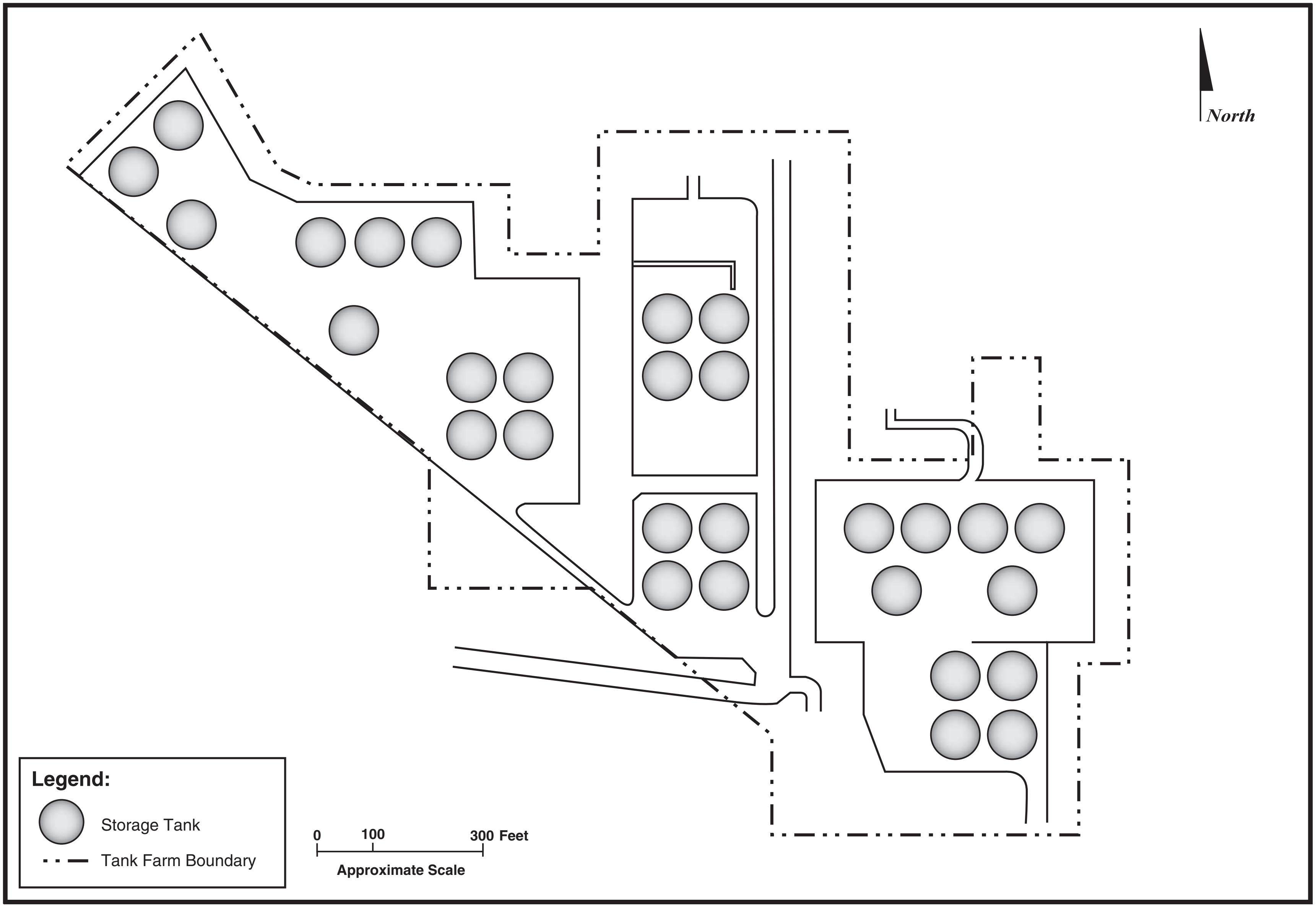
Figure 2-3. General layout of F-Area Tank Farm.



NW TANK/General Closure Plan Update/Grfx/2-4 Gen layout H-Area Tank Farm.ai

Figure 2-4. General layout of H-Area Tank Farm.

DOE is currently evaluating alternate salt disposition technologies to replace the ITP process.]

- Sludge washing system (i.e., Extended Sludge Processing) to pretreat the accumulated sludge prior to immobilization at the DWPF Vitrification Facility

Sections 4.0 and 7.0 of the *As-Built Construction Permit Application for an Industrial Wastewater Treatment Facility for the F- and H-Area Radioactive Waste Tank Farms* (WSRC 1991) contain detailed descriptions and discussion of the tank farm equipment.

2.1 Tanks

The F- and H-Area tanks are of four different designs, all constructed of carbon-steel, inside of reinforced concrete containment vaults. Table 2-1 summarizes information about the tanks. Two designs (Types I and II) have 5-foot-high secondary annulus "pans" and forced cooling (Figure 2-5). The 12 Type I tanks (Tanks 1 through 12) were built in 1952 and 1953, 5 of which (Tanks 1, 9 through 12) have known leak sites in which waste leaked from the primary containment to the secondary containment. The leaked waste is kept dry by air circulation, and there is no evidence that the waste has leaked from the secondary containment. The tank tops are about 9.5 feet below grade. The bottoms of Tanks 1 through 8, in F-Area, are situated above the seasonal high water table. Tanks 9 through 12 in the H-Area Tank Farm are in the water table.

The four Type II Tanks (Tanks 13 through 16) were built in 1956 in the H-Area Tank Farm (Figure 2-5). All four have known leak sites in which waste leaked from primary to secondary containment. In Tank 16, the waste overflowed the annulus pan (secondary containment) and tens of gallons of waste migrated into the surrounding soil. Waste removal from the Tank 16 primary vessel was completed in 1980. However, not all of the waste that leaked into the annulus has been removed. These tanks are above the seasonal high water table.

The fourth design (Type IV) has a single steel wall and does not have forced cooling (Figure 2-5). The eight Type IV Tanks (Tanks 17 through 24) were built between 1958 and 1962. Tanks 17 through 20 are in the F-Area Tank Farm and Tanks 21 through 24 are in H-Area. Tank 19 has recently developed a lateral crack, approximately 18 inches in length, running parallel to the weld seam above the waste level. Tank 20 (which has been closed) has known cracks that are believed to have been caused by groundwater corrosion of the tank wall. The bottoms of Tanks 17 through 20 are slightly above the water table. Tank 17 has also been closed. Tanks 21 through 24 are above the groundwater table; however, they are in a perched water table caused by the original basemat under the tank area.

The newest design (Type III) has a full-height secondary tank and forced water cooling (Figure 2-5). All of the Type III tanks (25 through 51) are above the water table. These tanks were placed in service between 1969 and 1986. None of them has known leak sites.

DOE intends to remove from service in accordance with the schedule presented in Appendix E, ~~by 2022~~ and close all tank systems that have experienced leaks or do not have full-height secondary containment. Thus, the 24 Type I, II, and IV tanks will be removed from service while the 27 Type III tanks will remain in service until there is no further need for the tanks ~~(currently planned to be after 2028)~~.

2.2 Evaporator Systems

Each tank farm has two single-stage, bent-tube evaporators that concentrate waste following receipt from the canyons. At present, two of these evaporators (242-16F and 242-16H) are operating, one in each tank farm. Each operating evaporator is made of stainless steel and operates at near atmospheric pressure under alkaline conditions. The evaporators are 8 feet in diameter and have an operating capacity of approximately 1,800 gallons. An additional

Table 2-1. Waste tank information.[a]

Tank number	Design type	Location	Year constructed	First used
1[b]	I	F	1952	1954
2	I	F	1952	1955
3	I	F	1952	1954
4	I	F	1952	1961
5[b]	I	F	1952	1959
6[b]	I	F	1952	1964
7	I	F	1952	1954
8	I	F	1952	1958
9[b]	I	H	1953	1955
10[b]	I	H	1953	1955
11[b]	I	H	1953	1955
12[b]	I	H	1953	1956
13[b]	II	H	1956	1959
14[b]	II	H	1956	1957
15[b]	II	H	1956	1960
16[b]	II	H	1956	1960
17	IV	F	1958	1961
18	IV	F	1958	1958
19[b]	IV	F	1958	1961
20	IV	F	1958	1960
21	IV	H	1961	1961
22	IV	H	1962	1965
23	IV	H	1962	1963
24	IV	H	1962	1963
25	III	F	1978	1980
26	III	F	1978	1980
27	III	F	1978	1980
28	III	F	1978	1980
29	III	H	1970	1971
30	III	H	1970	1974
31	III	H	1970	1972
32	III	H	1970	1971
33	III	F	1969	1969
34	III	F	1972	1972
35	III	H	1976	1977
36	III	H	1977	1977

Table 2-1. (continued).

Tank number	Design type	Location	Year constructed	First used
37	III	H	1977	1978
38	III	H	1979	1981
39	III	H	1979	1982
40	III	H	1979	1986
41	III	H	1979	1982
42	III	H	1979	1982
43	III	H	1979	1982
44	III	F	1980	1982
45	III	F	1980	1982
46	III	F	1980	1986
47	III	F	1980	1980
48	III	H	1981	1983
49	III	H	1981	1983
50	III	H	1981	1983
51	III	H	1981	1986

a. Source: WSRC (1991).
b. Has one or more known cracks in primary tank shell (WSRC 2004).

evaporator system, the Replacement High-Level Waste Evaporator (RHLWE or 242-25H), in H-Area began operations in 2000. The RHLWE is fabricated of INCO alloy G3 to allow higher design temperatures; it has almost twice the operating capacity of the existing evaporators. Because of the radioactivity emitted from the waste, the evaporator systems are either shielded (i.e., lead, steel, or concrete vaults) or placed underground. The process equipment is designed to be operated and maintained remotely.

Waste supernate is transferred from the evaporator feed tanks and heated to the aqueous boiling point in the evaporator vessel. The evaporated liquids (overheads) are condensed and, if required, processed through an ion-exchange column for cesium removal. The overheads are transferred to the F/H Effluent Treatment Facility (ETF) for final treatment before being discharged to Upper Three Runs Creek. The overheads can be recycled back to a waste tank if evaporator process upsets occur. Supernate can be reduced to about 25 percent of its original volume and immobilized as crystallized salt by successive evaporations of liquid supernate.

2.3 Transfer System

A network of transfer lines is used to transfer wastes between the waste tanks, process units, and various SRS areas (i.e., F-Area, H-Area, S-Area, and Z-Area). These transfer lines have diversion boxes that contain removable pipe segments (called jumpers) to complete the desired transfer route. Jumpers of various sizes and shapes can be fabricated and installed to enable the transfer route to be changed. The use of diversion boxes and jumpers allows flexibility in the movement of wastes. The diversion boxes are usually underground, constructed of reinforced concrete, and either sealed with waterproofing compounds or lined with stainless steel.

Pump pits are intermediate pump stations in the F- and H-Area Tank Farm transfer systems. These pits contain pump tanks and hydraulic pumps or jet pumps. Many pump pits are associated with diversion boxes. The pits are constructed of reinforced concrete and have a stainless-steel liner.

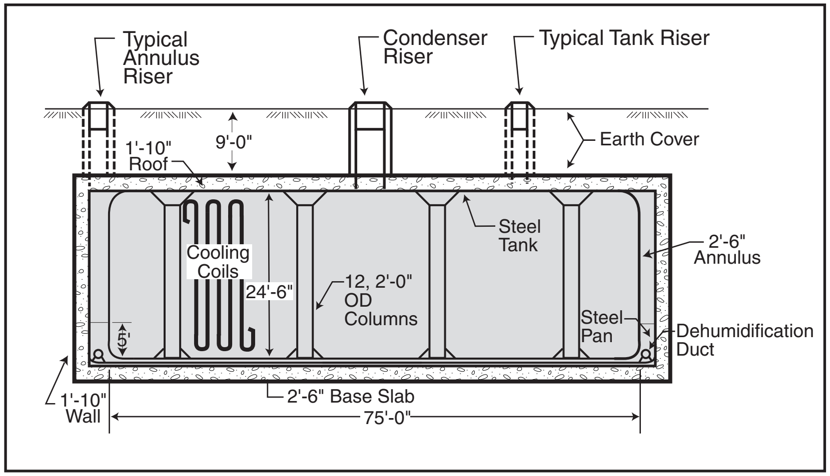


Figure 2-5A. Cooled Waste Storage Tank, Type I (Original 750,000 gallons)

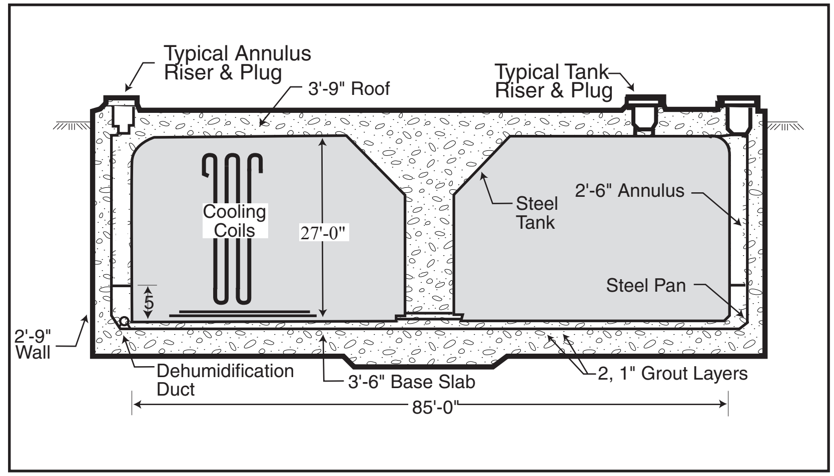


Figure 2-5B. Cooled Waste Storage Tank, Type II (1,030,000 gallons)

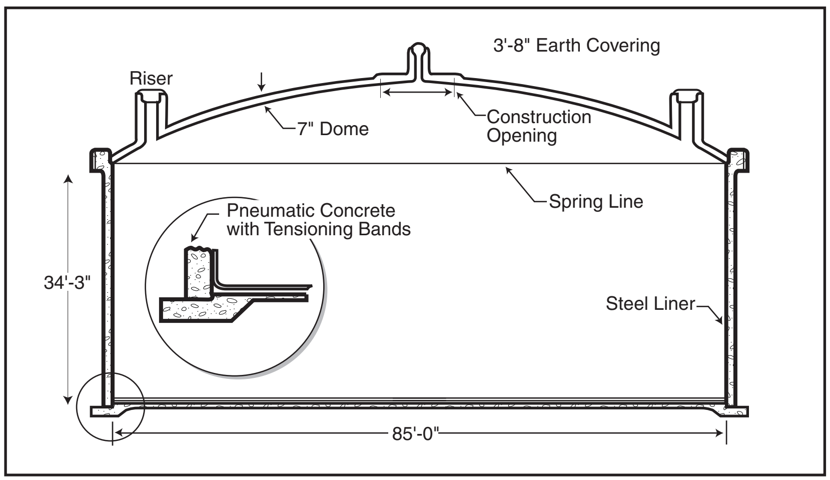


Figure 2-5C. Uncooled Waste Storage Tank, Type IV (Prestressed concrete walls, 1,300,000 gallons)

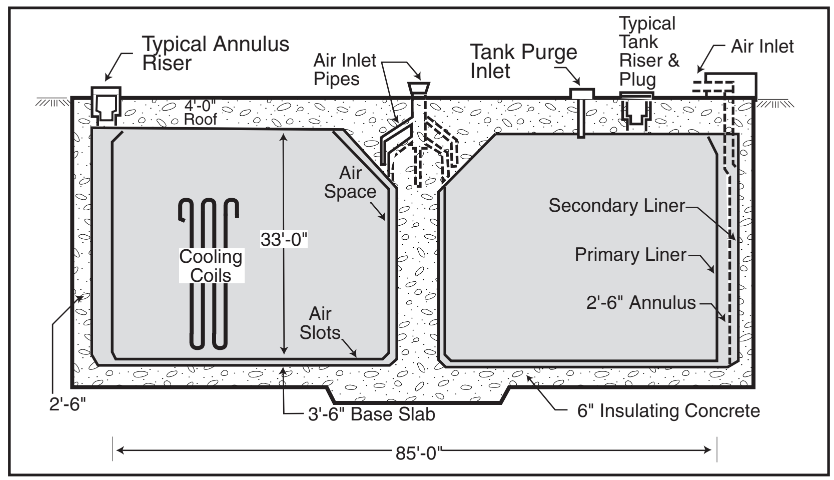


Figure 2-5D. Cooled Waste Storage Tank, Type III (Stress Relieved Primary Liner, 1,300,000 gallons)

NW TANK/General Closure Plan Update/Grfx/2-5 Tank config.ai

Figure 2-5. Tank configuration.

References

WSRC (Westinghouse Savannah River Company), 1991, *As-Built Construction Permit Application for an Industrial Wastewater Treatment Facility for the F/H-Area High-Level Radioactive Waste Tank Farms*, Aiken, South Carolina, Rev. 0, April 16.

WSRC (Westinghouse Savannah River Company), 2004, *F/H-Area High-Level Waste Tanks Status Report for CY2003.* CBU-ENG-2004-00068, March.

CHAPTER 3. ENVIRONMENTAL CONDITIONS

This chapter describes the affected environment of the F- and H-Area Tank Farms. The information emphasizes the environmental features of the F- and H-Areas that are important in the performance evaluation for the tank system closure discussed in Chapter 4. The affected environment is addressed in the following subsections: Land Use and Demographics, Geology and Soils, Groundwater, Surface Water, Biota, Air Quality, and Cultural Resources. Most of the information is from existing Savannah River Site (SRS) documents, environmental impact statements (EISs), safety analysis reports (SARs), hydrogeologic studies, etc. that address the F- and H-Areas.

3.1 Land Use and Demographics

3.1.1 LAND USE

The SRS is in south-central South Carolina (Figure 3-1), approximately 100 miles from the Atlantic Coast. The major physical feature at SRS is the Savannah River, about 20 miles of which serve as the southwestern boundary of the site and the South Carolina-Georgia border. The SRS includes portions of Aiken, Barnwell, and Allendale Counties in South Carolina.

The SRS occupies an almost circular area of approximately 300 square miles or 192,000 acres and contains production, service, and research and development areas (Figure 3-2). The production facilities occupy less than 10 percent of the SRS area; the remainder of the site is undeveloped forest or wetlands.

The F- and H-Areas are in the north-central portion of the SRS, bounded by Upper Three Runs to the north and Fourmile Branch to the south. The two separations areas, F and H (Figures 3-3 and 3-4), occupy 364 and 395 acres, respectively. Land use within the F-and H-Areas is classified as heavy industrial. Land within a 5-mile radius of these areas is entirely within the SRS boundaries and is used for either industrial purposes or as forested land.

DOE intends that the SRS defense processing and environmental management areas (the area between Fourmile Branch and Upper Three Runs) would continue to be under institutional control for the next 100 years and, after that, the area would be zoned as industrial for an indefinite period with deed restrictions on the use of the groundwater (DOE 1998). For the purposes of this closure plan and the modeling used to support its conclusions, DOE assumes that the area directly on the opposite side (the south side) of Fourmile Branch would be available for residential use (DOE 1998).

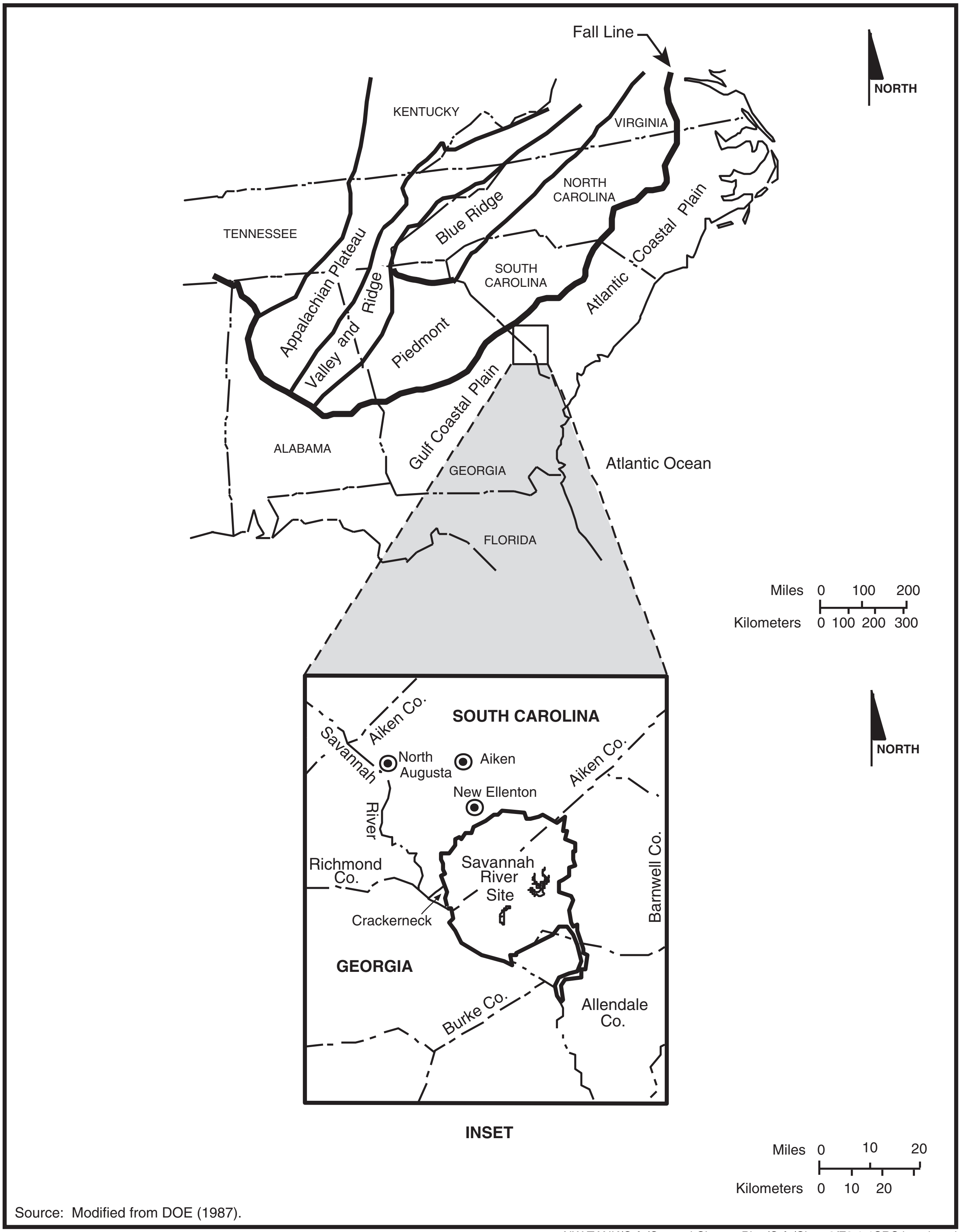
3.1.2 DEMOGRAPHICS

Because collective radiation dose (population dose) to members of the public is not pertinent to the HLW tank system closure, no performance objectives are needed. Therefore, demographic information is not used in the modeling to support this plan. However, if there were to be a performance objective limiting collective radiation dose, demographic data would be needed to assess compliance with this objective. The SRS High-Level Waste Tank Closure EIS (DOE 2002) presents detailed demographic information for the region surrounding SRS.

3.2 Geology and Soils

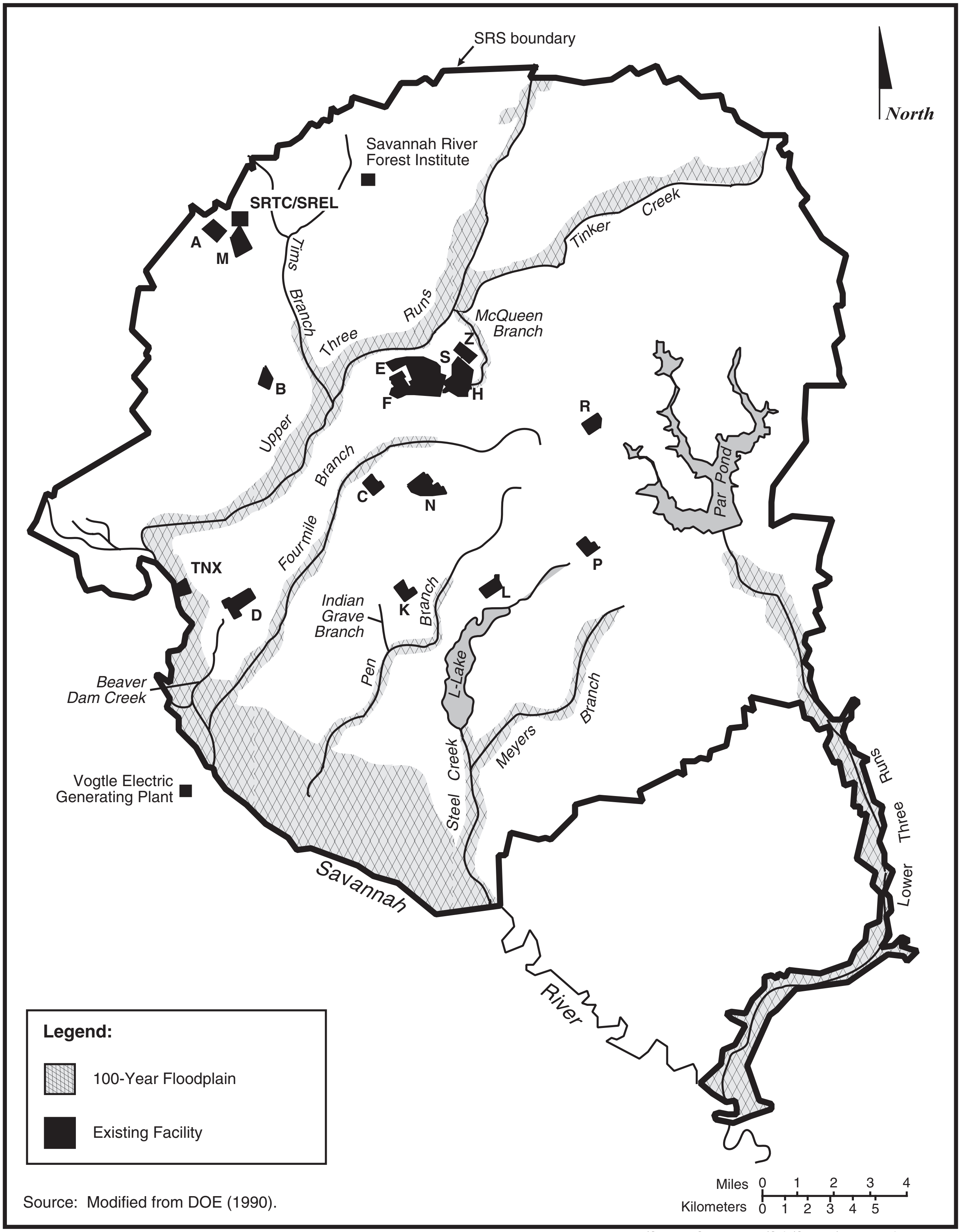
3.2.1 GEOLOGY

SRS is on the Aiken Plateau, which is bounded by the Savannah and Congaree Rivers and extends from the fall line to the Orangeburg Scarp. The highly dissected surface of the Aiken Plateau is characterized by broad interfluvial areas with narrow, steep-sided valleys. Local relief is as much as 300 feet. The plateau is generally well drained, although many poorly drained sinks and depressions (called Carolina Bays) do occur (DOE 1995).



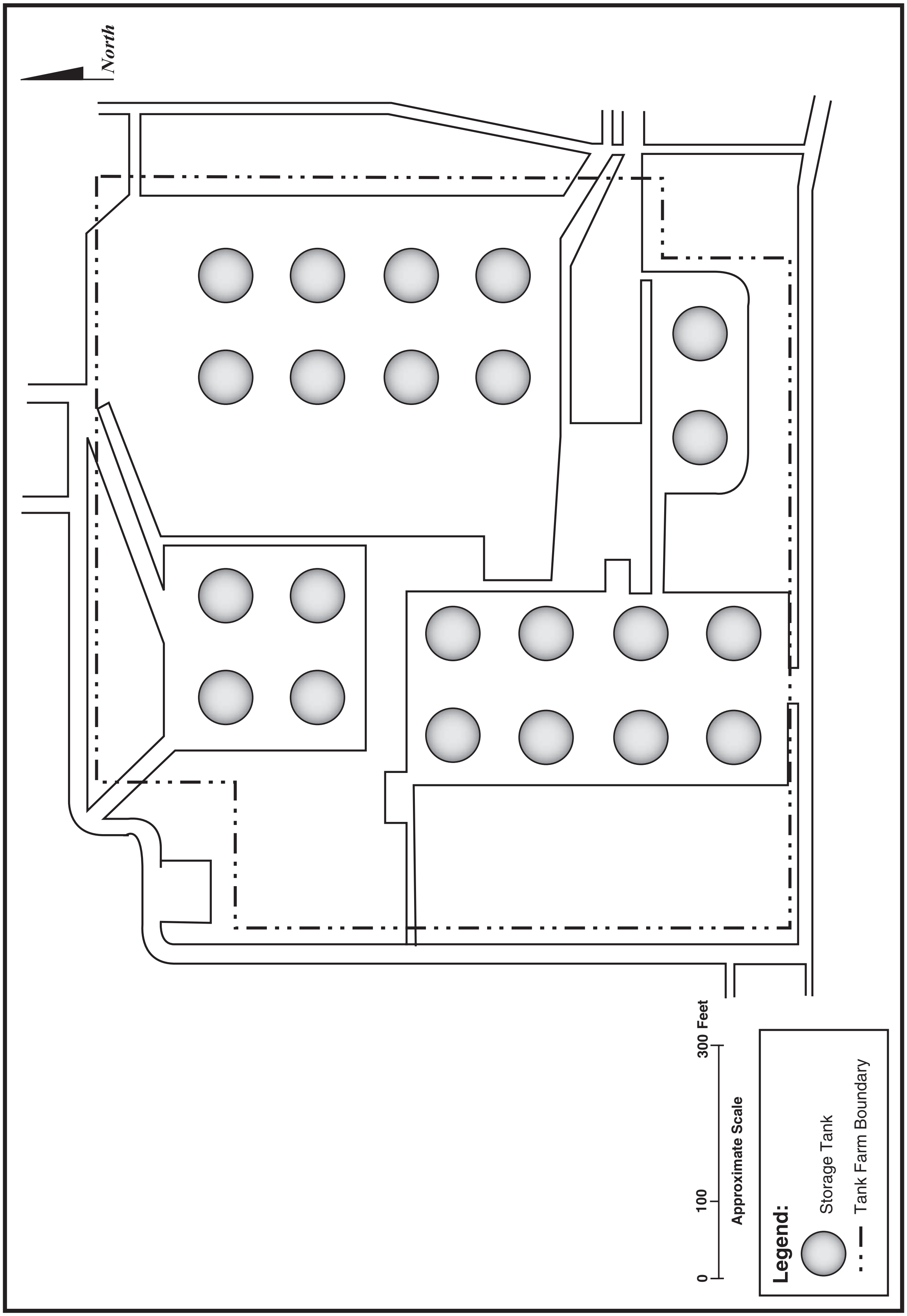
NW TANK/Grfx/General Closure Plan/Grfx/Chap 3/F3.1-1SRS location.ai

Figure 3-1. Generalized location of Savannah River Site and its relationship to physiographic provinces of southeastern United States.



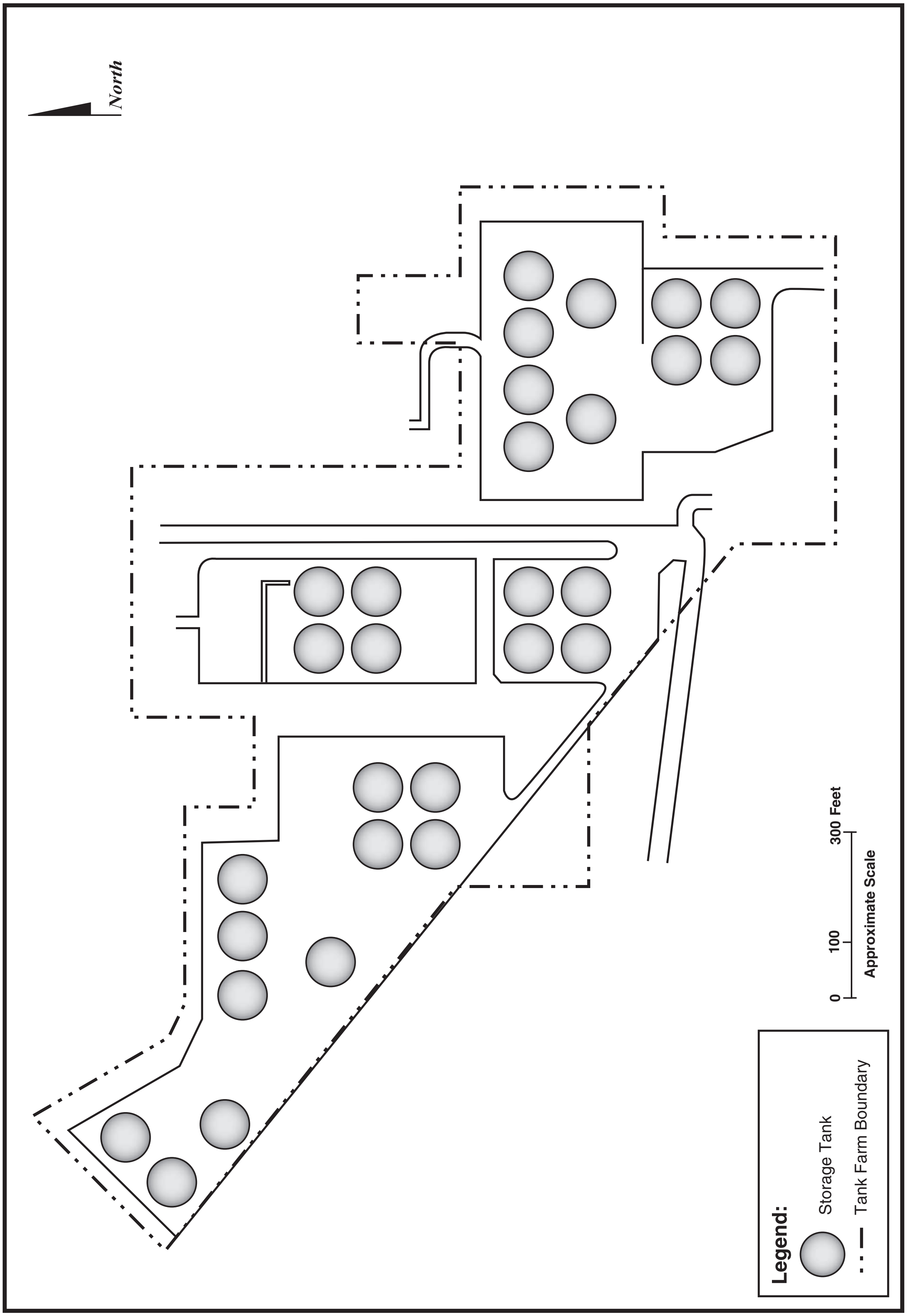
NW Tank/General Closure Plan/Grfx/Chap 3/3-2 100yr floodplain.ai

Figure 3-2. Savannah River Site, showing 100-year floodplain and major stream systems.



NW TANK/General Closure Plan/Grfx/Chap 3/3-3 Gen layout F-Area Tank Farm.ai

Figure 3-3. General layout of F-Area Tank Farm.



NW TANK/General Closure Plan/Grfx/Chap 3/3-4 Gen layout H-Area Tank Farm.ai

Figure 3-4. General layout of H-Area Tank Farm.

The surface of the Upper Atlantic Coastal Plain Province, on which the Aiken Plateau is located, slopes gently seaward. This province is underlain by a southeastern dipping wedge of unconsolidated and semiconsolidated sediments that extends and progressively thickens from the fall line (separates the Piedmont Plateau from the Atlantic Coastal Plain) southeastward to the edge of the continental shelf. The stratigraphic section underlying SRS ranges from approximately 600 feet to more than 1,400 feet of mostly unconsolidated sands, and clays, and limestones of Tertiary and Cretaceous age.

A more complete description of the geology and soils of the F- and H-Areas can be found *in Geology and Hydrogeology of the Savannah River Site* (WSRC 1993a) and in a report titled *Hydrogeologic Framework of West-Central South Carolina* (SCDNR 1995). The latter report, prepared by the State of South Carolina Department of Natural Resources, focuses on SRS and compares the chronostratigraphic, lithostratigraphic, and hydrostratigraphic units in the SRS region.

3.2.2 LOCAL GEOLOGY AND SOILS

The principal surface and near-surface soils in F- and H- Areas consist of cross-bedded, poorly sorted sands and pebbly sands with lenses and layers of silts and clays. The surface and near surface soils contain a greater percentage of clay which has demonstrated a good retention capacity for most radionuclides (Parsons 1996). A significant portion of the surface soils around the F- and H- Area Tank Farms are composed of backfill material resulting from previous excavation and construction activities.

The vadose zone is comprised of the middle to late Miocene-age "Upland Unit," which extends over much of SRS. The term "Upland Unit" is an informal name used to describe sediments at higher elevations located in the Upper Coastal Plain in southwestern South Carolina. This area has also been referred to as the Aiken Plateau which is bounded by the Savannah and Congaree Rivers and extends from the Fall Line to the Orangeburg escarpment. This unit is highly dissected and is characterized by broad interfluvial areas with narrow, steep-sided valleys (SCDNR, 1995). Erosion in these dissected, steep-sided valley areas expose older, underlying deposits.

The occurrence of cross-bedded, poorly sorted sands with clay lenses indicate fluvial deposition (high-energy channel deposits to channel-fill deposits) with occasional transitional marine influence. This depositional environment results in wide differences in lithology and presents a very complex system of transmissive and confining beds or zones (SCDNR, 1995). The lower surface of the "Upland Unit" is very irregular due to erosion of the underlying formations (Fallow and Price, 1992). The thickness of the "Upland Unit" ranges from 16 feet to 40 feet in the vicinity of the F- and H- Area Seepage Basins (WSRC, 1991), but may be as thick as 70 feet in the Central Savannah River Area (Fallow and Price, 1992). The F- and H- Area Seepage Basins are located southwest and west of the F- and H- Area Tank Farms, respectively.

A notable feature of the "Upland Unit" is its compositional variability (Figure 3-5). This formation predominantly consists of red-brown to yellow-orange, gray, and tan colored, coarse to fine grained sand, pebbly sand with lenses and beds of sandy clay and clay. Generally vertically upward through the unit, sorting of grains becomes poorer, clay beds become more abundant and thicker, and sands become more argillaceous and indurated (Fallow and Price, 1992). In some areas, small-scale joints and fractures, both of which are commonly filled with sand or silt, traverse the unit. The mineralogy of the sands and pebbles primarily consists of quartz, with some feldspars. In areas to the east-southeast, sediments may become more phosphatic and dolomitic. The mineralogy of the clays consists of kaolinite, resulting from highly weathered feldspars, and muscovite (Nystrom et al., 1991). The soils at F- and H- Areas may contain as much as 20 to 40 percent clay (WSRC, 1991).

3.3 Groundwater

3.3.1 HYDROGEOLOGY

In the SRS region, the subsurface contains two hydrogeologic provinces. The uppermost, consisting of a wedge of unconsolidated Coastal Plain sediments of Late Cretaceous and Tertiary age, is the Atlantic Coastal Plain Hydrogeologic Province. Beneath the sediments of the Atlantic Coastal Plain Hydrogeologic Province are rocks of the Piedmont Hydrogeologic Province. These rocks consist of Paleozoic igneous and metamorphic basement rocks and lithified mudstone, sandstone, and conglomerates of the Dunbarton basin of the Upper Triassic. Sediments of the Atlantic Coastal Plain Hydrogeologic Province are divided into three main aquifer systems, the Floridan Aquifer System, the Dublin Aquifer System, and the Midville Aquifer System as shown in Figure 3-5 (Aadland et al. 1995). The Meyers Branch Confining System and/or the Allendale Confining System separate the aquifer systems of interest.

Groundwater within the Floridan System (the shallow aquifer beneath the tank farms) flows slowly toward streams and swamps and into the Savannah River at rates ranging from inches to several hundred feet per year. The depth to which nearby streams cut into sediments, the lithology of the sediments, and the orientation of the sediment formations control the horizontal and vertical movement of the groundwater. The valleys of smaller perennial streams, such as Fourmile Branch, McQueen Branch, Crouch Branch, allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (e.g., Upper Three Runs) drain formations of greater depth. With the release of water to the streams, the hydraulic head of the aquifer unit releasing the water can become less than that of the underlying unit. If this occurs, groundwater has the potential to migrate upward from the lower unit to the overlying unit.

3.3.2 GROUNDWATER STANDARDS

All groundwater within the state, including those at the SRS, are classified as Class GB Water for which the State of South Carolina has set quality standards. The South Carolina Department of Health and Environmental Control (SCDHEC) recognizes that Class GB might not be suitable for some groundwater reservoirs and has two other classifications: GA (exceptionally valuable groundwater) and GC (groundwater with little potential for use as an underground source of drinking water). The quality standards that SCDHEC has set for Class GB water are referenced in SCDHEC Regulation R.61-68 H(9) for inorganic and organic chemicals. Items such as manmade radionuclides, priority pollutant volatile organic compounds, pesticides, herbicides, polychlorinated biphenyls, synthetic organic compounds not specified, treated wastes, thermal wastes, deleterious substances, colored wastes, and other wastes or constituents thereof are not to exceed concentrations or amounts that interfere with groundwater use, actual or intended, as determined by SCDHEC. The groundwater beneath the tank farms is classified as GB.

3.3.3 POTENTIALLY AFFECTED AQUIFERS

The aquifers of interest for F- and H-Areas that lie within the General Separations Area (GSA) are the Upper Three Runs and Gordon Aquifers. The Upper Three Runs Aquifer (i.e., Water Table and Barnwell-McBean Aquifers) is the first aquifer zone encountered beneath the F- and H-Area Tank Farms. This aquifer is defined by the hydrogeologic properties of the Tinker/Santee Formation, the Dry Branch Formation, and the Tobacco Road Formation (DOE 1997a). As shown in Figure 3-5 these formations are separated by the Twiggs Clay Member of the Dry Branch Formation that acts as a confining unit (i.e., Tan Clay) that separates the Upper Three Runs Aquifer into an upper and lower zone. The Upper Three Runs Aquifer is severely

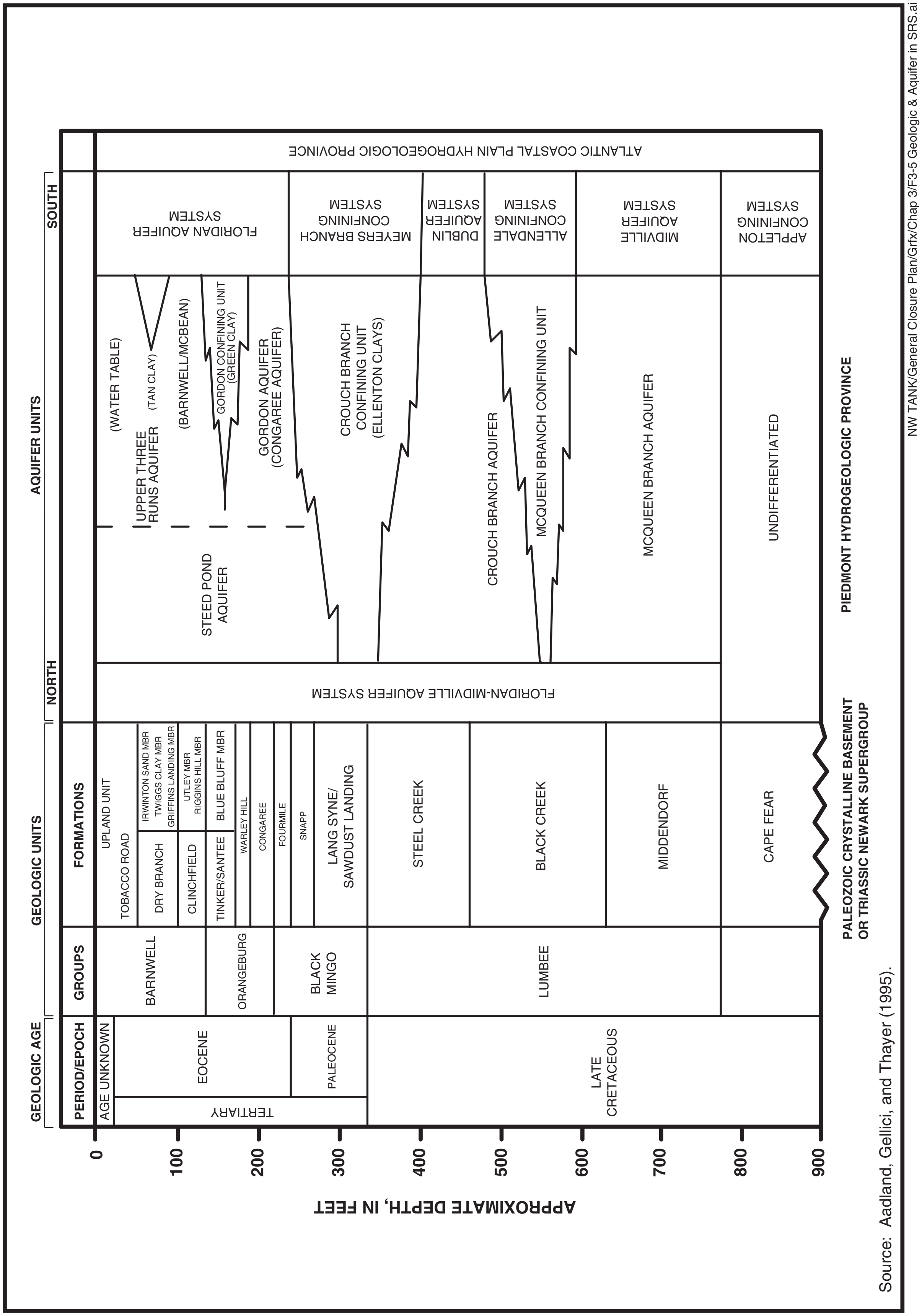


Figure 3-5. Generalized geologic and aquifer units in SRS region.

eroded along both the Upper Three Runs Creek and its tributaries to the north of the tank farms and along Fourmile Branch to the south of the tank farms.

Groundwater flow in the Upper Three Runs Aquifer is generally horizontal but may have a vertically downward component. In the groundwater divide areas generally located between surface water drainages a component of groundwater flow is downward due to the decreasing hydraulic head with increasing depth. Because the F- and H-Area Tank Farms lie near the groundwater divide the groundwater flow direction may be toward either Upper Three Runs and its tributaries to the north or Fourmile Branch to the south. In areas along Fourmile Branch shallow groundwater moves generally in a horizontal direction and deeper groundwater has vertically upward potential to the shallow aquifers. In these areas, hydraulic heads increase with depth. Therefore, along Fourmile Branch any contaminants in the Upper Three Runs Aquifer are prevented from migrating into deeper aquifers by the prevailing hydraulic gradient and the low permeability of the Tan and Green Clay confining units. To the north of the tank farms, however, the rising elevation of the Upper Three Runs Aquifer and the deep incision of Upper Three Runs Creek result in truncation of the entire aquifer. In these areas shallow groundwater may seep out along the major tributaries to Upper Three Runs Creek above the valley floor or may seep downward to the next underlying aquifer zone and discharge along the stream valley.

The Gordon Confining Unit (i.e., Green clay), that separates the Upper Three Runs and Gordon Aquifers, consists of the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone (Figure 3-5). It is not a continuous clay unit but consists of several superimposed lenses of green and gray clay that thicken, thin, and pinch out abruptly. Locally, beds of calcareous mud add to the thickness of the unit with minor interbeds of clayey sand or sand (Aadland et al. 1995).

The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. The Gordon Aquifer is overlain by the lower zone (i.e., Barnwell-McBean aquifer) of the Upper Three Runs Aquifer along the valley of Fourmile Branch. Along Upper Three Runs Creek the Gordon Aquifer has been partially eroded by the deep streambed incision. The aquifer discharges along the outcrop area of Upper Three Runs Creek and is locally recharged by leakage from overlying aquifers in the tank farms vicinity. The southeast-to-northwest hydraulic gradient that is observed for this aquifer layer at the GSA is consistent across SRS.

The stratigraphic relationships of the locally-known aquifer and confining units along with their typical thickness' in the vicinity of the F- and H-Area Tank Farms are shown in Figure 3-6. Figure 3-7 shows the relationship of the tank farms to local surface water features and shows the First Quarter 1993 potentiometric surface map of the Water Table Aquifer. The groundwater divide, potentiometric contours, and groundwater flow arrows shown in Figure 3-7 are representative of the shallow groundwater flow beneath the site (e.g., compare with Figure 6-2 in Chapter 6 of this report) although variations in these features are known to occur over time in response to seasonal and manmade influences.

3.4 Surface Water

The Savannah River, which forms the boundary between Georgia and South Carolina, is the principal surface-water system near SRS. The river adjoins the site along its southwestern boundary for a distance of about 20 miles, and the site is 160 river miles from the Atlantic Ocean. Five upstream reservoirs -- Jocassee, Keowee, Hartwell, Richard B. Russell, and Strom Thurmond – minimize the effects from droughts and the impacts of low flow on downstream water quality and fish and wildife resources in the river. River flow averages about 10,000 cubic feet per second at SRS (DOE 1995).

	HYDROSTRATIGRAPHIC UNIT	THICKNESS RANGE (FEET)
Upper Three Runs Aquifer	Water Table Aquifer	0-110
	Tan Clay	0-33
	Barnwell McBean Aquifer	39-81
Gordon Confining Unit (Green Clay)		2-30
Gordon Aquifer Unit (Congaree Aquifer)		52-107
Crouch Branch Confining Unit (Ellenton Clays)		>100

NW TANK/Grfx/General Closure Plan Update/Grfx/Chap 3/3-6Hydrostratic.ai

Figure 3-6. Hydrostratigraphic Units of the General Separations Area.

NW TANK/Grfx/General Closure Plan/Grfx/Chap 3/3-7 Gen Sep Area water table.ai

Figure 3-7. General Separations Area Water Table Aquifer Surface Data 1Q93.

Five tributaries discharge directly to the Savannah River from SRS: Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs (Figure 3-2). A sixth stream, Pen Branch, which does not flow directly into the river, joins Steel Creek in the Savannah River floodplain swamp. These tributaries drain all of SRS with the exception of a small area on the northeast side, which drains to a tributary of the Salkehatchie River. Each of these six streams originates on the Aiken Plateau in the Coastal Plain and descends 50 to 200 feet before discharging into the river (DOE 1995).

The source of most of the surface water on SRS is either natural rainfall, which averages 49.5 inches annually, water pumped from the Savannah River and used for cooling site facilities, or groundwater discharging to surface streams (WSRC 1995a). The streams, which historically have received varying amounts of effluent from SRS operations, are not commercial sources of water. Downstream of the SRS, the river supplies domestic and industrial water (DOE 1995).

The natural flow of SRS streams range from 10 cubic feet per second in smaller streams to 245 cubic feet per second in Upper Three Runs. In 1995, the mean flow of Upper Three Runs at Road A was 8.0 m^3/s (284 ft^3/s) and the 7Q10 (minimum 7 day average flow rate that occurs with an average frequency of once in 10 years) was 2.8 m^3 (100 ft^3/s). The mean flow in 1995 of Fourmile Branch at Road A-13.2 was 1.1 m^3/s (37.3 ft^3/s) and the 7Q10 was 0.23m^3/s (8.2 ft^3/s) (Halverson et al. 1997). The *SRS Ecology Environmental Information Document* and the *Final Environmental Impact Statement for the Shutdown of the River Water System* at the Savannah River Site contain detailed information on flow rate and water quality of the Savannah River and SRS streams (DOE 1997a).

SCDHEC regulates the physical properties and concentrations of chemicals and metals in SRS effluents under the National Pollutant Discharge Elimination System (NPDES) program. SCDHEC, which also regulates biological water quality standards for SRS waters, has classified the Savannah River and SRS streams as "Freshwaters." "Freshwaters" are described as suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with SCDHEC requirements. "Freshwaters" are suitable for fishing, for the survival and propagation of a balanced indigenous aquatic community of fauna and flora, and for industrial and agricultural uses. A comparison of 1996 Savannah River water quality analyses showed no significant differences between up and downstream SRS stations and are within guidelines for drinking water established by the U.S. Environmental Protection Agency (EPA), SCDHEC, and DOE (Arnett and Mamatey 1999a).

F- and H-Areas are situated on the divide that separates the drainage into Upper Three Runs (including McQueen Branch and Crouch Branch) and Fourmile Branch; approximately half of each area drains into each stream (DOE 1997b). F- and H-Areas are relatively elevated areas of SRS and are centrally located inside the SRS boundary. Surface elevations range from approximately 270 to 320 feet above mean sea level for F- and H-Areas, respectively. The F- and H-Areas are drained by Upper Three Runs to the north and west and by Fourmile Branch to the south. In addition, the Water Table Aquifer for both F- and H-Areas outcrops at the seeplines along both Fourmile Branch and Upper Three Runs.

Upper Three Runs, the longest of the SRS streams, is a large blackwater stream in the northern part of SRS that discharges to the Savannah River. It drains an area of over 195 square miles and is approximately 25 miles long, with its lower 17 miles within SRS boundaries. This creek receives more water from underground sources than other SRS streams and is the only stream with headwaters arising outside the site. It is the only major tributary on SRS that has not received thermal discharges (Halverson et al. 1997). The Upper Three Runs valley has meandering channels, especially in the lower reaches. It has a steep southeastern side and gently sloping northwestern sides (WSRC 1995a).

Fourmile Branch is a blackwater stream that originates near the center of SRS and flows southwest for 15 miles before emptying into the Savannah River (Halverson et al. 1997). It drains an area of about 22 square miles inside SRS including much of F-, H-, and C-Areas. Fourmile Branch flows parallel to the Savannah River behind natural levees and enters the river through a breach downriver from Beaver Dam Creek (WSRC 1995a). In its lower reaches, Fourmile Branch broadens and flows via braided channels through a delta formed by the deposition of sediments eroded from upstream during high flows. Downstream from the delta, the channels rejoin into one main channel. Most of the flow discharges into the Savannah River while a small portion flows west and enters Beaver Dam Creek (DOE 1995). The valley is V-shaped, with sides varying from fairly steep to gently sloping. The floodplain is up to 1,000 feet wide (WSRC 1995a).

There are various potential sources of contamination to the Upper Three Runs and Fourmile Branch watersheds in and around the F- and H-Areas. These potential sources have been identified in the SRS Federal Facility Agreement, Appendix C, RCRA/CERCLA Units and are listed in Table 3-1. These potential sources could contribute contaminants to the surface waters of Upper Three Runs and Fourmile Branch in the same manner as the F- and H-Area Tank Farms.

3.5 Biota

This section describes the biota specific to both the general site area and the F- and H-Areas.

Table 3-1. Potential F- and H-Area contributors of contamination to Upper Three Runs and Fourmile Branch.

Fourmile Branch Watershed	Upper Three Runs Watershed
Burial Ground Complex Groundwater[a]	Burial Ground Complex Groundwater[a]
Burial Ground Complex [the Old Radioactive Waste Burial Ground (643-E) and Solvent Tanks S01-S22 portions]	Burial Ground Complex [the Low-Level Radioactive Waste Disposal Facility (643-7E) portion]
F-Area Coal Pile Runoff Basin, 289-F	Burma Road Rubble Pit, 231-4F
F-Area Hazardous Waste Management Facility, 904-41G, -42G, -43G	F-Area Burning/Rubble Pits, 231-F, -1F, -2F
F-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-1F	F-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-1F
F-Area Retention Basin, 281-3F	
F-Area Seepage Basin Groundwater Operable Unit	H-Area Coal Pile Runoff Basin, 289-H
H-Area Hazardous Waste Management Facility, 904-44G, -45G, -46G, -56G	H-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-H
H-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-H	
H-Area Retention Basin, 281-3H	Old F-Area Seepage Basin, 904-49G
H-Area Seepage Basin Groundwater Operable Unit	211-FB Pu-239 Release, 081-F
H-Area Tank Farm Groundwater	
Mixed Waste Management Facility, 643-28E	
Warner's Pond, 685-23G	

a. Units located in more than one watershed.

3.5.1 GENERAL SITE AREA

The SRS represents one of the most intensively studied environmental systems in the United States. The area has a variety of habitats, ranging from well-drained upland forests to swamps, other wetlands, and river systems. The entire site has been designated as a National Environmental Research Park by DOE. The aquatic resources of SRS have been the subject of intensive study for more than 30 years. Research has focused on the flora and fauna of the Savannah River, the tributaries of the river that drain the SRS, and the artificial impoundments on two of the tributary systems (DOE 1995). The *SRS Ecology Environmental Information Document* (Wike et al. 1994) describes the aquatic and terrestrial vegetation cover types and wildlife species that are commonly found on SRS and evaluates the importance and sensitivity of the systems to site activities. In addition, several monographs; the eight volume comprehensive cooling water study; and several EISs describe the aquatic biota (fish and macroinvertebrates) and aquatic system of SRS (DOE 1995).

The diversity and abundance of wildlife inhabiting the SRS reflect the variety of habitats found on the site. SRS is near the transition between northern oak-hickory-pine forest and southern mixed forest. Species typical of both occur on the site (DOE 1995). Each of the six streams that drain SRS has floodplains with bottomland hardwood forests or scrub-shrub wetlands in varying stages of succession. Areas that are slightly elevated and well drained are characterized by a mixture of oak species as well as red maple, sweetgum, and other hardwood species. Low-lying areas that are continuously flooded are dominated by second-growth bald cypress and water tupelo. The mild climate and diversity of aquatic and terrestrial habitats on SRS support an abundant herpetofauna, including 44 species of amphibiants and 59 species of reptiles. The Savannah River Ecology Laboratory has conducted extensive studies of reptiles and amphibians living in the SRS wetlands (Halverson et al. 1997).

More than 255 species of birds occur on the SRS. Large mammals inhabiting the site include white-tailed deer and feral hogs. Raccoon, beaver, and otter are relatively common throughout the wetlands of SRS. In addition, the gray fox, opossum, bobcat, gray squirrel, fox squirrel, eastern cottontail, mourning dove, northern bobwhite, and eastern wild turkey are common at SRS (DOE 1995). Diatoms and approximately 400 species of algae have been identified in the Savannah River. Aquatic macrophytes are limited to areas of reduced current and edges of the river's tributaries. Eight species of vascular plants have been identified in the river adjacent to SRS. A diverse aquatic invertebrate fauna is found in the shallow areas and quiet backwaters and marshes off the river. The river and associated marshes and tributaries support a diverse fish fauna (WSRC 1991).

Threatened, endangered, and candidate plant and animal species known to occur or that might occur on the SRS include the smooth coneflower, bald eagle, woodstork, red-cockaded woodpecker, and shortnose sturgeon. The U.S. Fish and Wildlife Service has not designated any critical habitats on the SRS (WSRC 1991).

3.5.2 F- AND H-AREAS

The F- and H-Area Tank Farms are located within a densely developed, industrialized area of SRS. The immediate area provides habitat for only those animal species typically classified as urban wildlife (Mayer and Wike 1997). Species commonly encountered in this type of urban landscape include the Southern toad, green anole, rat snake, rock dove, European starling, house mouse, opossum, and feral cats and dogs (Mayer and Wike 1997). Lawns and landscaped areas within F- and H-Area also provide some marginal terrestrial wildlife habitat. A number of ground-foraging bird species (e.g., American robin, killdeer, and mourning dove) and small mammals (e.g., cotton mouse, cotton rat, and Eastern cottontail) that use lawns and landscaped areas around buildings may be present at certain times of the year, depending on the level of human activity (e.g., frequency of mowing)

(Mayer and Wike 1997). Pine plantations managed for timber production by the U.S. Forest Service (under an interagency agreement with DOE) occupy surrounding areas (DOE 1994).

As mentioned in Section 3.3.2, F- and H-Areas are on a near-surface groundwater divide, and groundwater from these areas discharges at seeplines adjacent to Fourmile Branch and Upper Three Runs. The biota associated with the seepage areas are discussed in the following paragraphs.

The Fourmile Branch seepline area is located in a bottomland hardwood forest community (DOE 1997b). The canopy layer of this bottomland forest is dominated by sweetgum, red maple, and red bay. Sweet bay is also common. The understory consists largely of saplings of these same species, as well as a herbaceous layer of smilax, dog hobble, giant cane, poison ivy, chain fern, and hepatica. At the seepline's upland edge, scattered American holly and white oak occur. Dominant along Fourmile Branch in this area are tag alder, willow, sweetgum, and wax myrtle.

The Fourmile Branch floodplain in the vicinity of the seepline provides habitat for a myriad of aquatic, semiaquatic, and terrestrial animal species. During a site visit on April 5, 1996, the following animals were identified in the vicinity of the seepage area by direct observation or by tracks, scat, and bird calls: white-tailed deer, rabbit, raccoon, beaver, mink, shrew, various small rodents, crayfish, gray rat snake, and several species of birds. For detailed lists of animals known or expected to occur in this area, see Gibbons et. al (1986), (DOE 1997a) and Halverson et al. (1997).

The Upper Three Runs seepline is located in a bottomland hardwood forest community (Halverson et al. 1997). The wildlife species in this area are expected to be similar to those described in the preceding paragraphs.

According to summaries of studies on Upper Three Runs documented in the *SRS Ecology Environmental Information Document* (Halverson et al. 1997), the macroinvertebrate communities of Upper Three Runs drainage are unusual. They include many rare species and contain species not often found living together in the same freshwater system. Upper Three Runs is a spring-fed stream and is colder and generally clearer than most surface water at its low elevation, typical species of unpolluted streams in northern North America or Southern Appalachian Mountains are found here along with lowland (Atlantic Coastal Plain) species (Halverson et al. 1997).

The fish community of Upper Three Runs is typical of third- and higher-order streams on SRS that have not been greatly affected by industrial operations, with shiners and sunfish dominating collections. The smaller tributaries to Upper Three Runs are dominated by shiners and other small-bodied species (i.e., pirate perch, madtoms, and darters) indicative of unimpacted streams in the Atlantic Coastal Plain (Halverson et al. 1997). In the 1970s, the U.S. Geological Service designated Upper Three Runs as a National Hydrological Benchmark Stream due to its high water quality and rich fauna. However, this designation was rescinded in 1992 due to increased development of the Upper Three Runs watershed north of the SRS (Halverson et al. 1997).

Following the shutdown of C-Reactor in June 1985, macroinvertebrate communities began to recover, and in some reaches of Fourmile Branch began to resemble those in non-thermal and unimpacted streams of the SRS (Halverson et al. 1997). Fourmile Branch was rapidly recolonized by fish from the Savannah River swamp system. Centrarchids (sunfish) and cyprinids (minnows) were the most common taxa.

No endangered or threatened fish or wildlife species have been recorded near the Fourmile Branch and Upper Three Runs seeplines. The seeplines and associated bottom land community do not provide habitat favored by endangered or threatened fish and wildlife species known to occur at SRS. The American alligator is the only federally-protected species that could potentially occur in the area of the seeplines.

Several populations of rare plants have been found in undeveloped areas adjacent to F- and H-Areas. One population of *Nestronia* and three populations of Oconee azalea (*Rhododendron flammeum*) were located on the steep slopes adjacent to the Upper Three Runs floodplain approximately one mile north of the F-Area Tank Farm (DOE 1995: SRFS 1996). Populations of two additional rare plants, Elliott's croton (*Croton elliotti*) and spathulate seedbox (*Ludwigia spathulata*) were found in the pine forest southeast of H-Area, approximately one-half mile from the H-Area Tank Farm (SRFS 1996).

3.6 Air Quality

This section describes the climate, meteorology, and ambient air quality at SRS.

3.6.1 CLIMATE AND METEOROLOGY

The climate at SRS is temperate with short mild winters and long humid summers. Throughout the year, the weather is affected by warm, moist maritime air masses (DOE 1995). The average annual temperature at SRS is 64.7°F. July is the warmest month of the year with an average daily maximum of 92°F and an average daily minimum near 72°F; January is the coldest month with an average daily high around 56°F and an average daily low of 36°F. Temperature extremes recorded at SRS since 1961 range from a maximum of 107°F in July 1986 to -3°F in January 1985.

Annual precipitation averages 49.5 inches. Summer is the wettest season of the year with an average monthly rainfall of 5.2 inches. Fall is the driest season with a monthly average rainfall of 3.3 inches. Relative humidity averages 70 percent annually with an average daily maximum of 91 percent and an average daily minimum of 45 percent.

Wind directions frequently observed at SRS show that there is no prevailing wind at SRS, which is typical for the lower Midlands of South Carolina. According to wind data collected from 1992 through 1996 and illustrated in Figure 3-8, winds are most frequently from the southwest sector (9.7 percent) (Arnett and Mamatey 1998a). Measurements of turbulence are used to determine whether the atmosphere has relatively high, moderate, or low potential to disperse airborne pollutants (commonly identified as unstable, neutral, or stable atmospheric conditions, respectively). Generally, SRS atmospheric conditions were categorized as unstable 56 percent of the time (DOE 1997c).

The average wind speed for a measured 5-year period was 8.5 miles per hour. Average hourly wind speeds of less than 4.5 miles per hour occur approximately 10 percent of the time (NOAA 1994).

An average of 54 thunderstorm days per year were observed at the National Weather Service in Augusta, Georgia office during the period 1951 to 1995. About half of the thunderstorms occurred during the summer. Since operations began at SRS, 10 confirmed tornadoes, which have occurred on or in close proximity to the Site. Several of these tornadoes, which were estimated to have winds up to 150 miles per hour, did considerable damage to forested areas of SRS. None caused damage to structures. Tornado statistics indicate that the average frequency of a tornado striking any single point on the Site is 2×10^{-4} per year or about once every 5,000 years (Weber 1998).

The highest sustained wind (fastest-mile) recorded at the Augusta National Weather Service Office is 82 miles per hour. Hurricanes struck South Carolina 36 times during the period 1700 to 1992, which equates to an average recurrence frequency of once every 8 years. A hurricane force wind of 75 miles per hour has been observed at SRS only once, during Hurricane Gracie in 1959.

3.6.2 AMBIENT AIR QUALITY

SCDHEC has air quality regulatory authority at SRS and determines compliance based on pollutant emission rates and estimates of ambient concentrations at the SRS facility boundary based on air dispersion modeling results. DOE complies with National Ambient Air Quality Standards and the gaseous fluoride and total suspended particulate standards, as required by SCDHEC Regulation R.61-62.5, Standard 2 ("Ambient Air Quality Standards"). DOE has identified emission sources for 139 of the 256 SCDHEC Standard No. 8 air toxics; the modeling results indicate that SRS complies with SCDHEC air quality standards (DOE 1995).

3.6.3 EXISTING RADIOLOGICAL CONDITIONS

Ambient air concentrations of radionuclides at SRS include nuclides of natural origins, such as radon from uranium in soils; manmade radionuclides, such as fallout from worldwide testing of nuclear weapons; and emissions from coal-fired and nuclear power plants. DOE operates a 23-station atmospheric surveillance program; the stations are inside the SRS perimeter, on the perimeter, and as far as 100 miles from SRS (WSRC 1997).

Routine SRS operations result in releases of quantities of alpha- and beta-gamma-emitting radioactive materials in the form of gases and particulates. Gross alpha and gross beta meas urements are used as a screening method for determining the concentration of all radionuclides in the air.

The radioactivity in air measured at SRS and at distances of 25 miles from SRS is listed in Table 3-2. With the exception of tritium concentrations, no significant difference was observed between the average concentration measured on site near the operating facilities and the average concentration observed at the site perimeter.

3.7 Cultural Resources

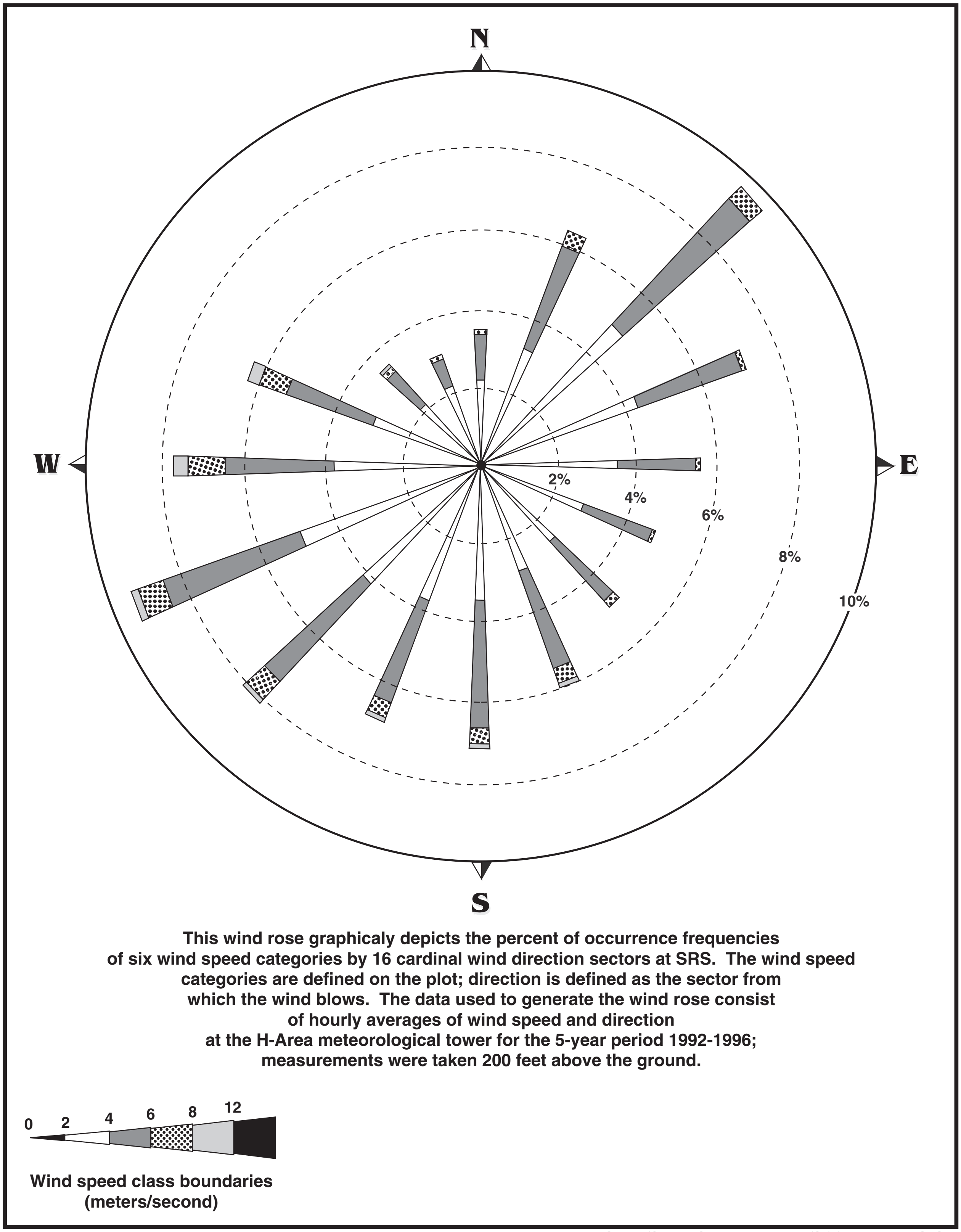
DOE uses a memorandum of agreement, ratified on August 24, 1990, on the management of cultural resources at the SRS to identify cultural resources, assess them in terms of eligibility for the National Register of Historic Places, and develop mitigation plans for affected resources in consultation with the State Historic Preservation Officer.

If any historic or archaeological resources are threatened by HLW tank system closure activities under this plan, DOE would take appropriate steps to identify the resource and to contact the appropriate agency (i.e., the Savannah River Archaeological Research Program and the South Carolina Institute of Archaeology and Anthropology at the University of South Carolina).

Table 3-2. Radioactivity in air at the SRS boundary and at a 25-mile radius during 1998 (picocuries per cubic meter).[a]

Location	Tritium	Gross alpha	Gross beta	Cobalt-60	Cesium-137	Strontium-89.90	Plutonium-238	Plutonium-239
Site boundary								
Average[b]	11.3	1.4×10^{-3}	0.017	1.3×10^{-3}	2.6×10^{-4}	1.1×10^{-5}	7×10^{-7}	(c)
Maximum[d]	79.6	5.9×10^{-3}	0.061	0.021	0.011	1.1×10^{-4}	4.1×10^{-6}	7.4×10^{-7}
25-mile radius								
Average	6.7	1.5×10^{-3}	0.019	1.5	2.8×10^{-4}	(c)	(c)	(c)
Maximum	54	3.6×10^{-3}	3.0×10^{-3}	0.011	7.9×10^{-3}	5.1×10^{-4}	8.6×10^{-6}	2.9×10^{-6}

a. Source: Arnett and Mamatey (1999a).
b. The average value is the average of the arithmetic means reported for the site perimeter sampling locations.
c. Below background levels.
d. The maximum value is the highest value of the maximum reported for the site perimeter sampling locations..



P: NW Tank Closure/General Closure Plan Update/Grfx/3-8 Wind rose SRS.ai

Figure 3-8. Wind Rose for SRS, 1992-1996.

References

Arnett, M. W., and A. R. Mamatey, 1999a, *Savannah River Site Environmental Report for 1998*, WSRC-TR-98-00312, Westinghouse Savannah River Company, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1990, *Final Environmental Impact Statement - Continued Operation of K-, L-, and P-Reactors, Savannah River Site*, DOE/EIS-0147, Volume I, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1994b, *Final F-Canyon Plutonium Solutions Environmental Impact Statement, Savannah River Plant, Aiken, South Carolina*, DOE/EIS-0219, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1995, *Final Environmental Impact Statement, Waste Management, Savannah River Plant, Aiken, South Carolina*, DOE/EIS-0217, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1997a, *Final Environmental Impact Statement Shutdown of the River Water System at the Savannah River Site,* DOE/EIS-0268, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1997c, *Draft Environmental Impact Statement*, *Accelerator Production of Tritium at the Savannah River Site*, DOE/EIS-0270D, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1998, *Savannah River Site Future Use Plan,* Savannah River Operations Office, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency), 1993, Federal Facility Agreement between the U.S. Environmental Protection Agency Region IV, the U.S. Department of Energy, and the South Carolina Department of Health and Environmental Control, Docket No. 89-05-FF, August 16.

Fallow, Wallace and Price, Van, *Geological Investigations of the Central Savannah River Area, South Carolina and Georgia,* Carolina Geological Society Field Trip Guidebook, 1992.

Gibbons, J. W., W. D. McCort, J. L. Knight, and S. S. Novak, 1986, *Semi-Aquatic Vertebrates of the Savannah River Plant, Comprehensive Cooling Water Study, Final Report*, Savannah River Ecology Laboratory, Aiken, South Carolina.

Halverson, N. V., L. D. Wike, K. K. Patterson, J. A. Bowers, A. L. Bryan, K. F. Chen, C. L. Cummins, B. R. del Carmen, K. L. Dixon, D. L. Dunn, G. P. Friday, J. E. Irwin, R. K. Kolka, H. E. Mackey, Jr., J. J. Mayer, E. A. Nelson, M. H. Paller, V. A. Rogers, W. L. Specht, H. M. Westbury, and E. W. Wilde 1997, *SRS Ecology Environmental Information Document*, WSRC-TR-97-0223, Westinghouse Savannah River Company, Aiken, South Carolina.

Mayer, J. J. and L. D. Wike, 1997, *SRS Urban Wildlife Environmental Information Document*, WSRC-TR-97-0093, Westinghouse Savannah River Company, Aiken, South Carolina.

NOAA (National Oceanic and Atmospheric Administration), 1994, *Local Climatological Data Annual Summaries for 1993 Part II - Southern Region*, National Climatic Data Center, Asheville, North Carolina.

Nystrom, Paul, Widoughby, Ralph, Price, Lucille Kite, "Cretaceous and Tertiary Stratigraphy of the Upper Coastal Plain, South Carolina," *The Geology of the Carolinas*, Carolina Geological Society, The University of Tennessee Press, 1991.

SCDHEC (South Carolina Department of Health and Environmental Control), 1993, Water Classifications and Standards, Regulation 61-68.

SCDNR (South Carolina Department of Natural Resources), 1995, *Hydrogeologic Framework of West Central, South Carolina*, Water Resources Division Reports.

SRFS (Savannah River Forest Station), 1996, *Savannah River Site Threatened, Endangered, and Sensitive Flora and Fauna*, map, compiled by SRFS-GIS, New Ellenton, South Carolina, July.

Weber, A. H., J. H. Weber, M. J. Parker, C. H. Hunter, C. O. Minyard, 1998, *Tornado, Maximum Wind Gust, and Extreme Rainfall Event Recurrence Frequencies at the Savannah River Site (U)*, WSRC-TR-98-00329, Westinghouse Savannah River Company, Aiken, South Carolina.

Wike, L. D., D. B. Moore-Shedrow, and C. B. Shedrow, 1996, *Site Selection for the Accelerator for Production of Tritium at the Savannah River Site*, WSRC-TR-96-0279 Rev. 1, Westinghouse Savannah River Company, Aiken, South Carolina, October 9.

WSRC (Westinghouse Savannah River Company), 1991, *Baseline Risk Assessment For The F- and H-Area Seepage Basins Groundwater Unit, Draft Final*, WSRC-RP-91-950, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1993a, *Draft Environmental Information Document: Geology and Hydrogeology of the Savannah River Site*, WSRC-TR-93-147, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1995a, *Safety Analysis Report Savannah River Site*, WSRC-SA-19, Rev. 0, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1997, *Savannah River Site Environmental Report for 1997*. WSRC-TR-97-00322, Aiken, South Carolina.

CHAPTER 4. WASTE REMOVAL/CLOSURE STRATEGY

This closure plan sets forth the general protocol by which U.S. Department of Energy (DOE) will close the F- and H-Area high-level waste (HLW) tank systems at SRS after completion of waste removal to ensure protection of human health and the environment while being cost effective and prudent. The scope of the tank closure project (Figure 4-1) encompasses the general strategy for HLW tank systems closure, including the general methods for selection and implementation of appropriately protective methods for decontamination of tank systems and stabilization of residual contaminants left in individual tank systems. With respect to interfacing programs, the SRS Environmental Restoration (ER) Program will perform subsequent evaluation or remediation of contaminant releases as part of the overall remediation of the F- and H-Area Tank Farms.

The preferred closure option for the HLW tank systems consists of removing the waste from the tanks using hydraulic slurrying techniques or other cleaning techniques of comparable or greater effectiveness. After waste removal, each tank will be filled with pumpable, self-leveling backfill material(s) (e.g., grout). The fill material will be high enough in pH to be compatible with the carbon-steel walls of the waste tank. The fill material formula will include chemical properties that will retard the movement of radionuclides and chemical constituents from the closed tank. The *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement* (DOE 2002) provides DOE's analysis of a range of major alternatives for closing the HLW tank systems and DOE's selected closure configuration alternatives. Chapter 6 describes the methods DOE will use to evaluate the selected configuration with respect to performance objectives and refine the closure configuration, as appropriate. DOE's plans for closure of individual HLW tank systems will documented in specific modules for approval by South Carolina Department of Health and Environmental Control (SCDHEC).

4.1 Waste Removal and Schedule for Tank System Closure

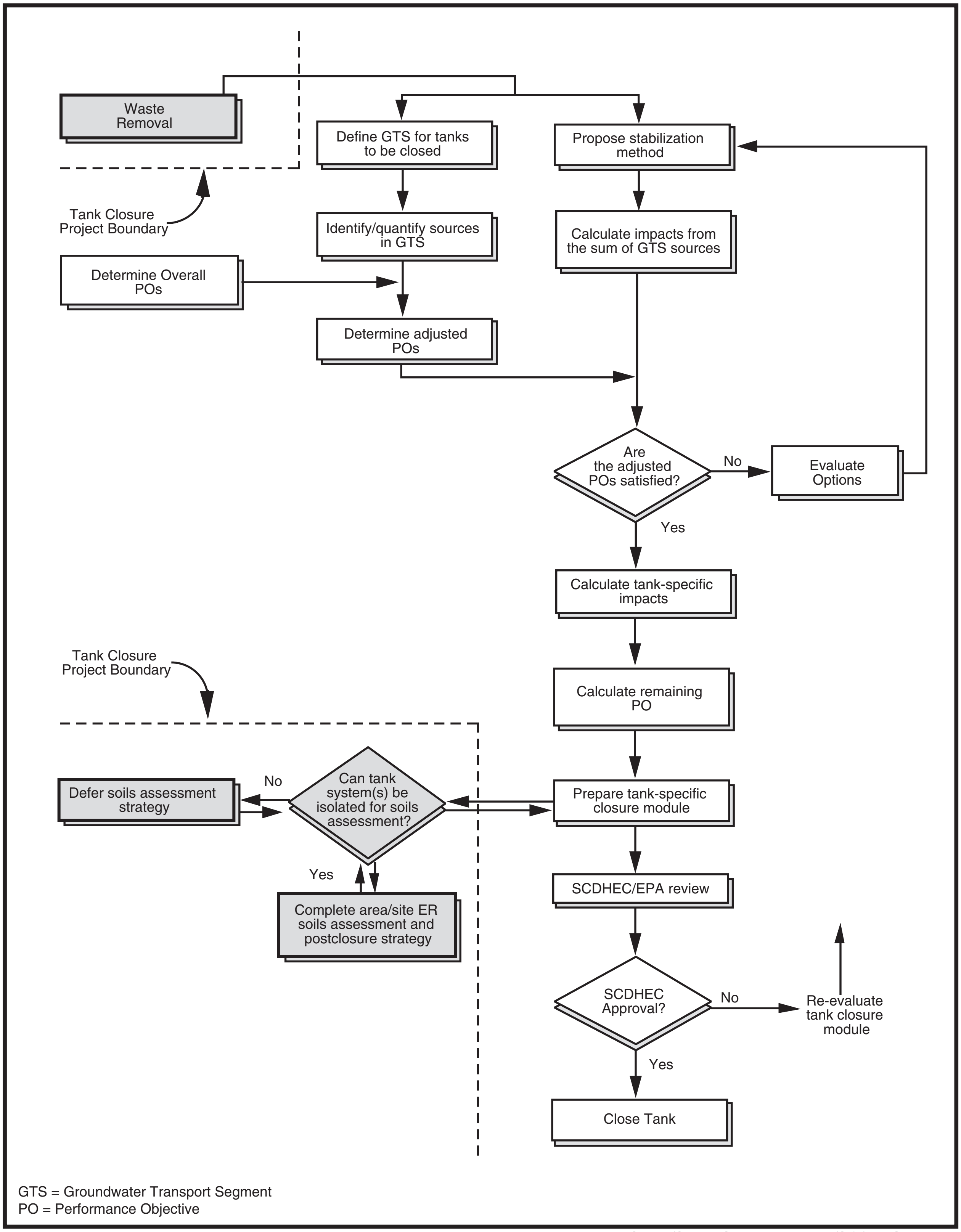
Before turning a HLW tank system over to the tank closure project, DOE will remove waste from the tanks. Waste removal is subject to a variety of operating constraints including (1) maintaining emergency tank space, (2) controlling tank chemistry, including radionuclide and fissile material inventory, (3) requirements to remove waste from tanks with a leakage history and tanks that do not meet secondary containment and leak detection requirements, and (4) preparing waste for downstream waste treatment facilities. The complex interdependency of the safety and process requirements of the various HLW facilities drives the sequencing of waste removal from tanks.

The waste removal process will use the following techniques or other techniques of comparable or greater effectiveness; Appendix A provides additional detail.

- Bulk waste removal - Slurry pumps, transfer pumps, and transfer jets will be used to remove as much HLW as practical from the tank systems.

- ~~Spray~~ Water washing ~~–~~ If needed t~~T~~he interior of the tank will be ~~sprayed~~ washed with ~~jets of hot~~ water to dislodge loose contamination that was not removed during bulk waste removal.

- Annulus cleaning - On tanks that have leaked waste from primary to secondary containment, as much waste as is practical will be removed from the annulus.



P: NW Tank Closure/General Closure Plan Update/Grfx/F1-1 Summary.ai

Figure 4-1. Summary of HLW tank closure process.

After the tank closure process begins for a given tank, DOE may determine that further waste removal of a particular tank is necessary to meet the performance objectives. DOE will then perform ~~enhanced~~ further waste removal, such as acid rinsing, ~~or~~ mechanical ~~means~~methods, or other means.

The tanks are grouped, by operational interdependency or other rationale. See Figures 2-3 and 2-4 for tank groupings. Just as waste removal has a sequence necessitated by various requirements and constraints, tank groupings will be closed in a necessary sequential order following a DOE schedule. The rationale for the ordering of closure within a group will be detailed in the first module developed for each tank grouping. The ancillary equipment or facilities not construed as “waste tanks” such as evaporator systems and concentrate transfer system may be closed independently of waste tank closure.

DOE’s anticipated schedule~~s~~ for closure of the HLW tank systems ~~are provided in the *Savannah River Site High Level Waste System Plan* (WSRC 1999). The closure schedules were~~was developed in accordance with Federal and state agreements. The Federal Facility Agreement (FFA) (EPA 1993) includes provisions for removal from service of noncompliant tanks (i.e., tanks that do not meet the standards set forth in Appendix B of the Agreement). ~~The “F/H-Area High Level Waste Removal Plan and Schedule” (Waste Removal Plan and Schedule) was submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and Environmental Protection Agency (EPA) Region IV on June 22, 1998.~~ The Waste Removal Plan and Schedule provides dates for removal from service and operational closure of each noncompliant tank and commits to complete closure of all noncompliant tanks ~~no later than fiscal year 2022~~. The Waste Removal Plan and Schedule is provided in Appendix E of this plan.

4.2 Determination and Use of Performance Objectives

DOE has identified pertinent substantive requirements with which it will comply and guidance it will consider (Chapter 5) to ensure that closure of the tank systems will be protective of human health and the environment. DOE will use these requirements and guidance to develop tank system closure performance objectives that provide a basis for comparison of different closure configurations. The performance objectives apply to the completed closure of all 51 tank systems; however, DOE must close the tanks one at a time over a period of decades. Therefore, the Department has developed an iterative methodology of accounting for the piecewise consumption of the performance objectives as the tanks are closed. The methodology ensures that when the final tank is ready to be closed, a sufficient component of the performance objectives remains to ensure public health and safety and environmental protection.

To further ensure that closure of the tank systems will be protective of human health and the environment, DOE considers contributions from non-tank farm related contaminants. Studies of groundwater transport (see Section 6.3.3) in the General Separations Area indicate that contaminant plumes from F- and H-Area tanks will not intersect. Therefore, DOE has established independent Groundwater Transport Segments (GTSs) for the two tank farms that represent the contaminant plume from the tank farm. DOE requires that contributions from all contaminant sources within a GTS, both tank farm-related and non-tank farm-related, be considered in comparison of modeled impacts to the performance objectives.

4.3 Closure Module Preparation and Approval

On completion of bulk waste removal and water rinsing, each tank or group will be sampled to estimate the inventory of contaminants in the residual waste. This waste characterization information will be used to select a closure configuration. Chapter 6 describes the methodology of calculating closure impacts and comparing them against the performance objectives. If the performance objectives are met, the closure configuration will be proposed in a tank-specific module. If performance objectives cannot be met, additional waste removal steps could be taken or the stabilization method could be revised to comply with the performance objectives.

A tank-specific closure module detailing the closure configuration of an individual tank system will be submitted to SCDHEC for review and approval. In addition, the closure module will be provided to EPA Region IV and SCDHEC FFA project managers for review to ensure consistency with the FFA requirements for overall remediation of the Tank Farms. The closure module will be provided to members of the public for their review and comment prior to SCDHEC approval.

If necessary, additional individual modules will be written for the evaporators, diversion boxes, pump pits, and transfer lines~~,~~. Each module will be a stand-alone document and will build off of this General Closure Plan and provide specific details for closure of an individual HLW tank system. The tank-specific module will present analyses and modeling calculations to show that the proposed closure configuration (i.e., combination of source removal/reduction and stabilization options) is protective of human health and the environment and that the applicable performance objectives will be met. In addition, the module will contain characterization information on the residual waste, describe the end-state of the tank (e.g., type and characteristics of fill material, residual volume and contamination level), and include details (e.g., methods, schedule) for implementing the closure. ~~and the In-Tank Precipitation Facility filter and stripper building~~. ~~In addition, the closure module will be provided to EPA Region IV and SCDHEC FFA project managers for review to ensure consistency with the FFA requirements for overall remediation of the Tank Farms.~~

4.4 Tank Stabilization

Each of the HLW tanks has a unique operating history, as well as various hydrogeologic settings, such as the distance from the water table and the distance to nearby streams. DOE will determine the closure configuration for each tank or group of tanks on a case-by-case basis, although all closures will have common features. Common features include (1) isolation by eliminating mechanical and electrical services, removing or isolating accessible piping and conduits, and cutting and capping transfer lines, and (2) pumping fill material into the facility~~, and (3) backfilling soil around tank to cover risers, equipment, and other protuberances~~. ~~The anticipated~~A potential closure configuration~~s~~ ~~are~~ is shown in Figure 4-2 for an individual waste tank system. Appendix A ~~explains the advantages of each option and how it promotes long-term stability.~~describesDOE's tank closure methods.

The layers in and above the tank, from bottom to top, are as follows:

- The concrete basement of the tank.
- The residual waste at the bottom of the tank is the waste that remains in place after selected waste removal techniques have been applied.
- Fill material composed of a combination of pumpable, self-leveling backfill materials for tank system closure. It is anticipated that grout technologies will be enhanced during the course of tank closure. DOE plans to take advantage of improvements

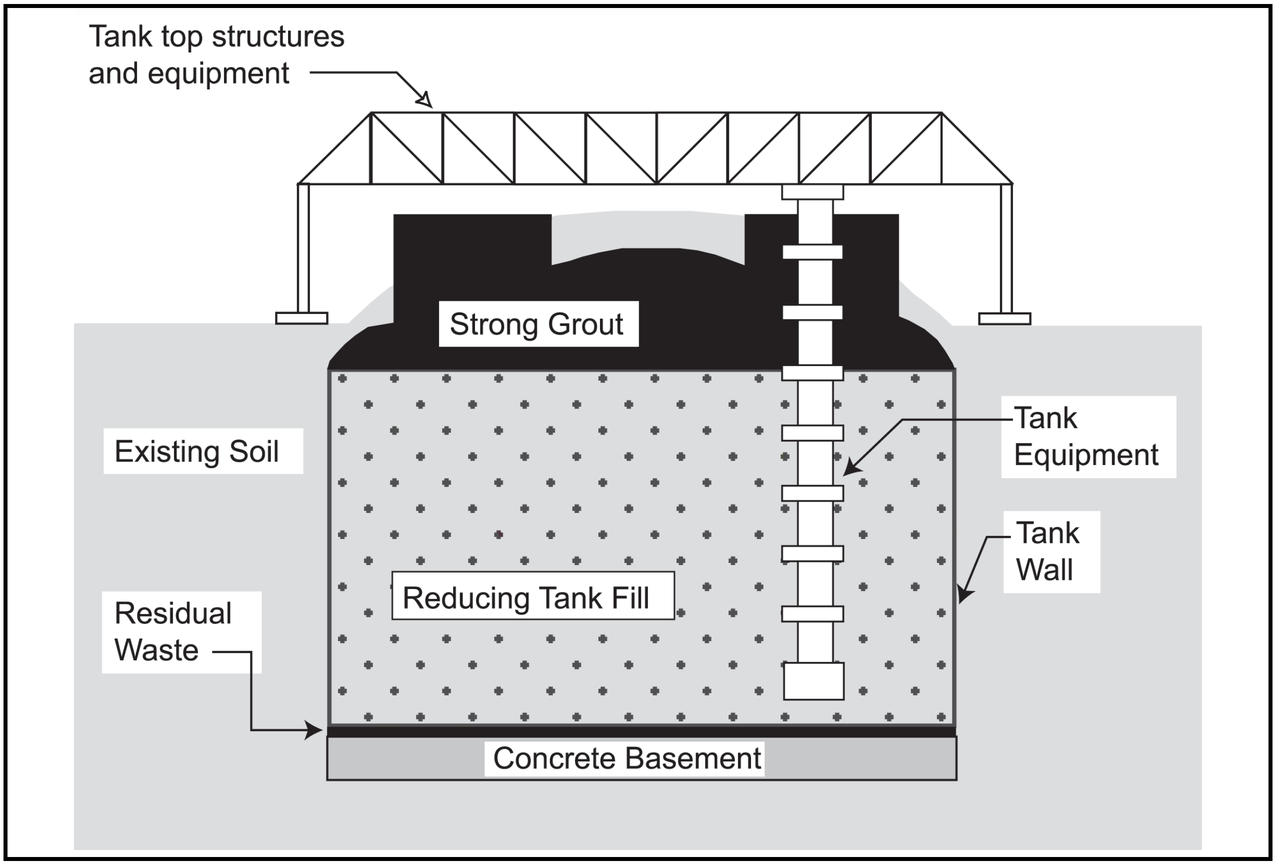


Figure 4-2. Tank closure example.

and to discuss them in subsequent closure modules. The following fill materials are considered suitable:

– Reducing tank fill composed of primarily cement, flyash, and blast furnace slag (plus reducing chemicals such as sodium thiosulfate). The chemical properties of liquid that leaches through this backfill material will reduce the mobility of certain radionuclides and chemical constituents.

~~– Controlled Low Strength Material (CLSM) which was used in the closure of Tanks 17 and 20, is a self-leveling concrete composed of sand and cement formers. Similar to reducing grout, it is pumped into the tank. The compressive strength of the material depends on the amount of cement in the mixture.~~

– Strong grout is a pumpable grout with compressive strengths in the normal concrete range. This material is used to fill voids near the top of the tank created around risers and tank equipment.

- Concrete encapsulating risers.

- ~~Soil backfill to cover risers, equipment, and other protuberances. For those tanks below grade, fill will be added to grade.~~

This closure configuration would promote long-term stability of the closed tank system by the fill material reducing the migration of radionuclides and chemical constituents, filling the voids to the extent practicable, and preventing subsidence of the tank roof. Also, the closure configuration discourages inadvertent intrusion.

Transfer lines associated with the tank system being closed will be filled to the extent the reducing grout flows freely into these lines.

Because not all tank systems will be closed at the same time, there will be an interim period where some tanks remain operational, while others are closed. During this interim period, controls will continue to be maintained to restrict access to the closed tank systems by unauthorized personnel. The existing stormwater systems will be maintained (including monitoring and surveillance activities) to channel rainwater away from the tanks. The existing monitoring well systems will detect releases from the closed tank systems.

To further ensure the long-term stability of the closed tank systems, DOE has proposed institutional control of the site in perpetuity with the ownership remaining with the Federal government and the prohibition of residential use of the land. DOE assumed for modeling purposes (see Appendix D) that after 100 years the land may be used for industrial purposes with the area immediately around the F-and H-Area Tank Farms –restricted to industrial/commercial use for an indefinite period with deed restrictions on the use of the groundwater.

In addition to the residual waste at the bottom of the tank, which is the major focus of closure activities, there will be residual contamination on equipment inside and near the tank (e.g., slurry pumps used for waste removal, cooling coils inside the tank, transfer piping in and out of the tank, and the secondary containment system and leak detection system for the tank). In addition, the tank farms include other equipment for processing the waste, such as evaporators, diversion boxes, pump tanks, and interarea transfer lines from F- to H-Area and from H-Area to Defense Waste Processing Facility and Saltstone. DOE anticipates that the amount of contamination left on this equipment will be small compared to the amount of contamination in the tanks, so closure of this equipment will have a relatively small environmental impact in comparison to closure of the tanks.

4.5 Environmental Restoration Program Activities

The FFA (EPA 1993) directs the comprehensive remediation of the SRS. It contains requirements for site investigation and remediation of releases and potential releases of hazardous substances and expands the site investigation process begun at SRS to address releases of hazardous or radioactive substances. The agreement also establishes requirements for the prevention and mitigation of releases or potential releases at or from the high-level radioactive waste tank farms and the remediation of soils and groundwater when the tank systems have been removed from service.

The HLW tank systems will remain under the responsibility of the Closure Business Unit Liquid Waste Disposition until all the tank systems in an operational area, such as F-Area Tank Farm or H-Area Tank Farm, are closed in accordance with the approved closure plan and a decision has been made to transition the tank farm(s) to the Soil and Groundwater Closure Project (SGCP). A network of groundwater wells, recently established in the area around the tank farms, monitors any impacts from legacy releases. This monitoring network was established as a part of the FFA.

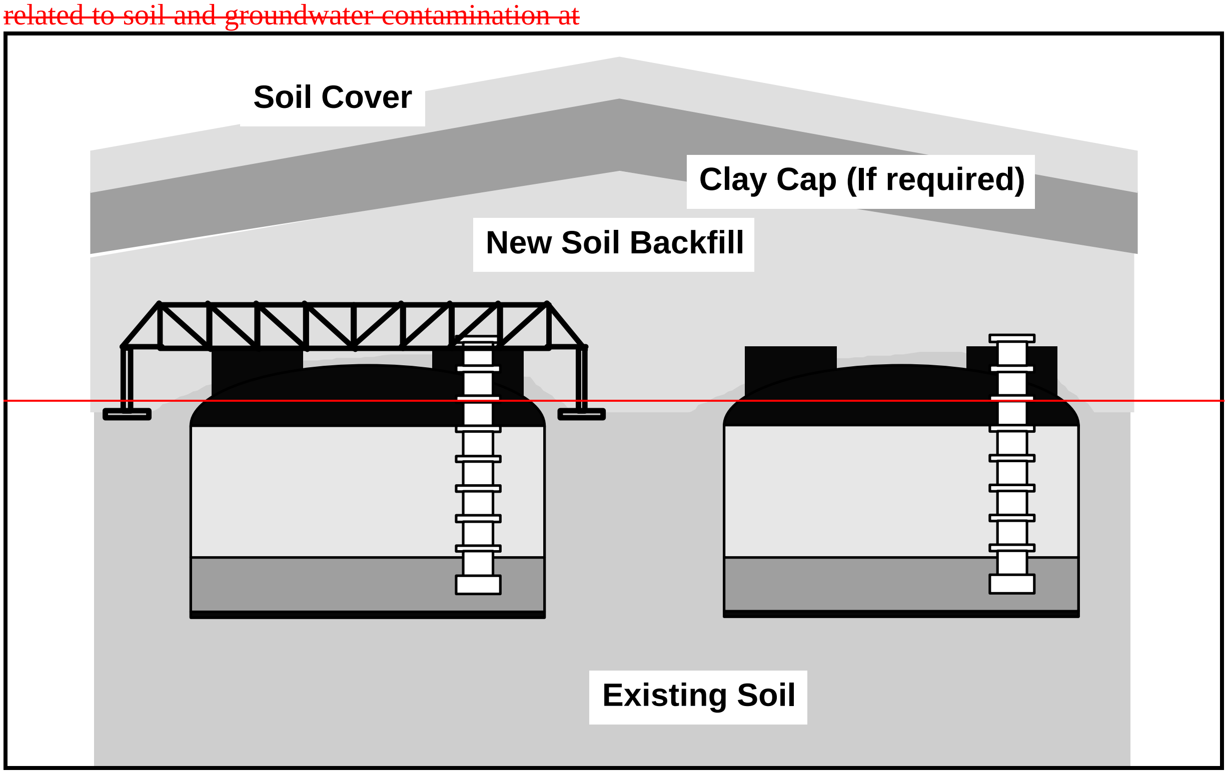
DOE anticipates working with SCDHEC and EPA in the development and optimization of the various strategies for soils assessment/remedial and post-closure maintenance through the FFA process. The schedules for investigation and remediation are maintained in Appendices D and E of the FFA and are subject to renegotiations as the final closure confirmation of the tank farms changes.

~~After a tank is closed, the SRS ER Program will conduct field investigations and remedial actions. The ER Program is concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater are responsibilities of this program. The investigations will take~~

place after nearby tanks in an operational grouping are closed (to avoid interference with the other operational tanks) and conditions are determined to be safe for ER intrusive sampling. Once an operational grouping is closed, the HLW operations organization and the ER organization will establish a Co-Occupancy Plan (COP) to ensure safe and efficient soils assessment and remediation. The HLW organization will be responsible for operational control and the ER organization will be responsible for ER activities. The primary purpose of the COP is to provide the two organizations with a formal process to plan, control, and coordinate the ER activities in the tank farm areas where the existing HLW management and operational procedures can be continuously utilized.

The Program Plan (DOE 1996) provides general information on postclosure activities and tank-specific closure modules will also address postclosure activities. However, the investigation, determination of remediation requirements, and implementation of potential remedial actions related to soil and groundwater contamination at the tank farms will be conducted in accordance with RCRA/CERCLA requirements pursuant to the FFA. The ER organization would have the responsibility for these activities. Plans for such postclosure measures as monitoring, inspections, and corrective action plans would also be governed by the FFA and would be premature to state at this time because conditions that would exist at the restored area are not known. For example, the area may be capped or an *in situ* groundwater treatment system may be installed.

Figure 4-3 presents an example of the closure configuration for a group of tanks. The necessity for a low-permeability cap, such as a clay cap, over a tank group to reduce rainwater infiltration will be established in accordance with the environmental restoration program described in the FFA (EPA 1993). Figure 4-3 shows a conceptual cap design. The cap construction would ensure that rain falling on the area drains away from the closed tank(s) and surrounding soil. A soil cover could be placed over the cap and seeded to prevent erosion.



References

DOE (U.S. Department of Energy), 1996, *High-Level Waste Tank Closure Program Plan*, Revision 0, Savannah River Operations Office, Aiken, South Carolina, December 16.

DOE (U.S. Department of Energy), 2002, *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement*, DOE/EIS-0303, Savannah River Operations Office, Aiken, South Carolina, May.

EPA (Environmental Protection Agency), 1993, Federal Facility Agreement Between the U.S. Environmental Protection Agency Region IV, the U.S. Department of Energy, and the South Carolina Department of Health and Environmental Control, Docket No. 89-05-FF, August 16.

CHAPTER 5. CLOSURE STANDARDS

This section summarizes the regulatory framework for closure of the Savannah River Site (SRS) high-level waste (HLW) tank systems as determined through consultation with South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (EPA) Region IV.

DOE will close the HLW tank systems, which are permitted by SCDHEC under authority of the South Carolina Pollution Control Act (SCPCA) as wastewater treatment facilities, in accordance with applicable laws and regulations, DOE Orders, and South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities." These regulations and orders require that such closures be performed in accordance with site-specific guidelines to prevent health hazards and to promote safety in and around the tank systems. To facilitate compliance with this requirement and in recognition of the necessity for consistency with ultimate remedial action of the SRS under the Federal Facility Agreement (FFA), DOE has adopted a general strategy for HLW tank system closure that includes evaluation of the closed tank system with respect to pertinent, substantive environmental requirements and guidance and other appropriate criteria (e.g., technical feasibility, cost). The general strategy for HLW tank system closure is thus consistent in its substance with comparative analyses performed as part of a Resource Conservation and Recovery Act (RCRA) corrective measures study/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) feasibility study under the FFA.

DOE will complete the overall remediation of the F and H-Area Tank Farms in accordance with the SRS FFA, which defines the RCRA corrective action and CERCLA requirements for the site. DOE's closure strategy for the HLW tank systems is intended to be consistent with the requirements of RCRA and CERCLA which control the overall remediation of the Tank Farms.

DOE has identified the environmental requirements and guidance applicable to the closure of the F- and H-Area HLW tank systems (Appendix B). Compliance with these requirements will ensure that closure of the HLW tank systems will be protective of human health and the environment and consistent with final remedial action for SRS as implemented under the FFA. Details of these requirements and guidance, the process used to identify them, and their intended use in the HLW tank systems closure plan are described in Appendix B.

DOE will review the list of requirements and guidance in Appendix B when it develops each tank system-specific closure module to determine if any changes to substantive provisions of the regulations and guidance have occurred that are pertinent to HLW tank system closure activities. If so, DOE will incorporate them into the performance standards for HLW tank-specific closure modules.

5.1 Performance Standards

The performance standards for HLW tank system closure are generally numerical standards, such as concentration or dose limits for specific radiological or chemical constituents released to the environment. These numerical standards apply to various environmental media, at different points of compliance, at various periods during or after closure. They will be used to develop performance objectives that provide a basis for comparison of different tank system closure configurations. The performance objectives for HLW tank system closure will be the groundwater protection standards applied at the point where groundwater discharges to the surface (seepline) and the surface-water quality standards applied in the receiving stream. Closure options will be evaluated to show conformance with the performance objectives as part of the overall evaluation [similar to compliance with applicable or relevant and appropriate requirements (ARARs) as one of the nine

CERCLA criteria]. In a manner similar to CERCLA requirements, appropriate justification will be necessary to select a nonconforming closure option.

The performance evaluation will focus on the exposure pathways and contaminants of most concern for a specific HLW tank system. DOE anticipates that the limiting exposure pathway for the HLW tank system closures will be via contaminant releases to groundwater and migration of those contaminants to onsite surface waters. The contaminants of most concern in that exposure pathway will be those constituents subject to the most stringent performance standards for points of compliance in that pathway. Tables B-4 through B-6 in Appendix B summarize the nonradiological air quality, nonradiological groundwater and surface water quality, and radiological (all potential pathways) performance standards applicable to closure of the SRS HLW tank systems. The tables in Appendix B are organized to enable comparison of the various performance standards to aid in identifying the most stringent limit that would be applicable at a specific point of compliance. The lowest concentration limit for a specific constituent would become the performance objective for that constituent in the specific media (i.e., air, groundwater, or surface water for nonradiological constituents) and the lowest dose or concentration limit for a specified exposure pathway (i.e., air, soil, groundwater, multipathway) would become the performance objective for the radiological constituents.

5.2 Regulatory Basis for HLW Tank Closure

Appendix B identifies the Performance Standards applicable to HLW tank system closures at SRS. These performance standards are:

1. compliance with the SCDHEC Primary drinking Water Standards for radionuclides (i.e. 4 mrem/year beta-gamma dose and 15 pCi/L total alpha concentration) at the seepline, and;
2. compliance with the SCDHEC water quality criteria, criteria to protect aquatic life, or Maximum Contaminant Level, whichever is more restrictive, for nonradiological constituents at the seepline.

The planned activities for the preparation and closure of HLW tanks at SRS will meet all performance objectives applicable to closure of a high-level waste tank system at SRS.

DOE has determined that there are further requirements for closure of the high-level waste tanks at SRS. These requirements are that the tank wastes:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical,
2. Will be managed to meet safety requirements comparable to performance objectives set out by the Nuclear Regulatory Commission (NRC) in Title 10, Code of Federal Regulation, Part 61 (10 CFR 61), Subpart C, Performance Objectives and,
3. Are to be managed, pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, provided that the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level radioactive waste as stated in 10 CFR §61.55, Waste Classification; or will meet alternative requirements for waste classification and characterization as DOE may authorize

CHAPTER 6. PERFORMANCE EVALUATION

This chapter describes methods for determining if specific tank closures satisfy the performance objectives discussed in Chapter 5. A major component of the decision process involves fate and transport modeling to evaluate compliance of alternative closure configurations with those performance objectives.

The 51 tanks in the F- and H-Area Tank Farms will be closed at various times over a period of decades. The 24 tanks that do not meet the standards established in Appendix B of the Federal Facility Agreement (FFA) will be removed from service ~~by 2022~~ and subsequently closed. Appendix E provides a schedule for removing these tanks from service. The remaining 27 tanks will remain in service until there is no further need for them. Thus, for the tanks that remain in service, U.S. Department of Energy (DOE) can provide only estimates about the condition of the tank systems and the wastes in the tanks at the time of closure. In addition, potential impacts from the closure of a high-level waste (HLW) tank must be projected for a period that extends thousands of years into the future. The process described in this section has been developed to allow closure of individual tanks to proceed, while recognizing and considering the uncertainty of the source terms of the tanks remaining in service.

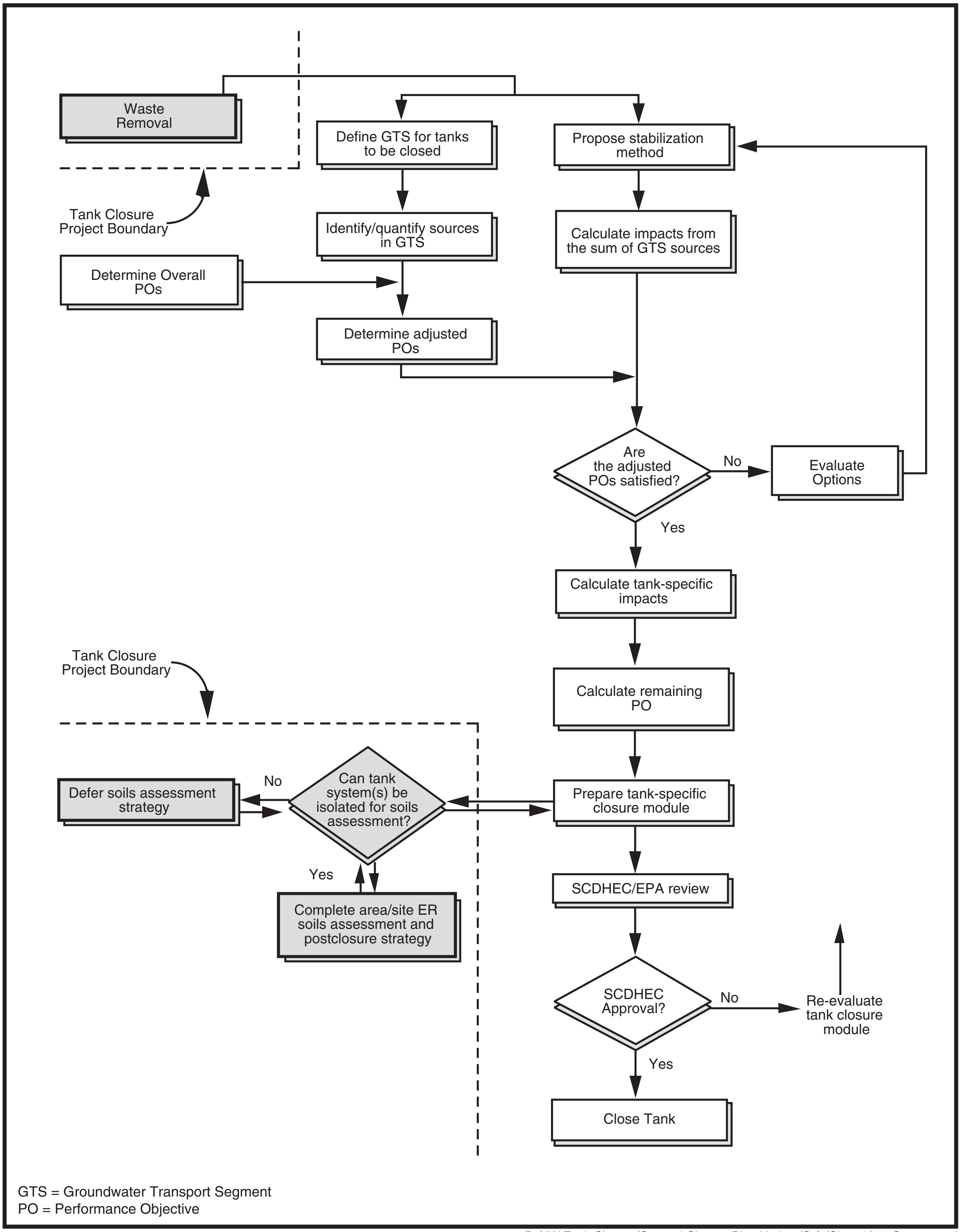
6.1 Summary of the Technical Approach

To close a tank, overall performance objectives have been selected from the performance standards as described in Appendix B. In the F- and H-Area Tank Farms, the major sources of potential contamination are the HLW tank systems, but the approach must consider other sources outside the tank farms. Thus, potential impacts from other tanks and other nontank sources up- and downgradient from the tank system to be closed are considered in the development of specific performance objectives for the tank system to be closed. Fate and transport modeling of alternative closure configurations is the primary tool used to evaluate conformance with the performance objectives. The groundwater pathway is considered the limiting exposure pathway for determining conformance of a closure configuration to the performance objectives. If the approach determined, however, that an exposure pathway other than groundwater is limiting for a particular HLW tank system, the tank-specific closure module would address that pathway.

Figure 6-1 shows the overall process for closing the HLW tank system and the sequence of steps involved in evaluating tank-specific performance.

These steps consist of:

1. Defining a groundwater transport segment (GTS) for the tank system to be closed.
2. Identifying and quantifying sources within the GTS.
3. Developing "adjusted" performance objectives to account for non-tank sources in the GTS.
4. Conducting fate and transport modeling to determine if adjusted performance objectives for the GTS are satisfied.
5. Conducting fate and transport modeling to determine impacts for the tank to be closed (the "target" tank).
6. Accounting for the tank-specific impacts and previous closure impacts against the adjusted performance objectives.



P: NW Tank Closure/General Closure Plan Update/Grfx/Chap 6/6-1 Summary.ai

Figure 6-1. Summary of HLW tank closure process.

Each of these steps is described in detail in the following sections. Appendix C presents an example of fate and transport modeling that could be used to support this process. Appendix D provides an example of the process itself.

6.2 Applicable Performance Standards

Appendix B lists performance standards applicable to high-level waste tank system closure. In general, these standards can be divided into four categories:

1. Air quality performance standards
2. Groundwater and surface-water protection performance standards
3. Performance standards that pertain to radiation protection of hypothetical human receptors (e.g., intruder, worker, resident farmer)
4. Performance standards related to protection of biota

This section discusses the performance standards that DOE considers pertinent to the closure of high-level waste tanks.

As discussed in Appendix C, the tank closure configuration, which entails filling the tank with a grout material, would not result in exposure to receptors by the atmospheric pathway. Therefore, the air quality performance standards listed in Appendix B are not applicable to the closure of the tanks.

The groundwater and surface-water performance standards generally apply drinking water standards as a limit at various points of compliance, depending on the source of the requirement. For example, the Maximum Contaminant Level could be applied as a limit in groundwater at locations 1 meter and 100 meters downgradient from the edge of the tank farm. As shown in Appendix C, compliance with drinking water standards at these locations might not be achievable, given the current state of technology for waste removal from tanks. DOE will ensure that the SRS defense processing and environmental management areas (including the F- and H-Area Tank Farms) will be zoned "industrial" for an indefinite period with deed restrictions on the use of the groundwater. In 1972, SRS was designated as the nation's first National Environmental Research Park (NERP) by an Executive Order that provided for tracts of land where the effects of human impacts on the environment can be studied. Therefore, for the closure of the tank system, the performance standard related to protection of water resources will be compliant with South Carolina Department of Health and Environmental Control (SCDHEC) water quality criteria, criteria to protect aquatic life, or Maximum Contaminant Levels, whichever is more restrictive, applied at the point where groundwater discharges to the surface (the seepline).

As shown in Appendix C, the calculated doses to an intruder and to the postulated worker at the seepline after HLW tank closure would be much less than the calculated dose from consumption of water at the seepline and would account for a smaller proportion of the regulatory standard. Similarly, the calculated doses to the hypothetical adult and child resident and from consumption of water from Fourmile Branch would be much less than and proportionately smaller than the standard than the calculated dose from consumption of water at the seepline. Appendix C also demonstrates that the calculated impacts to biota residing on or near the F- and H-Area Tank Farms would be well within the performance standards for both radiological and nonradiological constituents. For these reasons, DOE is confident that if it meets drinking water standards at the seepline, then it would also meet the performance standards for the hypothetical human receptors (e.g., intruder, worker, resident farmer) and for biota.

Therefore, the remainder of this chapter will discuss the performance of the high-level waste tank closure in relation to the following performance standards: (1) compliance with the SCDHEC Primary Drinking Water Standards for radionuclides (i.e., 4 mrem/year beta-gamma dose and 15 pCi/L total alpha concentration) at the seepline, and (2) compliance with the SCDHEC water quality criteria, criteria to protect aquatic life, or Maximum Contaminant Level, whichever is more restrictive, for nonradiological constituents at the seepline. The nonradiological performance standards are listed in Table 6-1.

Table 6-2 provides the concentrations of beta-gamma emitting radionuclides equivalent to the 4 mrem/yr dose limit established by the SCDHEC Primary Drinking Water Regulations. The table includes the beta-gamma emitting contaminants analyzed in detail because they were determined to be important dose contributors for HLW tank system closures (see Section C.8.5 for rationale).

6.3 Defining the Groundwater Transport Segment

6.3.1 GTS CONCEPTUALIZATION

GTSs represent the approximate flowpath of contaminants from a tank system or group of tanks based strictly on the groundwater potentiometric contours in the areas surrounding the high-level waste tanks and the nearby streams. For fate and transport modeling, the GTS is a convenient method to identify all potential sources whose contaminant plumes may overlap.

The GTS is used (see Appendix D) to adjust the performance objectives to account for all the sources (both tank and non tank) contained within the GTS (Section 6.5). The adjustment is based on the relative impact at the point of exposure at the time of greatest impact of the various sources in the GTS. To demonstrate compliance with drinking water standards, a hypothetical receptor is assumed to drink the groundwater at the location of maximum concentration at a point of exposure agreed upon between DOE and SCDHEC (i.e., the seepline). A fundamental assumption of the GTS is that contaminant plume flow is such that a particular GTS is independent of its neighboring GTSs, allowing the overall performance objectives to be applied totally to each GTS.

6.3.2 GTS SELECTION METHODOLOGY

A GTS consists of a physically defined area of the aquifers directly underlying the tank closure configuration that extends in both the upgradient and downgradient groundwater flow direction. By definition, each GTS contains all HLW tanks and other contaminant sources that lie within its boundaries. The nominal width of the GTS is determined by the size of the tank closure configuration footprint perpendicular to the groundwater flow direction. The GTS extends upgradient to a point sufficient to include all potential upgradient contaminant sources or to a groundwater divide, whichever occurs first. The GTS extends downgradient to a point of exposure agreed upon by SCDHEC and DOE (i.e., the seepline). The lateral boundaries of the GTS are drawn perpendicular to the groundwater potentiometric contours; therefore, the width of a GTS may be variable along its length. Because of the three dimensional nature of groundwater flow and the layered aquifer system that lies beneath the general separations area (referred to as the GSA, which includes the F- and H-Areas Separations Facilities, the F- and H-Area Tank Farms, F and H Seepage Basins, and the Burial Ground Complex), a GTS may contain stacked layers which represent pathways through the potentially affected aquifers. Since the aquifers do not all discharge at the same time or to the same surface water body, multiple exposure points may occur for each GTS.

The GTS concept is not intended to define the modeling methodology. The types of sources involved (e.g., types of tanks) may suggest that the impact from the GTS may be calculated through several means. For instance, each source within the GTS could be modeled separately and the individual impacts summed to determine the total impact. Similarly, groups of sources could be modeled and the group impacts summed, or the entire GTS could be modeled at one time to determine the impacts. The GTS is

Table 6-1. Nonradiological groundwater and surface-water performance standards applicable to high-level waste tank system closure.

Constituents of concern	Maximum contaminant level (40 CFR §141.62) (mg/L)[a]	Maximum contaminant level goal (40 CFR §141.51) (mg/L)[b]	Maximum contaminant levels (SC R.61-58.5.B(2)) (mg/L)[c]	Water quality criteria for protection of human health (SC R.61-68, Appendix 2) (mg/L)[d,e]		Criteria to protect aquatic life (SC R.61-68, Appendix 1) (mg/L)[d,f]	
				MCL	Organic Consumption	Average	Maximum
Aluminate							
Aluminum						0.087	0.750
Barium	2.0	2.0	2.0				
Boron							
Calcium							
Carbonate							
Chloride							
Chromium III						0.120[g]	0.980[g]
Chromium VI						0.011[g]	0.016[g]
Total chromium	0.1	0.1	0.1	0.1	-		
Copper		1.3				0.0065[g]	0.0092[g]
Hydroxide							
Fluoride	4.0	4.0	4.0				
Iron						1.000	2.000
Lead		zero[h]				0.0013[g]	0.034[g]
Lithium							
Magnesium						9.091	18.182
Manganese						0.03	0.061
Mercury	0.002	0.002	0.002	-	1.5×10^{-4}	1.2×10^{-5}[g]	0.0024[g]
Molybdenum							
Nickel			0.1	0.1	4.6	0.088[g]	0.790[g]
Nitrate	10 (as N)	10 (as N)	10 (as N)				
Nitrite	1 (as N)	1 (as N)	1 (as N)				
Total nitrate & nitrite	10 (as N)	10 (as N)	10 (as N)				
Oxalate							
Phosphate							
Potassium							
Selenium	0.05	0.05	0.05	0.05	-	0.0050[g]	0.020[g]
Silicon							
Silver							0.0012[g]
Sodium							
Sulfate							
Titanium							
Tributylphosphate							

Table 6-1. (continued).

Constituents of concern	Maximum contaminant level (40 CFR §141.62) (mg/L)[a]	Maximum contaminant level goal (40 CFR §141.51) (mg/L)[b]	Maximum contaminant levels (SC R.61-58.5.B(2)) (mg/L)[c]	Water quality criteria for protection of human health (SC R.61-68, Appendix 2) (mg/L)[d,e]		Criteria to protect aquatic life (SC R.61-68, Appendix 1) (mg/L)[d,f]	
				MCL	Organic Consumption	Average	Maximum
Zinc						0.059	0.065
Zirconium							

Note: Not all contaminants present in the tank residual have applicable performance objectives; however, all contaminants are listed in this table.

a. Safe Drinking Water Act (SDWA) - The MCLs (§141.62) for inorganic contaminants apply to community water systems, nontransient noncommunity water systems, and transient noncommunity water systems.

b. SDWA - The MCLGs (§141.51) are nonenforceable health goals corresponding to the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and that allows an adequate margin of safety.

c. SC SDWA - The MCLs for inorganic contaminants specified in R.61-58.5.B(2) apply to all public water systems.

d. SC Water Classifications and Standards - The water quality standards are applicable to both surface waters and groundwaters unless indicated otherwise (R.61-68.C).

- With the exception of human health criteria listed in Section E.12, the numeric standards of this regulation are applicable to any flowing waters when the flow rate is equal to or greater than the minimum 7-day average flow rate that occurs with an average frequency of once in 10 years (7Q10). State water quality standards for human health protection will be applicable to surface waters at average annual flow conditions or a average tidal dilution conditions, whichever is appropriate (R.61-68.C.2.a).
- Numeric criteria for all class surface waters are adopted for toxic pollutants for which EPA has published national criteria to protect aquatic life pursuant to Section 304(a) for the Federal CWA and for ammonia and chlorine. No numeric criteria are listed in this regulation; however, the national numeric criteria developed and published by EPA are incorporated by reference. If the State develops site-specific criteria for any substances for which EPA has developed national criteria, the site-specific criteria will supersede the national criteria. If metal concentrations for national criteria are hardness-dependent, the chronic and acute concentrations shall be based on 50 mg/L hardness if the ambient hardness is less than 50 mg/L and based on the actual mixed stream hardness if it is greater than 50 mg/L (R.61-68.E.11.a (3)).
- Freshwater standards for toxic pollutants listed in Section 307 of the Federal CWA and for which EPA has developed national criteria are subject to the standards prescribed in Sections E.11 and E.12 of this regulation (R.61-68.G(8)).
- It is policy of the Department to maintain the quality of groundwater consistent with its highest potential uses. For this reason, all South Carolina groundwater is classified GB effective on June 28, 1995. Quality standards for inorganic chemicals in Class GB Groundwaters are those set forth in the State Primary Drinking Water Regulations R.61-58.5.B(2) (R.61-68.H).

e. SC Water Classifications and Standards - State water quality standards for human health protection specified in Section 8(a) will be applicable to surface waters at average annual flow conditions or at average tidal dilution conditions, whichever is appropriate (R.61-68.E.12.b).

f. Average and maximum values for water quality to protect aquatic life identified in spreadsheet obtained from A. Wright of SCDHEC.

g. Denotes compounds with national criteria to protect aquatic life identified in R.61-68.E.11.a (5).

h. Action level for lead is 0.015 mg/L.

Table 6-2. Derived concentration limits for man-made beta-gamma emitters for high-level waste tank system closure.

Radionuclide	Concentration (pci/L)[a]
Selenium-79	900
Technetium-99	900
Carbon-14	2,000
Iodine-129	1
Strontium-90	8
Cesium-137	200

a. Derived concentration limits equivalent to 4 mrem/yr dose taken from 65 FR 21605-21614.

used to ensure that all sources are accounted for; the actual method of doing so will depend on the sources themselves, the calculational techniques involved, and the fate and transport models employed.

6.3.3 THE F- AND H-AREA GTSs

Currently, DOE has identified three GTSs for the two tank farms, with 1 GTS in F-Area and 2 GTSs in H-Area. Due to the three-dimensional nature of groundwater flow and leakage between the stacked aquifer layers beneath the GSA, each GTS contains three layers. The boundaries of the Water Table Aquifer layer of the GTS, which is the first aquifer layer impacted by a future release from the Tank Farms, will be used to define the boundaries for the underlying Barnwell-McBean Aquifer layer of the GTS. In turn, the Barnwell-McBean Aquifer layer of the GTS will control the boundaries of the underlying Congaree Aquifer layer of the GTS. Therefore, the fate and transport modeling at each tank farm will include components for each of the aquifer layers within each GTS. Figures 6-2, 6-3, and 6-4 show the boundaries of the GTS layers for each of the tank farm areas.

DOE will derive representative hydraulic parameters from the conceptual system described in Appendix C to utilize in the Multimedia Environmental Pollutant Assessment System (MEPAS), the fate and transport code currently being used. The selection of a unique set of potentiometric contours to represent site conditions over the modeled time period (10,000 years) is not possible. To eliminate potential bias in selecting a set of representative potentiometric contours, the steady-state potentiometric contours for each aquifer layer from a recent GSA-wide modeling effort will be used for this purpose as discussed in Appendix C.

6.4 Identifying and Quantifying Sources within the GTS

The entire F-Area Tank Farm, comprised of 22 HLW tanks, is within the F-Area GTS. Except for Tanks 17 and 20, the source term for the GTS is based on process knowledge and scattered historical sample results. The Tanks 17 and 20 source term is based on process knowledge, modified by recent sampling and analysis. The only non-tank-farm source within the GTS with potential for significant and measurable impacts is the F-Area Seepage Basins.

The H-Area Tank Farm, comprised of 29 HLW tanks, contains seven tank groups that are divided into two GTSs due to the presence of a groundwater divide in the Water Table Aquifer. Eighteen tanks lie in the northward flowing GTS and eleven tanks lie in the southward flowing GTS. Potential non-tank farm sources that

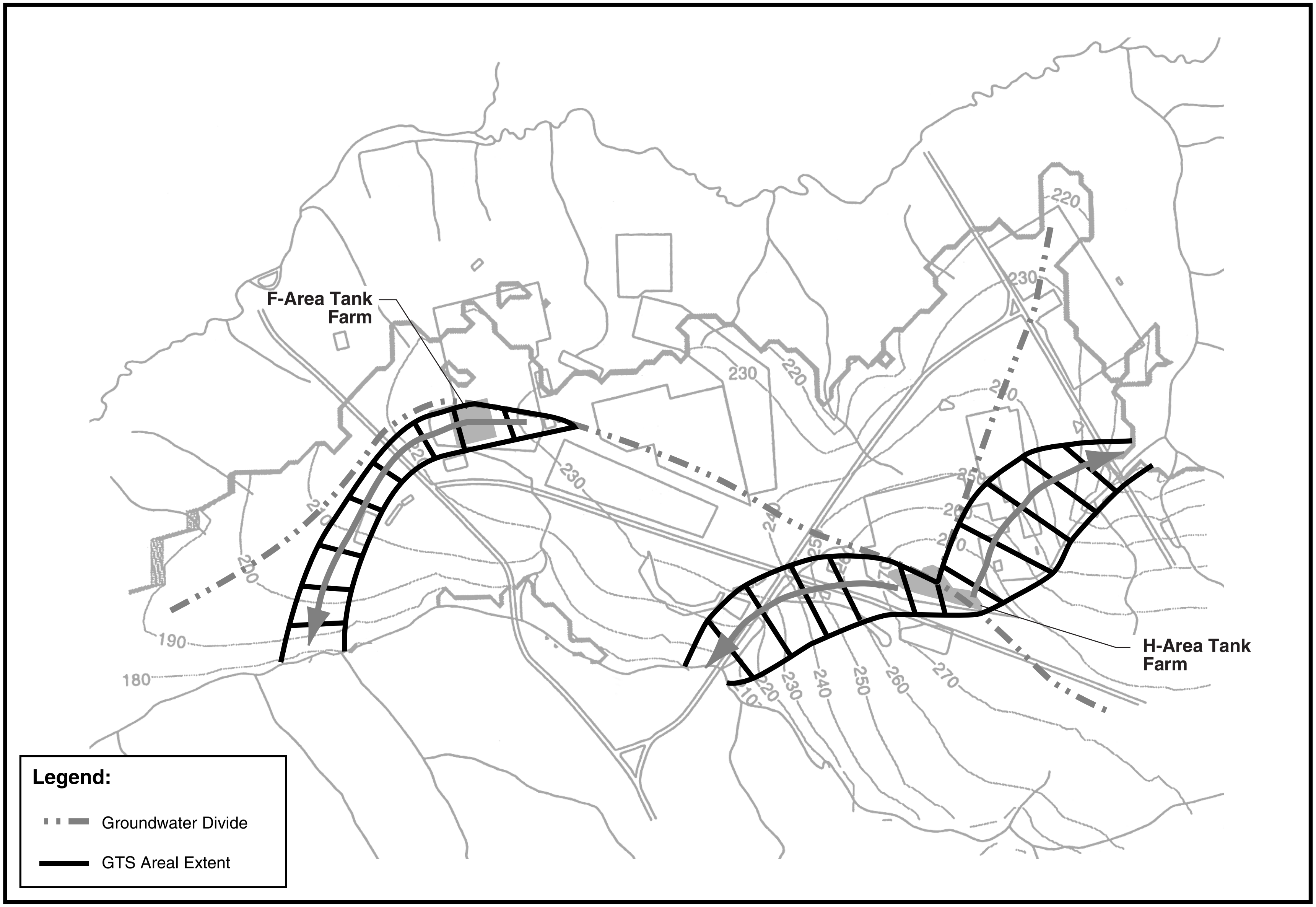


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Figure 6-2. Calibrated potentiometric surface (ft) for the Water Table aquifer.

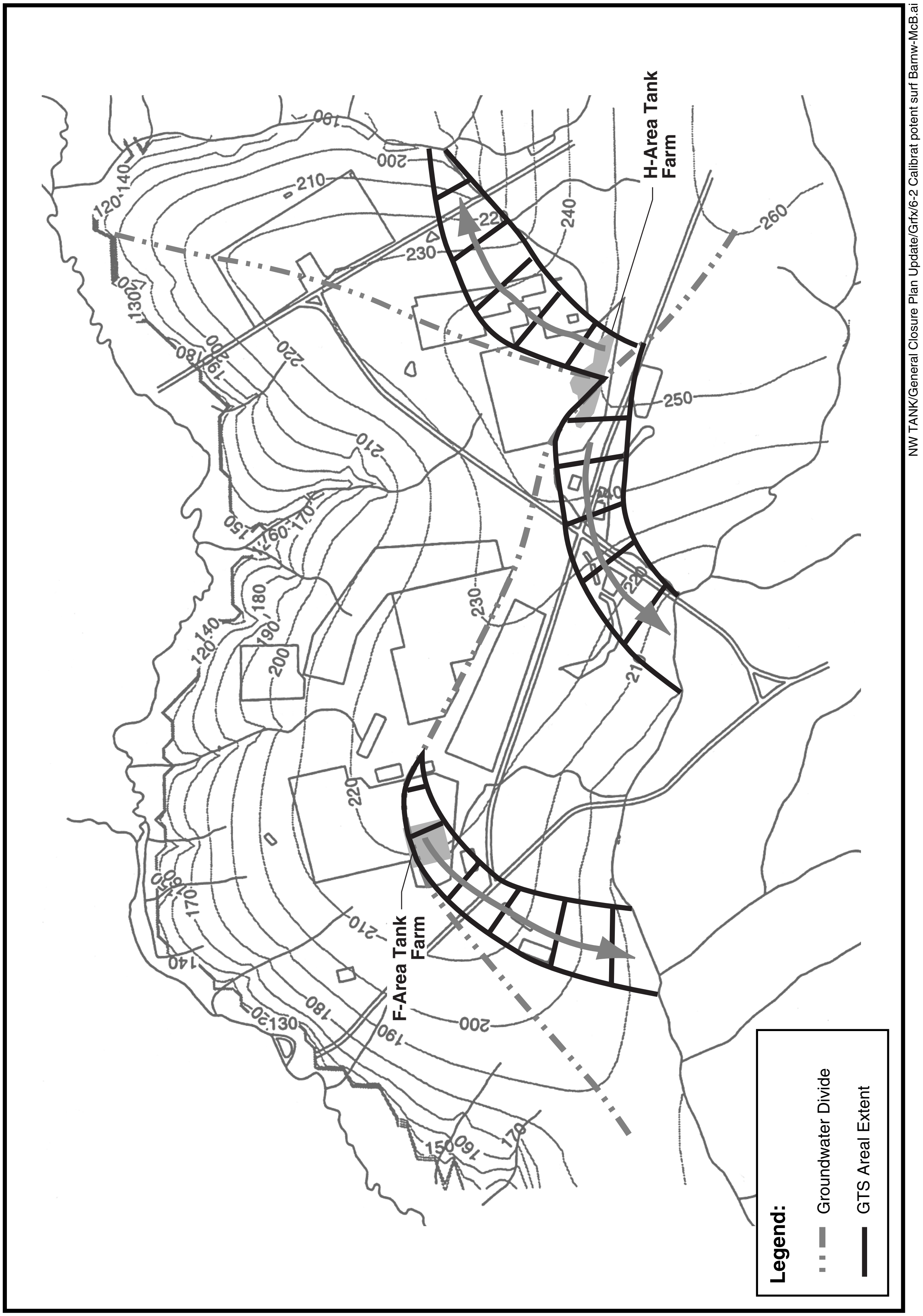
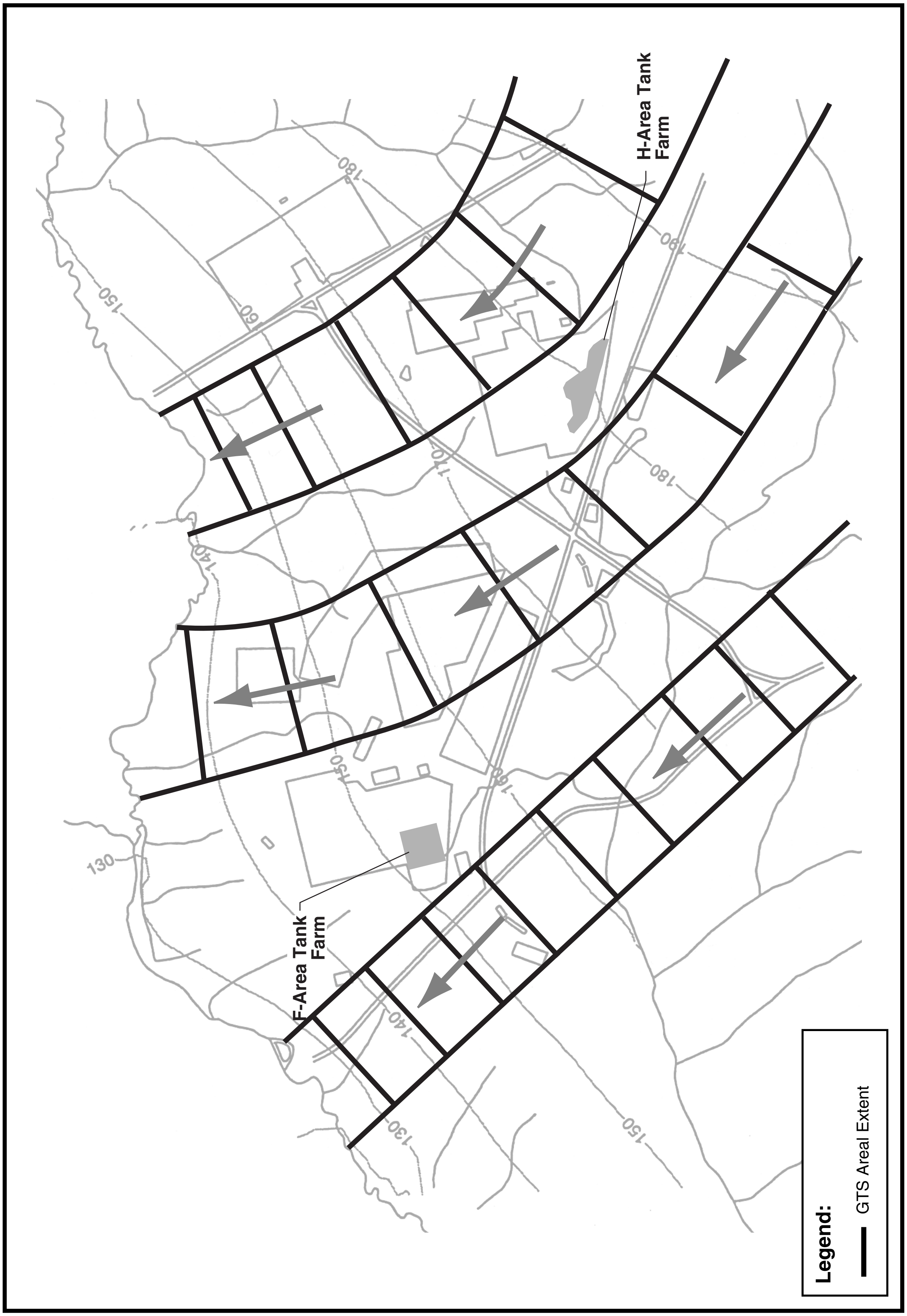


Figure 6-3. Calibrated potentiometric surface (ft) for the Barnwell/McBean aquifer.



NW TANK/General Closure Plan Update/Grfx/6-2 Calibrat potent surf Cong.ai

Figure 6-4. Calibrated potentiometric surface (ft) for the Congaree aquifer.

could impact the GTSs in H-Area include the following:

- H-Area Seepage Basin
- 294-H, 294-1H Sand Filters (Water Table and Barnwell-McBean Aquifers only)
- 221-H Canyon (marginally)
- 221-S Vitrification Building (marginally)

The results in this chapter do not include any potential H-Area contribution. As part of preparing for closing the first tank in H-Area, DOE will analyze impacts of non-tank sources in H-Area.

6.5 Developing Adjusted Performance Objectives

DOE will consider all nontank-farm sources within each GTS to determine their potential contribution to environmental impacts. For the F-Area GTS, DOE considered previous evaluations of the F-Area Seepage Basins. These evaluations determined that none of the constituents of concern from the F-Area Seepage Basins will be detected at the seepline concurrent with F-Tank Farm impacts. Therefore, the adjusted performance objectives are identical in magnitude to the overall performance objectives. The adjusted performance objectives for the parameters identified in section 6.1 are presented in Table 6-1. DOE will follow the same approach for the H-Area GTS when evaluating the closure of tanks in the H-Area Tank Farm.

6.6 Modeling to Determine if Adjusted Performance Objectives are Satisfied

Using the methodology illustrated in Appendix C, DOE will model the impacts of closing every tank in each GTS using reasonable estimates of the amount of waste removal DOE could achieve. The results of these modeling efforts will then be compared to the performance objectives described in Section 6.2. For example, in the F-Area Tank Farm (the F-Area GTS), the results for comparison against the performance objectives are identified in section 6.2 are provided in Table 6-3. Appendices C and D demonstrate that seepline concentrations in the Barnwell-McBean Aquifer provide the limiting cases. Therefore, the Table 6-3 results pertain to concentrations of contaminants in the Barnwell-McBean Aquifer at the seepline. Although water in the Barnwell-McBean Aquifer mixes with water from the Water Table Aquifer at the seepline, the degree of mixing is uncertain. Any mixing would reduce the reported concentrations.

6.7 Modeling to Determine Target Tank Impacts

DOE will model the impacts of closing the specific tank undergoing closure (the target tank). For the F-Area Tank Farm, Appendix D contains details of the modeling for a given target tank (Tank 17). The results are presented in Table 6-3 for the selected parameters. Concentrations and doses are for the Barnwell-McBean Aquifer at the seepline, assuming no mixing with other waters. The results represent the Tank 17 contribution to the overall GTS impacts at the time the GTS impacts are maximum. Maximum Tank 17 impacts occur later than the maximum GTS impacts. Maximum Tank 17 impacts are also well below performance objectives.

6.8 Accounting for Target Tank Impacts

After completing the analysis described in Section 6.7, DOE will determine the amount of the adjusted performance objective remaining after the impacts of the target tank and previous tank closures have been accounted for. For example, the last column of Table 6-3 provides the remaining budget of adjusted performance objectives after closure of Tank 17 and shows that all performance objectives are met for the F-Area

Table 6-3. Comparison of modeling results to performance objectives at the seepline.[a]

	Units	Adjusted PO	F-Area GTS impact	Previous closures impact[b]	Tank 17 impact	Remaining PO
Radiological						
Beta-gamma dose	mrem/yr	4.0	1.9	0.0055	0.022	3.99
Alpha concentration	pCi/L	15	3.9×10^{-2}	(c)	(c)	15
Total dose	mrem/yr	4.0	1.9	0.0055	0.022	3.99
Nonradiological						
Nickel	mg/L	0.1	(d)	0	(d)	0.1
Chromium[e]	mg/L	0.1	4.6×10^{-5}	5.0×10^{-6}	1.1×10^{-5}	0.1
Mercury	mg/L	0.002	(d)	0	(d)	0.002
Silver	mg/L	0.05	1.7×10^{-3}	1.9×10^{-4}	4.1×10^{-4}	0.049
Copper	mg/L	1.3	(d)	0	(d)	1.3
Nitrate	mg/L	10 (as N)	1.2×10^{-2}	1.3×10^{-3}	7.5×10^{-3}	10 (as N)
Lead	mg/L	0.015	(d)	0	(d)	0.015
Fluoride	mg/L	4.0	1.1×10^{-3}	1.3×10^{-4}	2.7×10^{-4}	4
Barium	mg/L	2.0	(d)	0	(d)	2

PO = Performance Objective
a. Values taken from Appendix C.
b. Tank 20.
c. Concentration is less than 1.0×10^{-13} pCi/L.
d. Concentration is less than 1.0×10^{-06} mg/L.
e. Total chromium (chromium III and VI).

GTS. Future closures will be compared to these values. The reported values are the difference between the adjusted performance objective and the sum of Tank 17 impacts and the impacts of previous closures.

DOE will follow the same approach for the H-Area GTS when evaluating the closure of tanks in the H-Area Tank Farm.

APPENDIX A

DESCRIPTION OF HIGH-LEVEL WASTE TANK CLOSURE METHODS

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APPENDIX A

DESCRIPTION OF HIGH-LEVEL WASTE TANK CLOSURE METHODS

This appendix supplements the information in Chapter 4 by providing additional details on the technical and operational steps to close a tank system. _These general steps are (1) waste removal, which includes bulk waste removal (2) ~~enhanced~~ further waste removal (when necessary), and if needed ~~spray~~ water washing ~~spray water washing~~, (3) annulus cleaning (if applicable), and~~and~~ (~~3~~4) stabilization. ~~Enhanced waste removal and stabilization are considered part of the tank closure process. Waste removal is an operational precursor to tank closure.~~

A.1 Waste Removal

A.1.1 BULK WASTE REMOVAL

In the Federal Facility Agreement between DOE, EPA, and the State of South Carolina, DOE committed to removing wastes from older tanks that do not meet secondary containment requirements (Types I, II, and IV). The HLW removal operations would comply with the proposed plan and schedule provided under the Agreement. Therefore, as shown in Figure 1-1, waste removal is not within the scope of the General Closure Plan. Nevertheless, it is described here for completeness.

The schedule for removing waste from the tanks is closely linked to salt and sludge processing capacity and the Defense Waste Processing Facility (DWPF) schedule. The priorities for determining the sequence of waste removal from the tanks are as follows:

1. Maintain emergency tank space in accordance with safety analyses.
2. Control tank chemistry, including radionuclides and fissile material inventory.
3. Enable continued operation of the evaporators.
4. Ensure blending of processed waste to meet salt processing, sludge processing, defense waste processing, and saltstone feed criteria.
5. Remove waste from tanks with leakage history.
6. Remove waste from tanks that do not meet the Federal Facility Agreement requirements.
7. Provide continuous radioactive waste feed to the DWPF.
8. Maintain an acceptable precipitate balance with the salt processing facility.
9. Remove waste from the remaining tanks.

The general technique for waste removal is hydraulic slurrying. Slurry pumps or other mixing equipment are installed in the risers of the tank. DOE is exploring other methods for more efficient waste removal.

A.1.2 ~~SPRAY~~ WATER WASHING

Following completion of bulk waste removal, if needed, DOE ~~will~~ may rinse the tank using ~~spray~~ water washing, if necessary. In this process, water is used to ~~remove the remaining residual waste~~ dislodge loose contamination that was not removed during bulk waste removal. ~~This water may be heated if necessary. After spray washing, the contents of the tank are pumped to another HLW tank.~~

A.1.3 ANNULUS CLEANING

Tank 16 ~~is the most badly cracked tank and~~ has a documented case of leakage into the annulus and thus represents a special case for annulus cleaning. In this tank, a number of welds were sandblasted to understand the stress corrosion cracking phenomena. The sand fell on top of salt and then mixed with the salt during a waste removal effort in 1978 that removed about 70 percent of the salt. Recent samples have shown that the sand and compounds that formed when the sand mixed with the salt make it more difficult to dissolve the waste in this annulus. Chemical cleaning (such as oxalic acid) may be needed to dissolve the waste in the Tank 16 annulus. Since this will be a one-time operation, plans are to develop the cleaning techniques when needed.

Eleven HLW tanks at SRS have shown evidence of cracks in the primary tank shell. In two of the tanks, the cracks are above the current liquid level and there is no evidence that waste escaped primary containment. In the remaining nine tanks, the waste level has been lowered to below the cracks and leaked salt has been observed on the exterior of the primary tank shell. The cracks in these tanks are hairline cracks and the annuli in these tanks are ventilated to dry the waste. The waste seeped through the cracks slowly and dried in the annulus. This waste appears as dried salt deposits on the side of the primary tank and sometimes on the floor of the secondary tank.

DOE ~~has~~ will develop~~ed~~ methods to clean the annulus ~~using recirculating water jets installed through annulus risers. The water is heated and circulated through the annulus into the primary tank.~~for those tanks for which it is deemed necessary. DOE will evaluate the extent of annulus cleaning needed for these tanks.

A.2 ~~Enhanced~~ Further Waste Removal

As evaluation for a tank system closure begins, DOE ~~may~~ will determine the extent of tank cleaning required ~~that some tanks need more thorough cleaning~~ to meet tank closure performance objectives. ~~In such cases,~~ DOE ~~would~~ could first use additional hydraulic slurrying to remove more waste from the tank. ~~If spray water washing does not accomplish the required reduction in waste,~~ DOE ~~would~~ could employ other methods to reduce the waste content to the point where the performance objectives could be met.

One method DOE could use ~~if spray water washing is not effective~~ is oxalic acid cleaning. In this process, ~~hot~~ oxalic acid is ~~sprayed through nozzles on locations where sludge remains. After oxalic acid cleaning is complete, the tank would be spray washed with inhibited water to neutralize the remaining acid.~~ added to the tank. The tank contents may be agitated to enhance contact between the acid and the residual material. The spent acidic waste is then transferred from the tank. Oxalic acid has advantages over other cleaning agents for the following reasons:

- Oxalic acid dissolves portions of the sludge and causes the particles to break down, allowing removal of sludge deposits that are difficult to mobilize using hydraulic slurrying alone.

- Oxalic acid is only moderately aggressive against carbon steel. Corrosion rates are on the order of 0.5 inch per year. This rate is acceptable for a short-term process such as cleaning.

Between 1978 to 1980, Tank 16 was the subject of a rigorous waste removal, water washing, and oxalic acid cleaning demonstration. The demonstration determined the increased effectiveness of oxalic acid cleaning for sludge removal. However, the process generates large quantities of sodium oxalate that must be disposed by the Saltstone Manufacturing and Disposal Facility and Defense Waste Processing Facility.

DOE will also evaluate other methods of enhanced waste removal such as mechanical means.

A.3 Stabilization

A.3.1 TANK FILL MATERIAL

Each tank would be filled with a pumpable, self-leveling grout, a concrete-like material. The

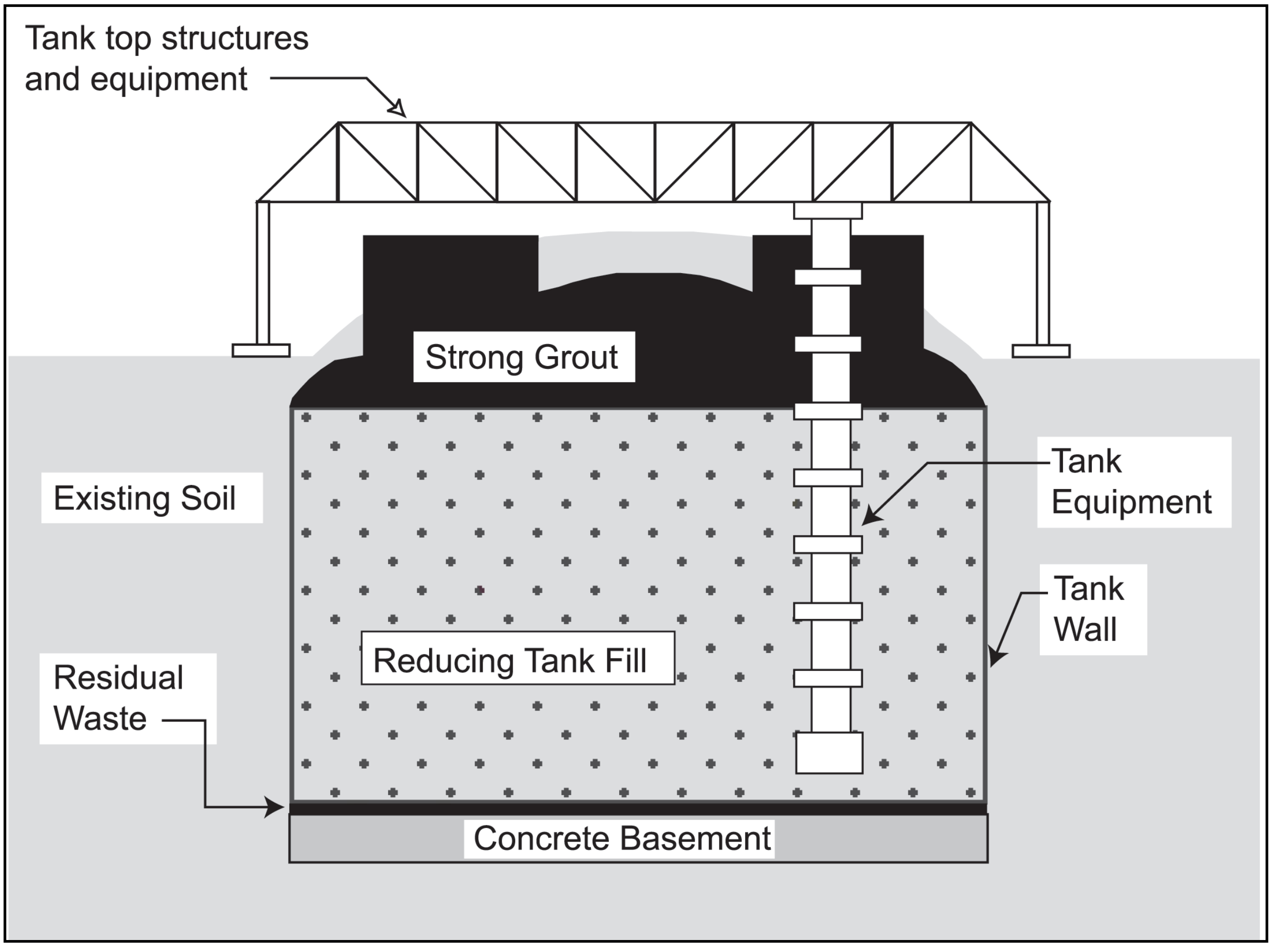

Figure A-1. Typical layers of the fill with grout option.

material would have a high pH, which is compatible with the carbon steel of the tank. The fill material would also be formulated with chemical properties that would retard the movement of radionuclides and chemical constituents from the closed tank. A combination of different types of grout could be used. They would be mixed at a nearby batch plant and delivered to the tank. Figure A-1 shows how the layers of grout would be poured. The potential combination of layers of grout is as follows:

- Reducing tank fill is a pumpable, self-leveling backfill material similar in composition to that used at the SRS Saltstone Manufacturing and Disposal Facility, composed primarily of cement, flyash, and blast furnace slag. The chemical properties of the liquid that leaches through this backfill material will reduce the mobility of selected radionuclides and chemical constituents under conditions described in Bradbury and Sarrot (1995). The formulation may require adjustment for a tank based on specific circumstances. The material is pumped into the waste tank through an available opening (e.g., tank riser).

- Controlled Low-Strength Material (CLSM) is a self-leveling concrete composed of sand and cement formers. CLSM was used in the closure of Tanks 17 and 20. Similar to reducing grout, it is pumped into the tank. The compressive strength of the material is controlled by the amount of cement in the mixture. The advantages of using CLSM rather than ordinary concrete or grout for most of the fill are control of compressive strength, low heat of hydration, and relatively low cost.

- The compressive strength of the material can be controlled so that it will provide adequate strength for the overbearing strata and yet could be potentially excavated with conventional excavation equipment. Although excavation of the tank is not anticipated, filling the tank with low-strength material would enhance the opportunity for future removal of tank contaminants or perhaps the tank itself, if future generations were to decide that excavation is desirable.
- CLSM has a low heat of hydration, which allows large or continuous pours. The heat of hydration in ordinary grout limits the rate at which the material can be placed because the high temperatures generated by thick pours prevent proper curing of the grout. Thus, large pours of grout are usually made in layers, allowing the grout from each layer to cool before the next layer is poured.
- CLSM is relatively inexpensive.
- CLSM is widely used at SRS, so there is considerable experience with its formulation and placement, and in controlling the composition to provide the required properties.

• Strong grout is a loose grout with compressive strengths in the normal concrete range. This formulation is advantageous near the top of the tank because:

- The loose consistency of the grout is advantageous for filling voids near the top of the tank created around risers and tank equipment. The grout would be injected in such a manner to ensure that voids were filled to the extent practicable. This may involve several injection points, each with a vent.
- A relatively strong grout will discourage an intruder from accidentally accessing the waste if institutional control of the area is discontinued.

Other potential combinations of multiple or single grout layers may be used. It is expected that new/innovative grout mixes will be developed during the tank closure period. Any new grout formulas will be evaluated in the applicable closure module.

A.3.2 OPERATIONAL ACTIVITIES

The specific actions needed before and during closure include tank isolation, tank modifications to facilitate introduction of grout, production and installation of grout, and riser cleanup. These activities are described below in more detail.

Mechanical and electrical services would be isolated from the tank such that future use is prohibited. Accessible piping and conduits would be removed and pulled back from each riser so that a physical break is made from the tank.

DOE would leave the tank structures intact. No support steel would be removed unless it is necessary to be removed to disconnect services from the tank risers. Equipment already installed in the tank and equipment directly used in tank closure operations (such as temporary submersible pumps, cables, temporary transfer hoses, backfill transfer pipes or tremmies, and sample pump) would be entombed in the backfill material as part of the closure process. ~~Items removed in preparation for closure under this module (such as slurry pump motors, instrument racks, piping, and insulation) may be decontaminated to such levels that they may be sent to the Solid Waste Management Facilities as scrap. Otherwise, they would be appropriately characterized and shipped as low-level waste.~~It is permissible for tank equipment to be relocated from tank to tank within a given tank farm in order to maximize the efficiency of the tank closure process, to reduce radiation exposure to workers, and entomb the equipment in the closure process. This equipment transfer does not include transfers between the two tank farms.

The tank risers would be modified to permit backfill material to be placed into the tank. Provisions would be made to provide a delivery point into the tank, to manage air displacement, to address bleed water build-up, and to handle any tank top overflow.

Risers would be prepared to allow addition of the backfill material. Equipment located at the riser would be disconnected. A backfill transfer line would be inserted through an access port to allow introduction of the backfill into the tank. Tank venting would be predominately through the existing permanently installed ventilation system until the backfill material nears the top of the tank. However, a newly constructed vent device, equipped with a breather high-efficiency particulate filter, would be supplied for the final filling operation.

During the filling process, excess water (bleed water) is expected to float to the top of the grout. The amount of bleed water would be minimized during the actual closure operation by limiting the amount of water in the grout and by specifying the fill material cure times. It is expected that any bleed water produced would be re-absorbed back into the fill material. The amount of re-absorption would be dictated by the cure times. The possible overflow of bleed water and grout from around the riser joints would be controlled by constructing forms around the risers and sealing those forms for watertightness as part of pre-closure preparation for riser grouting operations. Each riser would be prepared for local filling and venting to ensure that the top void spaces are filled.

The transfer lines connected to the tank system being closed will be filled to the extent the reducing grout flows freely into these lines.

Portable concrete batch plants would supply the grout needed to fill the tanks. All applicable environmental permits will be obtained.

Backfill material produced at the plants would be introduced into the risers of the tanks through piping from the plants located just outside the Tank Farm fence.

The actual backfill material installation would be governed by SRS procedures in accordance with design engineering requirements as outlined in the construction and subcontractor work packages. The filling progress would be monitored by an in-tank video camera. The backfill material level would be measured using visual indications. During riser closure operations, containment provisions would be made to restrict or contain grout overflows. Tank components such as the transfer pump, slurry pumps, wiring, cables, steel tapes, hoses, and sample collection apparatus would be encapsulated during tank grouting operations.

The risers and void spaces in the installed equipment remaining in the tank would be filled with highly flowable grout material to ensure that all voids are filled to the fullest extent practical. The tank fill and riser backfilling operations would be performed in such a way as to eliminate rainwater intrusion into the tank. Upon completion of the tank closure, the riser tops would be left in a clean and orderly condition. Risers would be encapsulated in concrete using forms constructed of rolled steel plates or removable wooden forms previously installed around each riser. The riser encapsulation would be completed at the end of the tank dome fill operation.

Piping and conduit at each of the risers that is not removed would be entombed in the riser filling operations. Each riser and the lead lining within it would be encased in concrete, and decontamination of the remaining riser formwork structures and adjacent areas will be performed, if necessary. The tank appurtenances, such as the riser inspection port plugs, riser plug caps, and the transfer valve box covers, which would have been removed to ensure complete backfilling of the tank, would be entombed at the same time as the associated risers are filled and backfilled.

References

Bradbury, M. H., and F. Sarott, 1995, Sorption Database for the Cementitious Near-Field of a L/ILW Repository for Performance Assessment, ISSN 1019-0643, Paul Scherrer Institute, Switzerland.

APPENDIX B

HLW TANK SYSTEM CLOSURE ENVIRONMENTAL REQUIREMENTS, GUIDANCE, AND PERFORMANCE STANDARDS

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APPENDIX B

HLW TANK SYSTEM CLOSURE ENVIRONMENTAL REQUIREMENTS, GUIDANCE, AND PERFORMANCE STANDARDS

B.1. Identification of Requirements and Guidance

B.1.1 INTRODUCTION

The U.S. Department of Energy (DOE) has identified pertinent substantive requirements and guidance it will comply with and consider, respectively, to ensure that closure of the F- and H-Area high-level waste (HLW) tank systems at the Savannah River Site (SRS) will be protective of human health and the environment and consistent with overall remediation of the SRS as implemented under the Federal Facility Agreement (FFA). These requirements and guidance, the process DOE used to identify them, and their intended use in the HLW tank closure strategy and plan are described in this appendix.

B.1.2 TECHNICAL APPROACH

DOE will close the HLW tank systems, which are permitted by the South Carolina Department of Health and Environmental Control (SCDHEC) under authority of the South Carolina Pollution Control Act (SCPCA) as wastewater treatment facilities, in accordance with SC Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities." This regulation requires the performance of such closures be carried out in accordance with site-specific guidelines established by SCDHEC to prevent health hazards and to promote safety in and around the tank systems. To facilitate compliance with this requirement and recognizing the necessity for consistency with overall remediation of the SRS under the FFA, DOE has adopted a general strategy for HLW tank system closure that includes evaluation of an appropriate range of closure alternatives with respect to pertinent, substantive environmental requirements and guidance and other appropriate criteria (e.g., technical feasibility, cost). The general strategy for HLW tank system closure is thus consistent in its substance with comparative analyses performed as part of a Resource Conservation and Recovery Act (RCRA) corrective measures study/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) feasibility study (CMS/FS) under the FFA.

DOE will close all HLW tank systems in the F- and H-Area Tank Farms in accordance with this strategy, including Tank 16, which is no longer operational and hence was not permitted as part of the industrial wastewater treatment facility. However, with respect to closure of the tank system, Tank 16 is subject to the same considerations that determine acceptable closure alternatives for the other 50 HLW tank systems. The past release from Tank 16 that resulted in its removal from service will be addressed along with the release from the Tank 37 condensate transfer system as the H-Area Tank Farm Groundwater Operable Unit (Appendix C of the FFA) in accordance with provisions of the FFA.

In developing this plan, DOE sought to identify, in consultation with SCDHEC and EPA Region IV, those substantive environmental requirements and guidance documents most pertinent to selection and implementation of appropriate closure option(s). These requirements and guidance are comparable to those established as applicable or relevant and appropriate requirements (ARARs) and to-be-considered materials (TBCs) in the context of a CMS/FS under the FFA. These terms, with comparable definitions to those used in CERCLA, were adopted for use in this closure plan.

The initial step in this process involved compiling and evaluating potential "ARARs" documents listed in Appendix A of the FFA (Federal and South Carolina statutes and, by reference, implementing regulations), additional laws and regulations (including potentially useful proposed regulations), DOE Orders implementing the Atomic Energy Act, SRS environmental permits, environmental enforcement documents (e.g., consent orders, settlement agreements) currently in force for SRS, and selected EPA guidance. These documents were screened with respect to applicability, relevance and appropriateness, or usefulness as TBCs in general accord with pertinent EPA guidance for determination of "ARARs" for CERCLA remedial actions (EPA 1988, 1989a, 1989b, 1990a, 1990b, 1990c, and 1991) using the following definitions:

> Applicable - Substantive Federal or State environmental protection requirements, criteria, or limits that directly apply to SRS high-level waste tank system closure operations.

> Relevant and Appropriate - Substantive Federal and State environmental protection requirements, criteria, or limits that, while not directly applicable, are judged to be well suited for use for SRS high-level waste tank system closure operations based on their applicability to similar operations.

> To-be-Considered Materials - Advisories, guidance, proposed rules and the like issued by Federal or State government that are not legally binding, but that are judged to be useful in establishing environmental protection protocols and performance objectives or in evaluating closure options with respect to protection of human health and the environment.

The results of this initial screening process are listed in Table B-1.

Documents determined to constitute or contain "ARARs" or TBCs based on this initial screening were subjected to more detailed evaluation, and substantive requirements and guidance were extracted or summarized, tabulated, and sorted by category (i.e., Applicable, Relevant and Appropriate, and To-be-Considered). The tabulated results were reviewed by the regulatory agencies (SCDHEC and EPA Region IV). The requirements and guidance were subsequently evaluated to identify redundancies (e.g., common standards for environmental protection that are invoked by more than one regulatory program or authority) and confounding or conflicting requirements. Annotations were included in the "Rationale for Use" column explain why certain requirements and guidance should be carried forward to identify specific environmental regulatory standards while others could be dropped from consideration. In general, a requirement or guidance in the Relevant and Appropriate or To-be-Considered Materials categories was included if it is more stringent than the corresponding requirement or guidance in the Applicable category, and excluded if it is less stringent than a requirement or guidance in the Applicable category or if compliance is met by adherence to general provisions of this Closure Plan. The results of this effort are listed in Table B-2.

In the next step, redundancies in the requirements and guidance were eliminated to develop a shortened, but no less comprehensive, list from which to identify specific environmental regulatory standards. All the requirements and guidance listed as Applicable in Table B-2 were retained. Of the requirements and guidance denoted as Relevant and Appropriate or TBC Materials, only those that provide more stringent or more specific standards than those listed as Applicable were retained. Those Relevant and Appropriate or TBC requirements and guidance listed in Table B-2 that are fulfilled by compliance with a standard that is more applicable to the HLW tank system closure activities or that is met by adherence to general provisions of this closure plan were deleted. The results of this effort are listed in Table B-3.

B.2. Performance Standards

Performance standards for HLW tank closure were identified based on the requirements and guidance listed in Table B-3. These performance standards are generally numerical, such as concentration or dose limits for specific radiological or chemical constituents in releases to the environment, which are set forth in the requirements and guidance. The numerical standards apply at different points of compliance and at various periods during or after closure. Summaries of the performance standards for HLW tank closure are presented in Tables B-4 (nonradiological air quality standards), B-5 (nonradiological groundwater and surface-water standards), and B-6 (radiological standards).

The performance objectives that will be used in the evaluations performed for tank system-specific closure modules are a subset of these environmental performance standards. The performance objectives for the HLW tank system closures will be the groundwater protection standards applied at the point where groundwater discharges to the surface (seepline) and the surface-water quality standards applied in the receiving stream.

The performance standards provide a basis for comparison of different closure configurations. Closure options will be evaluated with respect to conformance with specific performance objectives based on these performance standards, and conformance of the closure configuration option selected with the requirements and guidance listed in Table B-3 as part of the overall evaluation (similar to compliance with ARARs as one of the nine CERCLA criteria). In a manner substantially similar to CERCLA requirements, appropriate justification will be necessary to select a nonconforming closure option.

Table B-1. Initial screening of potential requirements and guidance for high-level waste tank system closure.

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Administrative Procedures Act, 5 U.S.C. 551 et seq.	None	Imposes no substantive requirements for HLW tank closure.
Atomic Energy Act, 42 U.S.C. 7401 et seq., as implemented by the U.S Department of Energy:		
• DOE Order 5400.5, "Radiation Protection of the Public and the Environment"	Applicable	Chapter II, "Requirements for Radiation Protection of the Public and the Environment," and Chapter IV, "Residual Radioactive Material," include substantive requirements implementing provisions of the Atomic Energy Act that are applicable to SRS HLW tank closure. The remainder of the order consists primarily of administrative requirements, which would not be as useful discriminators for tank closure options.
• 10 CFR 834, "Radiation Protection of the Public and the Environment" (Proposed Rule)	To-be-Considered Materials	Proposed by DOE to replace DOE Order 5400.5; includes similar, in many cases identical, requirements.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Atomic Energy Act, 42 U.S.C. 7401 et seq., as implemented by the U.S Department of Energy: (cont.)		
• 10 CFR 835, "Radiation Protection for Occupational Workers"	None	Requirements to protect worker health and safety are applicable to all SRS radiological operations, including HLW tank closure. However, requirements do not specifically address closure of waste management facilities and would not be useful discriminators for tank closure options.
Atomic Energy Act, 42 U.S.C. 7401 et seq., as implemented by the Nuclear Regulatory Commission:		
• 10 CFR 20, "Standards for Protection Against Radiation," Subpart E, "Radiological Criteria for License Termination"	Relevant and Appropriate	Known as the License Termination Rule, this regulation provides specific radiological criteria for the decommissioning of lands and structures licensed by or subject to jurisdiction of the NRC. Not applicable to HLW tank closure, but potentially relevant and appropriate in that the HLW tank closure is closely analogous and could provide meaningful performance objectives and criteria for tank closure options. The License Termination Rule has been proposed as the decommissioning criteria for the West Valley Demonstration Project, which includes HLW tank systems. The remainder of the regulation provides requirements to protect worker health and safety, for which DOE has applicable requirements in place.
• 10 CFR 20, "Standards for Protection Against Radiation," "Permissible Doses, Levels, and Concentrations" and Subpart D, "Radiation Dose Limits for Individual Members of the Public"	Relevant and Appropriate	Not applicable to HLW tank closure, but potentially relevant and appropriate because requirements are well suited for use as indicators of protection of human health and the environment and are similar in scope and content to DOE Orders and other Federal requirements that are applicable or are being considered as relevant and appropriate to the HLW tank closure.
• 10 CFR 61, "Performance Objectives"	Relevant and Appropriate	Provides criteria for performance of low-level waste disposal facilities. While not directly applicable to HLW tank closure, the performance objectives set forth in Subpart C of 10 CFR 61 are invoked in the criteria described in Section 5.2.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
• 10 CFR 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada	Relevant and Appropriate	Provides criteria for performance of the proposed repository for disposal of spent nuclear fuel and HLW at Yucca Mountain, Nevada. Not applicable to HLW tank closure, but provides radiation protection standards that are well suited as indicators of protection of human health and the environment for the HLW tank closure project. NRC has promulgated performance objectives for repository operations (e.g., 15 mrem per year to a member of the public in the general environment as a result of normal operations) and for long-term performance after permanent closure (15 mrem/per year to the reasonably maximally exposed individual during the first 10,000 years). The reasonably maximally exposed individual resides in a farming community located near Lathrop Wells, Nevada, approximately 20 km south of the proposed disposal area. NRC proposes a 10,000-year period for evaluating compliance of the disposal system with the long-term performance objective.
Atomic Energy Act, 42 U.S.C. 7401 et seq., as implemented by the U.S. Environmental Protection Agency:		
• 40 CFR 191, "Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes"	Relevant and Appropriate	Requirements of Subpart B, "Environmental Standards for Disposal," are applicable to disposal of any waste associated with HLW tank closure determined to be HLW and therefore subject to NRC licensing requirements per requirements of the Energy Reorganization Act of 1974. For waste that is not considered high-level waste, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. The remaining subparts of 40 CFR 191, which address management of spent fuel, high-level, and transuranic waste, are neither applicable nor relevant and appropriate because they apply only to facilities regulated by the NRC or Agreement States. (AEA requirements for nondisposal facilities associated with the HLW tank closure project would continue under the jurisdiction of DOE, which has its own AEA implementing requirements.)

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
• 40 CFR 193, "Environmental Radiation Protection Standards for the Management, Storage and Disposal of Low-Level Radioactive Waste" (Preproposal Draft, November 30, 1994)	To-be-Considered Materials	When promulgated, these requirements would be applicable to DOE LLW disposal facilities. Subpart B, "Environmental Standards for Disposal," and Subpart C, "Environmental Standards for the Protection of Underground Sources of Drinking Water," are well suited for use as indicators of protection of human health and the environment for the HLW tank closure project and could be considered at that time to be relevant and appropriate requirements; they are classified TBC material at this time because the rule has not yet been promulgated. The remainder of this rule addresses management and storage of low-level waste for which DOE has applicable standards.
• 40 CFR 196, "Radiation Site Cleanup Regulations" (Preproposal Draft, May 11, 1994)	To-be-Considered Materials	This draft proposed EPA Federal regulation, when promulgated, will be applicable to activities resulting in residual radioactive material, including SRS HLW tank closure. These requirements are well suited for use as indicators of protection of human health and the environment for the HLW tank closure project. They are classified as TBC material at this time because the rule has not been promulgated.
• 40 CFR 197, "Environmental Radiation Protection Standards for Yucca Mountain, Nevada"	Relevant and Appropriate	Public health and safety standards for storage and disposal of radioactive material at the proposed repository at Yucca Mountain. Not applicable to HLW tank closure, but these requirements are well suited for use as indicators of protection of human health and the environment for the HLW tank closure project.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Clean Air Act, 42 U.S.C. 2011 et seq., South Carolina Pollution Control Act, and associated Federal and State regulations related to air quality: • 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" • 40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards" • SC R.61-62, "Air Pollution Control Regulations and Standards"	Applicable	Include requirements applicable to all SRS operations, including HLW tank closure, and provide criteria that might be useful for discriminating among tank closure options. 40 CFR 61, Subpart H regulates emissions of radionuclides to the ambient air from DOE facilities. 40 CFR 50 and R.61-62, Standard No. 2 provide ambient air quality standards for criteria pollutants. R.61-62, Standard No. 8, includes ambient air quality standards for toxic air pollutants. R.61-62.6 provides requirements for control of fugitive particulate matter.
Clean Water Act, 33 U.S.C. 1251 et seq., South Carolina Pollution Control Act, South Carolina Stormwater Management and Reduction Act, and implementing regulations for discharge of wastewater and stormwater to surface waters: • 40 CFR 125, "Criteria and Standards for the National Pollutant Discharge Elimination System" • SC R.61-9, "Water Pollution Control Permits"	Applicable	Requirements for process wastewater discharges are applicable to F-/H-Area Effluent Treatment Facility and other facilities that would process waste from HLW tank closure activities, but are not directly applicable to HLW tank closure *per se*. Requirements for stormwater management and discharge from HLW tank operations (e.g., routing of potentially contaminated stormwater to retention basins; discharge limits for stormwater outfalls) would be applicable to HLW tank waste removal operations, but would not be useful discriminators for tank closure options. Requirements for stormwater management from construction-type activities associated with HLW tank closure (e.g., tank exhumation, cap installation) would be applicable and probably would require development of stormwater pollution prevention plans.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Clean Water Act, 33 U.S.C. 1251 et seq., South Carolina Pollution Control Act, South Carolina Stormwater Management and Reduction Act, and implementing regulations for discharge of wastewater and stormwater to surface waters (cont.): • SRS NPDES Permits: Nos. SCR100000 (Stormwater Discharges from Construction Activities), SCR000000 (Stormwater Discharges from Industrial Activities), SC0000175 (Industrial Wastewater Discharges) • SC R.72-300, SC Land Resources Conservation Commission (LRCC), "Standards for Stormwater Management and Sediment Reduction" • LRCC General Permit for Stormwater Management and Sediment Reduction at the Savannah River Site		
Clean Water Act, 33 U.S.C. 1251 et seq., South Carolina Pollution Control Act, and implementing regulations for wastewater treatment facility permitting and closure: • SC R.61-67, "Standards for Wastewater Facility Construction" • SC R.61-82, "Proper Closeout of Wastewater Treatment Facilities" • F-/H-Area High-Level Radioactive Waste Tank Farms Permit No. 17,424-IW • Tank 50 Permit No. 14520	Applicable	Include requirements that are directly applicable to HLW tank closure. SC R.61-82 provides closure requirements for wastewater treatment facilities, and is invoked by the FFA (Section IX.E.4) and SRS Waste Removal Plan and Schedule submitted on November 9, 1993, in response to requirements of the FFA (Section IX.E.1) as applicable, with some exceptions (e.g., Tank 16; tanks that are impracticable to decontaminate). [Note the November 9, 1993 document was replaced by the "F/H Area High Level Waste Removal Plan and Schedule" submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and EPA Region IV on June 22, 1998.] F- and H-Area Tank Farm system modifications made as part of or as a result of closure activities might necessitate changes to Permit No. 17,424-IW, supported by engineering reports prepared in accordance with SC R.61-67.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Clean Water Act, 33 U.S.C. 1251 et seq., South Carolina Pollution Control Act, and implementing regulations related to water quality standards for surface water and groundwater: • 40 CFR 131, "Water Quality Standards" • SC R.61-68, "Water Classifications and Standards" • SC R.61-69, "Classified Waters"	Applicable	Include generally applicable standards for maintaining quality of surface water and groundwater and provide criteria useful as discriminators for HLW tank closure options. 40 CFR, Section 131 includes requirements for states to establish water quality standards.
Coastal Zone Management Act and Corresponding SC Statutes and Regulations	None	Not applicable because SRS is outside the coastal zone. Not appropriate to tank closure project, because statute addresses land use planning and associated public involvement, both of which are being addressed at SRS in the broader context of SRS environmental restoration and future site missions.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601 et seq.:		
• 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan" [The NCP implements CERCLA oil and hazardous substance release response requirements.]	Relevant and Appropriate	The extent to which CERCLA requirements are applicable to HLW tank closure is specified in the SRS FFA, which specifies that tanks that cannot practicably be decontaminated be remediated in accordance with CERCLA remedial action protocols (i.e., Remedial Investigation/Feasibility Study process as described in the 40 CFR 300.400 series regulations, part of the NCP). CERCLA requirements, particularly those setting forth the process, criteria, and performance objectives for evaluation of remedial alternatives, are considered to be relevant and appropriate to HLW tank closure, because: (a) this process is indicated as an appropriate process in DOE Order 435.1 and, (b) releases, if any, from the closed HLW tanks would be addressed by the SRS environmental restoration program in accordance with CERCLA remedial action requirements under the FFA; tank closure should therefore be consistent with the final remedial action under that program, as would be required if tank closure were to be conducted as a CERCLA interim action. Remaining CERCLA requirements, which address such activities as release reporting, are applicable to all SRS operations, including the HLW tank project, but would not be useful discriminators for evaluation of tank closure options.
SRS Federal Facility Agreement [Entered into pursuant to Section 120 of CERCLA to implement CERCLA remedial action and RCRA Section 3004(u) and 3004(v) corrective action requirements at SRS.]	Applicable	Section IX and Appendix B of the FFA include requirements applicable to the HLW tank closure project, including removal of HLW from the tanks, stabilization, and environmental restoration consistent with CERCLA actions. These requirements may need to be revised to accommodate closure of all SRS HLW tanks under authority of R.61-82. Section XXIII, "Permits," and Section XXIV, "Creation of Danger," are applicable to activities undertaken pursuant to the FFA, including HLW tank closure.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601 et seq.: (cont.)		
F-/H-Area High Level Waste Removal Plan and Schedule as Required by the Federal Facility Agreement for the Savannah River Site (WSRC-RP-93-1477, Rev. 0, November 1993)	Applicable	Includes a plan and schedule for removing from service (including waste removal and decontamination) those SRS HLW tanks, except Tank 16, that do not meet secondary containment standards in the FFA or that leak or have leaked. Made applicable by Section IX.E of the FFA. This document has been replaced by the "F/H Area High Level Waste Removal Plan and Schedule" (WRP&S) submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and EPA Region IV on June 22, 1998. The WRP&S provides dates for removal from service and operational closure of each noncompliant tank and commits to complete closure of all noncompliant tanks no later than fiscal year 2022. The approved WRP&S is provided in the Savannah River Site High Level Waste System Plan.
High-Level Waste Tank Closure Program Plan, (Rev. 1, August 2001)		DOE's planning tool for managing HLW tank system closure activities, including the environmental restoration (ER) program's soil assessment/remedial actions related to the closed tank systems. Chapter 4 includes a rationale for the proposed tank closure sequence and identifies operational tank groupings. Chapter 5 provides a process description and generic schedule for field investigation and remedial actions on contaminated soil around tank groupings as they are closed by the HLW program. It describes the development of tank grouping-specific co-occupancy plans (COPs) to define the HLW and ER program responsibilities, plan and schedule, and coordination of intrusive activities under the ER program with ongoing HLW operations in the Tank Farms.
Decommissioning Handbook, DOE/EM-0142P, U.S. Department of Energy Office of Environmental Restoration March 1994	To-be-Considered Materials	Technical guidance for the decommissioning of nuclear facilities, including removal of radioactive and hazardous materials to levels protective of human health and the environment. Chapter 13 identifies standards for air, surface water, and groundwater quality during decommissioning including the National Ambient Air Water Quality Standards, DOE Order 5400.5, "National Emissions Standards for Hazardous Air Pollutants," and Safe Drinking Water Act maximum contaminant levels.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Emergency Planning and Community Right-to Know Act, 42 U.S.C. 11001 et seq.	None	Includes requirements applicable to all SRS operations, including tank closure, with respect to such activities as release reporting and chemical inventories. However, requirements do not specifically address closure of waste management facilities and would not provide useful discriminators for tank closure options.
Executive Orders 11990, "Protection of Wetlands," and 11988, "Floodplain Management," as implemented by 10 CFR 1022	To-be Considered Materials	Includes requirements to avoid adverse impacts to wetlands when practicable alternative exists. Applicable to the extent that water quality of riparian wetlands and surface streams (e.g., Fourmile Branch) could be affected by HLW tank closure options. No tank closure activities are anticipated in wetlands or floodplains.
Endangered Species Act, 16 U.S.C. 531 et seq. and related statutes (Fish and Wildlife Coordination Act, Anadromous Fish Conservation Act, Migratory Bird Treaty Act, Bald Eagle Protection Act, South Carolina Nongame and Endangered Species Conservation Act)	Applicable	Requirements to evaluate potential impact to protected species is applicable to all SRS projects. Differential impact potential of HLW tank closure options would be formally evaluated in the context of NEPA and ecological risk assessment for HLW tank closure.
Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. 136 et seq.:	None	HLW tanks do not contain pesticides and closure will not involve their use.
Hazardous Materials Transportation Act	None	Includes requirements applicable to all SRS operations, including tank closure, with respect to any offsite transport of hazardous materials. However, requirements do not specifically address closure of waste management facilities and would not be useful discriminators for tank closure options.
National Environmental Policy Act, 42 U.S.C. 4321 et seq.: • 10 CFR 1021, "Compliance with NEPA"	Applicable	Requirements of NEPA to evaluate SRS HLW tank closure options are applicable and would be fulfilled in accordance with DOE's implementing regulations (10 CFR 1021). NEPA evaluation will address impacts, including occupational exposure to site personnel, associated with the various closure alternatives.
National Historic Preservation Act, 16 U.S.C. 470 et seq. and related legislation (e.g., Antiquities Act, Historic Sites Act, Archeological and Historic Preservation Act, Archaeological Resources Protection Act, American Indian Religious Freedom Act)	Applicable	Requirements to evaluate potential impacts to cultural resources is applicable to all SRS projects. Impact potential on cultural resources for HLW tank closure options, if any, would be formally evaluated in the context of NEPA.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Occupational Safety and Health Act, 29 U.S.C. 651 et seq.:	None	Requirements to protect worker health and safety are applicable to all SRS operations, including HLW tank closure. However, requirements do not specifically address closure of waste management facilities and would not be useful discriminators for tank closure options.
River and Harbors Act of 1989	None	Requirements are applicable only to work in waterways, which is not anticipated for HLW tank closure. No analogous activities associated with tank closure would make requirements relevant and appropriate.
Safe Drinking Water Act (Public Health Service Act), 42 U.S.C. 300(f) et seq.: • 40 CFR 141, "National Primary Drinking Water Standards" • SC R.61-58.5, "Maximum Contaminant Levels in Drinking Water"	Applicable	Maximum contaminant levels (MCLs) promulgated in 40 CFR 141 and in the corresponding SC regulations are applicable to the HLW closure in that they are invoked as groundwater protection standards in applicable requirements (e.g., DOE Orders 435.1, 5400.5).

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Solid Waste Disposal Act (as amended by the Resource Conservation and Recovery Act and the Federal Facility Compliance Act), 42 U.S.C. 6901 et seq.:		
• 40 CFR 260-270 "Hazardous Waste Management Regulations" (and corresponding portions of the SC Hazardous Waste Management Regulations) [Implement Subtitle C of RCRA.]	Applicable/ Relevant and Appropriate	RCRA regulatory requirements, most notably generator standards (Part 262), treatment, storage and disposal standards (Parts 264 and 265), and land disposal restriction treatment requirements (Part 268) would be variously applicable to hazardous waste removed from the HLW tanks as part of the closure process (e.g., tank rinsewater and solids meeting the definition of hazardous waste; HLW), generated during the closure process (e.g., job control waste, contaminated debris meeting the definition of hazardous waste), and hazardous waste remaining in the HLW tanks (if any). The operation and closure of the HLW tanks are regulated by SCDHEC as wastewater treatment units and thus are exempted from RCRA operating and closure standards (Parts 264 and 265) and permit requirements (Part 270). Parts 264 and 265, Subpart G, include requirements that are potentially relevant and appropriate to closure of the HLW tanks, because they are applicable to closure of hazardous waste tank systems that are not subject to the wastewater treatment unit exemption. Certain RCRA requirements, particularly those setting forth the process, criteria, and performance objectives for evaluation of corrective action alternatives, are relevant and appropriate to HLW tank closure, because: (a) this process is indicated as an appropriate process in DOE Order 435.1 and, (b) releases, if any, from the closed HLW tanks would be addressed by the SRS environmental restoration program in accordance with the RCRA corrective action requirements for solid waste management units (SWMUs) under the FFA; tank closure should therefore be consistent with any corrective action under that program.
Consent Order 95-22-HW [Issued in conformance with requirements of the Federal Facility Compliance Act to enforce compliance with requirements of the SRS Approved Site Treatment Plan.]	Applicable	Includes applicable requirements for identification and treatment of SRS radioactive mixed waste (MW) streams, including HLW removed from HLW tanks and MW generated as a result of HLW tank closure operations.

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
40 CFR 280, "Underground Storage Tank Regulations" (including SC Underground Storage Tank Control Regulations R.61-92) [Implements Subtitle I of RCRA.]	None	Not applicable. Although these regulations provide requirements applicable to management standards for underground storage tanks (USTs) for oil and hazardous substances, including requirements for closure and corrective action, USTs for hazardous waste (e.g., SRS HLW tanks) are regulated under RCRA Subtitle C unless exempted (e.g., as wastewater treatment units subject to regulation, including closure, under authority of the Clean Water Act, as is the case with the SRS HLW tanks). Not relevant and appropriate, because UST regulations (i.e., R.61-92.3.I(1)) do not apply to tanks that contain hazardous waste (see Memorandum of Agreement between DOE and SCDHEC dated April 8, 1985, as amended May 5, 1988).
40 CFR 258, "Criteria for Municipal Solid Waste Landfills" (Final Rule) and 40 CFR 257, "Criteria for Classification of Solid Waste Disposal Facilities and Practices" (Rule for industrial nonhazardous solid waste landfills) and corresponding state regulations (R.61-107) [Implements Subtitle D of RCRA.]	None	RCRA Subtitle D requirements as applied under the corresponding SC program include requirements applicable to all SRS operations, including HLW tank closure, with respect to such operations as recycling and disposal of nonhazardous solid waste; however, these requirements do not specifically address closure of waste management facilities and would not be useful discriminators for HLW tank closure options. Title 40 CFR 258 and 40 CFR 257 include groundwater protection standards (SDWA MCLs at a point of compliance as far as 150 meters from a landfill). However these groundwater protection standards are not appreciably different than those considered applicable to the HLW project.
South Carolina Administrative Procedures Act, 1-23-10	None	Imposes no substantive requirements for HLW tank closure.
South Carolina Atomic Energy and Radiation Control Act, 13-7-10: • R.61-63, "Radioactive Materials"	Relevant and Appropriate	Not applicable to HLW tank closure, but considered potentially relevant and appropriate because requirements are well suited for use as indicators of protection of human health and the environment and are similar in scope and content to DOE Orders and other Federal requirements that are applicable or relevant and appropriate to the HLW tank closure.
South Carolina Hazardous Waste Management Act, S.C. Code Ann. 44-56-10, et seq.	Applicable/ Relevant and Appropriate	See entry for Solid Waste Disposal Act as amended by RCRA. [Implements Subtitle C of RCRA in SC.]

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
South Carolina Oil and Gas Exploration, Drilling, and Transportation Act, 48-43-10	None	Not applicable because requirements address operations that affect or involve oil and gas exploration, extraction, and transportation. No oil or gas resources are known to exist in areas potentially affected by HLW tank closure operations. Not relevant and appropriate because tank closure operations are not analogous to regulated operations.
South Carolina Pollution Control Act, S.C. Code An. 48-1-10 et seq.	Applicable	SCPCA and implementing regulations include some substantive requirements that are applicable or relevant and appropriate to HLW tank closure, including R.61-82, "Proper Closeout of Wastewater Treatment Facilities," a directly applicable requirement for closure of HLW tanks, which are permitted as wastewater treatment units.
South Carolina Safe Drinking Water Act, 44-55-10, et seq.: • SC R.61-58.5, "Maximum Contaminant Levels in Drinking Water"	Applicable	See entry for Safe Drinking Water Act. [Implements SDWA in SC.]
South Carolina Solid Waste Policy and Management Act, 44-96-10, et seq.	None	See entry for Solid Waste Disposal Act as amended by RCRA. [Implements Subtitle D of RCRA in SC.]
Toxic Substances Control Act, 15 U.S.C. 2601 et seq.	None	Some TSCA requirements, particularly those that address management of PCB items and significant new uses of toxic chemicals, are applicable to all SRS operations and could be applicable to HLW tank closure (e.g., disposition of PCB containing electrical insulation, hydraulic oil, if any). However, requirements do not specifically address closure of waste management facilities and would not be useful discriminators for tank closure options.
Uranium Mill Tailings Radiation Control Act, 42 U.S.C. 7910 et seq.	None	Not applicable because requirements address operations involving uranium and thorium mill tailings, none of which are associated with HLW tank closure. Not relevant and appropriate in that health and safety standards exist that are applicable or more clearly relevant and appropriate to HLW tank closure (see entries for Atomic Energy Act).

Table B-1. (Continued).

Statute/Regulation	Requirements/ Guidance[a] Potential	Rationale
Wild and Scenic Rivers Act	None	No designated scenic rivers exist in areas potentially affected by HLW tank closure activities.
Wilderness Act	None	No designated wilderness areas exist in areas potentially affected by HLW tank closure activities.

a. Categories are defined as follows:
- Applicable - Substantive Federal and State environmental protection requirements, criteria, or limits that apply directly to SRS high-level waste tank system closure operations.
- Relevant and Appropriate - Substantive Federal and State environmental protection requirements, criteria, or limits that, while not directly applicable, are judged to be well suited for use for SRS high-level waste tank system closure operations based on their applicability to similar operations.
- To-be-Considered Materials - Advisories, guidance, proposed rules, and the like issued by Federal or State government that are not legally binding, but that are judged to be useful in establishing environmental protection protocols and performance objectives or in evaluating closure options with respect to protectiveness of human health and the environment.

Table B-2. Potential requirements and guidance detail for SRS high-level waste tank system closure.

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SCPCA R.61-82, Section IV	<u>Proper Closeout of Waste Treatment Facilities Not Defined As Lagoons and Package Plants</u> - Waste treatment units shall be closed in accordance with guidelines issued by SCDHEC on an individual basis. These guidelines shall be designed to prevent health hazards and to promote safety in and around the abandoned sites.	Applicable to SRS HLW tanks that are permitted by SCDHEC as industrial wastewater treatment facilities (FFA, Section IX.E.4). Made applicable to all SRS HLW tanks except Tank 16 by DOE's commitment in its November 9, 1993, Waste Removal Plan and Schedule (FFA, Section IX.E.1, 2). [Note the November 9, 1993 document was replaced by the “F/H-Area High Level Waste Removal Plan and Schedule” submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and EPA Region IV on June 22, 1998.] Applicability extended to all SRS HLW tank systems pursuant to discussions with SCDHEC and EPA.	A
CWA R.61-68.E(11)	<u>Water Quality Criteria to Protect Aquatic Life</u> - Numeric criteria for all class surface waters are adopted for toxic pollutants for which the EPA has published national criteria to protect aquatic life pursuant to Section 304(a) of the Federal CWA and for ammonia and chlorine. No numeric criteria are listed in this regulation; however, the national numeric criteria developed and published by EPA are hereby adopted by reference. Compounds with national criteria to protect aquatic life listed in this regulation include: Arsenic — Mercury Cadmium — Nickel Chromium (+3 and +6) — Selenium (+4) Copper — Silver Lead — Zinc [Additional standards are included for pesticides and PCBs.]	Generally applicable standards for maintaining quality of surface water.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA NPDES Permit Limitations and Rationale Guidance	<u>Water Quality Criteria</u> - SCDHEC guidance (spreadsheet dated January 12, 1999) that identifies ambient water quality criteria (concentration limits for individual constituents) for deriving NPDES permit limits.	SCDHEC guidance to be considered in the identification of appropriate ambient water quality criteria for protection of aquatic life and human health.	TBC
CWA R.61-68.E(12)(a-b)	<u>Water Quality Standards to Protect Human Health</u> - State ambient water quality standards to protect human health are listed in Appendix 2 of this regulation. These standards will be applicable to surface waters at average annual flow conditions or at average tidal dilution conditions, whichever is appropriate. The substances and their standards (µg/l) are:	Generally applicable standards for maintaining quality of surface water.	A

	MCL	Organic Consumption
Antimony	6	4,300
Arsenic	–	1.4
Beryllium	4	–
Cadmium	5	–
Chromium (total)	100	–
Mercury	–	0.15
Nickel	100	4,600
Selenium	50	–
Thallium	2	6.3

[Additional standards are included for cyanide, asbestos, and organics.]

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA R.61-68.E(10)	<u>Water Quality Standards to Protect Human Health</u> - A list of water quality standards based on organoleptic data (prevention of undesirable taste and odor) are adopted herein. Those substances and their adopted standards are listed in Appendix 3. For substances that have both aquatic life and/or human health standards and organoleptic standards, the more stringent of the three will be used to derive effluent limits. The substances and their standards (µg/l) are: Copper 1,000 Zinc 5,000 Chlorobenzene 20 2-chlorophenol 0.1 2,4-dichlorophenol 0.3 2,4-dimethylphenol 400 3-methyl-4-chlorophenol 3,000 Pentachlorophenol 30 Phenol 300 Acenaphthene 20 Hexachlorocyclopentadiene 1	Generally applicable standards for maintaining quality of surface water.	A
CWA R.61-68.G(8)(c)	<u>Class Descriptions, Designations, and Specific Standards for Surface Waters</u> - Freshwaters shall meet standards for toxic pollutants listed in Section 307 of the Federal CWA and for which EPA has developed national criteria, and ammonia and chlorine. Standards for these substances are prescribed in Sections E.11 and E.12 of this regulation. [The surface waters potentially affected by HLW tank closure activities, Fourmile Branch and Upper Three Runs, are classified as "freshwaters" under R.61-68.G.]	Generally applicable standards for maintaining quality of surface water.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA R.61-68.H	Class Descriptions and Specific Standards for Ground Waters - All South Carolina groundwater is classified GB effective June 28, 1995. Quality standards for Class GB groundwaters are: • Inorganic chemicals shall meet standards set forth in the State Primary Drinking Water Regulations, R.61-58.5.B(2). • Organic chemicals shall meet standards set forth in the State Primary Drinking Water Regulations, R.61-58.5.D(2). • Manmade radionuclides shall not exceed concentrations or amounts such as to interfere with use, actual or intended, as determined by the Department. [This standard also includes primary pollutant VOCs, pesticides, herbicides, PCBs, synthetic organic compounds, and various wastes.]	Generally applicable standards for maintaining quality of groundwater.	A
SDWA 40 CFR 141.66(b)~~15~~ (Subpart ~~B~~G) R.61-58.5(J)(2)	Maximum Contaminant Levels - The ~~following are the~~ maximum contaminant levels for ~~radium-226, radium-228, and gross alpha particle radioactivity:~~ ~~(a) C~~combined radium-226 and radium-228 - 5 pCi/L. ~~(b) Gross alpha particle activity (including radium-226 but excluding radon and uranium) - 15 pCi/L.~~	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(c) (Subpart G) R.61-58.5(J)(2)	Maximum Contaminant Levels - The maximum contaminant level for gross alpha particle activity (including radium-226 but excluding radon and uranium) is 15 pCi/L.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.66(d)(1) (Subpart G) R.61-58.5(L)(2)(a)	Maximum Contaminant Levels - The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/year.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(d)(2) (Subpart G) R.61.58.5(L)(2)(b)	Maximum Contaminant Levels - Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents must be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure" (NBS Handbook 69 as amended August 1963, U.S. Department of Commerce). If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or any organ shall not exceed 4 mrem/year. Table A - Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr Radionuclide / Critical Organ / pCi per liter Tritium / Total body / 20,000 Strontium-90 / Bone marrow / 8	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(e) (Subpart G)	Maximum Contaminant Levels – The maximum contaminant level for uranium is 30 µg/L.	EPA Federal regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.51 (Subpart F)	Maximum Contaminant Levels Goals - The MCLGs for inorganic constituents are: Contaminant — Milligrams per liter Antimony — 0.006 Barium — 2 Beryllium — 0.004 Cadmium — 0.005 Chromium — 0.1 Copper — 1.3 Fluoride — 4 Lead — zero[1] Mercury — 0.002 Nitrate — 10 (as N) Nitrite — 1 (as N) Total nitrate & nitrite — 10 (as N) Selenium — 0.05 Thallium — 0.0005 [1]action level for lead is 0.015 mg/l	EPA Federal regulation applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. [Provides relevant and appropriate groundwater quality standards for copper and lead.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.62(b) (Subpart G) R.61-58.5(B)(2)	Maximum Contaminant Levels - The MCLs for inorganic constituents are: Contaminant — Milligrams per liter Fluoride — 4.0 Arsenic — 0.01 Barium — 2.0 Cadmium — 0.005 Chromium — 0.1 Mercury — 0.002 Nitrate — 10 (as N) Nitrite — 1 (as N) Total nitrate & nitrite — 10 (as N) Selenium — 0.05 Antimony — 0.006 Beryllium — 0.004 Cyanide (as free cyanide) — 0.2 ~~Nickel — 0.1[1]~~ Thallium — 0.002 ~~[1]nickel standard is in R.61.58.5(B)(2) only~~ [Standard also includes asbestos fiber limit.]	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Made applicable by R.61-68.H.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA SRS FFA WSRC-05-94-42 - DOE, EPA & SCDHEC, 8/16/93	The agreement directs the comprehensive remediation of SRS and also delineates the relationship between its requirements and the requirements for corrective measures being conducted under RCRA Sections 3004 (u) and (v) according to the conditions of the Federal and State RCRA permit. Section IX - High-Level Radioactive Waste Tank System(s) Section IX.E.1 - DOE has submitted a waste removal plan and schedule for the waste tank systems. DOE shall remove the tanks from service according to the approved plan(s) and schedule(s). Waste tanks deemed unsuitable by SCDHEC shall not receive additional waste prior to schedule approval for such receipt and only if waste receipt is approved as part of the plan associated with such a schedule. Section IX.E.2 - The DOE waste tank system(s) removal plan(s) shall provide for the removal or decontamination of all residues, contaminated containment systems components (liners, etc.), contaminated soils and structures and equipment contaminated with hazardous and/or radioactive substances. If DOE demonstrates that it cannot practicably remove or decontaminate soils or structures and equipment, then DOE shall conduct all necessary response actions under Section XI through XVI of this Agreement for those waste tank system(s). Section IX.E.3 - DOE will submit to EPA and SCDHEC an annual report on the status of the tanks being removed from service under Subsection E.1.	Standards for SRS HLW tank systems set forth in Section IX and Appendix B of the FFA apply to tank operations, including closure activities. Section XXIII, "Permits," and Section XXIV, "Creation of Danger," are applicable to activities undertaken pursuant to the FFA, including HLW tank closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA SRS FFA WSRC-05-94-42 - DOE, EPA & SCDHEC, 8/16/93 (cont.)	Section IX.E.4 - For waste tank system(s) that DOE decides to remove from service that have been issued an industrial wastewater permit under the SC Pollution Control Act (SCPCA): DOE shall remove such waste tank system(s) from service in accordance with the SCPCA and all applicable regulations promulgated pursuant to the SCPCA. For any waste tank systems(s) for which closure or removal from service is or has been conducted under the SCPCA, DOE shall conduct Site Evaluation in accordance with Section X of the FFA.		
CERCLA Waste Removal Plan and Schedule for the HLW Tank Farms, WSRC-RP-93-1477, Rev. 0, 11/9/93	Waste removal plan and schedule for the HLW tank system(s) and/or component(s) that do not meet secondary containment standards or that leak or have leaked as required by Section IX.E of the SRS FFA. This 1993 document was replaced by the "F/H Area High Level Waste Removal Plan and Schedule" (WRP&S) submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and EPA Region IV on June 22, 1998. The WRP&S provides dates for removal from service and operational closure of each non-compliant tank and commits to complete closure of all non-compliant tanks no later than fiscal year 2022. The approved WRP&S is provided in the Savannah River Site High Level Waste System Plan.	Applicable to the removal of SRS HLW tanks from service in accordance with Section IX.E.1 of the FFA.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA High-Level Waste Tank Closure Program Plan, (Rev. 1, August 2001)		DOE's planning tool for managing HLW tank system closure activities, including the environmental restoration (ER) program's soil assessment/remedial actions related to the closed tank systems. Chapter 4 includes a rationale for the proposed tank closure sequence and identifies operational tank groupings. Chapter 5 provides a process description and generic schedule for field investigation and remedial actions on contaminated soil around tank groupings as they are closed by the HLW program. It describes the development of tank grouping-specific co-occupancy plans (COPs) to define the HLW and ER program responsibilities, plan and schedule, and coordination of intrusive activities under the ER program with ongoing HLW operations in the Tank Farms.	A
CAA 40 CFR 61.92 (NESHAP)	Standard - Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.	EPA Federal regulation that is applicable to all SRS operations, including HLW tank closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CAA SC R.61-62.5 Air Pollution Control Standard No. 2	Ambient Air Quality Standard - The following table constitutes the ambient air quality standards for the State of South Carolina. The analytical methods to be used will be those applicable Federal Reference Methods published in 40 CFR 50, Appendices A-H as revised July 1, 1986. In the case of fluorides either the double paper tape sampler methods (ASTM D-3266-79) or the sodium bicarbonate-coated glass tube and particulate filter method (ASTM D3268-78) may be used.	SC standards which implement national primary and secondary ambient air quality standards. Standards are applicable to all SRS operations, including HLW tank closure and provide standards for evaluation of criteria pollutant emissions and impacts.	A

Pollutant	Measuring Interval	Standard ($\mu g/m^3$ unless noted otherwise) (1)(2)
Sulfur dioxide	3 hour	1,300(3)
	24 hours	365(3)
	annual	80
Total suspended particulates	Annual geometric mean	75
PM_{10}	24 hours	150(4)
	annual	50(4)
$PM_{2.5}$	24 hours	65(5)
	annual	15(5)
Carbon monoxide	1 hour	40 mg/m^3
	8 hour	10 mg/m^3
Ozone	1 hour	0.12 ppm (4)
	8 hour	0.08 ppm (5)
Gaseous fluorides (as HF)	12 hr. avg.	3.7
	24 hr avg.	2.9
	1 wk. avg.	1.6
	1 mo. avg.	0.8

Table B-2. (Continued).

Citation	Requirement/Guidance Summary			Rationale for Use[a]	Requirements/ Guidance Category[b]
CAA SC R.61-62.5 Air Pollution Control Standard No. 2 (cont.)	Nitrogen dioxide	annual	100		
	Lead	Calendar quarterly mean	1.5		

(1) Arithmetic average except in case of total suspended particulate matter.

(2) At 25°C and 760 mm Hg.

(3) Not to be exceeded more than once a year.

(4) Attainment determinations will be made based on the criteria contained in Appendixes H and K, 40 CFR 50, July 1, 1987.

(5) Amendments to R.61-62.5 to incorporate new Federal standards for ozone and $PM_{2.5}$ pending EPA implementation rules.

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CAA SC R.61-62.5 Air Pollution Control Standard No. 8, Toxic Air Pollutants	<u>II. Toxic Air Emissions</u> - E. The allowable ambient air concentrations of a toxic air pollutant beyond the plant property line as determined by modeling under Part A shall be limited to the value listed in the following table in this section, which include:	SC Standards that implement Federal air toxic control program requirements. Standards are applicable to all SRS operations, including HLW tank closure and provide standards for evaluation of toxic pollutant emissions and impact.	A

Chemical Name	CAS No.	Maximum Allowable Concentration (µg/m^3)[a]
Category I: Low Toxicity		
None		
Category II: Moderate Toxicity		
Oxalic acid	144-62-7	10.00
Category III: High Toxicity		
Benzene	71-43-2	150.00
Chromium(+6) compounds	None	2.50
Manganese compounds	None	25.00
Mercury	7439-97-6	0.25
Nickel	7440-02-0	0.50
Selenium compounds	None	1.00

[a]For the purpose of this standard, these values shall be rounded to the nearest hundredth of a µg/m^3. For example, a test or modeled value of 0.005 through 0.01 would be rounded to 0.01 but values less than 0.005 would be rounded to 0.00.

[Note: See SC R.61-62.5 for a complete list of pollutants and corresponding standards.]

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
National Environmental Policy Act, 42 U.S.C. 4321 et seq., 10 CFR 1021	Requirements of NEPA to evaluate SRS HLW tank closure options would be fulfilled in accordance with DOE implementing regulations (10 CFR 1021). NEPA evaluation will address impacts, including occupational exposure to site personnel, associated with various closure alternatives.	Environmental analysis requirements of NEPA are applicable to all SRS operations, including HLW tank closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); 50 CFR 402 and related statutes (Anadromous Fish Conservation Act, Bald Eagle Protection Act, South Carolina Nongame and Endangered Species Conservation Act, Migratory Bird Treaty Act, Fish and Wildlife Coordination Act)	Prohibits Federally authorized actions that probably would jeopardize the existence of any threatened or endangered or otherwise protected species or result in the destruction or adverse modification of a critical habitat.	Applicable if threatened or endangered or otherwise protected species or habitats exist on or near the site, or could be affected by the proposed action.	A
National Historic Preservation Act, 16 U.S.C. 470 et seq. and related legislation (e.g., Antiquities Act, Historic Sites Act, Archeological and Historic Preservation Act, Archaeological Resources Protection Act, American Indian Religious Freedom Act)	Impact potential on cultural resources for HLW tank closure options, if any, would be formally evaluated in the context of NEPA.	Requirements to evaluate potential impact to cultural resources is applicable to all SRS projects.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
Executive Orders 11990 "Protection of Wetlands" and 11988 "Floodplain Management" as implemented by 10 CFR 1022	Includes requirements to avoid adverse impacts to wetlands when practicable alternative exists.	Applicable to the extent that water quality of riparian wetlands and surface streams (e.g., Fourmile Branch) could be affected by HLW tank closure options. No tank closure operations are anticipated in wetlands or floodplains. [Requirement met by compliance with R.61-68.]	TBC
CERCLA 42 U.S.C. 9621 Section 121(d) (Cleanup Standards)	<u>Degree of Cleanup</u> - Remedial actions shall attain a degree of (1) cleanup of hazardous substances, pollutants, or contaminants released into the environment and (2) control future releases which assures protection of human health and the environment. Section 121(d) of CERCLA requires that remedial action attain a level or standard of control for any hazardous constituent, pollutant, or contaminant which at least attains: • Any legally applicable or relevant and appropriate standard, requirement, criterion, or limitation under Federal environmental law • Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent that any Federal standard, requirement, or limitation and that has been identified by the state in a timely manner Such remedial action shall require a level or standard of control which attains MCL goals established under the SDWA and water quality criteria under section 304 or 303 of the CWA, where such goals are relevant and appropriate under the circumstances of the release or threatened release.	Potentially relevant and appropriate to ensure that HLW tank closure activities are consistent with final remedial actions for the F- and H-Area Tank Farms pursuant to the FFA. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA 40 CFR 300.400(g)	Identification of applicable or relevant and appropriate requirements - The lead and support agencies shall identify requirements applicable to the release or remedial action contemplated based upon an objective determination of whether the requirement specifically addressees a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance found at a CERCLA site. If it is determined that a requirement is not applicable to a specific release, the requirement may still be relevant and appropriate to the circumstances of the release. In evaluating relevance and appropriateness, the factors in paragraphs (g)(2)(i) through (viii) of this section shall be examined, where pertinent, to determine whether a requirement addresses problems or situations sufficiently similar to the circumstances of the release or remedial action contemplated, and whether the requirement is well suited to the site, and is therefore both relevant and appropriate.	Potentially relevant and appropriate to ensure that HLW tank closure activities are consistent with final remedial action for the F- and H-Area Tank Farms pursuant to the FFA. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA 40 CFR 300.430(e)(2)(i)	The remediation goals establish acceptable exposure levels that are protective of human health and the environment and are developed by considering ARARs (e.g., chemical-specific ARARs) under Federal or state environmental or facility siting laws, if available, and the following factors: For systemic toxicants, acceptable exposure levels represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect, during a lifetime or part of a lifetime, incorporating an adequate margin of safety. For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}. The 10^{-6} risk level is the point of departure for determining remediation goals for alternatives where ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple exposure pathways.	Potentially relevant and appropriate to ensure that HLW tank closure activities are consistent with final remedial action for the F- and H-Area Tank Farms pursuant to the FFA. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA 40 CFR 300.430(e)(9)	Nine Criteria for Evaluation - The analysis of remedial alternatives under CERCLA shall consider nine criteria: (1) Overall protection of human health and the environment (2) Compliance with applicable, or relevant and appropriate requirements (ARARs) (3) Long-term effectiveness and permanence including the magnitude of the residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities and the adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste (4) Reduction of toxicity, mobility, or volume through treatment (5) Short-term effectiveness (6) Implementability including technical feasibility, administrative feasibility, and availability of services and materials (e.g., treatment, storage, or disposal capacity, prospective technologies) (7) Cost (8) State acceptance (9) Community acceptance The first two, overall protection of human health and the environment and compliance with ARARs, are threshold requirements that must be met by each alternative to be eligible for selection. The next five are the primary balancing criteria and state and community acceptance are the modifying criteria to be considered in remedy selection.	Potentially relevant and appropriate to ensure that HLW tank closure activities are consistent with final remedial action for the F- and H-Area Tank Farms pursuant to the FFA. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA 40 CFR 300.430(f)(1)(ii)(C)	An alternative may be selected that does not meet an ARAR under Federal environmental law or state environmental or facility siting laws under the following circumstances: (1) The alternative selected is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate Federal or state requirement (2) Compliance with such requirements will result in greater risk to human health and the environment than alternative options (3) Compliance with the requirements is technically impracticable from an engineering perspective (4) The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation, through use of another method or approach (5) With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state	Potentially relevant and appropriate to ensure that HLW tank closure activities are consistent with final remedial action for the F- and H-Area Tank Farms pursuant to the FFA. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 262 R.61-79.262	Standards Applicable to Generators of Hazardous Waste - Generators of hazardous waste are required to do the following: • Determine if the waste is hazardous waste and identify requirements for management of hazardous waste as set forth in Parts 264, 265, and 268; obtain an EPA identification number (Subpart A) • Comply with manifest requirements for transport of hazardous waste off the site (Subpart B) • Comply with pretransport requirements for hazardous waste packaging, labeling, marking, placarding, and accumulation; comply with storage facility requirements of Parts 264, 265, and 270 if hazardous waste is stored for more than 90 days (Subpart C) • Comply with recordkeeping and reporting requirements for hazardous waste generation, offsite transport, treatment, storage, and disposal (Subpart D)	Applicable to any hazardous waste generated as a result of SRS HLW tank closure activities. Hazardous wastes that are managed in wastewater treatment units (e.g., wastes transferred to other HLW tank systems) can be excluded from RCRA permitting and operating standards.	A
RCRA 40 CFR 265 (Subpart G) R.61-79.265 (Subpart G)	Closure and Postclosure - Includes closure standards applicable to all HWMFs (Section 265.111-115) and postclosure standards (Section 265.116-120) applicable to postclosure care of tank systems required under Section 265.197 to meet the requirement for landfills.	Administrative closure and postclosure requirements of Subpart G are not considered as ARARs, because applicable administrative requirements are provided by R.61-82. Substantive closure requirements of Subpart G are generally relevant and appropriate to closure of HLW tank systems, because these tank systems contain or have contained RCRA hazardous waste. These closure requirements are relevant and appropriate in individual tank closure decisions made under this plan to the extent that individual tank closures must be consistent with final remedial actions for the F- and H-Area Tank Farms pursuant to the FFA.	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 265 (Subpart G) R.61-79.265 (Subpart G) (cont.)		Similarly, postclosure requirements of Subpart G are relevant and appropriate to the extent that individual HLW tank closure activities must be consistent with a reasonable postclosure program to be planned and implemented as part of the SRS ER Program under the FFA. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensures that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	
RCRA 40 CFR 265.111 (Subpart G) R.61-79.265.111 (Subpart G)	Closure Performance Standard for HWMFs - The owner/operator must close the facility in a manner that: (1) Minimizes the need for further maintenance (2) Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere (3) Complies with the closure requirements of Part 265 (e.g., Section 265.197 for tank systems)	Provides relevant and appropriate general performance standards for closure of tank systems that have been used to manage RCRA hazardous waste. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 265.114 (Subpart G) R.61-79.265.114 (Subpart G)	Closure of HWMFs: Disposal or Decontamination of Equipment, Structures, and Soils - During partial and final closure periods, all contaminated equipment, structures, and soils must be properly disposed of or decontaminated, unless otherwise specified (e.g., under Section 265.197 for tank systems). By removing any hazardous wastes or hazardous constituents during partial or final closure, the owner/operator can become a generator of hazardous waste and must handle that waste in accordance with all applicable requirements of 40 CFR 262.	Provides relevant and appropriate standards for the disposition of structures or environmental media contaminated with hazardous waste or hazardous constituents. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 265.117 (Subpart G) R.61-79.265.117 (Subpart G)	Closure of HWMFs: Postclosure Care and Use of Property Postclosure care of each hazardous waste management unit subject to the requirements of Section 265.117-120 must begin after completion of closure of the unit and continue for 30 years after that date. It must consist of at least the following: (1) Monitoring and reporting in accordance with requirements of subparts F, K, L, M, and N of this part. (2) Maintenance and monitoring of waste containment systems in accordance with the requirements of subparts F, K, L, M, and N. The Department may extend the postclosure care period applicable to the unit if it finds that the extended period is necessary to protect human health and the environment (e.g., leachate or groundwater monitoring results indicate a potential for migration of hazardous wastes at levels that may be harmful to human health or the environment). The Department may require continuation of any of the security requirements of Section 265.14 during part or all of the postclosure period.	Provides relevant and appropriate standards for postclosure care and use of property contaminated with hazardous waste or hazardous constituents. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 265.117 (Subpart G) R.61-79.265.117 (Subpart G) (cont.)	Postclosure use of the property on or in which hazardous wastes remain after closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the facility's monitoring systems, unless the Department finds that the disturbance is necessary to the proposed use of the property and will not increase the potential hazard to human health or the environment or is necessary to reduce a threat to human health or the environment.		
RCRA 40 CFR 265.197 (Subpart J) R.61-79.265.197 (Subpart J)	<u>Tank System Closure and Postclosure Care</u> - At closure of a tank system, the owner/operator must remove or decontaminate all waste residues, contaminated containment system components, contaminated soils, and structures or equipment contaminated with waste, and manage them as hazardous waste (unless they no longer meet the definition of hazardous waste). If the owner/operator demonstrates that not all contaminated soils can be practicably removed or decontaminated, he must close the tank system and perform postclosure care in accordance with the closure and postclosure care requirements that apply to landfills (Section 265.310). Such a tank system is considered to be a landfill and must meet the requirements for landfills in Part 265, Subpart G.	Provides relevant and appropriate standards for the disposition of structures or environmental media contaminated with hazardous waste or hazardous constituents. [Requirement to manage contaminated components, structures, equipment, and hazardous waste/constituents removed during closure met through compliance with 40 CFR and SCHWMR R.61-79, Parts 262, 264/265, and 268. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 265.310(a) (Subpart N) R.61-79.265.310(a) (Subpart N)	Landfill Closure - At final closure of the landfill or upon closure of any cell, the owner/operator must cover the landfill or cell with a final cover designed to: (1) Provide long-term minimization of migration of liquids through the closed landfill. (2) Function with minimal maintenance. (3) Promote drainage and minimize erosion or abrasion of the cover. (4) Accommodate settling and subsidence so that the cover's integrity is maintained. (5) Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Provides relevant and appropriate standards for the closure of HWMFs from which hazardous waste or hazardous constituents cannot be removed at the time of closure. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 265.310(b) (Subpart N) R.61-79.265.310(b) (Subpart N)	Landfill Postclosure Care - After final closure, the owner/operator is also required to comply with postclosure care requirements in Section 265.117-120 and: (1) Maintain the integrity and effectiveness of the final cover. (2) Continue to operate the leachate collection and removal system until leachate is no longer detected. (3) Maintain and monitor the leak detection system. (4) Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of Part 265 Subpart F. (5) Prevent runoff from eroding or otherwise damaging the final cover. (6) Protect and maintain surveyed benchmarks.	Provides relevant and appropriate standards for the postclosure care and monitoring of HWMFs from which hazardous waste or hazardous constituents cannot be removed at the time of closure. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264 (Subpart F) R.61-79.264 (Subpart F)	Releases from Solid Waste Management Units - Subpart F requires: (a) for all solid waste management units at facilities seeking a RCRA permit, corrective action as necessary to protect human health and the environment from all releases of hazardous waste or hazardous constituents, and (b) for surface impoundments, waste piles, land treatment units, and landfills that have received hazardous waste after July 26, 1982, establishment of a groundwater protection standard, monitoring with respect to the standard, and corrective action program if the standard is exceeded.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 264.91 (Subpart F) R.61-79.264.91 (Subpart F)	Required Programs - Owners/operators subject to this subpart must conduct a monitoring and response program as follows: (1) Whenever hazardous constituents under Section 264.93 from a regulated unit are detected at a compliance point under Section 264.95, the owner/operator must institute a compliance monitoring program under Section 264.99. Detected is defined as statistically significant evidence of contamination as described in Section 264.98(f). (2) Whenever the groundwater protection standard under Section 264.92 is exceeded, the owner/operator must institute a corrective action program under Section 264.100. Exceeded is defined as statistically significant evidence of increased contamination as described in Section 264.99(d).	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.91 (Subpart F) R.61-79.264.91 (Subpart F)	(3) Whenever hazardous constituents under Section 264.93 from a regulated unit exceed concentration limits under Section 264.94 in groundwater between the compliance point under Section 264.95 and the downgradient facility property boundary, the owner/operator must institute a corrective action program under Section 264.11. (4) In all cases, the owner/operator must institute a detection monitoring program under Section 264.98.		
RCRA 40 CFR 264.92 (Subpart F) R.61-79.264.92 (Subpart F)	Groundwater Protection Standard - The owner/operator must comply with conditions specified in the facility's permit that are designed to ensure that hazardous constituents under Section 264.93 detected in the groundwater from a regulated unit do not exceed the concentration limits under Section 264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance under Section 264.95 during the compliance period under Section 264.96. SCDHEC will establish the groundwater protection standard in the facility permit when hazardous constituents have been detected in the groundwater.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 264.93 (Subpart F) R.61-79.264.93 (Subpart F)	Hazardous Constituents - Hazardous constituents are those constituents identified in Appendix VIII of R.61-79.261 that have been detected in groundwater in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless SCDHEC has granted an exclusion of a constituent or constituents under paragraph (b) of this section. Paragraph (b) allows for the exclusion of an Appendix VIII constituent from the groundwater protection standard if the owner/operator can demonstrate that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. Criteria to be considered in such demonstrations or set forth in paragraph (b) include assessing potential adverse effects on groundwater quality and hydraulically connected surface waters.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.94 (Subpart F) R.61-79.264.94 (Subpart F)	Concentration Limits - The concentration of a hazardous constituent must not exceed: (1) The background level of that constituent in the groundwater at the time the limit is specified in the permit. (2) The respective MCL value for that constituent if the background level is below the MCL level. (3) An ACL established by the SCDHEC under paragraph (b). Paragraph (b) establishes criteria for establishing an ACL. The owner operator must demonstrate that the constituent will not pose a substantial threat to human health or the environment as long as the ACL is not exceeded.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 264.95 (Subpart F) R.61-79.264.95 (Subpart F)	Point of Compliance - The owner/operator must specify the point of compliance at which the groundwater protection standard of Section 264.92 applies and at which groundwater monitoring must be performed. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit(s). The waste management area is the limit, projected in the horizontal plane, of the area on which waste will be placed during the active life of the regulated unit, including horizontal space taken up by any liner, dike, or other barrier to contain waste in a regulated unit. If the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.96 (Subpart F) R.61-79.264.96 (Subpart F)	<u>Compliance Period</u> - The owner/operator will specify the compliance period during which the groundwater protection standard of Section 264.92 applies. The compliance period is the number of years equal to the active life of the waste management area (including any waste management activity prior to permitting, and the closure period). If the owner/operator is engaged in a corrective action program at the end of the compliance period, the period is extended until the owner/operator can demonstrate that the groundwater protection standard of Section 264.92 has not been exceeded for a period of 3 consecutive years.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
RCRA 40 CFR 264.97 (Subpart F) R.61-79.264.97 (Subpart F)	<u>General Groundwater Monitoring Requirements</u> - The owner/operator must comply with the following requirements for any groundwater monitoring program developed to satisfy Sections 264.98, 264.99, or 264.100. The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that: (1) Represent the quality of background water that has not been affected by leakage from a regulated unit (2) Represent the quality of groundwater passing the point of compliance (3) Allow for detection of contamination when hazardous waste or hazardous constituents have migrated from the waste management area to the uppermost aquifer	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.97 (Subpart F) R.61-79.264.97 (Subpart F) (cont.)	This section also sets forth standards for groundwater monitoring systems at a facility that contains more than one regulated unit; standards for construction of monitoring wells; requirements for groundwater sampling and analysis procedures; requirements for the determination of groundwater surface elevation; sampling, monitoring, and statistical analysis requirements for background wells and compliance points; and groundwater monitoring data recordkeeping requirements.		
RCRA 40 CFR 264.98 (Subpart F) R.61-79.264.98 (Subpart F)	<u>Detection Monitoring Program</u> - The owner/operator required to establish a detection monitoring program under this subpart must: (a) Monitor for indicator parameters, waste constituents, and reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. (b) Install a groundwater monitoring system at the compliance point as specified under Section 264.95. The groundwater monitoring system must comply with Sections 264.97(a)(2), (b), and (c). (c) Conduct a groundwater monitoring program using sampling procedures and statistical methods appropriate for the facility as specified in the permit. Maintain a record of groundwater analytical data as measured and in a form necessary for the determination of statistical significance. (d) Collect samples and conduct tests at the specified frequency to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.98 (Subpart F) R.61-79.264.98 (Subpart F) (cont.)	(e) Determine groundwater flow rate and direction in the uppermost aquifer at least annually. This section also specifies requirements for responding to a determination that statistically significant evidence of groundwater contamination exists.		
RCRA 40 CFR 264.99 (Subpart F) R.61-79.264.99 (Subpart F)	<u>Compliance Monitoring Program</u> - The owner/operator must establish a compliance monitoring program to: (a) Monitor the groundwater to determine whether regulated units are in compliance with the groundwater protection standard under Section 264.92. (b) Install a groundwater monitoring system at the compliance point as specified under Section 264.95. The groundwater monitoring system must comply with Sections 264.97(a)(2), (b), and (c). (c) Conduct a groundwater monitoring program for each chemical parameter and hazardous constituent specified in the permit. Maintain a record of groundwater analytical data as measured and in a form necessary for the determination of statistical significance. (d) Collect samples and conduct tests at the specified frequency to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent. (e) Determine groundwater flow rate and direction in the uppermost aquifer at least annually.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.99 (Subpart F) R.61-79.264.99 (Subpart F) (cont.)	At least annually, the owner/operator must analyze samples from all monitoring wells at the compliance point for all constituents contained in Appendix IX of Part 264 to determine whether additional hazardous constituents are present in the uppermost aquifer and, if so, at what concentration. This section sets forth requirements that are applicable if the owner/operator finds Appendix IX constituents in the groundwater that are not already identified in the permit as monitoring constituents.		
RCRA 40 CFR 264.100 (Subpart F) R.61-79.264.100 (Subpart F)	Corrective Action Program - An owner/operator required to establish a corrective action program must: (a) Take corrective action to ensure that regulated units are in compliance with the groundwater protection standard under Section 264.92. (b) Implement a corrective action program that prevents hazardous constituents from exceeding their respective concentration limits at the compliance point by removing hazardous waste constituents or treating them in place. (c) Begin corrective action within a reasonable period after the groundwater protection standard is exceeded. (d) In conjunction with a corrective action program, establish and implement a groundwater monitoring program based on the requirements for compliance monitoring under Section 264.99 and as effective in determining compliance with the groundwater protection standards and in determining the success of a corrective action program.	Potentially relevant and appropriate only with respect to establishing a performance objective for groundwater protection. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 264.100 (Subpart F) R.61-79.264.100 (Subpart F) (cont.)	(e) Conduct corrective action to remove or treat in place any hazardous constituents under Section 264.93 that exceed concentration limits under Section 264.94 in groundwater. (f) Continue corrective action measures during the compliance period to the extent necessary to ensure that the groundwater protection standard is not exceeded. If the owner/operator is conducting corrective action at the end of the compliance period, he must continue that corrective action as long as necessary to achieve compliance with the groundwater protection standard.		
RCRA 40 CFR 264.100 (Subpart F) R.61-79.264.100 (Subpart F) (cont.)	This section also sets forth reporting requirements and procedures for seeking modifications to the approved corrective action program.		
RCRA 40 CFR 264.101 (Subpart F) R.61-79.264.101 (Subpart F)	<u>Corrective Action for Solid Waste Management Units</u> - An owner/operator seeking a permit for the treatment, storage, or disposal of hazardous waste must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any Solid Waste Management Unit at the facility, regardless of the time at which the waste was placed in such unit. Corrective action will be specified in the permit application in accordance with this section and subpart S. The owner/operator must implement corrective action beyond the facility property boundary, where necessary to protect human health and the environment, unless he demonstrates that he was unable to obtain the necessary permission to undertake such actions. This section also sets forth standards for monitoring well installation.	Applicable to the HLW tanks because the F- and H-Area Tank Farms are identified on the site evaluation list (Appendix G) of the FFA. Compliance with the requirements of the FFA, including the schedules and commitments therein, will constitute compliance with the corrective action requirements at SWMUs and Areas of Concern (AOCs) set forth in Module IV, "Corrective Action," of the SRS RCRA permit. Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA requirements for corrective action for SWMUs with respect to the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268 R.61-79.268	Land Disposal Restrictions - Specifies standards to which hazardous waste must be treated prior to land disposal and prohibits storage of untreated hazardous waste except under specified conditions. Subpart D sets forth the treatment standards and Subpart E identifies prohibitions on storage applicable to restricted wastes.	LDR applicable to land disposal of hazardous wastes: • Removed from HLW tanks as part of tank closure activities • Generated as a result of tank closure activities	A
RCRA 40 CFR 268.40 (Subpart D) R.61-79.268.40 (Subpart D)	Applicability of Treatment Standards - A waste identified in the table "Treatment Standards for Hazardous Wastes" in this section may be land disposed only if it meets the requirements found in the table. For each waste, the table identifies one of three types of treatment requirements: (1) All hazardous constituents in the waste or in the treatment residues must be at or below the levels found in the table ("total waste standards") (2) The hazardous constituents in the extract of the wastes or the treatment residue must be at or below the levels found in the table ("waste extract standards") (3) The waste must be treated using the technology specified in the table ("technology standard") These standards are established for two types of waste: "wastewaters" which are generally wastes containing less than 1 percent by weight TOC and less than 1 percent by weight TSS and "nonwastewaters" [Sections 268.2(d) and (f)]. The table includes entries specific to certain mixed wastes: "Radioactive high level wastes generated during the reprocessing of fuel rods" (nonwastewaters only) that are D002 or D004-D011 hazardous wastes are subject to the HLVIT standard.	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268.40 (Subpart D)	"Radioactive lead solids" (nonwastewaters only) that are D008 hazardous wastes are subject to the MACRO standard.		
R.61-79.268.40 (Subpart D) (cont.)	"Elemental mercury contaminated with radioactive materials" (nonwastewaters only) that are D009 hazardous wastes are subject to the AMLGM standard.		
	In the Third Third rule, EPA indicated that the HLVIT standard would apply to the "high-level fraction of the mixed waste generated during the reprocessing of fuel rods" exhibiting the characteristics of corrosivity and toxicity for metals (see 55 FR 22627). Incidental wastes associated with HLW tank closure that are also mixed wastes would not require treatment by vitrification, but could nevertheless require treatment in accordance with the applicable LDR treatment standards for any hazardous characteristics, including standards for any underlying hazardous constituents.		
	In addition to a specified technology or waste-specific concentration standard, wastes may also be subject to LDR treatment standards for underlying hazardous constituents set forth in Section 268.48. For example, a corrosive characteristic waste (D002) would have to be deactivated (i.e., rendered no longer corrosive) and treated to achieve the UTS concentration limits for any underlying hazardous constituents.		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268.45 R.61-79.268.45	<u>Treatment Standards for Hazardous Debris</u> - Hazardous debris may be treated in accordance with the waste-specific standards or, alternatively, the debris may be treated in accordance with the standards set forth in Table 1 of this section. The alternative standards for hazardous debris include extraction, destruction, and immobilization technologies. Debris that is treated using one of the specified extraction or destruction technologies, and which does not exhibit a hazardous waste characteristic, is no longer subject to regulation as hazardous waste. Debris that is treated using one of the specified immobilization technologies may be excluded (e.g., debris that, after immobilization, no longer exhibits the characteristic for which the debris was hazardous waste).	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A
RCRA 40 CFR 268.48 R.61-79.268.48	<u>Universal Treatment Standards</u> - Table UTS in this section identifies the hazardous constituents and their nonwastewater and wastewater treatment standard levels. For determining compliance with the treatment standards for underlying hazardous constituents as defined in Section 268.2(i), these constituent-specific treatment standards may not be exceeded.	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A
RCRA 40 CFR 268.50 (Subpart E) R.61-79.268.50 (Subpart E)	<u>Prohibitions on storage of restricted wastes</u> - Storage of hazardous wastes restricted from land disposal is prohibited unless such storage is in tanks, containers, or containment buildings solely for the purpose of accumulating such quantities of hazardous waste as necessary to facilitate proper recovery, treatment, or disposal.	Applicable to management of hazardous wastes generated as a result of SRS HLW tank closure activities.	A
RCRA Section 3004(c)	<u>Liquids in Landfills</u> - The placement of bulk or noncontainerized liquid hazardous waste or free liquids contained in hazardous waste (whether or not absorbents have been added) in any landfill is prohibited. Disposal in landfills of liquids that have been absorbed in materials that biodegrade or that release liquids when compressed as might occur during routine landfill operations is also prohibited.	Relevant and appropriate to determining stabilization requirements for any free liquids that are disposed of in the course of HLW tank closure activities. [Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, G(1)(d)2.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA Section 3004(o)	Minimum Technology Requirements - The design of any new or replacement landfill or surface impoundment unit, or lateral expansion to a landfill or surface impoundment unit, shall include two or more liners and a leachate collection system (for landfills) between such liners.	Might be relevant and appropriate to hazardous waste disposal that occurs outside the boundaries of an existing unit. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	RA
AEA Regulation 61-63, RHA 7.14	Postclosure Observation and Maintenance - The licensee shall observe, monitor, and carry out necessary maintenance and repairs at the disposal site until the site closure is complete and the license is transferred by the Department in accordance with 7.15. Responsibility for the disposal site must be maintained by the licensee for 5 years. A shorter or longer time period for postclosure observation and maintenance may be established and approved as part of the site closure plan, based on site-specific conditions.	SC state regulation that, while not directly applicable to HLW tank closure, is relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [No direct comparison for license termination. Substantive requirement met by compliance with DOE Orders 435.1 and 5400.5.]	RA
AEA Regulation 61-63, RHA 7.18	Protection of the General Population from Releases of Radioactivity - Concentration of radioactive material that might be released to the general environment in groundwater, surface water, air, soil, plant, or animals shall not result in an annual dose exceeding an equivalent of 25 millirem (0.25 mSv) to the whole body, 75 millirem (0.75 mSv) to the thyroid, and 25 millirem (0.25 mSv) to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluent to the general environment as low as reasonably achievable.	SC state regulation that, while not directly applicable to HLW tank closure, is relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a public dose limit of 100 mrem/yr. More stringent requirement for public dose limit of 25 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA Regulation 61-63, RHA 7.19	Protection of Individuals from Inadvertent Intrusion - Design, operation, and closure of the land disposal facility shall ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.	SC state regulation that, while not directly applicable to HLW tank closure, is relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, P(2)(h), which stipulates maximum inadvertent intruder exposure limits.]	RA
AEA Regulation 61-63, RHA 7.21	Stability of the Disposal Site After Closure - The disposal facility shall be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care is required.	SC state regulation that, while not directly applicable to HLW tank closure, is relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, M(1)(c) and M(3)(c).]	RA
AEA 40 CFR 191.3(a)	Dose Limits - Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities regulated by the NRC or by Agreement States shall be conducted in a manner that provides reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from (1) discharges of radioactive material and direct radiation from such management and storage and (2) all operations covered by Part 190 shall not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ.	EPA regulations that would be applicable to any waste associated with HLW tank closure that is HLW. For waste that is not HLW, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.c which stipulates a dose equivalent not to exceed 25 mrem/yr to the whole body or a committed dose equivalent not to exceed 75 mrem/yr to any organ. More stringent requirements for dose equivalent not to exceed 75 mrem/yr to the thyroid and 25 mrem/yr to any other organ will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 191.3(b)	Dose Limits - Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities for the disposal of such fuel or waste that are operated by the DOE and that are not regulated by the NRC or Agreement States shall be conducted in a manner that provides reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.c which stipulates a dose equivalent not to exceed 25 mrem/yr to the whole body or a committed dose equivalent not to exceed 75 mrem/yr to any organ.	RA
AEA 40 CFR 191.13(a)	Containment Requirements - Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based on performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that might affect the disposal system shall (1) have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (Appendix A), and (2) have a likelihood of less than one chance in 1,000 of exceeding 10 times the quantities calculated according to Table 1 (Appendix A).	EPA regulations that would be applicable to any waste associated with HLW tank closure that is HLW. For waste that is not HLW, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [More specific requirements regarding quantities of radionuclides that might be released will be evaluated to determine impact, if any, on remedial goals.]	RA
AEA 40 CFR 191.15	Dose Limits - (a) Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that, for 10,000 years after disposal, undisturbed performance of the disposal system shall not cause the annual committed effective dose, received through all potential pathways from the disposal system, to any member of the public in the accessible environment, to exceed 15 mrem. (b) Annual committed effective dose shall be calculated in accordance with Appendix B of this part.	[Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.c stipulates that releases to the environment should result in a dose equivalent that does not exceed 25 mrem/yr to the whole body or a committed dose equivalent of 75 mrem/yr to any organ. More specific requirements for a committed effective dose not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 191.24	<u>Disposal Standards</u> - Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that 10,000 years of undisturbed performance after disposal shall not cause the levels of radioactivity in any underground source of drinking water in the accessible environment to exceed the limits specified in 40 CFR Part 141 as they exist on January 19, 1994.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.d.]	RA
AEA 10 CFR 61.40 (Subpart C)	<u>Performance Objectives</u> - Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within limits established in the performance objectives in Sections 61.41 through 61.44.	NRC regulations that, while not directly applicable to HLW tank closure, would be relevant and appropriate because they are well suited for use as indicators of the protection of human health and the environment. [Requirements met by compliance with applicable requirements of DOE Orders 5400.5 and 435.1, with specific exceptions noted below.]	RA
AEA 10 CFR 61.41 (Subpart C)	<u>Protection of the general population from releases of radioactivity</u> - Concentrations of radioactive material that might be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual effective dose exceeding an equivalent of : • 25 mrem whole body • 75 mrem thyroid • 25 mrem any other organ Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as reasonably achievable.	[Requirement met by compliance with applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1), which establishes a dose limit of 25 mrem/year from all pathways, excluding radon and its progeny in air. Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements for dose equivalent not to exceed 25 mrem/yr whole body, 75 mrem/yr to the thyroid, and 25 mrem/yr to any other organ will be evaluated to determine impact, if any, on remedial goals.]	RA
AEA 10 CFR 61.42 (Subpart C)	<u>Protection of individuals from inadvertent intrusion</u> - Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.	[Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, P(2)(h), which stipulates maximum inadvertent intruder exposure limits.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 61.43 (Subpart C)	Protection of individuals during operations - Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in Part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by Section 61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as reasonably achievable.	[Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1) establishes performance objectives for low-level waste disposal. More specific requirements in the referenced regulations (10 CFR 20, 10 CFR 61.41) are evaluated to determine impact, if any, on remedial goals.]	RA
AEA 10 CFR 61.44 (Subpart C)	Stability of the disposal site after closure - The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.	[Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, M(1)(c) and M(3)(c).]	RA
AEA 10 CFR 61.52(a)(6)	Near surface disposal facility operation and disposal site closure - Wastes must be placed and covered in a manner that limits the radiation dose rate at the surface of the cover to levels that at a minimum will permit the licensee to comply with all provisions of Sections 20.1301 and 20.1302 of this chapter at the time the license is transferred pursuant to Section 61.30 of this part.	[No direct comparison for license termination. Specific requirements in the referenced regulation (10 CFR 20.1301) are evaluated separately to determine impact, if any, on remedial goals.]	RA
AEA 10 CFR 61.55(a)(2)(iv)	Classification of waste for near surface disposal - Waste that is not generally acceptable for near-surface disposal is waste for which waste form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific requirements in this part, proposals for disposal of this waste can be submitted to the Commission for approval, pursuant to Section 61.58 of this part.	[No direct comparison for Class C limit for near-surface disposal. Requirement met by compliance with DOE Manual 435.1-1 Chapter IV, P(2)(g), which requires that limits on radionuclides that may be disposed of near-surface be established based on a site-specific radiological performance assessment.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 61.58	Alternative requirements for waste classification and characteristics - The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a special basis if after evaluation of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in Subpart C of this part.	[Requirement met by compliance with criteria described in Section 5.2.	RA
AEA 10 CFR 63.111	Performance Objectives for the Geologic Repository Operations Area through Permanent Closure - (a) Protection against radiation exposures and releases of radioactive material (1) The geologic repository operations area must meet the requirements of Part 20 of this chapter. (2) During normal operations, and for Category 1 event sequences, the annual TEDE to any real member of the public, located beyond the boundary of the site shall not exceed the preclosure standard specified at 10 CFR 63.204. (b) Numerical guides for design objectives (1) The geologic repository operations area must be designed so that, taking into consideration Category 1 event sequences and until permanent closure has been completed, the aggregate radiation exposures and the aggregate radiation levels in both restricted and unrestricted areas, and the aggregate releases of radioactive materials to unrestricted areas, will be maintained within the limits specified in paragraph (a) of this section.	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements (e.g., dose equivalent not to exceed 25 mrem/yr) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.111 (cont.)	(2) The geologic repository operations area must be designed so that, taking into consideration any single Category 2 event sequence and until permanent closure has been completed, no individual located on, or beyond, any point on the boundary of the site, will receive as a result of the Category 2 event sequence, the more limiting of a TEDE of 0.05 Sv (5 rem), or the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv (50 rem). The lens dose equivalent may not exceed 0.15 Sv (15 rem), and the shallow dose equivalent to skin may not exceed 0.5 Sv (50 rem).		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.113	<u>Performance objective for the geologic repository after permanent closure</u> (a) The geologic repository must include multiple barriers, consisting of both natural barriers and an engineered barrier system. (b) The engineered barrier system must be designed so that, working in combination with natural barriers, radiological exposures to the reasonably maximally exposed individual are within the limits specified at § 63.311 of subpart L of this part. Compliance with this paragraph must be demonstrated through a performance assessment that meets the requirements specified at § 63.114 of this subpart, and §§ 63.303, 63.305, 63.312 and 63.342 of Subpart L of this part. (c) The engineered barrier system must be designed so that, working in combination with natural barriers, releases of radionuclides into the accessible environment are within the limits specified at § 63.331 of subpart L of this part. Compliance with this paragraph must be demonstrated through a performance assessment that meets the requirements specified at § 63.114 of this subpart and §§ 63.303, 63.332 and 63.342 of subpart L of this part.	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements (e.g., dose equivalent no to exceed 25 mrem/yr for 10,000 years) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.113 (cont.)	(d) The ability of the geologic repository to limit radiological exposures to the reasonably maximally exposed individual, in the event of human intrusion into the engineered barrier system, must be demonstrated through an analysis that meets the requirements at §§ 63.321 and 63.322 of subpart L of this part. Estimating radiological exposures to the reasonably maximally exposed individual requires a performance assessment that meets the requirements specified at § 63.114 of this subpart, and §§ 63.303, 63.305, 63.312 and 63.342 of subpart L of this part.		
AEA 10 CFR 63.114	Performance Assessment - Any performance assessment used to demonstrate compliance with Sec. 63.113 must: (a) Include data related to the geology, hydrology, and geochemistry (including disruptive processes and events) of the Yucca Mountain site, and the surrounding region to the extent necessary, and information on the design of the engineered barrier system used to define parameters and conceptual models used in the assessment. (b) Account for uncertainties and variabilities in parameter values and provide for the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. (c) Consider alternative conceptual models of features and processes that are consistent with available data and current scientific understanding, and evaluate the effects that alternative conceptual models have on the performance of the geologic repository. (d) Consider only events that have at least one chance in 10,000 of occurring over 10,000 years.	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P.(2) establishes a performance assessment period of 1,000 years after closure. More stringent requirements (e.g., 10,000 years after closure) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.114 (cont.)	(e) Provide the technical basis for either inclusion or exclusion of specific features, events, and processes in the performance assessment. Specific features, events, and processes of the geologic setting must be evaluated in detail if the magnitude and time of the resulting radiological exposures to the reasonably maximally exposed individual, or radionuclide releases to the accessible environment, would be significantly changed by their omission. (f) Provide the technical basis for either inclusion or exclusion of degradation, deterioration, or alteration processes of engineered barriers in the performance assessment, including those processes that would adversely affect the performance of natural barriers. Degradation, deterioration, or alteration processes of engineered barriers must be evaluated in detail if the magnitude and time of the resulting radiological exposures to the reasonably maximally exposed individual, or radionuclide releases to the accessible environment, would be significantly changed by their omission. (g) Provide the technical basis for models used in the performance assessment such as comparisons made with outputs of detailed process-level models and/or empirical observations (e.g., laboratory testing, field investigations, and natural analogs).		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.115	<u>Multiple barriers</u> – Demonstration of compliance with Section 63.113(a) must: (a) Identify those design features of the engineered barrier system, and natural features of the geologic setting, that are considered barriers important to waste isolation. (b) Describe the capability of barriers, identified as important to waste isolation, to isolate waste, taking into account uncertainties in characterizing and modeling the behavior of the barriers. (c) Provide the technical basis for the description of the capability of barriers, identified as important to waste isolation, to isolate waste. The technical basis for each barrier's capability shall be based on and consistent with the technical basis for the performance assessments used to demonstrate compliance with Sec. 63.113(b) and (c).	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P.(2) establishes a performance assessment period of 1,000 years after closure. More stringent requirements (e.g., 10,000 years after closure) will be evaluated to determine impact, if any, on remedial goals.]	
CERCLA "Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (HHEM) (Part A)," Interim Final, Dec. 1989, EPA/540/1-89/002		To be considered as guidance for risk assessments conducted at hazardous waste sites. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC
CERCLA "RAGS/HHEM (Part B), Development of Risk-Based Preliminary Remediation Goals," Interim, Dec. 1991, EPA/540/R-92/003		To be considered as guidance for risk assessments conducted at hazardous waste sites. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA "RAGS/HHEM (Part C), Risk Evaluation of Remedial Alternatives," Interim, Dec. 1991, EPA/540/R-92/004		To be considered as guidance for risk assessments conducted at hazardous waste sites. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC
CERCLA "RAGS: Volume II - Environmental Evaluation Manual," Interim Final, March 1989, EPA/540/1-89/001		To be considered as guidance for risk assessments conducted at hazardous waste sites. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC
CERCLA "Supplemental Guidance to RAGS: Region 4 Bulletins," Human Health Risk Assessment, Bulletins 1-5 November 1995	Region IV clarifications and interpretations supplementing EPA-wide guidance (RAGS) for risk assessments at hazardous waste sites.	EPA Region 4 bulletins intended as guidance to all risk assessors preparing human health assessments for CERCLA NPL sites and Federal sites in the region. To be considered as guidance for risk assessments conducted for non-CERCLA remedial actions, such as the HLW tank closures. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA *Policy on Decommissioning of Department of Energy Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act*	The Policy, dated May 22, 1995, establishes a decommissioning framework that presumes DOE's decommissioning projects will be conducted as non-time-critical removal actions under CERCLA. Non-time-critical removal actions are defined in the NCP as removals with a planning horizon of 6 months or more. The Policy concludes that non-time-critical removals are the appropriate CERCLA action for decommissioning projects for the following reasons: (1) The alternative approaches available to conduct decommissioning projects typically are clear and very limited, a situation that usually will eliminate the need for more detailed analysis of alternatives required for remedial action. (2) The requirements for non-time-critical removal actions provide greater flexibility to develop decommissioning plans that are appropriate for the circumstances presented. (3) Non-time-critical removal actions usually will provide benefits to worker safety, public health, and the environment more rapidly and cost-effectively than remedial action.	Appropriate to the extent activities associated with HLW tank closure constitute final decommissioning of the subject facilities. [Requirement substantially met by the general process set forth in this closure plan, which requires compliance with substantive applicable requirements and consideration of relevant and appropriate requirements for HLW tank closure.]	TBC
CERCLA *Policy on Decommissioning of Department of Energy Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act* (cont.)	Under Section 300.415(b)(1), the lead agency (DOE) shall determine if there is a threat to public health or welfare or the environment , and if so take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release. Section 300.415(b)(2) of the NCP sets forth criteria for determining the appropriateness of a removal action, which include: "(iii) Hazardous substances of pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release."		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
Decommissioning Handbook DOE/EM-0142P U.S. Department of Energy Office of Environmental Restoration, March 1994	Technical guidance for the decommissioning of nuclear facilities, including removal of radioactive and hazardous materials to levels protective of human health and the environment. Chapter 13 identifies standards for air, surface-water, and groundwater quality during decommissioning including the National Ambient Air Water Quality Standards, DOE Order 5400.5, National Emissions Standards for Hazardous Air Pollutants, and Safe Drinking Water Act maximum contaminant levels.	Appropriate to the extent activities associated with HLW tank closure under this plan constitute final decommissioning of the F- and H-Area Tank Farms. [Compliance with this plan ensures consistency with substantive provisions of this handbook. Specific requirements in the regulations and Orders referenced in the handbook (AWQS, NESHAP, SDWA, DOE Order 5400.5) have been evaluated and, where applicable or relevant and appropriate, addressed in this plan.]	TBC
Ambient Water Quality Criteria (AWQC)	EPA's AWQC for protection of freshwater organisms will be preferentially used to judge ecological impacts to aquatic resources. Other resources will be used for chemicals without AWQC.	AWQC provides the most appropriate criteria for judging ecological impacts. [Requirement met by compliance with R.61-68.E(7).]	TBC
AEA 40 CFR 193.13(a) (Proposed)	Standards for Disposal - Disposal systems for low-level radioactive waste shall be designed to provide a reasonable expectation that [*OPTION 1. "within 1,000 years of disposal, no member of the public shall receive,"*] or [*OPTION 2. "the highest projected dose following disposal and received through all pathways from the disposal system will not exceed,"*] or [*OPTION 3. "no member of the public shall receive, through all pathways from the disposal system, during a period following disposal as determined by the implementing agency,"*] an annual committed effective dose of more than 150 microsieverts (15 mrem).	Proposed EPA Federal regulation that, when promulgated, will be applicable to activities involving disposal of low-level radioactive waste. While not directly applicable to HLW tank closure, these requirements would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1)(a) stipulates releases to the environment should result in an effective dose equivalent that does not exceed 25 mrem/yr. More specific requirement for a committed effective dose not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals. The 15 mrem/yr committed effective dose standard is also imposed by 40 CFR 191.15 for a 10,000-year performance period.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 193.24(a) (Proposed)	Standards for Protection of Underground Sources of Drinking Water - Disposal systems for low-level radioactive waste shall be designed to provide a reasonable expectation that the levels of radioactivity from the disposal system in any underground source of drinking water will not exceed [*OPTION 1. "the MCLs, as they exist on the effective date of this subpart, regardless of pre-existing contamination*] or [*OPTION 2. "up to the MCLs, as they exist on the effective date of this subpart, if the pre-existing contamination is below the MCLs and permit up to one additional MCL if the pre-existing contamination is above the MCLs.*]	[Requirement met by compliance with DOE Order 5400.5 Chapter II, 1.d. The MCL standards are also invoked by 40 CFR 191.24 for a 10,000-year performance period.]	TBC
AEA 10 CFR 834.101(a) (Proposed)	Dose Limits - A DOE activity shall be conducted in a manner such that the exposure of members of the public to ionizing radiation will: (1) comply with the ALARA program requirements in Section 834.104; and (2) not cause a TEDE greater than 100 mrem (1 mSv) in a year from all sources of ionizing radiation and exposure pathways, excepting: (i) dose from radon and its decay products (which is regulated separately); (ii) dose received by patients from medical sources of radiation used for diagnostic or therapeutic purposes, and by volunteers in medical research programs; (iii) dose from background radiation; and (iv) dose to workers that arises from DOE activities during the performance of work duties and that is regulated under 10 CFR 835.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.a and substantially equivalent ALARA requirements in Chapter II, 2.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.101(b) (Proposed)	Dose Limits - On request, the Department may authorize temporary dose limits for members of the public in excess of 100 mrem (1 mSv) in a year, but not in excess of 500 mrem (5 mSv). A request for an authorization for a temporary operation that could result in a higher dose level shall: (1) be submitted as soon as practicable when the need is recognized and, where possible, before the 100-mrem dose limit is exceeded; (2) contain: (i) a justification for the higher dose limit; (ii) a discussion of the alternatives considered; (iii) an ALARA evaluation; (iv) an estimate of how long the higher limit will be necessary; and (v) a description of what is being done to return to normal operations and to minimize doses to members of the public; and (3) be made promptly a matter of public record delineating the nature of the unusual operating condition, and the basis for the variance as documented under Section 834.101(b)(2).	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Substantive requirement met by compliance with DOE Order 5400.5, Chapter II, 1.a(4)(a).]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.201(a) (Proposed)	Dose Limits - A DOE activity shall be conducted in a manner such that the release of radioactive material to the atmosphere shall: (1) be evaluated using the ALARA process; (2) not cause any member of the public to receive a TEDE in excess of 10 mrem (0.1 mSv) in a year, excluding doses from radon-220 and radon-222 and their decay products and from background sources; (3) not cause annual radon-222 flux rates to exceed 20 pCi (0.7 Bq)/(m^2sec) averaged over the surface area overlaying the waste, including the covering or other confinement structures, wherever radium-226 residues are accepted for storage or disposal; (4) not cause outdoor annual concentrations of radon-220 or radon-222 resulting from a facility where sources of radon are handled or processed to exceed 3 pCi (0.1 Bq)/L above background at the facility or at any location beyond the facility boundary that is accessible to the public; and (5) not cause an annual radon-220 or radon-222 average concentration to exceed 0.5 pCi (0.02 Bq)/L above background at any offsite location where people reside or work.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.b and Chapter IV, 6.d(1).]	TBC
AEA 10 CFR 834.214(a) (Proposed)	Dose Limits - The drinking water system for a DOE activity shall be managed in a manner that complies with the provisions of 40 CFR 141 -- National Primary Drinking Water Regulations Pursuant to Section 1412 of the Safe Drinking Water Act.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with R.61-68 and DOE 5400.5, Chapter II, 1.d(1).]	TBC
AEA 10 CFR 834.214(b) (Proposed)	Dose Limits - Discharges from DOE activities shall be managed in a manner that will not cause private or public drinking water systems downstream or downgradient of the facility discharge to exceed the drinking water maximum contamination levels in 40 CFR 141.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with R.61-68 and DOE Order 5400.5, Chapter II, 1.d(3).]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.221(a) (Proposed)	<u>Dose Limits</u> - A DOE activity shall be conducted in a manner such that exposure of members of the public to radiation from radioactive waste: (1) complies with ALARA process requirements; and (2) does not exceed a TEDE of 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources, except radon and its daughters.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [More stringent requirement for TEDE not to exceed 25 mrem/yr will be evaluated to determine impact, if any, on remedial goals. Applicable requirement (DOE Order 5400.5, Chapter II, 1.a) limit is 100 mrem/yr.]	TBC
AEA 10 CFR 834.231 (Proposed)	<u>Dose Limits for aquatic organisms</u> - A DOE activity shall be conducted in a manner such that the absorbed dose to aquatic animal organisms (e.g., fish, crustaceans, mollusks, and benthic invertebrates) will not exceed 1 rad (0.01 gray) per day from exposure to radiation or radioactive material discharged in liquid waste to natural waterways.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter II, 3.a(5).]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.301(a) (Proposed)	Release of Property Containing Residual Radioactive Material - DOE property or personal property containing residual radioactive material shall not be released from DOE control unless: (1) the release of property is in compliance with Authorized Limits (Section 834.301(b)) and Supplemental Limits (Section 834.301(d)) for concentrations of residual radioactive material on property surfaces or interior; (2) the property is evaluated and appropriately surveyed to identify and characterize contamination within the property and removable radioactive material and total radioactive material on property surfaces (including contamination present on and under any coating); and (3) documentation, in a Department-approved format, is completed that: (i) describes the property, (ii) describes the radiological history of the property, (iii) states the criteria for release of the property and the bases for the criteria which have been approved by the Department and coordinated with appropriate state and Federal organizations, (iv) describes any restrictions on use or disposition of the property and how the implementation of the restrictions will be ensured, (v) describes the survey of the property, including the date, the identity of the surveyor, the types and identification numbers of the instruments used, and the results of the survey, (vi) indicates the quantity and disposition of the waste resulting from any decontamination effort, and (vii) identifies the recipient of the property, its destination, or its disposition; and (4) appropriately notifies the recipient or owner of the property of the results of the survey of the property, including the availability of documentation required by Section 834.301(a)(3).	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter II, 5.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.301(b) (Proposed)	Release of Property Containing Residual Radioactive Material - The Authorized Limits shall be derived in accordance with the ALARA process requirements, documented, approved by the Department, and made part of the public record.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter II.5.]	TBC
AEA 10 CFR 834.302(a) (Proposed)	Soil - Authorized Limits and Supplemental Limits for all radionuclides in soil shall be derived using approved models in accordance with the requirements of this subpart and selected on the basis of the ALARA process.	Proposed DOE regulation, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.a.]	TBC
AEA 10 CFR 834.302(b) (Proposed)	Soil - Authorized Limits for radon-226 and radon-228 shall be selected consistent with Section 834.302(a) and shall not exceed 5 pCi/gram (0.2 Bq/gram) in excess of background levels, averaged over 100 m^2, in the first 15-cm depth of the surface layer of soil; and 15 pCi/gram (0.56 Bq/gram) in excess of background levels, averaged over any subsequent 15-cm subsurface layer of soil.	Proposed DOE regulation, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.a(2).]	TBC
AEA 10 CFR 834.303(a) (Proposed)	Radon - Remedial actions shall be conducted on habitable and occupied structures with the objective of reducing residual radioactive material levels such that the annual average radon-222 decay product concentration will not exceed 0.02 WL (or 4 pCi/L radon, when 0.02 WL is approximately equivalent to 4 pCi/L assuming that the radon decay products are at 50 percent of equilibrium), including background, in the structure. [A working level (WL) is any combination of short-lived radon decay products in 1 L of air that will result in the ultimate emission of 1.3 x 10^5 MeV of potential alpha energy.]	Proposed DOE regulation, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.b.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.303(b) (Proposed)	Radon - If residual radioactive material cannot be reduced, practicably, to levels that reduce radon decay product concentration in a habitable structure to 0.02 WL, remedial measures, including active controls, shall be employed to reduce concentrations to 0.03 WL, or less. In any case, the radon decay product concentration shall not exceed 0.03 WL, including background, in such structures as a result of residual radioactive material.	Proposed DOE regulation, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.b.]	TBC
AEA 10 CFR 834.304 (Proposed)	Structures - Authorized Limits and Supplemental Limits for residual radionuclides in or on structures at specific DOE properties shall be (a) established in accordance with the requirements of this subpart, (b) consistent with Department guidelines or derived using DOE-approved models, and (c) selected on the basis of the ALARA process.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.d.]	TBC
AEA 10 CFR 834.306(c) (Proposed)	Control and Disposition of Residual Radioactive Material - A property may be maintained under an interim management arrangement when the residual radioactive material exceeds authorized limits developed for unrestricted release if: (1) the residual radioactive material is in locations that are not readily accessible to members of the public; (2) the residual contamination would be unreasonably costly to remove; and (3) when needed, administrative controls are instituted by the operating organization to protect members of the public.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6.c.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.306(d) (Proposed)	Control and Disposition of Residual Radioactive Material - (1) Appropriate administrative and physical controls for the management of storage or disposal activities shall be developed, documented, and implemented to limit access, use, and removal of material contaminated with residual radioactive material. (2) Controls shall be designed such that concentrations of radionuclides in the groundwater and residual radioactive material will not cause the requirements of this part to be exceeded. (3) Control and stabilization features for the interim management and storage of residual radioactive material shall be designed to meet the applicable dose limits and dose constraints selected through application of the ALARA process for 25 years at a minimum, and 50 years if practicable to do so. (4) The controls shall be designed to limit radon concentrations in the atmosphere above facilities to levels that will not exceed: (i) an annual average radon-220 and radon-222 concentration of 0.5 pCi (0.02 Bq)/L, above background, at any offsite location where persons are likely to reside or work; (ii) flux rates from the storage of radon-producing wastes of 20 pCi (0.7 Bq)/(m^2 sec), averaged over the area containing the radon-generating material.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.306(e) (Proposed)	Control and Disposition of Residual Radioactive Material - (1) Long-term management of residual radioactive material in residue and waste from a DOE activity shall be in accordance with this section and DOE approved plans. (2) Long-term management of the residue and waste shall be conducted in a manner that will: (i) comply with dose limits (Sections 834.201, 834.214, and 834.221); (ii) comply with the ALARA requirements of this part (Section 834.104); (iii) comply with the Ground-Water Protection Management Plan (Section 834.215); (iv) limit radon-222 emanation to the atmosphere from radon-222 generating waste to less than an annual average release rate of 20 pCi (0.7 Bq)/(m^2 sec) averaged over the surface area overlying the waste, including the covering or other confinement structures; (v) limit radon-220 emanation to the atmosphere from waste to an annual average release rate of 20 pCi (0.7 Bq)/(m^2 sec), and (vi) limit increases in the annual average radon-222 or radon-220 concentration at or above any location outside the boundary of the controlled area to 0.5 pCi (0.02 Bq)/L. (3) Control and stabilization features shall be designed to: (i) be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years; (ii) minimize unauthorized public access or use that might breach containment of waste; and (iii) provide for proper conditioning or barriers to control the generation and escape of biogenic gases from potentially biodegradable contaminated waste or residue to ensure that this material will not cause the emission limits or dose limits to be exceeded and biodegradation within the facility will not result in premature structural failure. (4) In the development of controls and waste management plans, where appropriate, the impacts of alternative disposal modes shall be evaluated beyond the 1,000-year design requirement, to 10,000 years.	Proposed DOE Federal regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirements met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 10 CFR 834.306(e)(4) constitutes a more stringent requirement for evaluation of alternative disposal modes to 10,000 years.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.306(e) (Proposed) (cont.)	(5) For wastes containing a high specific activity (e.g., ≥1 nCi/g) of radium or thorium, alternative disposal methods, such as deep land disposal, protective covers (e.g., riprap), concrete vaults, or geologic repositories that provide additional protection from possible inadvertent intrusion shall be evaluated and employed if justified by potential risk considerations.		
AEA 10 CFR 20.1301	Dose Limits for Individual Members of the Public - Each licensee shall conduct operations such that: (1) The total effective dose equivalent (TEDE) to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewerage in accordance with §20.2003; and (2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any 1 hour. If the licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals. A licensee may apply for prior NRC authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). In addition to the requirements of this part, a licensee subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 shall comply with those standards. The Commission may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose.	NRC regulation that, while not directly applicable to HLW tank closure, would be relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.a, except for TEDE not to exceed 2 mrem in any one hour. This more stringent requirement will be evaluated to determine impact, if any, on remedial goals]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1402	Radiological Criteria for Unrestricted Use - A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year; including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.	NRC regulation that, while not directly applicable to HLW tank closure, would be relevant and appropriate because it provides requirements for NRC licensee activities resulting in residual radioactive material. The License Termination Rule has been proposed as the decommissioning criteria for the West Valley Demonstration Project, which includes HLW tank systems. [Applicable requirement (DOE Order 5400.5, Chapter IV, 3.a) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 25 mrem/year will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1403	Criteria for License Termination Under Restricted Conditions - A site will be considered acceptable for license termination under restricted conditions if: (a) The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of §20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. (b) The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) per year. (c) The licensee has provided sufficient financial assurance to enable a third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. (d) The licensee has submitted a decommissioning plan of License Termination Plan (LTP) to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82(a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee intends to decommission by restricting use of the site. The licensee shall document in the LTP or decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.	[Applicable requirement (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 25 mrem/year will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1403 (cont.)	(e) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is ALARA and would not exceed either: (1) 100 mrem (1 mSv) per year , or (2) 500 mrem (5 mSv) per year provided the licensee: (i) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem (1 mSv) value of paragraph (e)(1) of this section are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm; (ii) Makes provisions for durable institutional controls; and (iii) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that institutional controls remain in place as necessary to meet the criteria in §20.1403(b) and to assume and carry out responsibilities for any necessary control and maintenance of those controls.		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1404	Alternate Criteria for License Termination – The Commission may terminate a license using alternate criteria greater than the dose criterion of §§20.1402, 20.1403(b), and 20.1403(d)(1)(i)(A), if the licensee: (1) Provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100 mrem (1 mSv) per year limit of subpart D, by submitting an analysis of possible sources of exposure; (2) Has employed to the extent practical restrictions on site use according to the provisions of §20.1403 in minimizing exposures at the site; and (3) Reduces doses to ALARA levels taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal; (4) Has submitted a decommissioning plan or LTP to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82(a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee shall document in the decommissioning plan or LTP how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice.	[Applicable requirement (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 196.04(a) (Proposed)	Environmental Standards for Site Remediation - Remediation of sites shall be conducted to provide a reasonable expectation that, for 10,000 years after completion of the remedial action, radionuclide concentrations in excess of natural background levels shall not exceed those amounts that could cause any member of the public to receive, through all potential pathways under a residential land use scenario, an annual committed effective dose of 15 mrem/yr (0.15 mSv/yr).	Proposed EPA regulation that, when promulgated, will be applicable to activities resulting in residual radioactive material, including SRS HLW tank closure. [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 40 CFR 196.04(a) constitutes a more stringent requirement of 15 mrem/yr dose limit for 10,000 years.]	TBC
AEA 40 CFR 196.04(c) (Proposed)	Environmental Standards for Site Remediation - In the event that remediation of a site will not meet the conditions of Section 196.04(a), the implementing agency shall: (1) remediate the site to provide a reasonable expectation that, for 10,000 years after completion of the remedial action, radionuclide concentrations in excess of natural background levels shall not exceed those concentrations that could cause any member of the public to receive, through all potential pathways under the conditions of the selected active control measures, an annual committed effective dose of 15 mrem/yr (0.015 mSv/yr); and (2) remediate the site to provide a reasonable expectation that, for 10,000 years after completion of the remedial action in the absence of active control measures, radionuclide concentrations in excess of natural background levels on the site shall not exceed those amounts that could cause any member of the public to receive, through all potential pathways under the conditions of residential land use, an annual committed effective dose that is less than 75 mrem/yr (0.075 mSv/yr).	[Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 40 CFR 196.04(a) constitutes a more stringent requirement of 15 mrem/yr dose limit for 10,000 years.]	TBC
AEA 40 CFR 196.04(d) (Proposed)	Environmental Standards for Site Remediation - All existing and future structures on sites shall meet the guidelines of the EPA Radon Program.	[Requirement met by compliance with DOE Order 5400.5, Chapter IV, 4.b.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 196.04(e) (Proposed)	Environmental Standards for Site Remediation - The implementing agency shall perform compliance assessments. Compliance assessments need not provide complete assurance that the requirements of Section 196.04 of this subpart will be met. Because of the long period involved and the nature of the processes and events of interest, there may be substantial uncertainties in projective remedial action performance. Proof of the future annual committed effective dose from radioactive concentrations is not to be had in the ordinary sense of the word in situations that deal with much shorter timeframes. Rather, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with Section 196.04 will be achieved.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 5.]	TBC
AEA 40 CFR 196.23(a) (Proposed)	Environmental Standards for Groundwater Protection - Remediation of sites shall be conducted to provide a reasonable expectation that 10,000 years after completion of the remedial action, onsite radioactive material shall not cause the levels of radioactivity in any groundwater that is a current or potential source of drinking water, in the accessible environment, to exceed the limits specified in 40 CFR 141.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.d.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 196.23(b) (Proposed)	Environmental Standards for Groundwater Protection - Compliance assessments need not provide complete assurance that the requirements of Section 196.23 of this subpart will be met. Because of the long time period involved and the nature of the processes and events of interest, there will inevitably be substantial uncertainties in projecting remedial action performance. Proof of the future levels of radioactivity in any groundwater that is a current or potential source of drinking water, in the accessible environment, is not to be had in the ordinary sense of the word in situations that deal with much shorter timeframes. Rather, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with Section 196.23 will be achieved.	[Requirement met by compliance with DOE Manual 435.1-1, Chapter IV, P(2).]	TBC
AEA 40 CFR 196.23(c) (Proposed)	Environmental Standards for Groundwater Protection - Compliance with Section 196.23(a) of this subpart will not be required, if the implementing agency determines compliance to be technically impracticable from an engineering perspective. In this situation, the implementing agencies shall: (1) select active control measures that ensure members of the public will not be exposed to groundwater that is drinking water, in which the levels of radioactivity exceed the limits specified in 40 CFR 141; (2) select and perform remedial actions that limit, to the greatest extent, contamination of groundwater that is not already contaminated, as is reasonable under the circumstances; (3) select and perform remedial actions that restore, to the greatest extent, groundwater that is already contaminated, as is reasonable under the circumstances; (4) comply with the public notice and comment requirements of Section 196.03(a) of subpart A; and (5) comply with the periodic verification requirements of Section 196.24 of this subpart.	[More specific requirement for active control measures over groundwater which exceeds levels of radioactivity specified in 40 CFR 141 will be evaluated to determine impact, if any, on remedial goals.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197, Subpart B	Public Health and Environmental Standards for Disposal - Controlled area means: (1) The surface area, identified by passive institutional controls, that encompasses no more than 300 square kilometers. It must not extend farther: (a) South than 36° 40' 13.6661" north latitude, in the predominant direction of groundwater flow; and (b) Than five kilometers from the repository foot-print in any other direction; and (2) The subsurface underlying the surface area	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirement of DOE Manual 435.1-1, IV.P(2)(b), establishes the point of compliance as the point of highest projected dose beyond a 100 meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is pro-vided.]	RA
AEA 40 CFR 197.20	Individual-Protection Standard - DOE must demonstrate, using performance assessment, that there is a reasonable expectation that, for 10,000 years following disposal, the reasonably maximally exposed individual receives no more than an annual committed effective dose equivalent of 150 microsieverts (15 mrem) from releases from the undisturbed Yucca Mountain disposal system. DOE's analysis must include all potential pathways of radionuclide transport and exposure.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.21	Reasonably maximally exposed individual – The reasonably maximally exposed individual is a hypothetical person who meets the following criteria: (a) Lives in the accessible environment above the highest concentration of radionuclides in the plume of contamination; (b) Has a diet and living style representative of the people who now reside in the Town of Amargosa Valley, Nevada. DOE must use projections based upon surveys of the people residing in the Town of Amargosa Valley, Nevada, to determine their current diets and living styles and use the mean values of these factors in the assessments conducted for §§ 197.20 and 197.25; and (c) Drinks 2 liters of water per day from wells drilled into the ground water at the location specified in paragraph (a) of this section.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.25	Human Intrusion Standard - DOE must determine the earliest time after disposal that the waste package would degrade sufficiently that a human intrusion (see Sec. 197.26) could occur without recognition by the drillers. DOE must: (a) If complete waste package penetration is projected to occur at or before 10,000 years after disposal: (1) Demonstrate that there is a reasonable expectation that the reasonably maximally exposed individual receives no more than an annual committed effective dose equivalent of 150 microsieverts (15 mrem) as a result of a human intrusion, at or before 10,000 years after disposal. The analysis must include all potential environmental pathways of radionuclide transport and exposure; and (2) If exposures to the reasonably maximally exposed individual occur more than 10,000 years after disposal, include the results of the analysis and its bases in the environmental impact statement for Yucca Mountain as an indicator of long-term disposal system performance; and (b) Include the results of the analysis and its bases in the environmental impact statement for Yucca Mountain as an indicator of long-term disposal system performance, if the intrusion is not projected to occur before 10,000 years after disposal.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.30	Ground Water Protection Standards - DOE must demonstrate that there is a reasonable expectation that, for 10,000 years of undisturbed performance after disposal, releases of radionuclides from waste in the Yucca Mountain disposal system into the accessible environment will not cause the level of radioactivity in the representative volume of ground water to exceed the limits in the following Table 1: Table 1 - Limits on Radionuclides in the Representative Volume. --- Radionuclide or type of radiation emitted / Limit / Is natural background included? --- Combined radium-226 and radium-228 / 5 pCi/L / Yes Gross alpha activity (including radium-226 but excluding radon and uranium / 15 pCi/L / Yes Combined beta and photon emitting radionuclides / 4 mrem/yr to the whole body or any organ, based on drinking 2 L of water per day from the representative volume. / No	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [No comparable provision for "representative volume" but SDWA MCLs are invoked as groundwater protection standards by DOE Order 5400.5, Chapter II, 1.d.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.31	<u>Representative volume</u> (a) It is the volume of ground water that would be withdrawn annually from an aquifer containing less than 10,000 milligrams of total dissolved solids per liter of water to supply a given water demand. DOE must project the concentration of radionuclides released from the Yucca Mountain disposal system that will be in the representative volume. DOE must then use the projected concentrations to demonstrate a reasonable expectation to NRC that the Yucca Mountain disposal system complies with § 197.30. DOE must make the following assumptions concerning the representative volume: (1) It includes the highest concentration level in the plume of contamination in the accessible environment; (2) Its position and dimensions in the aquifer are determined using average hydrologic characteristics which have cautious, but reasonable, values representative of the aquifers along the radionuclide migration path from the Yucca Mountain repository to the accessible environment as determined by site characterization; and (3) It contains 3,000 acre-feet of water (about 3,714,450,000 liters or 977,486,000 gallons). (b) DOE must use one of two alternative methods for determining the dimensions of the representative volume. DOE must propose its chosen method, and any underlying assumptions, to NRC for approval.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [No comparable provision for "representative volume" but SDWA MCLs are invoked as groundwater protection standards by DOE Order 5400.5, Chapter II, 1.d.]	RA

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.31 (cont.)	(1) DOE may calculate the dimensions as a well-capture zone. If DOE uses this approach, it must assume that the: (i) Water supply well(s) has (have) characteristics consistent with public water supply wells in the Town of Amargosa Valley, Nevada, for example, well-bore size and length of the screened intervals; (ii) Screened interval(s) include(s) the highest concentration in the plume of contamination in the accessible environment; and (iii) Pumping rates and the placement of the well(s) must be set to produce an annual withdrawal equal to the representative volume and to tap the highest concentration within the plume of contamination. (2) DOE may calculate the dimensions as a slice of the plume. If DOE uses this approach, it must: (i) Propose to NRC, for its approval, where the location of the edge of the plume of contamination occurs. For example, the place where the concentration of radionuclides reaches 0.1% of the level of the highest concentration in the accessible environment; (ii) Assume that the slice of the plume is perpendicular to the prevalent direction of flow of the aquifer; and (iii) Assume that the volume of ground water contained within the slice of the plume equals the representative volume.		

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA EPA Proposed Federal Guidance for Protection of the Public from Radiation, December 23, 1994	Recommendation 1 - There should be no exposure of the general public to ionizing radiation unless it is justified by the expectation of an overall benefit from the activity causing the exposure. Justified activities may be allowed, provided exposure of the general public is limited in accordance with these recommendations.	To be considered as guidance for public health and safety standards for radioactive material. [Requirement met by compliance with DOE Order 5400.5, Chapter II, 2.]	TBC
	Recommendation 2 - A sustained effort should be made to ensure that doses to individuals and to populations are maintained as low as reasonably achievable.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 2.]	TBC
	Recommendation 3 - The combined radiation doses incurred in any single year from all sources of exposure covered by these recommendations should not normally exceed a Radiation Protection Guide of 1 mSv (100 mrem) effective dose equivalent to an individual. The Radiation Protection Guide applies to the sum of the effective dose equivalent resulting from exposure to external sources of radiation during a year and the committed effective dose equivalent incurred from the intake of radionuclides during that year. The Radiation Protection Guide might not be reasonably achievable in some unusual situations. It may be exceeded temporarily in situations that are not anticipated to recur chronically and when Recommendations 1 and 2 are satisfied, provided that the radiation dose incurred in any year does not exceed 5 mSv (500 mrem) effective dose equivalent. Continued exposure of an individual over substantial portions of a lifetime at or near the level of the Radiation Protection Guide should be avoided.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.a.]	TBC

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA "Design and Construction of RCRA/CERCLA Final Covers," EPA/625/4-91/025, May 1991	EPA recommendations to be considered in the design of low hydraulic conductivity cover systems.	Relevant and appropriate to the design of a cover system if capping is performed as part of the HLW tank closure activities. [Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA closure and postclosure care requirements for the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.]	TBC
AEA DOE 5400.5, Chapter II, 1.a	<u>Dose Limits</u> - Except as provided by II.1a(4), the exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem (1 mSv).	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.a(3)(a)	<u>Dose Limits</u> - DOE operators shall make a reasonable effort to be aware of the existence of other than DOE manmade sources of radiation that, combined with the DOE sources, might present a potential for exceeding contributions of 10 mrem (0.1 mSv) effective dose equivalent in a year. Reasonable efforts shall be made to limit dose to members of the public, from multiple sources of radiation, to 100 mrem (1 mSv) EDE, or less, in a year.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.a(4)(a)	<u>Dose Limits</u> - Operations Office may request from EH-1 specific authorization for a temporary public dose limit higher than 100 mrem (1 mSv), but not to exceed 500 mrem (5 mSv), for the year.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.b	<u>Dose Limits</u> - The exposure of members of the public to radioactive materials released to the atmosphere as a consequence of routine DOE activities shall not cause members of the public to receive, in a year, an effective dose equivalent greater than 10 mrem (0.1 mSv).	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter II, 1.c	Dose Limits - The exposure of members of the public to direct radiation or radioactive materials released from DOE management and storage activities at a disposal facility for spent nuclear material or for high-level or transuranic radioactive wastes that are not regulated by the NRC shall not cause members of the public to receive, in a year, a dose equivalent greater than 25 mrem (0.25 mSv) to the whole body or a committed dose equivalent greater than 75 mrem (0.75 mSv) to any organ.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure. Requirements would be applicable to any waste associated with HLW tank closure that is considered high-level waste. For waste that is not considered high-level waste, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [Applicable if residual waste is determined to be HLW.]	RA
AEA DOE 5400.5, Chapter II, 1.d	Dose Limits - The level of protection provided to the public for drinking water must be equivalent to the drinking water standards of 40 CFR 141. These systems shall not cause persons consuming the water to receive an effective dose equivalent greater than 4 mrem (0.04 mSv) in a year. Combined radium-226 and radium-228 shall not exceed 5×10^{-9} µCi/ml and gross alpha activity (including radium-226 but excluding radon and uranium) shall not exceed 1.5×10^{-8} µCi/ml.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.d(3)	Dose Limits - The liquid effluents from DOE activities shall not cause private or public drinking water systems downstream of the facility discharge to exceed the drinking water radiological limits in 40 CFR 141.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 3.a(5)	Dose Limits for Aquatic Organisms - To protect native animal aquatic organisms, the absorbed dose to these organisms shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter II, 5.a	Residual Radioactivity - Release of real property (land and structures) shall be in accordance with the guidelines and requirements for residual radioactive material presented in Chapter IV. These guidelines and requirements apply to both DOE-owned facilities and to private properties that are being prepared by DOE for release. Real properties owned by DOE that are being sold to the public are subject to the requirements of Section 120(h) of CERCLA, as amended, concerning hazardous substances, and to any other applicable Federal, state, and local requirements. The requirements of 40 CFR 192 are applicable to properties remediated by DOE under Title I of the UMTRA.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.a	Residual Radionuclides in Soil - Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these derivations are given in DOE/CH-8901. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2. (1) If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, [where A is the area (in square meters) of the region in which the concentrations are elevated] limits for "hot spots" shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclides that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil. (2) The generic guidelines for residual concentrations of radium-226, radium-228, thorium-230 and thorium-232 are: (a) 5 pCi/g, averaged over the first 15 cm of soil below the surface (b) 15 pCi/g, averaged over 15-cm thick layers of soil more than 15 cm below the surface	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.b	Airborne Radon Decay Products - Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for release without restriction; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. [A working level (WL) is any combination of short-lived radon decay products in 1 L of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.] In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required to comply with this guideline when there is reasonable assurance that residual radioactive material is not the source of the radon concentration.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 4.c	Residual Radioactivity - The average level of gamma radiation inside a building or habitable structure on a site to be released without restrictions shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an "appropriate-use" scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic limit and the ALARA process, considering appropriate-use scenarios for the area.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.d	Residual Radioactivity - The generic surface contamination guidelines provided in Figure IV-1 are applicable to existing structures and equipment. These limits apply to both interior equipment and building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in paragraph IV.6a are applicable to the resulting contamination in the ground.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 5.a	Residual Radioactivity - The authorized limits for each property shall be set equal to the generic or derived guidelines unless it can be established, on the basis of specific property data (including health, safety, practical, programmatic, and socioeconomic considerations), that the guidelines are not appropriate for use at the specific property. The authorized limits shall be established to (1) provide that, at a minimum, the basic dose limits in paragraph IV.3 will not be exceeded under the "worst-case" or "plausible-use" scenarios, consistent with the procedures and guidance provided in DOE/CH-8901, or (2) be consistent with applicable generic guidelines. The authorized limits shall be consistent with limits and guidelines established by other applicable Federal and state laws. The authorized limits are developed through the project offices in the field and are approved by the Headquarters Program Office.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 5.b	Residual Radioactivity - Remedial action shall not be considered complete until the residual radioactive material levels comply with the authorized limits, except as authorized pursuant to paragraph IV.7 for special situations where the supplemental limits and exceptions should be considered and it is demonstrated that it is not appropriate to decontaminate the area to the authorized limit or guideline value.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(1)	Residual Radioactivity - Control and stabilization features shall be designed to provide, to the extent reasonably achievable, an effective life of 50 years with a minimum life of at least 25 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.b(2)	Residual Radioactivity - Controls shall be designed such that Rn-222 concentrations in the atmosphere above facility surfaces or openings in addition to background levels, will not exceed: (a) 100 pCi/L at any given point; (b) an annual average concentration of 30 pCi/L over the facility site; (c) an annual average concentration of 3 pCi/L at or above any location outside the facility site; and (d) flux rates from the storage of radon producing wastes shall not exceed 20 pCi/(m^2sec), as required by 40 CFR 61.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(3)	Residual Radioactivity - Controls shall be designed such that concentrations of radionuclides in the groundwater and quantities of residual radioactive material will not exceed applicable Federal or state standards.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(4)	Residual Radioactivity - Access to a property and use of onsite material contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR 192. These control features should be designed to provide, to the extent reasonable, an effective life of at least 25 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.c	<u>Interim Management</u> - A property may be maintained under an interim management arrangement when the residual radioactive material exceeds the guideline values if the residual radioactive material is in accessible locations and would be unreasonably costly to remove; provided that administrative controls are established by the responsible authority (Federal, state, or local) to protect members of the public and that such controls are approved by the appropriate Program Assistant Secretary or Director. The administrative controls include but are not limited to: periodic monitoring as appropriate; appropriate shielding; physical barriers to prevent access; and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate. The owner of the property should be responsible for implementing the administrative controls and cognizant Federal, state, and local authorities should be responsible for enforcing them.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.d(1)	Residual Radioactivity - For uranium, thorium, and their decay products: (a) Control and stabilization features shall be designed to provide, to the extent reasonably achievable, an effective life of 1,000 years with a minimum life of at least 200 years. (b) Control and stabilization features shall be designed to limit Rn-222 emanation to the atmosphere from the wastes to less than an annual average release rate of 20 pCi/(m^2sec) and prevent increases in the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates shall be in accordance with the requirements of 40 CFR Part 61. (c) Before any potentially biodegradable contaminated wastes are placed in a long-term management facility, such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause the requirement in paragraph IV.6d(1)(b) to be exceeded and that biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph IV.6d(1)(a). (d) Groundwater shall be protected in accordance with legally applicable Federal and state standards. (e) Access to a property and use of onsite material contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR Part 192. These controls should be designed to be effective to the extent reasonable for at least 200 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-2. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 7	Residual Radioactivity - If specific property circumstances indicate that the guideline or authorized limits established for a given property are not appropriate for any portion of that property, supplemental limits or an exception may be requested. Any supplemental limits shall achieve the basic dose limits set forth in Chapter II of this Order for both current and potential unrestricted uses of a property. Exceptions to the authorized limits defined for a property may be applied to any portion of the property when it is established that the authorized limits cannot reasonably be achieved and that restrictions on use of the property are necessary. It shall be demonstrated that the exception is justified and that the restrictions will protect members of the public within the basic dose limits of this Order.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

a. Entry shown in brackets provides rationale for including/excluding guidance in the Relevant and Appropriate and To-be-Considered Materials categories from the consolidated table. In general, such guidance is included in the consolidated table (Table B-3) in cases where it is more stringent than a requirement in the Applicable category, and excluded from the consolidated table in cases where it is less stringent than a requirement in the Applicable category or where compliance is met by adherence to general provisions of the Closure Plan.

b. Categories are defined as follows:

- A = Applicable (substantive Federal and state environmental protection requirements, criteria, or limits that directly apply to SRS high-level waste tank system closure operations.)
- RA = Relevant and Appropriate (substantive Federal and state environmental protection requirements, criteria, or limits that, while not directly applicable, are judged to be well suited for use for SRS high-level waste tank system closure operations based on their applicability to similar operations.)
- TBC = To-be-Considered Materials (advisories, guidance, proposed rules and the like issued by Federal or State government that are not legally binding, but that are judged to be useful in establishing environmental protection protocols and performance objectives or in evaluating closure options with respect to protectiveness of human health and the environment.)

Table B-3. Consolidate potential requirements and guidance details for SRS high-level waste tank system closure.

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SCPCA R.61-82, Section IV	Proper Closeout of Waste Treatment Facilities Not Defined As Lagoons or Package Plants - Waste treatment units shall be closed in accordance with guidelines issued by SCDHEC on an individual basis. These guidelines shall be designed to prevent health hazards and to promote safety in and around the abandoned sites.	Applicable to SRS HLW tanks that are permitted by SCDHEC as industrial wastewater treatment facilities (FFA, Section IX.E.4). Made applicable to all SRS HLW tanks except Tank 16 by DOE's commitment in its November 9, 1993, Waste Removal Plan and Schedule (FFA, Section IX.E.1,2). Applicability extended to all SRS HLW tank systems pursuant to discussions with SCDHEC and EPA.	A
CWA R.61-68.E(7)	Water Quality Criteria to Protect Aquatic Life - Numeric criteria for all class surface waters are adopted for toxic pollutants for which the EPA has published national criteria to protect aquatic life pursuant to Section 304(a) of the Federal CWA and for ammonia and chlorine. No numeric criteria are listed in this regulation; however, the national numeric criteria developed and published by EPA are hereby adopted by reference. Compounds with national criteria to protect aquatic life listed in this regulation include: Arsenic; Mercury Cadmium; Nickel Chromium (+3 and +6); Selenium (+4) Copper; Silver Lead; Zinc [Additional standards are included for pesticides and PCBs.]	Generally applicable standards for maintaining quality of surface water.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA NPDES Permit Limitations and Rationale Guidance	Water Quality Criteria - SCDHEC guidance (spreadsheet dated January 12, 1999) that identifies ambient water quality criteria (concentration limits for individual constituents) for deriving NPDES permit limits.	SCDHEC guidance to be considered in the identification of appropriate ambient water quality criteria for protection of aquatic life and human health.	TBC
CWA R.61-68.E(12)(a-b)	Water Quality Standards to Protect Human Health - State ambient water quality standards to protect human health are listed in Appendix 2 of this regulation. These standards will be applicable to surface waters at average annual flow conditions or at average tidal dilution conditions, whichever is appropriate. The substances and their standards (μg/l) are:	Generally applicable standards for maintaining quality of surface water.	A

	MCL	Organic Consumption
Antimony	6	4,300
Arsenic	–	1.4
Beryllium	4	–
Cadmium	5	–
Chromium (total)	100	–
Mercury	–	0.15
Nickel	100	4,600
Selenium	500	–
Thallium	2	6.3

[Additional standards are included for cyanide, asbestos, and organics.]

Table B-3. (Continued).

Citation	Requirement/Guidance Summary		Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA R.61-68.E(10)	Water Quality Standards to Protect Human Health - A list of water quality standards based on organoleptic data (prevention of undesirable taste and odor) are adopted herein. Those substances and their adopted standards are listed in Appendix 3. For substances that have both aquatic life and/or human health standards and organoleptic standards, the more stringent of the three will be used to derive effluent limits. The substances and their standards (µg/l) are:		Generally applicable standards for maintaining quality of surface water.	A
	Copper	1,000		
	Zinc	5,000		
	Chlorobenzene	20		
	2-chlorophenol	0.1		
	2,4-dichlorophenol	0.3		
	2,4-dimethylphenol	400		
	3-methyl-4-chlorophenol	3,000		
	Pentachlorophenol	30		
	Phenol	300		
	Acenaphthene	20		
	Hexachlorocyclopentadiene	1		
CWA R.61-68.G(8)(c)	Class Descriptions, Designations, and Specific Standards for Surface Waters - Freshwaters shall meet standards for toxic pollutants listed in Section 307 of the Federal CWA and for which EPA has developed national criteria, and ammonia and chlorine. Standards for these substances are prescribed in Sections E.11 and E.12 of this regulation. [The surface waters potentially affected by HLW tank closure activities, Fourmile Branch and Upper Three Runs, are classified as "freshwaters" under R.61-68.G.]		Generally applicable standards for maintaining quality of surface water.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CWA R.61-68.H	Class Descriptions and Specific Standards for Ground Waters - All South Carolina groundwater is classified GB effective June 28, 1995. Quality standards for Class GB groundwaters are: • Inorganic chemicals shall meet standards set forth in the State Primary Drinking Water Regulations, R.61-58.5.B(2). • Organic chemicals shall meet standards set forth in the State Primary Drinking Water Regulations, R.61-58.5.D(2). • Manmade radionuclides shall not exceed concentrations or amounts such as to interfere with use, actual or intended, as determined by the Department. [This standard also includes primary pollutant VOCs, pesticides, herbicides, PCBs, synthetic organic compounds, and various wastes.]	Generally applicable standards for maintaining quality of groundwater.	A
SDWA 40 CFR 141.66(b) (Subpart G) R.61-58.5(J)(2)	Maximum Contaminant Levels - The maximum contaminant levels for combined radium-226 and radium-228 - 5 pCi/L.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(c) (Subpart G) R.61-58.5(J)(2)	Maximum Contaminant Levels - The maximum contaminant level for gross alpha particle activity (including radium-226 but excluding radon and uranium) is 15 pCi/L.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.15 (Subpart B) R.61-58.5(J)(2)	Maximum Contaminant Levels - The following are the maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity: (a) Combined radium-226 and radium-228 - 5 pCi/L. (b) Gross alpha particle activity (including radium-226 but excluding radon and uranium) - 15 pCi/L.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.16(a) (Subpart B) R.61-58.5(L)(2)(a)	Maximum Contaminant Levels - The average annual concentration of beta particle and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/year.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(d)(1) (Subpart G) R.61-58.5(L)(2)(a)	Maximum Contaminant Levels - The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/year.	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.66(d)(2) (Subpart G) R.61.58.5(L)(2)(b)	Maximum Contaminant Levels - Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents must be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure" (NBS Handbook 69 as amended August 1963, U.S. Department of Commerce). If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or any organ shall not exceed 4 mrem/year. Table A - Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr Radionuclide / Critical Organ / pCi per liter Tritium / Total body / 20,000 Strontium-90 / Bone marrow / 8	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A
SDWA 40 CFR 141.66(e) (Subpart G)	Maximum Contaminant Levels – The maximum contaminant level for uranium is 30 µg/L.	EPA Federal regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.16(b) (Subpart B) R.61-58.5(L)(2)(b)	Maximum Contaminant Levels - Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2-liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure" (NBS Handbook 69 as amended August 1963, U.S. Department of Commerce). If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or any organ shall not exceed 4 mrem/year. Table A - Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr Radionuclide — Critical Organ — pCi per liter Tritium — Total body — 20,000 Strontium-90 — Bone marrow — 8	EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Invoked by DOE Order 5400.5, Chapter II, 1.d as applicable.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.51 (Subpart F)	Maximum Contaminant Levels Goals - The MCLGs for inorganic constituents are: Contaminant — Milligrams per liter Antimony — 0.006 Barium — 2 Beryllium — 0.004 Cadmium — 0.005 Chromium — 0.1 Copper — 1.3 Fluoride — 4 Lead — zero[1] Mercury — 0.002 Nitrate — 10 (as N) Nitrite — 1 (as N) Total nitrate & nitrite — 10 (as N) Selenium — 0.05 Thallium — 0.0005 [1]action level for lead is 0.015 mg/l	EPA Federal regulation applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. [Provides relevant and appropriate groundwater quality standards for copper and lead.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary		Rationale for Use[a]	Requirements/ Guidance Category[b]
SDWA 40 CFR 141.62(b) (Subpart G) R.61-58.5(B)(2)	Maximum Contaminant Levels - The MCLs for inorganic constituents are:		EPA Federal regulation and corresponding SC regulation that is applicable to operators of public drinking water systems. These limits have been applied to groundwater beneath and adjacent to projects similar to the HLW tank closure and are well suited for use as indicators of groundwater protection. Made applicable by R.61-68.H.	A
	Contaminant	Milligrams per liter		
	Fluoride	4.0		
	Arsenic	0.01		
	Barium	2.0		
	Cadmium	0.005		
	Chromium	0.1		
	Mercury	0.002		
	Nitrate	10 (as N)		
	Nitrite	1 (as N)		
	Total nitrate & nitrite	10 (as N)		
	Selenium	0.05		
	Antimony	0.006		
	Beryllium	0.004		
	Cyanide (as free cyanide)	0.2		
	~~Nickel~~	~~0.1[1]~~		
	Thallium	0.002		
	~~[1]nickel standard is in R.61-58.5(B)(2) only~~			
	[Standard also includes asbestos fiber limit.]			

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA SRS FFA WSRC-05-94-42 - DOE, EPA & SCDHEC, 8/16/93	The agreement directs the comprehensive remediation of SRS and also delineates the relationship between its requirements and the requirements for corrective measures being conducted under RCRA Sections 3004 (u) and (v) according to the conditions of the Federal and State RCRA permit. Section IX - High-Level Radioactive Waste Tank System(s) Section IX.E.1 - DOE has submitted a waste removal plan and schedule for the waste tank systems. DOE shall remove the tanks from service according to the approved plan(s) and schedule(s). Waste tanks deemed unsuitable by SCDHEC shall not receive additional waste prior to schedule approval for such receipt and only if waste receipt is approved as part of the plan associated with such a schedule. Section IX.E.2 - The DOE waste tank system(s) removal plan(s) shall provide for the removal or decontamination of all residues, contaminated containment systems components (liners, etc.), contaminated soils and structures and equipment contaminated with hazardous and/or radioactive substances. If DOE demonstrates that it cannot practicably remove or decontaminate soils or structures and equipment, then DOE shall conduct all necessary response actions under Section XI through XVI of this Agreement for those waste tank system(s). Section IX.E.3 - DOE will submit to EPA and SCDHEC an annual report on the status of the tanks being removed from service under Subsection E.1.	Standards for SRS HLW tank systems set forth in Section IX and Appendix B of the FFA apply to tank operations, including closure activities. Section XXIII, “Permits,” and Section XXIV, “Creation of Danger,” are applicable to activities undertaken pursuant to the FFA, including HLW tank closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA SRS FFA WSRC-05-94-42 - DOE, EPA & SCDHEC, 8/16/93 (cont.)	Section IX.E.4 - For waste tank system(s) that DOE decides to remove from service that have been issued an industrial wastewater permit under the SC Pollution Control Act (SCPCA): DOE shall remove such waste tank system(s) from service in accordance with the SCPCA and all applicable regulations promulgated pursuant to the SCPCA. For any waste tank systems(s) for which closure or removal from service is or has been conducted under the SCPCA, DOE shall conduct Site Evaluation in accordance with Section X of the FFA.		
CERCLA Waste Removal Plan and Schedule for the HLW Tank Farms, WSRC-RP-93-1477, Rev. 0, 11/9/93	Waste removal plan and schedule for the HLW tank system(s) and/or component(s) that do not meet secondary containment standards or that leak or have leaked as required by Section IX.E of the SRS FFA. This 1993 document was replaced by the "F/H Area High Level Waste Removal Plan and Schedule" (WRP&S) submitted January 15, 1998 and approved by SCDHEC on February 26, 1998 and EPA Region IV on June 22, 1998. The WRP&S provides dates for removal from service and operational closure of each noncompliant tank and commits to complete closure of all noncompliant tanks no later than fiscal year 2022. The approved WRP&S is provided in the Savannah River Site High Level Waste System Plan.	Applicable to the removal of SRS HLW tanks from service in accordance with Section IX.E.1 of the FFA.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CERCLA High-Level Waste Tank Closure Program Plan, (Rev. 1, August 2001)		DOE's planning tool for managing HLW tank system closure activities, including the environmental restoration (ER) program's soil assessment/remedial actions related to the closed tank systems. Chapter 4 includes a rationale for the proposed tank closure sequence and identifies operational tank groupings. Chapter 5 provides a process description and generic schedule for field investigation and remedial actions on contaminated soil around tank groupings as they are closed by the HLW program. It describes the development of tank grouping-specific co-occupancy plans (COPs) to define the HLW and ER program responsibilities, plan and schedule, and coordination of intrusive activities under the ER program with ongoing HLW operations in the Tank Farms.	A
CAA 40 CFR 61.92 (NESHAP)	Standard - Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.	EPA Federal regulation that is applicable to all SRS operations, including HLW tank closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
CAA SC R.61-62.5 Air Pollution Control Standard No. 2	Ambient Air Quality Standard - The following table constitutes the ambient air quality standards for the State of South Carolina. The analytical methods to be used will be those applicable Federal Reference Methods published in 40 CFR 50, Appendices A-H as revised July 1, 1986. In the case of fluorides either the double paper tape sampler methods (ASTM D-3266-79) or the sodium bicarbonate-coated glass tube and particulate filter method (ASTM D3268-78) may be used.	SC standards which implement national primary and secondary ambient air quality standards. Standards are applicable to all SRS operations, including HLW tank closure and provide standards for evaluation of criteria pollutant emissions and impacts.	A

Pollutant	Measuring Interval	Standard ($\mu g/m^3$ unless noted otherwise) (1)(2)
Sulfur dioxide	3 hour	1,300(3)
	24 hours	365(3)
	annual	80
Total suspended particulates	Annual geometric mean	75
PM_{10}	24 hours	150(4)
	annual	50(4)
$PM_{2.5}$	24 hours	65(5)
	Annual	15(5)
Carbon monoxide	1 hour	40 mg/m^3
	8 hour	10 mg/m^3
Ozone	1 hour	0.12 ppm (4)
	8 hour	0.08 ppm (5)
Gaseous fluorides (as HF)	12 hr. avg.	3.7
	24 hr avg.	2.9
	1 wk. avg.	1.6
	1 mo. avg.	0.8

Table B-3. (Continued).

Citation	Requirement/Guidance Summary			Rationale for Use[a]	Requirements/ Guidance Category[b]
CAA SC R.61-62.5 Air Pollution Control Standard No. 2 (cont.)	Nitrogen dioxide	annual	100		
	Lead	Calendar quarterly mean	1.5		

(1) Arithmetic average except in case of total suspended particulate matter.

(2) At 25°C and 760 mm Hg.

(3) Not to be exceeded more than once a year.

(4) Attainment determinations will be made based on the criteria contained in Appendixes H and K, 40 CFR 50, July 1, 1987.

(5) Amendments to R.61-62.5 to incorporate new federal standards for ozone and $PM_{2.5}$ pending EPA implementation rules.

Table B-3. (Continued).

<table>
<tr><th>Citation</th><th>Requirement/Guidance Summary</th><th>Rationale for Use[a]</th><th>Requirements/ Guidance Category[b]</th></tr>
<tr><td>CAA
SC R.61-62.5
Air Pollution Control Standard No. 8, Toxic Air Pollutants</td><td>II. Toxic Air Emissions - E. The allowable ambient air concentrations of a toxic air pollutant beyond the plant property line as determined by modeling under Part A shall be limited to the value listed in the following table in this section, which include:
<table>
<tr><th>Chemical Name</th><th>CAS No.</th><th>Maximum Allowable Concentration (µg/m^3)[a]</th></tr>
<tr><td colspan="3">Category I: Low Toxicity</td></tr>
<tr><td>None</td><td></td><td></td></tr>
<tr><td colspan="3">Category II: Moderate Toxicity</td></tr>
<tr><td>Oxalic acid</td><td>144-62-7</td><td>10.00</td></tr>
<tr><td colspan="3">Category III: High Toxicity</td></tr>
<tr><td>Benzene</td><td>71-43-2</td><td>150.00</td></tr>
<tr><td>Chromium(+6) compounds</td><td>None</td><td>2.50</td></tr>
<tr><td>Manganese compounds</td><td>None</td><td>25.00</td></tr>
<tr><td>Mercury</td><td>7439-97-6</td><td>0.25</td></tr>
<tr><td>Nickel</td><td>7440-02-0</td><td>0.50</td></tr>
<tr><td>Selenium compounds</td><td>None</td><td>1.00</td></tr>
</table>
[a]For the purpose of this standard, these values shall be rounded to the nearest hundredth of a µg/m^3. For example, a test or modeled value of 0.005 through 0.01 would be rounded to 0.01 but values less than 0.005 would be rounded to 0.00.
[Note: See SC R.61-62.5 for a complete list of pollutants and corresponding standards.]</td><td>SC Standards that implement Federal air toxic control program requirements. Standards are applicable to all SRS operations, including HLW tank closure and provide standards for evaluation of toxic pollutant emissions and impact.</td><td>A</td></tr>
<tr><td>National Environmental Policy Act, 42 U.S.C. 4321 et seq., 10 CFR 1021</td><td>Requirements of NEPA to evaluate SRS HLW tank closure options would be fulfilled in accordance with DOE implementing regulations (10 CFR 1021). NEPA evaluation will address impacts, including occupational exposure to site personnel, associated with various closure alternatives.</td><td>Environmental assessment requirements of NEPA are applicable to all SRS operations, including HLW tank closure.</td><td>A</td></tr>
</table>

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); 50 CFR 402 and related statutes (Anadromous Fish Conservation Act, Bald Eagle Protection Act, South Carolina Nongame and Endangered Species Conservation Act, Migratory Bird Treaty Act, Fish and Wildlife Coordination Act)	Prohibits Federally authorized actions that probably would jeopardize the existence of any threatened or endangered or otherwise protected species or result in the destruction or adverse modification of a critical habitat.	Applicable if threatened or endangered or otherwise protected species or habitats exist on or near the site, or could be affected by the proposed action.	A
National Historic Preservation Act, 16 U.S.C. 470 et seq. and related legislation (e.g., Antiquities Act, Historic Sites Act, Archeological and Historic Preservation Act, Archaeological Resources Protection Act, American Indian Religious Freedom Act)	Impact potential on cultural resources for HLW tank closure options, if any, would be formally evaluated in the context of NEPA.	Requirements to evaluate potential impact to cultural resources is applicable to all SRS projects.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 262 R.61-79.262	Standards Applicable to Generators of Hazardous Waste - Generators of hazardous waste are required to do the following: • Determine if the waste is hazardous waste and identify requirements for management of hazardous waste as set forth in Parts 264, 265, and 268; obtain an EPA identification number (Subpart A) • Comply with manifest requirements for transport of hazardous waste off the site (Subpart B) • Comply with pretransport requirements for hazardous waste packaging, labeling, marking, placarding, and accumulation; comply with storage facility requirements of Parts 264, 265, and 270 if hazardous waste is stored for more than 90 days (Subpart C) • Comply with recordkeeping and reporting requirements for hazardous waste generation, offsite transport, treatment, storage, and disposal (Subpart D)	Applicable to any hazardous waste generated as a result of SRS HLW tank closure activities. Hazardous wastes that are managed in wastewater treatment units (e.g., wastes transferred to other HLW tank systems) can be excluded from RCRA permitting and operating standards.	A
RCRA 40 CFR 264.101 (Subpart F) R.61-79.264.101 (Subpart F)	Corrective Action for Solid Waste Management Units - An owner/operator seeking a permit for the treatment, storage, or disposal of hazardous waste must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any Solid Waste Management Unit at the facility, regardless of the time at which the waste was placed in such unit. Corrective action will be specified in the permit application in accordance with this section and subpart S. The owner/operator must implement corrective action beyond the facility property boundary, where necessary to protect human health and the environment, unless he demonstrates that he was unable to obtain the necessary permission to undertake such actions. This section also sets forth standards for monitoring well installation.	Applicable to the HLW tanks because the F- and H-Area Tank Farms are identified on the site evaluation list (Appendix G) of the FFA. Compliance with the requirements of the FFA, including the schedules and commitments therein, will constitute compliance with the corrective action requirements at SWMUs and Areas of Concern (AOCs) set forth in Module IV, "Corrective Action," of the SRS RCRA permit. Compliance with provisions of this closure plan and regulatory approval of individual HLW tank system closure plan modules ensure that closure activities to be conducted under this plan will be consistent with RCRA requirements for corrective action for SWMUs with respect to the F- and H-Area Tank Farms, which will be implemented in accordance with the FFA.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268 R.61-79.268	Land Disposal Restrictions - Specifies standards to which hazardous waste must be treated prior to land disposal and prohibits storage of untreated hazardous waste except under specified conditions. Subpart D sets forth the treatment standards and Subpart E identifies prohibitions on storage applicable to restricted wastes.	LDR applicable to land disposal of hazardous wastes: • Removed from HLW tanks as part of tank closure activities • Generated as a result of tank closure activities	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268.40 (Subpart D) R.61-79.268.40 (Subpart D)	Applicability of Treatment Standards - A waste identified in the table "Treatment Standards for Hazardous Wastes" in this section may be land disposed only if it meets the requirements found in the table. For each waste, the table identifies one of three types of treatment requirements: (1) All hazardous constituents in the waste or in the treatment residues must be at or below the levels found in the table ("total waste standards") (2) The hazardous constituents in the extract of the wastes or the treatment residue must be at or below the levels found in the table ("waste extract standards") (3) The waste must be treated using the technology specified in the table ("technology standard") These standards are established for two types of waste: "wastewaters" which are generally wastes containing less than 1 percent by weight TOC and less than 1 percent by weight TSS and "nonwastewaters" [Sections 268.2(d) and (f)]. The table includes entries specific to certain mixed wastes: "Radioactive high level wastes generated during the reprocessing of fuel rods" (nonwastewaters only) that are D002 or D004-D011 hazardous wastes are subject to the HLVIT standard. "Radioactive lead solids" (nonwastewaters only) that are D008 hazardous wastes are subject to the MACRO standard. "Elemental mercury contaminated with radioactive materials" (nonwastewaters only) that are D009 hazardous wastes are subject to the AMLGM standard.	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268.40 (Subpart D) R.61-79.268.40 (Subpart D) (cont.)	In the Third Third rule, EPA indicated that the HLVIT standard would apply to the "high-level fraction of the mixed waste generated during the reprocessing of fuel rods" exhibiting the characteristics of corrosivity and toxicity for metals (see 55 FR 22627). Incidental wastes associated with HLW tank closure that are also mixed wastes would not require treatment by vitrification, but could nevertheless require treatment in accordance with the applicable LDR treatment standards for any hazardous characteristics, including standards for any underlying hazardous constituents. In addition to a specified technology or waste-specific concentration standard, wastes may also be subject to LDR treatment standards for underlying hazardous constituents set forth in Section 268.48. For example, a corrosive characteristic waste (D002) would have to be deactivated (i.e., rendered no longer corrosive) and treated to achieve the UTS concentration limits for any underlying hazardous constituents.		
RCRA 40 CFR 268.45 R.61-79.268.45	Treatment Standards for Hazardous Debris - Hazardous debris may be treated in accordance with the waste-specific standards or, alternatively, the debris may be treated in accordance with the standards set forth in Table 1 of this section. The alternative standards for hazardous debris include extraction, destruction, and immobilization technologies. Debris that is treated using one of the specified extraction or destruction technologies, and which does not exhibit a hazardous waste characteristic, is no longer subject to regulation as hazardous waste. Debris that is treated using one of the specified immobilization technologies may be excluded (e.g., debris that, after immobilization, no longer exhibits the characteristic for which the debris was hazardous waste).	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
RCRA 40 CFR 268.48 R.61-79.268.48	Universal Treatment Standards - Table UTS in this section identifies the hazardous constituents and their nonwastewater and wastewater treatment standard levels. For determining compliance with the treatment standards for underlying hazardous constituents as defined in Section 268.2(i), these constituent-specific treatment standards may not be exceeded.	Applicable to land disposal of hazardous wastes that occurs as a result of HLW tank closure activities.	A
RCRA 40 CFR 268.50 (Subpart E) R.61-79.268.50 (Subpart E)	Prohibitions on storage of restricted wastes - Storage of hazardous wastes restricted from land disposal is prohibited unless such storage is in tanks, containers, or containment buildings solely for the purpose of accumulating such quantities of hazardous waste as necessary to facilitate proper recovery, treatment, or disposal.	Applicable to management of hazardous wastes generated as a result of SRS HLW tank closure activities.	A
AEA Regulation 61-63, RHA 7.18	Protection of the General Population from Releases of Radioactivity - Concentration of radioactive material that might be released to the general environment in groundwater, surface water, air, soil, plant, or animals shall not result in an annual dose exceeding an equivalent of 25 millirem (0.25 mSv) to the whole body, 75 millirem (0.75 mSv) to the thyroid, and 25 millirem (0.25 mSv) to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluent to the general environment as low as reasonably achievable.	SC state regulation that, while not directly applicable to HLW tank closure, is relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a public dose limit of 100 mrem/yr. More stringent requirement for public dose limit of 25 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 191.3(b)	Dose Limits - Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities for the disposal of such fuel or waste that are operated by the DOE and that are not regulated by the NRC or Agreement States shall be conducted in a manner that provides reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ.	[Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.c which stipulates a dose equivalent not to exceed 25 mrem/yr to the whole body or a committed dose equivalent not to exceed 75 mrem/yr to any organ.	RA
AEA 40 CFR 191.13(a)	Containment Requirements - Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based on performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that might affect the disposal system shall (1) have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (Appendix A), and (2) have a likelihood of less than one chance in 1,000 of exceeding 10 times the quantities calculated according to Table 1 (Appendix A).	EPA regulations that would be applicable to any waste associated with HLW tank closure that is HLW. For waste that is not HLW, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [More specific requirements regarding quantities of radionuclides that might be released will be evaluated to determine impact, if any, on remedial goals.]	RA
AEA 40 CFR 191.15	Dose Limits - (a) Disposal systems for waste and any associated radioactive material shall be designed to provide a reasonable expectation that, for 10,000 years after disposal, undisturbed performance of the disposal system shall not cause the annual committed effective dose, received through all potential pathways from the disposal system, to any member of the public in the accessible environment, to exceed 15 mrem. (b) Annual committed effective dose shall be calculated in accordance with Appendix B of this part.	[Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.c stipulates that releases to the environment should result in a dose equivalent that does not exceed 25 mrem/yr to the whole body or a committed dose equivalent of 75 mrem/yr to any organ. More specific requirements for a committed effective dose not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 61.40 (Subpart C)	Performance Objectives - Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within limits established in the performance objectives in Sections 61.41 through 61.44.	NRC regulations that, while not directly applicable to HLW tank closure, would be relevant and appropriate because they are well suited for use as indicators of the protection of human health and the environment. [Requirements met by compliance with applicable requirements of DOE Orders 5400.5 and 435.1, with specific exceptions noted below.]	RA
AEA 10 CFR 61.41 (Subpart C)	Protection of the general population from releases of radioactivity - Concentrations of radioactive material that might be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual effective dose exceeding an equivalent of : • 25 mrem whole body • 75 mrem thyroid • 25 mrem any other organ Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as reasonably achievable.	[Requirement met by compliance with applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1), which establishes a dose limit of 25 mrem/year from all pathways, excluding radon and its progeny in air. Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements for dose equivalent not to exceed 25 mrem/yr whole body, 75 mrem/yr to the thyroid, and 25 mrem/yr to any other organ will be evaluated to determine impact, if any, on remedial goals.]	RA
AEA 10 CFR 61.43 (Subpart C)	Protection of individuals during operations - Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in Part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by Section 61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as reasonably achievable.	[Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1) establishes performance objectives for low-level waste disposal. More specific requirements in the referenced regulations (10 CFR 20, 10 CFR 61.41) are evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.111	<u>Performance Objectives for the Geologic Repository Operations Area through Permanent Closure</u> - (a) Protection against radiation exposures and releases of radioactive material (1) The geologic repository operations area must meet the requirements of Part 20 of this chapter. (2) During normal operations, and for Category 1 event sequences, the annual TEDE to any member of the public, located beyond the boundary of the site shall not exceed the preclosure standard specified at 10 CFR 63.204. (b) Numerical guides for design objectives (1) The geologic repository operations area must be designed so that, taking into consideration Category 1 event sequences and until permanent closure has been completed, the aggregate radiation exposures and the aggregate radiation levels in both restricted and unrestricted areas, and the aggregate releases of radioactive materials to unrestricted areas, will be maintained within the limits specified in paragraph (a) of this section. (2) The geologic repository operations area must be designed so that taking into consideration any single Category 2 event sequence and until permanent closure has been completed, no individual located on, or beyond, any point on the boundary of the site, will receive as a result of the Category 2 event sequence,, the more limiting of a TEDE of 0.05 Sv (5 rem), or the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv (50 rem). The lens dose equivalent may not exceed 0.15 Sv (15 rem), and the shallow dose equivalent to skin may not exceed 0.5 Sv (50 rem).	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements (e.g., dose equivalent not to exceed 25 mrem/yr) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.113	Performance objective for the geologic repository after permanent closure (a) The geologic repository must include multiple barriers, consisting of both natural barriers and an engineered barrier system. (b) The engineered barrier system must be designed so that, working in combination with natural barriers, radiological exposures to the reasonably maximally exposed individual are within the limits specified at § 63.311 of subpart L of this part. Compliance with this paragraph must be demonstrated through a performance assessment that meets the requirements specified at § 63.114 of this subpart, and §§ 63.303, 63.305, 63.312 and 63.342 of Subpart L of this part. (c) The engineered barrier system must be designed so that, working in combination with natural barriers, releases of radionuclides into the accessible environment are within the limits specified at § 63.331 of subpart L of this part. Compliance with this paragraph must be demonstrated through a performance assessment that meets the requirements specified at § 63.114 of this subpart and §§ 63.303, 63.332 and 63.342 of subpart L of this part.	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Order 5400.5, Chapter II, 1.a establishes a dose limit of 100 mrem/yr. More stringent requirements (e.g., dose equivalent no to exceed 25 mrem/yr for 10,000 years) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.113 (cont.)	(d) The ability of the geologic repository to limit radiological exposures to the reasonably maximally exposed individual, in the event of human intrusion into the engineered barrier system, must be demonstrated through an analysis that meets the requirements at §§ 63.321 and 63.322 of subpart L of this part. Estimating radiological exposures to the reasonably maximally exposed individual requires a performance assessment that meets the requirements specified at § 63.114 of this subpart, and §§ 63.303, 63.305, 63.312 and 63.342 of subpart L of this part.		
AEA 10 CFR 63.114	Performance Assessment - Any performance assessment used to demonstrate compliance with Sec. 63.113 must: (a) Include data related to the geology, hydrology, and geochemistry (including disruptive processes and events) of the Yucca Mountain site, and the surrounding region to the extent necessary, and information on the design of the engineered barrier system used to define parameters and conceptual models used in the assessment. (b) Account for uncertainties and variabilities in parameter values and provide for the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. (c) Consider alternative conceptual models of features and processes that are consistent with available data and current scientific understanding, and evaluate the effects that alternative conceptual models have on the performance of the geologic repository. (d) Consider only events that have at least one chance in 10,000 of occurring over 10,000 years.	NRC standards applicable to disposal of spent nuclear fuel and high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada. While not directly applicable, these standards are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P.(2) establishes a performance assessment period of 1,000 years after closure. More stringent requirements (e.g., 10,000 years after closure) will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.114 (cont.)	(e) Provide the technical basis for either inclusion or exclusion of specific features, events, and processes in the performance assessment. Specific features, events, and processes of the geologic setting must be evaluated in detail if the magnitude and time of the resulting radiological exposures to the reasonably maximally exposed individual, or radionuclide releases to the accessible environment, would be significantly changed by their omission.		
	(f) Provide the technical basis for either inclusion or exclusion of degradation, deterioration, or alteration processes of engineered barriers in the performance assessment, including those processes that would adversely affect the performance of natural barriers. Degradation, deterioration, or alteration processes of engineered barriers must be evaluated in detail if the magnitude and time of the resulting radiological exposures to the reasonably maximally exposed individual, or radionuclide releases to the accessible environment, would be significantly changed by their omission.		
	(g) Provide the technical basis for models used in the performance assessment such as comparisons made with outputs of detailed process-level models and/or empirical observations (e.g., laboratory testing, field investigations, and natural analogs).		

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 63.115	Multiple barriers – Demonstration of compliance with Section 63.113(a) must: (a) Identify those design features of the engineered barrier system, and natural features of the geologic setting, that are considered barriers important to waste isolation. (b) Describe the capability of barriers, identified as important to waste isolation, to isolate waste, taking into account uncertainties in characterizing and modeling the behavior of the barriers. (c) Provide the technical basis for the description of the capability of barriers, identified as important to waste isolation, to isolate waste. The technical basis for each barrier's capability shall be based on and consistent with the technical basis for the performance assessments used to demonstrate compliance with Sec. 63.113(b) and (c).		
AEA 40 CFR 193.13(a) (Proposed)	<u>Standards for Disposal</u> - Disposal systems for low-level radioactive waste shall be designed to provide a reasonable expectation that [*OPTION 1. "within 1,000 years of disposal, no member of the public shall receive,*"] or [*OPTION 2. "the highest projected dose following disposal and received through all pathways from the disposal system will not exceed,*"] or [*OPTION 3. "no member of the public shall receive, through all pathways from the disposal system, during a period following disposal as determined by the implementing agency,"*] an annual committed effective dose of more than 150 microsieverts (15 mrem).	Proposed EPA Federal regulation that, when promulgated, will be applicable to activities involving disposal of low-level radioactive waste. While not directly applicable to HLW tank closure, these requirements would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [Comparable applicable requirement of DOE Manual 435.1-1, Chapter IV, P(1)(a) stipulates releases to the environment should result in an effective dose equivalent that does not exceed 25 mrem/yr. More specific requirement for a committed effective dose not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals. The 15 mrem/yr committed effective dose standard is also imposed by 40 CFR 191.15 for a 10,000-year performance period.]	TBC

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.221(a) (Proposed)	<u>Dose Limits</u> - A DOE activity shall be conducted in a manner such that exposure of members of the public to radiation from radioactive waste: (1) complies with ALARA process requirements; and (2) does not exceed a TEDE of 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources, except radon and its daughters.	Proposed DOE regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [More stringent requirement for TEDE not to exceed 25 mrem/yr will be evaluated to determine impact, if any, on remedial goals. Applicable requirement (DOE Order 5400.5, Chapter II, 1.a) limit is 100 mrem/yr.]	TBC

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.306(e) (Proposed)	<u>Control and Disposition of Residual Radioactive Material</u> - (1) Long-term management of residual radioactive material in residue and waste from a DOE activity shall be in accordance with this section and DOE approved plans. (2) Long-term management of the residue and waste shall be conducted in a manner that will: (i) comply with dose limits (Sections 834.201, 834.214, and 834.221); (ii) comply with the ALARA requirements of this part (Section 834.104); (iii) comply with the Ground-Water Protection Management Plan (Section 834.215); (iv) limit radon-222 emanation to the atmosphere from radon-222 generating waste to less than an annual average release rate of 20 pCi (0.7 Bq)/(m^2 sec) averaged over the surface area overlying the waste, including the covering or other confinement structures; (v) limit radon-220 emanation to the atmosphere from waste to an annual average release rate of 20 pCi (0.7 Bq)/(m^2 sec), and (vi) limit increases in the annual average radon-222 or radon-220 concentration at or above any location outside the boundary of the controlled area to 0.5 pCi (0.02 Bq)/L. (3) Control and stabilization features shall be designed to: (i) be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years; (ii) minimize unauthorized public access or use that might breach containment of waste; and (iii) provide for proper conditioning or barriers to control the generation and escape of biogenic gases from potentially biodegradable contaminated waste or residue to ensure that this material will not cause the emission limits or dose limits to be exceeded and biodegradation within the facility will not result in premature structural failure. (4) In the development of controls and waste management plans, where appropriate, the impacts of alternative disposal modes shall be evaluated beyond the 1,000-year design requirement, to 10,000 years. (5) For wastes containing a	Proposed DOE Federal regulation that, when promulgated, will be applicable to SRS HLW tank operations, including closure. (When promulgated, this rule will replace DOE Order 5400.5.) [Requirements met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 10 CFR 834.306(e)(4) constitutes a more stringent requirement for evaluation of alternative disposal modes to 10,000 years.]	TBC

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 834.306(e) (Proposed) (cont.)	high specific activity (e.g., $\geq$1 nCi/g) of radium or thorium, alternative disposal methods, such as deep land disposal, protective covers (e.g., riprap), concrete vaults, or geologic repositories that provide additional protection from possible inadvertent intrusion shall be evaluated and employed if justified by potential risk considerations.		
AEA 10 CFR 20.1301	<u>Dose Limits for Individual Members of the Public</u> - Each licensee shall conduct operations such that: (1) The total effective dose equivalent (TEDE) to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewerage in accordance with §20.2003; and (2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any 1 hour. If the licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals. A licensee may apply for prior NRC authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). In addition to the requirements of this part, a licensee subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 shall comply with those standards. The Commission may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose.	NRC regulation that, while not directly applicable to HLW tank closure, would be relevant and appropriate because it is well suited for use as an indicator of protection of human health and the environment. [Requirement met by compliance with DOE Order 5400.5, Chapter II, 1.a, except for TEDE not to exceed 2 mrem in any one hour. This more stringent requirement will be evaluated to determine impact, if any, on remedial goals]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1402	Radiological Criteria for Unrestricted Use - A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year; including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.	NRC regulation that, while not directly applicable to HLW tank closure, would be relevant and appropriate because it provides requirements for NRC licensee activities resulting in residual radioactive material. The License Termination Rule has been proposed as the decommissioning criteria for the West Valley Demonstration Project, which includes HLW tank systems. [Applicable requirement (DOE Order 5400.5, Chapter IV, 3.a) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 25 mrem/year will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1403	Criteria for License Termination Under Restricted Conditions - A site will be considered acceptable for license termination under restricted conditions if: (a) The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of §20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. (b) The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) per year. (c) The licensee has provided sufficient financial assurance to enable a third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. (d) The licensee has submitted a decommissioning plan of License Termination Plan (LTP) to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82(a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee intends to decommission by restricting use of the site. The licensee shall document in the LTP or decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.	[Applicable requirement (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 25 mrem/year will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1403 (cont.)	(e) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is ALARA and would not exceed either: (1) 100 mrem (1 mSv) per year , or (2) 500 mrem (5 mSv) per year provided the licensee: (i) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem (1 mSv) value of paragraph (e)(1) of this section are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm; (ii) Makes provisions for durable institutional controls; and (iii) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that institutional controls remain in place as necessary to meet the criteria in §20.1403(b) and to assume and carry out responsibilities for any necessary control and maintenance of those controls.		

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 10 CFR 20.1404	<u>Alternate Criteria for License Termination</u> – The Commission may terminate a license using alternate criteria greater than the dose criterion of §§20.1402, 20.1403(b), and 20.1403(d)(1)(i)(A), if the licensee: (1) Provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100 mrem (1 mSv) per year limit of subpart D, by submitting an analysis of possible sources of exposure; (2) Has employed to the extent practical restrictions on site use according to the provisions of §20.1403 in minimizing exposures at the site; and (3) Reduces doses to ALARA levels taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal; (4) Has submitted a decommissioning plan or LTP to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82(a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee shall document in the decommissioning plan or LTP how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice.	[Applicable requirement (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 196.04(a) (Proposed)	Environmental Standards for Site Remediation - Remediation of sites shall be conducted to provide a reasonable expectation that, for 10,000 years after completion of the remedial action, radionuclide concentrations in excess of natural background levels shall not exceed those amounts that could cause any member of the public to receive, through all potential pathways under a residential land use scenario, an annual committed effective dose of 15 mrem/yr (0.15 mSv/yr).	Proposed EPA regulation that, when promulgated, will be applicable to activities resulting in residual radioactive material, including SRS HLW tank closure. [Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 40 CFR 196.04(a) constitutes a more stringent requirement of 15 mrem/yr dose limit for 10,000 years.]	TBC
AEA 40 CFR 196.04(c) (Proposed)	Environmental Standards for Site Remediation - In the event that remediation of a site will not meet the conditions of Section 196.04(a), the implementing agency shall: (1) remediate the site to provide a reasonable expectation that, for 10,000 years after completion of the remedial action, radionuclide concentrations in excess of natural background levels shall not exceed those concentrations that could cause any member of the public to receive, through all potential pathways under the conditions of the selected active control measures, an annual committed effective dose of 15 mrem/yr (0.015 mSv/yr); and (2) remediate the site to provide a reasonable expectation that, for 10,000 years after completion of the remedial action in the absence of active control measures, radionuclide concentrations in excess of natural background levels on the site shall not exceed those amounts that could cause any member of the public to receive, through all potential pathways under the conditions of residential land use, an annual committed effective dose that is less than 75 mrem/yr (0.075 mSv/yr).	[Requirement met by compliance with DOE Order 5400.5, Chapter IV, 6 except that (proposed) 40 CFR 196.04(a) constitutes a more stringent requirement of 15 mrem/yr dose limit for 10,000 years.]	TBC

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 196.23(c) (Proposed)	<u>Environmental Standards for Groundwater Protection</u> - Compliance with Section 196.23(a) of this subpart will not be required, if the implementing agency determines compliance to be technically impracticable from an engineering perspective. In this situation, the implementing agencies shall: (1) select active control measures that ensure members of the public will not be exposed to groundwater that is drinking water, in which the levels of radioactivity exceed the limits specified in 40 CFR 141; (2) select and perform remedial actions that limit, to the greatest extent, contamination of groundwater that is not already contaminated, as is reasonable under the circumstances; (3) select and perform remedial actions that restore, to the greatest extent, groundwater that is already contaminated, as is reasonable under the circumstances; (4) comply with the public notice and comment requirements of Section 196.03(a) of subpart A; and (5) comply with the periodic verification requirements of Section 196.24 of this subpart.	[More specific requirement for active control measures over groundwater which exceeds levels of radioactivity specified in 40 CFR 141 will be evaluated to determine impact, if any, on remedial goals.]	TBC
AEA 40 CFR 197, Subpart B	<u>Public Health and Environmental Standards for Disposal</u> - Controlled area means: (1) Thesurface area, identified by passive institutional controls, that encompasses no more than 300 square kilometers. It must not extend farther: (a) South than 36° 40’ 13.6661” north latitude, in the predominant direction of groundwater flow; and (b) Than five kilometers from the repository footprint in any other direction; and (2) The subsurface underlying the surface area	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirement of DOE Manual 435.1-1, IV.P(2)(b), establishes the point of compliance as the point of highest projected dose beyond a 100 meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.20	Individual-Protection Standard - DOE must demonstrate, using performance assessment, that there is a reasonable expectation that, for 10,000 years following disposal, the reasonably maximally exposed individual receives no more than an annual committed effective dose equivalent of 150 microsieverts (15 mrem) from releases from the undisturbed Yucca Mountain disposal system. DOE's analysis must include all potential pathways of radionuclide transport and exposure.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA
AEA 40 CFR 197.21	Reasonably maximally exposed individual – The reasonably maximally exposed individual is a hypothetical person who meets the following criteria: (a) Lives in the accessible environment above the highest concentration of radionuclides in the plume of contamination; (b) Has a diet and living style representative of the people who now reside in the Town of Amargosa Valley, Nevada. The DOE must use projections based upon surveys of the people residing in the Town of Amargosa Valley, Nevada, to determine their current diets and living styles and use the mean values of these factors in the assessments conducted for §§ 197.20 and 197.25; and (c) Drinks 2 liters of water per day from wells drilled into the ground water at the location specified in paragraph (a) of this section.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.25	Human Intrusion Standard - DOE must determine the earliest time after disposal that the waste package would degrade sufficiently that a human intrusion (see Sec. 197.26) could occur without recognition by the drillers. DOE must: (a) If complete waste package penetration is projected to occur at or before 10,000 years after disposal: (1) Demonstrate that there is a reasonable expectation that the reasonably maximally exposed individual receives no more than an annual committed effective dose equivalent of 150 microsieverts (15 mrem) as a result of a human intrusion, at or before 10,000 years after disposal. The analysis must include all potential environmental pathways of radionuclide transport and exposure; and (2) If exposures to the reasonably maximally exposed individual occur more than 10,000 years after disposal, include the results of the analysis and its bases in the environmental impact statement for Yucca Mountain as an indicator of long-term disposal system performance; and (b) Include the results of the analysis and its bases in the environmental impact statement for Yucca Mountain as an indicator of long-term disposal system performance, if the intrusion is not projected to occur before 10,000 years after disposal.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [Applicable requirements (DOE Order 5400.5, Chapter IV, 7) establishes a dose limit of 100 mrem/yr. More stringent requirement of TEDE not to exceed 15 mrem/yr will be evaluated to determine impact, if any, on remedial goals.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.30	Ground Water Protection Standards - DOE must demonstrate that there is a reasonable expectation that, for 10,000 years of undisturbed performance after disposal, releases of radionuclides from waste in the Yucca Mountain disposal system into the accessible environment will not cause the level of radioactivity in the representative volume of ground water to exceed the limits in the following Table 1: Table 1 - Limits on Radionuclides in the Representative Volume.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [No comparable provision for "representative volume" but SDWA MCLs are invoked as groundwater protection standards by DOE Order 5400.5, Chapter II, 1.d.]	RA

Radionuclide or type of radiation emitted	Limit	Is natural background included?
Combined radium-226 and radium-228	5 pCi/L	Yes
Gross alpha activity (including radium-226 but excluding radon and uranium	15 pCi/L	Yes
Combined beta and photon emitting radionuclides	4 mrem/yr to the whole body or any organ, based on drinking 2 L of water per day from the representative volume.	No

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.31	Representative volume (a) It is the volume of ground water that would be withdrawn annually from an aquifer containing less than 10,000 milligrams of total dissolved solids per liter of water to supply a given water demand. DOE must project the concentration of radionuclides released from the Yucca Mountain disposal system that will be in the representative volume. DOE must then use the projected concentrations to demonstrate a reasonable expectation to NRC that the Yucca Mountain disposal system complies with § 197.30. DOE must make the following assumptions concerning the representative volume: (1) It includes the highest concentration level in the plume of contamination in the accessible environment; (2) Its position and dimensions in the aquifer are determined using average hydrologic characteristics which have cautious, but reasonable, values representative of the aquifers along the radionuclide migration path from the Yucca Mountain repository to the accessible environment as determined by site characterization; and (3) It contains 3,000 acre-feet of water (about 3,714,450,000 liters or 977,486,000 gallons). (b) DOE must use one of two alternative methods for determining the dimensions of the representative volume. DOE must propose its chosen method, and any underlying assumptions, to NRC for approval.	EPA regulation that establishes public health and safety standards for radioactive material stored or disposed of in the potential repository at Yucca Mountain, Nevada. [No comparable provision for "representative volume" but SDWA MCLs are invoked as groundwater protection standards by DOE Order 5400.5, Chapter II, 1.d.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA 40 CFR 197.31 (cont.)	(1) DOE may calculate the dimensions as a well-capture zone. If DOE uses this approach, it must assume that the: (i) Water supply well(s) has (have) characteristics consistent with public water supply wells in the Town of Amargosa Valley, Nevada, for example, well-bore size and length of the screened intervals; (ii) Screened interval(s) include(s) the highest concentration in the plume of contamination in the accessible environment; and (iii) Pumping rates and the placement of the well(s) must be set to produce an annual withdrawal equal to the representative volume and to tap the highest concentration within the plume of contamination. (2) DOE may calculate the dimensions as a slice of the plume. If DOE uses this approach, it must: (i) Propose to NRC, for its approval, where the location of the edge of the plume of contamination occurs. For example, the place where the concentration of radionuclides reaches 0.1% of the level of the highest concentration in the accessible environment; (ii) Assume that the slice of the plume is perpendicular to the prevalent direction of flow of the aquifer; and (iii) Assume that the volume of ground water contained within the slice of the plume equals the representative volume.		

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter II, 1.a	Dose Limits - Except as provided by II.1a(4), the exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem (1 mSv).	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.a(3)(a)	Dose Limits - DOE operators shall make a reasonable effort to be aware of the existence of other than DOE manmade sources of radiation that, combined with the DOE sources, might present a potential for exceeding contributions of 10 mrem (0.1 mSv) effective dose equivalent in a year. Reasonable efforts shall be made to limit dose to members of the public, from multiple sources of radiation, to 100 mrem (1 mSv) EDE, or less, in a year.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.a(4)(a)	Dose Limits - Operations Office may request from EH-1 specific authorization for a temporary public dose limit higher than 100 mrem (1 mSv), but not to exceed 500 mrem (5 mSv), for the year.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.b	Dose Limits - The exposure of members of the public to radioactive materials released to the atmosphere as a consequence of routine DOE activities shall not cause members of the public to receive, in a year, an effective dose equivalent greater than 10 mrem (0.1 mSv).	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.c	Dose Limits - The exposure of members of the public to direct radiation or radioactive materials released from DOE management and storage activities at a disposal facility for spent nuclear material or for high-level or transuranic radioactive wastes that are not regulated by the NRC shall not cause members of the public to receive, in a year, a dose equivalent greater than 25 mrem (0.25 mSv) to the whole body or a committed dose equivalent greater than 75 mrem (0.75 mSv) to any organ.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure. Requirements would be applicable to any waste associated with HLW tank closure that is considered high-level waste. For waste that is not considered high-level waste, these requirements, while not directly applicable, would be relevant and appropriate because they are well suited for use as indicators of protection of human health and the environment. [Applicable if residual waste is determined to be HLW.]	RA

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter II, 1.d	Dose Limits - The level of protection provided to the public for drinking water must be equivalent to the drinking water standards of 40 CFR 141. These systems shall not cause persons consuming the water to receive an effective dose equivalent greater than 4 mrem (0.04 mSv) in a year. Combined radium-226 and radium-228 shall not exceed 5 x 10^{-9} µCi/ml and gross alpha activity (including radium-226 but excluding radon and uranium) shall not exceed 1.5 x 10^{-8} µCi/ml.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 1.d(3)	Dose Limits - The liquid effluents from DOE activities shall not cause private or public drinking water systems downstream of the facility discharge to exceed the drinking water radiological limits in 40 CFR 141.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 3.a(5)	Dose Limits for Aquatic Organisms - To protect native animal aquatic organisms, the absorbed dose to these organisms shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter II, 5.a	Residual Radioactivity - Release of real property (land and structures) shall be in accordance with the guidelines and requirements for residual radioactive material presented in Chapter IV. These guidelines and requirements apply to both DOE-owned facilities and to private properties that are being prepared by DOE for release. Real properties owned by DOE that are being sold to the public are subject to the requirements of Section 120(h) of CERCLA, as amended, concerning hazardous substances, and to any other applicable Federal, state, and local requirements. The requirements of 40 CFR 192 are applicable to properties remediated by DOE under Title I of the UMTRA.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.a	<u>Residual Radionuclides in Soil</u> - Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these derivations are given in DOE/CH-8901. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2. (1) If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, [where A is the area (in square meters) of the region in which the concentrations are elevated] limits for "hot spots" shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclides that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil. (2) The generic guidelines for residual concentrations of radium-226, radium-228, thorium-230 and thorium-232 are: (a) 5 pCi/g, averaged over the first 15 cm of soil below the surface (b) 15 pCi/g, averaged over 15-cm thick layers of soil more than 15 cm below the surface	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.b	Airborne Radon Decay Products - Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for release without restriction; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. [A working level (WL) is any combination of short-lived radon decay products in 1 L of air that will result in the ultimate emission of 1.3 x 10^5 MeV of potential alpha energy.] In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required to comply with this guideline when there is reasonable assurance that residual radioactive material is not the source of the radon concentration.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 4.c	Residual Radioactivity - The average level of gamma radiation inside a building or habitable structure on a site to be released without restrictions shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an "appropriate-use" scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic limit and the ALARA process, considering appropriate-use scenarios for the area.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 4.d	Residual Radioactivity - The generic surface contamination guidelines provided in Figure IV-1 are applicable to existing structures and equipment. These limits apply to both interior equipment and building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in paragraph IV.6a are applicable to the resulting contamination in the ground.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 5.a	Residual Radioactivity - The authorized limits for each property shall be set equal to the generic or derived guidelines unless it can be established, on the basis of specific property data (including health, safety, practical, programmatic, and socioeconomic considerations), that the guidelines are not appropriate for use at the specific property. The authorized limits shall be established to (1) provide that, at a minimum, the basic dose limits in paragraph IV.3 will not be exceeded under the "worst-case" or "plausible-use" scenarios, consistent with the procedures and guidance provided in DOE/CH-8901, or (2) be consistent with applicable generic guidelines. The authorized limits shall be consistent with limits and guidelines established by other applicable Federal and state laws. The authorized limits are developed through the project offices in the field and are approved by the Headquarters Program Office.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 5.b	Residual Radioactivity - Remedial action shall not be considered complete until the residual radioactive material levels comply with the authorized limits, except as authorized pursuant to paragraph IV.7 for special situations where the supplemental limits and exceptions should be considered and it is demonstrated that it is not appropriate to decontaminate the area to the authorized limit or guideline value.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(1)	Residual Radioactivity - Control and stabilization features shall be designed to provide, to the extent reasonably achievable, an effective life of 50 years with a minimum life of at least 25 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.b(2)	Residual Radioactivity - Controls shall be designed such that Rn-222 concentrations in the atmosphere above facility surfaces or openings in addition to background levels, will not exceed: (a) 100 pCi/L at any given point; (b) an annual average concentration of 30 pCi/L over the facility site; (c) an annual average concentration of 3 pCi/L at or above any location outside the facility site; and (d) flux rates from the storage of radon producing wastes shall not exceed 20 pCi/(m^2sec), as required by 40 CFR 61.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(3)	Residual Radioactivity - Controls shall be designed such that concentrations of radionuclides in the groundwater and quantities of residual radioactive material will not exceed applicable Federal or state standards.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A
AEA DOE 5400.5, Chapter IV, 6.b(4)	Residual Radioactivity - Access to a property and use of onsite material contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR 192. These control features should be designed to provide, to the extent reasonable, an effective life of at least 25 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.c	Interim Management - A property may be maintained under an interim management arrangement when the residual radioactive material exceeds the guideline values if the residual radioactive material is in accessible locations and would be unreasonably costly to remove; provided that administrative controls are established by the responsible authority (Federal, state, or local) to protect members of the public and that such controls are approved by the appropriate Program Assistant Secretary or Director. The administrative controls include but are not limited to: periodic monitoring as appropriate; appropriate shielding; physical barriers to prevent access; and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate. The owner of the property should be responsible for implementing the administrative controls and cognizant Federal, state, and local authorities should be responsible for enforcing them.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 6.d(1)	<u>Residual Radioactivity</u> - For uranium, thorium, and their decay products: (a) Control and stabilization features shall be designed to provide, to the extent reasonably achievable, an effective life of 1,000 years with a minimum life of at least 200 years. (b) Control and stabilization features shall be designed to limit Rn-222 emanation to the atmosphere from the wastes to less than an annual average release rate of 20 pCi/(m^2sec) and prevent increases in the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates shall be in accordance with the requirements of 40 CFR Part 61. (c) Before any potentially biodegradable contaminated wastes are placed in a long-term management facility, such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause the requirement in paragraph IV.6d(1)(b) to be exceeded and that biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph IV.6d(1)(a). (d) Groundwater shall be protected in accordance with legally applicable Federal and state standards. (e) Access to a property and use of onsite material contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR Part 192. These controls should be designed to be effective to the extent reasonable for at least 200 years.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA DOE 5400.5, Chapter IV, 7	Residual Radioactivity - If specific property circumstances indicate that the guideline or authorized limits established for a given property are not appropriate for any portion of that property, supplemental limits or an exception may be requested. Any supplemental limits shall achieve the basic dose limits set forth in Chapter II of this Order for both current and potential unrestricted uses of a property. Exceptions to the authorized limits defined for a property may be applied to any portion of the property when it is established that the authorized limits cannot reasonably be achieved and that restrictions on use of the property are necessary. It shall be demonstrated that the exception is justified and that the restrictions will protect members of the public within the basic dose limits of this Order.	DOE Orders implement AEA requirements pertinent to SRS HLW tank operations, including closure.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA SECY-99-284	Classification of Savannah River Residual Tank Waste as Incidental - NRC staff recommends that an alternative waste classification be administered at SRS for the HLW tank residuals similar to that provided for in 10 CFR 61.58. Staff considers that residual tank waste concentrations should be limited to avoid unreasonably high concentrations, and to further protect the public health and safety. The following limits are related to the development of the Class C concentration limits, which is discussed in the Draft Environmental Impact Statement (DEIS) for the 10 CFR 61 rulemaking. Staff recommends the following alternative waste classification be administered at SRS for the HLW tank residuals similar to that provided for in 10 CFR 61.58. The reclassification shall redefine the maximum allowable radionuclide concentrations as follows: no radionuclide concentration shall exceed ten times the value specified in Table 1 of 10 CFR 61.55, at 500 years following the proposed CERCLA closure for each tank grouping, and no radionuclide concentration shall exceed the value specified in Table 2, Column 3 in 10 CFR 61.55. The procedure established in 10 CFR 61.55(a)(7) shall be followed such that the sum of the fractions for all Table 1 radionuclides shall not exceed ten, and the sum of the fractions for all Table 2 radionuclides shall not exceed one.	NRC guidance regarding classification of the SRS HLW tank system residuals as other than high-level waste.	A
AEA SECY-99-284 Attachment 1	Classification of Savannah River Residual Tank Waste as Incidental - NRC staff recommends that future performance assessments for SRS tank closures, including individual tank closure modules, and the H-Area Tank Farm Fate and Transport Modeling, include the full agriculture scenario (all pathways) as well as the discovery scenario, as described in the DEIS for 10 CFR 61.	NRC guidance regarding classification of the SRS HLW tank system residuals as other than high-level waste.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA SECY-99-284 Attachment 1	<u>Classification of Savannah River Residual Tank Waste as Incidental</u> - NRC staff notes that closure of ancillary piping and equipment must consider an inadvertent intruder. That is, performance assessment must consider disturbed surface piping and equipment, which in addition to tank sources must not exceed the 500 mrem per year (all pathways, total effective dose equivalent) for the discovery and agriculture scenarios. All external components should meet radionuclide concentration limits as stated in 10 CFR 61.55 without concentration averaging, unless DOE demonstrates that closed external components provide the protection to an inadvertent intruder (similar to that provided for the residual in the HLW tank bottoms).	NRC guidance regarding classification of the SRS HLW tank system residuals as other than high-level waste.	A
AEA SECY-99-284 Attachment 1	<u>Classification of Savannah River Residual Tank Waste as Incidental</u> - NRC staff recommends that a set waste sampling protocol be developed and followed. The number of samples obtained will be a function of the tank contents as well as the homogeneity of the sludge. All sample results should be compared to process estimates to ensure consistency and accuracy. Any significant inconsistencies resulting from tank sampling and process history should result in further sampling.	NRC guidance regarding classification of the SRS HLW tank system residuals as other than high-level waste.	A

Table B-3. (Continued).

Citation	Requirement/Guidance Summary	Rationale for Use[a]	Requirements/ Guidance Category[b]
AEA SECY-99-284 Attachment 1	Classification of Savannah River Residual Tank Waste as Incidental - NRC staff recommends that future tank closure modeling provide rigorous sensitivity and uncertainty analyses including, but not limited to: • early degradation of grout/cement fill for submerged tanks or tanks within the fluctuating water table zone • combined aquifer scenario (for both public and intruder) • horizontal versus vertical flux (particularly in the saturated zone) • conservative distribution coefficient analysis • dispersive solute flux for submerged scenarios • a revised leachate model for submerged tanks which incorporates geochemical and fluid transport effects. DOE should perform sensitivity analyses on key parameters that could be impacted by natural phenomenon changes.	NRC guidance regarding classification of the SRS HLW tank system residuals as other than high-level waste.	A

a. Entry shown in brackets provides rationale for including/excluding guidance in the Relevant and Appropriate and To-be-Considered Materials categories from this consolidated requirements and guidance table. In general, such guidance is included in the consolidated table in cases where it is more stringent than a requirement in the Applicable category, and excluded from the consolidated table in cases where it is less stringent than a requirement in the Applicable category or where compliance is met by adherence to general provisions of the Closure Plan.

b. Categories are defined as follows:

- A = Applicable (substantive Federal and State environmental protection requirements, criteria, or limits that directly apply to SRS high-level waste tank system closure operations.)
- RA = Relevant and Appropriate (substantive Federal and State environmental protection requirements, criteria, or limits that, while not directly applicable, are judged to be well suited for use for SRS high-level waste tank system closure operations based on their applicability to similar operations.)
- TBC = To-be-Considered Materials (advisories, guidance, proposed rules and the like issued by Federal or State government that are not legally binding, but that are judged to be useful in establishing environmental protection protocols and performance objectives or in evaluating closure options with respect to protectiveness of human health and the environment.)

Table B-4. Nonradiological air quality performance standards applicable to high-level waste tank system closure.

Ambient Air Quality Standard No. 2.[a]

Pollutant	Measuring Interval	Standard ($\mu g/m^3$ unless noted otherwise)[b,c]
Sulfur dioxide	3 hours	1300[d]
	24 hours	365[d]
	Annual	80
Total suspended particulates	Annual geometric mean	75
PM_{10}	24 hours	150[e]
	Annual	50[e]
$PM_{2.5}$	24 hours	65[f]
	Annual	15[f]
Carbon monoxide	1 hour	40 mg/m^3
	8 hours	10 mg/m^3
Ozone	1 hour	0.12 ppm[e]
	8 hour	0.08 ppm[f]
Gaseous fluorides (as HF)	12 hour average	3.7
	24 hour average	2.9
	1 week average	1.6
	1 month average	0.8
Nitrogen dioxide	Annual	100
Lead	Calendar quarterly mean	1.5

Ambient Air Quality Standard No. 8

Chemical Name[g]	Maximum Allowable Concentration ($\mu g/m^3$)[h]
Category I: Low Toxicity	
None	
Category II: Moderate Toxicity	
Oxalic acid	10.00
Category III: High Toxicity	
Benzene	150.00
Chromium (+6) compounds	2.50
Manganese compounds	25.00
Mercury	0.25
Nickel	0.50
Selenium compounds	1.00

a. See SC R.61-62.5 for detailed compliance requirements.
b. Arithmetic average except in case of total suspended particulate matter.
c. At 25°C and 760 mm Hg.
d. Not to be exceeded more than once per year.
e. Attainment determinations will be based on the criteria contained in Appendixes H and K, 40 CFR 50, July 1, 1987.
f. Amendments to R.61-62.5 to incorporate new Federal standards for ozone and $PM_{2.5}$ pending EPA implementation rules.
g. See SC R.61-62.5 Standard 8 for complete list of constituents and corresponding standards.
h For the purpose of this standard, these values are rounded to the nearest hundredth of a $\mu g/m^3$.

Table B-5. Nonradiological groundwater and surface-water performance standards applicable to high-level waste tank system closure.

Constituents of Concerns	Maximum Contaminant Level (40 CFR §141.62) (mg/l)[a]	Maximum Contaminant Level Goal (40 CFR §141.51) (mg/l)[b]	Maximum Contaminant Levels (SC R.61-58.5.B(2)) (mg/l)[c]	Water Quality Criteria for Protection of Human Health (SC R.61-68, Appendix 2) (mg/l)[d,e]	Criteria to Protect Aquatic Life (SC R.61-68, Appendix 1) (mg/l)[d,f]	
					Average	Maximum
Aluminate						
Aluminum					0.087	0.750
Boron						
Calcium						
Carbonate						
Chloride						
Chromium III						
Chromium VI					0.046[g]	0.069[g]
Total chromium	0.1	0.1	0.1		0.046	0.069
Copper		1.3			0.0065[g]	0.0092[g]
Hydroxide						
Fluoride	4.0	4.0	4.0			
Iron					1.000	2.000
Lead		zero[h]		0.050	0.0013	0.034
Lithium						
Magnesium						
Manganese						
Mercury	0.002	0.002	0.002	1.53 x 10^{-4}	0.00302 x [g]	0.0053[g]
Molybdenum						
Nickel				4.6	0.088[g]	0.790[g]
Nitrate	10 (as N)	10 (as N)	10 (as N)			
Nitrite	1 (as N)	1 (as N)	1 (as N)			
Total nitrate & nitrite	10 (as N)	10 (as N)	10 (as N)			
Oxalate						
Phosphate						
Potassium						
Selenium	0.05	0.05	0.05	0.10	0.0050[g]	0.020[g]
Silicon						
Silver				0.050		0.0012[g]
Sodium						
Sulfate						
Titanium						
Tributylphosphate						
Zirconium						

a. Safe Drinking Water Act (SDWA) - The MCLs (§141.62) for inorganic contaminants apply to community water systems, nontransient noncommunity water systems, and transient noncommunity water systems.

b. Safe Drinking Water Act (SDWA) - The MCLGs (§141.50) are nonenforceable health goals corresponding to the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and that allows an adequate margin of safety.

c. SC Safe Drinking Water Act (SC SDWA) - The MCLs for inorganic contaminants specified in R.61-58.5.B(2) apply to all public water systems.

Table B-5. (Continued).

d. SC Water Classifications and Standards - The water quality standards are applicable to both surface waters and groundwaters unless indicated otherwise (R.61-68.C).

- With the exception of human health criteria listed in Section E.11, the numeric standards of this regulation are applicable to any flowing waters when the flow rate is equal to or greater than the minimum 7-day average flow rate that occurs with an average frequency of once in 10 years (7Q10). State water quality standards for human health protection will be applicable to surface waters at average annual flow conditions or a average tidal dilution conditions, whichever is appropriate (R.61-68.E.12).
- Numeric criteria for all class surface waters are adopted for toxic pollutants for which EPA has published national criteria to protect aquatic life pursuant to Section 304(a) for the Federal CWA and for ammonia and chlorine. No numeric criteria are listed in this regulation; however, the national numeric criteria developed and published by EPA are incorporated by reference. If metal concentrations for national criteria are hardness-dependent, the chronic and acute concentrations shall be based on 50 mg/l hardness if the ambient hardness is less than 50 mg/l and based on the actual mixed stream hardness if it is greater than 50 mg/l (R.61-68.E.11.a(3)).
- Freshwater standards for toxic pollutants listed in Section 307 of the Federal CWA and for which EPA has developed national criteria and ammonia and chlorine are subject to the standards prescribed in Sections E.11 and E.12 of this regulation (R.61-68.G.8).
- It is policy of the Department to maintain the quality of groundwater consistent with its highest potential uses. For this reason, all South Carolina groundwater is classified GB effective on June 28, 1995. Quality standards for inorganic chemicals in Class GB Groundwaters are those set forth in the State Primary Drinking Water Regulations R.61-58 (R.61-68.H(2)).

e. SC Water Classifications and Standards - State water quality standards for human health protection specified in Section 11.a will be applicable to surface waters at average annual flow conditions or at average tidal dilution conditions, whichever is appropriate (R.61-68.E.12.b).

f. Average and maximum values for water quality to protect aquatic life identified in spreadsheet obtained from M. Vickers of SCDHEC.

g. Denotes compounds with national criteria to protect aquatic life identified in R.61-68.E.11.a(5).

h. Action level for lead is 0.015 mg/l.

Table B-6. Radiological performance standards applicable to high-level waste tank closure[a].

Agency/Type of Standard	DOE[b]	EPA[c]	NRC[d]	SCDHEC[e]
Standards that Apply to Radiation Site Cleanups	Multiple Pathways			
	100 mrem/yr	15 mrem/yr (residential exposure) or	25 mrem/yr (unrestricted use) or	
		15 mrem/yr (all pathways under selected active controls) and 75 mrem/yr (residential exposure)	25 mrem/yr (under institutional controls) and 100 mrem/yr (in the absence of those controls) or	
			25 mrem/yr (under institutional controls) and 500 mrem/yr (in the absence of those controls) if complying with the limit of 100 mrem/yr is not technically or economically feasible, would be prohibitively expensive, or would result in net public or environmental harm, or	
			alternate criteria (greater than the dose limits identified above) approved by NRC under 10 CFR 20.1404	
	Single Media - Soil			
	"Hot spot" limits developed and applied if the average concentration in any surface or below surface area ≦ 25 m^2 exceeds the limit by a factor of $(100/A)^{0.5}$ where A is area (m^2)			
	5 pCi/g; averaged over the first 15 cm of soil below the surface; and 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface			
	Annual average radon decay product concentration not to exceed 0.02 WL[f] and radon decay product concentration (including background) not to exceed 0.03 WL			
	Single Media - Air			
	10 mrem/yr			
	20 pCi/(m^2-sec) Rn-222 emanation to the atmosphere from wastes; and 0.5 pCi/l increase in annual average concentration at or above any location outside the boundary of the contaminated area			

Table B-6. (Continued).

Agency/Type of Standard	DOE[b]	EPA[c]	NRC[d]	SCDHEC[e]
Standards that Apply to Radiation Site Cleanups (cont.)				
	Single Media - Groundwater	4 mrem/yr beta particle and photon radioactivity 5 pCi/l combined radium-226 and radium-228 15 pCi/l gross alpha (including radium-226 but excluding radon and uranium) 20,000 pCi/l tritium 8 pCi/l strontium 30 µg/1 uranium If compliance with the above is impracticable: • Select active controls that preclude exposure to groundwater that exceeds MCLs • Limit contamination of groundwater that is not already contaminated • Restore groundwater to the greatest extent, as reasonable under the circumstances		
	Single Media - Buildings or Habitable Structures			
	20 µR/hour gamma radiation Surface contamination guidelines (DOE 5400.5, Figure IV-1) for equipment or building components; if the building is demolished, the guidelines are applicable to the resulting contamination in the ground Rn-122 concentrations in the atmosphere above facility surfaces or openings: • 100 pCi/l at any point • 30 pCi/l annual average over the facility site • 3 pCi/l annual average at or above any location outside the facility site • 20 pCi/(m^2-sec) flux rate from storage of radon producing wastes			

Table B-6. (Continued).

Agency/Type of Standard	DOE[b]	EPA[c]	NRC[d]	SCDHEC[e]
Standards that Apply to Radiation Exposure During Facility Operations	Multiple Pathways			
	100 mrem/yr		100 mrem/yr	
			200 mrem in any 1 hour	
			500 mrem/yr with prior authorization	
	25 mrem/yr whole body	25 mrem/yr whole body	25 mrem/yr whole body	25 mrem/yr whole body
	75 mrem/yr critical organ	75 mrem/yr any critical organ	75 mrem/yr thyroid	75 mrem/yr thyroid
			25 mrem/yr any other organ	25 mrem/yr any other organ
	25 mrem/yr [proposed 10 CFR 834.221(a)]			
	Single Media - Air			
	10 mrem/yr	10 mrem/yr		
	Single Media - Groundwater			
	4 mrem/yr beta particle and photon radioactivity	4 mrem/yr beta particle and photon radioactivity		4 mrem/yr beta particle and photon radioactivity
	5 x 10^{-9} μCi/ml combined radium-226 and radium-228	5 pCi/l combined radium-226 and radium-228		5 pCi/l combined radium-226 and radium-228
	1.5 x 10^{-8} μCi/ml gross alpha (including radium-226 but excluding radon and uranium)	15 pCi/l gross alpha (including radium-226 but excluding radon and uranium)		15 pCi/l gross alpha (including radium-226 but excluding radon and uranium)
	20,000 pCi/l tritium	20,000 pCi/l tritium		20,000 pCi/l tritium
	8 pCi/l strontium	8 pCi/l strontium		8 pCi/l strontium
		30 μg/1 uranium		
	Single Media - Surface Water (Aquatic Organisms)			
	1 rad/day from liquid discharges to natural waterways			

Table B-6. (Continued).

Agency/Type of Standard	DOE[b]	EPA[c]	NRC[d]	SCDHEC[e]
Standards that Apply to Radioactive Waste Management	Multiple Pathways			
• Low-Level Waste	25 mrem/yr	15 mrem/yr	25 mrem/yr whole body	
			75 mrem/yr thyroid	
			25 mrem/yr any other organ	
	100 mrem/yr - intruder (chronic)			
	500 mrem/yr - intruder (acute)			
• High-Level Waste		15 mrem/yr		
		15 mrem/yr to the reasonably maximally exposed individual (RMEI) for 10,000 years following disposal [40 CFR 197]	15 mrem/yr to the RMEI during the first 10,000 years after permanent closure [10 CFR 63]	
		Less than 1 chance in 10 of exceeding the quantities calculated according to Table 1 of 40 CFR 191.13 (Appendix A); and less than 1 chance in 1,000 of exceeding 10 times the quantities calculated according to Table 1 [40 CFR 191]		
	Single Media - Air			
	10 mrem/yr			
	Single Media - Groundwater			
		4 mrem/yr beta particle and photon radioactivity	4 mrem/yr beta particle and photon emitting radionuclides[g]	
		5 pCi/l combined radium-226 and radium-228	5 pCi/l combined radium-226 and radium-228[g]	
		15 pCi/l gross alpha (including radium-226 but excluding radon and uranium)	15 pCi/l gross alpha (including radium-226 but excluding radon and uranium) [g]	
		20,000 pCi/l tritium		
		8 pCi/l strontium		
		30 µg/1 uranium		

a. Dose limit for member of the public unless otherwise specified.
b. Includes DOE Orders 5400.5 and 435.1, proposed regulation 10 CFR 834.
c. Includes EPA Regulations 40 CFR 61, 40 CFR 141, and 40 CFR 191; draft proposed 40 CFR 193; preliminary draft 40 CFR 196; and 40 CFR 197.
d. Includes NRC Regulations 10 CFR 20, 10 CFR 61, and 10 CFR 63.
e. Includes SCDHEC Regulations R.61-58.5 and R.61-68.
f. A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3 x 10^5 MeV of potential alpha energy.
g. Groundwater protection standard applies to a “representative volume” of groundwater as defined in 10 CFR § 63.332.

References

EPA (U.S. Environmental Protection Agency), 1988, CERCLA Compliance With Other Laws Manual *(Interim Final)*, EPA 540/G-89/006, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., August.

EPA (U.S. Environmental Protection Agency), 1989a, *CERCLA Compliance With Other Laws Manual - RCRA ARARs: Focus on Closure Requirements*, Directive 9234.2-04/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., October.

EPA (U.S. Environmental Protection Agency), 1989b, *CERCLA Compliance With Other Laws Manual - CERCLA Compliance With State Requirements*, Publication 9234.2-05/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 1990a, *CERCLA Compliance With Other Laws Manual - CERCLA Compliance with the CWA and SDWA*, Publication 9234.2-06/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., February.

EPA (U.S. Environmental Protection Agency), 1990b, *CERCLA Compliance With Other Laws Manual - Summary of Part II, CAA, TSCA, and Other Statutes*, Publication 9234.2-07/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., April.

EPA (U.S. Environmental Protection Agency), 1990c, *ARARs Q's & A's: State Ground-Water Antidegradation Issues*, Publication 9234.2-11/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., July.

EPA (U.S. Environmental Protection Agency), 1991, *ARARs Q's & A's: Compliance with New SDWA National Primary Drinking Water Regulations for Organic and Inorganic Chemicals*, Publication 9234.2-15/FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., August.

EPA, DOE, and SCDHEC, 1993, Federal Facility Agreement for the Savannah River Site, Administrative Docket No. 89-05-FF, signed January 15, 1993, effective August 16, 1993, U.S. Environmental Protection Agency, U.S. Department of Energy, and South Carolina Department of Health and Environmental Control.

APPENDIX C

EXAMPLE OF FATE AND TRANSPORT MODELING

This appendix describes the methodology and results of the fate and transport modeling that the U.S. Department of Energy (DOE) performed to support the closure of high-level waste (HLW) tanks in the F-Tank Farm and the H-Tank Farm at the Savannah River Site (SRS). This modeling estimates potential human health and ecological impacts of residual contamination remaining after closure. It also estimates the groundwater concentrations and dose levels at the applicable groundwater outcropping (seepline), which is the established point of compliance.

The modeling assumed (1) institutional control for 100 years and subsequent industrial land use; (2) the area immediately around the tank farms remains in commercial/industrial use for the entire 10,000-year period of analysis; and (3) the area of commercial/industrial land use extends at least between Fourmile Branch and Upper Three Runs in the vicinity of the tank farms.

Potential impacts to workers, intruders, and nearby adult and child residents were analyzed. For informational purposes, concentrations and dose levels were also calculated at 1 meter and 100 meters downgradient from the edge of each tank farm.

The calculated impacts from the residual contamination in these tanks can be used in conjunction with results from modeling of other sources in the Groundwater Transport Segment (GTS) to account for tank farm impacts against the GTS performance objectives as discussed in Chapter 6.

C.1 Analyzed Scenario

In the analyzed scenario, the mobile contaminants in the tanks will gradually migrate through unsaturated or saturated soil to the hydrogeologic units comprising the Shallow Aquifer underlying the tank farms. The first hydrogeologic unit encountered will be the Water Table Aquifer. Some contaminants will be transported by groundwater through the Water Table Aquifer to the seepline and subsequently to the surface waters of either Upper Three Runs or Fourmile Branch. Upon reaching the surface water, the contaminants will contaminate the seepline, sediments, and the shoreline. Aquatic organisms in the streams and plants along the shoreline will become exposed to the contaminants. Terrestrial organisms might ingest the contaminated vegetation and obtain their drinking water from the contaminated stream. Human receptors could be exposed to contaminants through various pathways associated with the surface water.

Due to vertical leakage through the Tan Clay layer, a portion of the contaminants will migrate further downward into the underlying Barnwell-McBean Aquifer which predominantly discharges along Fourmile Branch. These contaminants will affect organisms and human receptors in and along surface streams in the same manner as those contaminants transported through the Water Table Aquifer.

Vertical leakage through the Green Clay layer underlying the Barnwell-McBean Aquifer results in flow from the Barnwell-McBean down to the Congaree Aquifer. Thus, a portion of those contaminants reaching the Barnwell-McBean Aquifer will move further downward into the Congaree Aquifer which predominantly discharges along Upper Three Runs. However, since there is minimal interchange between these two aquifers and the volume of water in the Congaree is quite large, impacts to humans and aquatic and terrestrial organisms at this location will be negligible. More details on the hydrogeology of the tank farm area can be found in Chapter 3.

The closure scenario assumes that the tanks will be filled with grout and no engineered structures will be used to reduce the infiltration of rain water.

C.2 Residual Material in HLW Tanks

The waste removal process will use the following techniques or other techniques of comparable or greater effectiveness; Appendix A provides additional detail.

- Bulk waste removal - Slurry pumps, transfer pumps, and transfer jets will be used to remove as much HLW as practical from the tank systems.
- ~~Spray~~Water washing ~~–~~ If needed, t~~T~~he interior of the tank will be ~~sprayed~~washed with water to dislodge loose contamination that was not removed during bulk waste removal.
- Annulus cleaning - On tanks that have leaked waste from primary to secondary containment, when required by evaluation, as much waste as is practical will be removed from the annulus.

After the tank closure process begins for a given tank, DOE may determine that further waste removal of a particular tank is necessary to meet the performance objectives. DOE will then perform further waste removal, such as acid rinsing, mechanical methods, or other means.

The residual material in the tanks would most likely be insoluble sludge material that settles into the bottom of the tanks. For purposes of analysis, all residual material in a tank is assumed to have a radionuclide distribution equal to that of the sludge material.

C.3 Tank Groupings for Modeling Source Term Calculation

Because each of the HLW tanks has a different history with regard to transfers of liquid waste over the years of operation, each tank has a different projected radionuclide distribution in the sludge material. In addition, there are 4 types of tanks in the two tank farms, and the distance from the bottom of the tanks to the water table aquifer varies by tank. To simplify the calculational process, tank groupings were determined for both tank farms that were based on the following factors:

- tank type
- distance to the water table aquifer
- proximity to other tanks of the tank type

Table C-1 below shows the characteristics of the tanks in both F- and H-Area Tank Farm. For each tank, the type of tank is noted along with the basemat thickness, tank bottom elevation, water table elevation, and vadose zone thickness. This information was used along with the geographical proximity to determine the appropriate groupings.

Based on the information in Table C-1, the tanks were assigned to groups as listed in Table C-2 below.

C.4 Source Term Values for the Tank Farms

As discussed earlier, it was assumed that the contaminants remaining in the tanks after any of the waste removal methods (bulk waste removal, water washing, oxalic acid cleaning, or mechanical means of waste removal) would be mixed in with the sludge in the tanks. Therefore, the source term calculation for the individual tanks, the aggregate groups, and the tank farms is based on the volume of sludge remaining in the tanks after cleaning. Because it was assumed that the concentration in the sludge in each tank would remain unchanged by the cleaning process (i.e., it was assumed that the sludge would contain mostly insoluble contaminants that would not be dissolved selectively from the sludge), the total source material in each tank is determined solely by the volume of sludge assumed to remain following the appropriate cleaning method.

Table C-1. Tank-specific characteristics of the HLW tanks at the SRS.

Tank #	Area	Tank type	Basemat thickness (ft)	Vadose zone thickness (ft)	Tank #	Area	Tank type	Basemat thickness (ft)	Vadose zone thickness (ft)
1	F	I	3.54	19.54	27	F	III	2.75	26.59
2	F	I	3.54	19.54	28	F	III	2.75	25.18
3	F	I	3.54	18.22	29	H	III	2.75	13.92
4	F	I	3.54	18.04	30	H	III	2.75	12.93
5	F	I	3.54	16.68	31	H	III	2.75	12.48
6	F	I	3.54	17.11	32	H	III	2.75	10.44
7	F	I	3.54	15.88	33	F	III	2.75	23.49
8	F	I	3.54	15.88	34	F	III	2.75	22.77
9	H	I	3.54	-28.3[a]	35	H	III	2.75	16.42
10	H	I	3.54	-29.47[a]	36	H	III	2.75	18.77
11	H	I	3.54	-30.69[a]	37	H	III	2.75	19.01
12	H	I	3.54	-31.81[a]	38	H	III	2.75	19.64
13	H	II	3.75	-1.64[a]	39	H	III	2.75	20.94
14	H	II	3.75	-2.22[a]	40	H	III	2.75	20.59
15	H	II	3.75	-1.32[a]	41	H	III	2.75	19.88
16	H	II	3.75	-2.21[a]	42	H	III	2.75	21.59
17	F	Tank has been previously closed.			43	H	III	2.75	22.27
18	F	IV	0.58	4.89	44	F	III	2.75	24.75
19	F	IV	0.58	4.21	45	F	III	2.75	26.9
20	F	Tank has been previously closed.			46	F	III	2.75	26.86
21	H	IV	0.58	7.99	47	F	III	2.75	25.35
22	H	IV	0.58	8.53	48	H	III	2.75	16.39
23	H	IV	0.58	8.06	49	H	III	2.75	16.95
24	H	IV	0.58	8.51	50	H	III	2.75	14.19
25	F	III	2.75	25.33	51	H	III	2.75	14.2
26	F	III	2.75	26.63					

a. Negative values for the vadose zone thickness indicate that the bottom of the tank is below the top of the water table aquifer.

Table C-2. Assigned tank groupings for HLW tanks in F-Area and H-Area..

Tank farm	Tank type	Tanks	Average basemat thickness (ft)	Average vadose zone thickness (ft)
F-Area	I[a]	1-8	3.54	17.61
	III	25-28, 33-34, 44-47	2.75	25.39
	IV	18, 19	0.58	4.55
H-Area	I	9-12	3.54	-30.07[b]
	II	13-16	3.75	-1.85[b]
	IV	21-24	0.58	8.27
	III	29-32	2.75	12.44
	III	48-51	2.75	15.43
	III	38-43	2.75	20.82
	III	35-37	2.75	18.07

a. The diameter of Type I tanks is 75 ft, while all other tanks have a diameter of 85 ft.
b. Negative values for the vadose zone thickness indicate that the bottom of the tank is below the top of the water table aquifer.

Estimates of the current contents of the tanks were used as the starting point for calculation of the source term expected to remain after cleaning of the tanks. The current contents estimates were provided by WSRC (Newman 1999). The concentration of constituents in the sludge was estimated by dividing the total amount of each contaminant by the mass of sludge for each constituent.

WSRC also provided estimates of the volume of sludge expected to remain after the various cleanings were performed for each tank. For the In some cases, individual tanks were expected to require only bulk waste removal to remove essentially all of the contaminants while other tanks were assumed to require further cleaning. For calculational purposes, the tanks to be cleaned only by bulk waste removal were assumed to contain 1,000 gallons of residual sludge while the tanks to be cleaned by further cleaning were assumed to contain 100 gallons of residual sludge. These volumes were then multiplied by the concentrations previously obtained to calculate the total inventory of contaminants expected to remain in each tank after cleaning.

The total inventory of contaminants for a given tank group was obtained by summing the contributions from the appropriate tanks. The concentration for the tank groupings was obtained by dividing the total inventory for the group and dividing by the total sludge remaining in all tanks in the group.

In addition to the tank contents, a small quantity of contamination is also expected in ancillary equipment and piping that connect the tanks to each other and to other portions of the Tank Farm Areas. For conservatism, the concentrations in the equipment and piping for a given tank grouping were assumed to be the same as in the tanks, and the total inventory in the equipment and piping were assumed to be equal to 20 percent of that contained in the tank grouping. However, in the future, DOE expects to estimate actual ancillary equipment and piping contamination to more closely approximate the actual contamination level. These estimates will be described in the applicable closure modules.

C.5 Calculational Methodology for Human Health Impact Analysis

Groundwater and surface water concentrations and human health impacts were calculated using the MEPAS computer code (Buck et al. 1995). MEPAS integrates source-term, transport, and exposure models for contaminants. In MEPAS, contaminants are assumed to be transported from a contaminated area to potential human receptors through various transport pathways. Human receptors then receive doses, both chemical and radiation, through exposure or intake routes and numerous exposure pathways. MEPAS includes models to estimate human health impacts from radiation exposure, carcinogenic chemicals, and noncarcinogenic chemicals. More details on the use of MEPAS are given in Section C.8.

It is expected that during the tank system closure period, new innovative modeling methods and programs may be substituted for those described in this appendix. Any new methods or programs will be discussed and approved in applicable closure modules.

This modeling assumed institutional control for 100 years and subsequent industrial land use. The area immediately around the tank farms would remain in commercial/industrial use for the entire 10,000-year period of analysis and would be unavailable for residential use based on the DOE's Future Use Plan for the Savannah River Site (DOE 1998). Figure C-1 shows the potential pathways by which the receptors could be exposed to contaminants. None of the analyzed scenarios took credit for engineered caps to be placed after completion of closure activities.

Potential impacts to the following hypothetical individuals were analyzed:

- *Worker:* An adult who has authorized access to, and works at, the tank farm and surrounding areas but is considered to be a member of the public for compliance purposes. This analysis assumes that the worker remains on the banks of Fourmile Branch or Upper Three Runs during working hours.
- *Intruder:* A teenager who gains unauthorized access to the tank farm and is potentially exposed to contaminants.
- *Nearby adult resident:* An adult who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the location of the seepline.
- *Nearby child resident:* A child who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the location of the seepline.

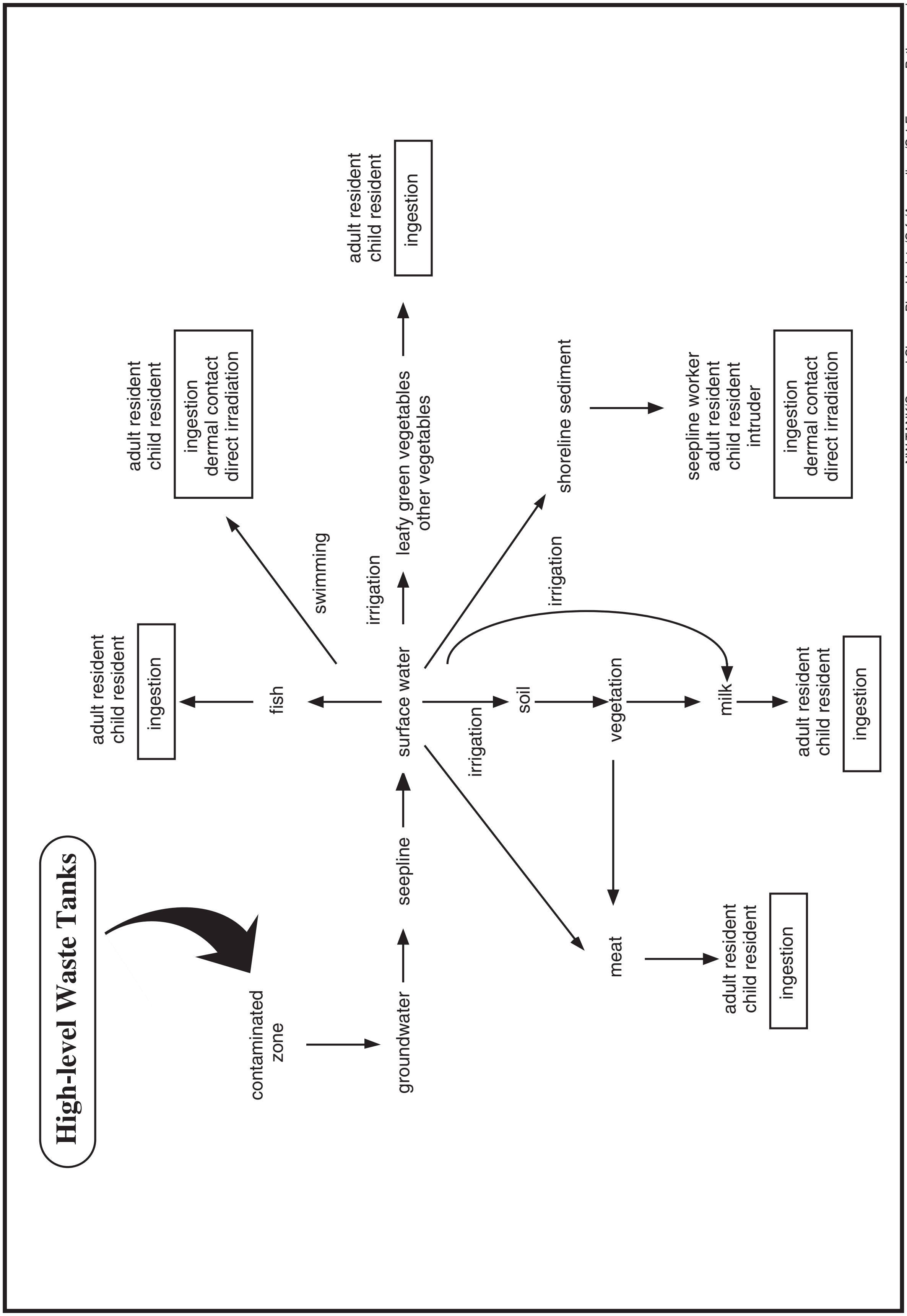
In addition to the hypothetical individuals identified above, concentration and dose levels were calculated at the groundwater seepline point of exposure. For informational purposes, concentration and dose levels were also calculated at 1-meter and 100 meters downgradient from the edge of the F-Area and H-Area Tank Farms.

Further information on the pathways analyzed for the various receptors is provided in the following sections.

C.5.1 WORKER

The worker is assumed to be located in the area including and surrounding the tank farms. Since institutional controls are in place, the potential for exposure of the worker to the primary source (residual material at the bottom of the tanks) is minimal. Therefore, this analysis assumed that the worker is located constantly at the nearest place where contaminants will be accessible (i.e., on the bank of either Fourmile Branch or Upper Three Runs), as part of his work duties. The assumption is conservative because the worker has a greater potential for exposure to contaminants at the seepline. Because the worker does not reside at the tank farms, the exposure pathways by which he could come in contact with contaminants is limited. The potential exposure pathways for the seepline worker are:

- Direct irradiation from the shoreline deposits (radioactive contaminants only)
- Incidental ingestion of the soil from the shoreline deposits
- Dermal contact with shoreline deposits.



NW TANK/General Closure Plan Update/Grfx/Appendices/C-1 Exposure Pathways.ai

Figure C-1. Potential exposure pathways for human receptors.

Exposure from inhalation of resuspended soil was not evaluated because the soil conditions at the seepline (i.e., the soil is very damp) are such that the amount of soil resuspended and potentially inhaled will be minimal.

C.5.2 INTRUDER

Another potential receptor is the intruder, a person who gains unauthorized access to the tank farm site and becomes exposed to the contaminants in some manner. The intruder scenario was analyzed for a point in time after institutional controls have ceased (i.e., after the 100-year period following tank closure). Because the intruder is assumed not to have residential habits, he would not have exposure pathways like that of a resident (e.g., the intruder does not build a house, grow produce, etc.). Instead, the intruder is potentially exposed to the same pathways as the seepline worker but for a shorter duration (4 hours per day for the intruder compared to 8 hours per day for the seepline worker).

C.5.3 NEARBY ADULT RESIDENT/ NEARBY CHILD RESIDENT

Nearby residents could also potentially be exposed to contaminants from the tank farms. While the SRS Land Use Plan calls for the entire SRS to be unavailable for public use in perpetuity, this analysis assumes that members of the public construct a dwelling near the tank farms on the Savannah River Site (but outside the tank farms). The location of the residential dwelling is assumed to be downgradient near Fourmile Branch or Upper Three Runs at a point 100 meters downstream of the groundwater cropping. The residents of this dwelling include both adults and children. The adult resident was modeled separately from the child resident because of different body weights and consumption rates.

The resident is assumed to use Fourmile Branch for recreational purposes; to grow and consume produce irrigated with water from Fourmile Branch; to obtain milk from cows raised on the residential property, and to consume meat that was fed contaminated vegetation from the area. Therefore, potential exposure pathways for both the nearby adult and nearby child resident are the following:

- Incidental ingestion of contaminated soil from shoreline deposits
- Inhalation of contaminated soil from shoreline deposits
- Direct irradiation from shoreline (radioactive contaminants only)
- Direct irradiation from surface water (radioactive contaminants only – recreation)
- Dermal contact with surface water
- Incidental ingestion of surface water
- Ingestion of contaminated meat
- Ingestion of produce grown on contaminated soil irrigated with water from Fourmile Branch or Upper Three Runs
- Ingestion of milk from cows that are fed contaminated vegetation
- Ingestion of aquatic foods (e.g., fish) from Fourmile Branch or Upper Three Runs

C.5.4 HUMAN HEALTH EXPOSURE PARAMETERS AND ASSUMED VALUES

Because the impact on a given receptor depends in large part on the physical characteristics and habits of the receptor, it is necessary to stipulate certain values to obtain meaningful results. Certain of these values are included as default values in MEPAS; however, others must be specified so that the receptors are modeled appropriately for the scenario being described.

For this modeling effort, site-specific values were used as much as possible: that is, values that had been used in other modeling efforts for the SRS were incorporated when available and appropriate. Table C-3 lists the major parameters that were used in assigning characteristics to the receptors used in the calculations.

C.6 Calculational Methodology for Ecological Risk Assessment Analysis

C.6.1 GENERAL METHODOLOGY

Several potential contaminant release mechanisms were considered for assessing ecological risks associated with tank closure. These included contamination of runoff water during rainstorms, soil contamination from air emissions following tank collapse, and contamination of groundwater. Onsite inspection showed that the tanks are well below (4 to 7 meters) the surrounding, original land surface. Therefore, runoff or soil contamination was not a reasonable assumption. Groundwater contamination was determined to be the most likely means of contaminant transport.

Several contaminant migration pathways were evaluated, which for half of H-Area (south of the groundwater divide) include seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. For the other half of H-Area (north of the groundwater divide), all three aquifers outcrop at Upper Three Runs with subsequent mixing with this stream. For F-Area, the analysis included seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch, and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. The groundwater-to-surface water contaminant migration pathway, together with potential routes of entry into ecological receptors, is shown in the conceptual site model (Figure C-2).

The habitat in the vicinity of the seeplines is bottomland hardwood forest. On the upslope side of the bottomland, the forest becomes a mixture of pine and hardwood.

Potential impacts to terrestrial receptors at the seepline and aquatic receptors in Fourmile Branch and Upper Three Runs were evaluated. For the assessment of risk due to toxicants, the aquatic receptors are treated as a group because water quality criteria have been derived for protection of aquatic life in general. These criteria, or equivalent values, are used as threshold concentrations. For the radiological risk assessment, the redbreast sunfish was selected as an indicator species due to its abundance in Fourmile Branch and Upper Three Runs (Halverson et al. 1997).

There are no established criteria for the protection of terrestrial organisms from toxicants. Receptor indicator species are usually selected for risk analysis and the results extrapolated to the populations, communities, or feeding groups (e.g., herbivores, predators) they represent. Two terrestrial animal receptors, the southern short-tailed shrew and the mink, were selected in accordance with EPA Region IV guidance, which calls for investigation of small animals with small home ranges. The guidance also calls for investigation of predators when biomagnifying contaminants (such as mercury) are being studied. The southern short-tailed shrew is small and one of the most common mammals on the SRS; the mink is a small-bodied predator associated with waterways and is found on SRS (Cothran et al. 1991). Species that are more abundant on SRS than the mink with similar eclogues were considered for use in this assessment, including the raccoon. However, the mink has a small body size relative to similar species, which results in a more conservative estimate of exposure. Also, the mink is considered to be a highly contaminant-sensitive species, and is almost exclusively carnivorous (which maximizes toxicant exposure). The short-tailed shrew and mink are also used in the radiological assessment.

Table C-3. Assumed human health exposure parameters.

Parameter	Applicable receptor	Value	Comments
Body mass	Adult	70 kg	This value is taken directly from ICRP (1975). In radiological dose calculations, this is the standard value in the industry.
	Child	30 kg	This value was obtained from ICRP (1975). Both a male and female child of age 9 have an average mass of 30 kg.
Exposure period	All	1 year	This value is necessary so that MEPAS will calculate an annual radiation dose. Lifetime doses can be calculated by multiplying the annual dose by the assumed life of the individual.
Leafy vegetable ingestion rate	Adult	21 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	8.53 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals (NRC 1977).
Other vegetables ingestion rate	Adult	163 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	163 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates (equal to unity) for maximum individuals (NRC 1977).
Meat ingestion rate	Adult	43 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	16 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Milk ingestion rate	Adult	120 L/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	128 L/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Water ingestion rate	All	2 L/day	This value is standard in MEPAS and is consistent with maximum drinking water rates in NRC (1977).
Finfish ingestion rate	Adult	9 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	2.96 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Time spent at shoreline	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Seepline worker	2080 hrs/yr	This value is based on the assumption of continuous exposure of the seepline worker during each working day.
	Intruder	1040 hrs/yr	This value is based on the conservative assumption of half-time exposure during each working day.
Time spent swimming	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).

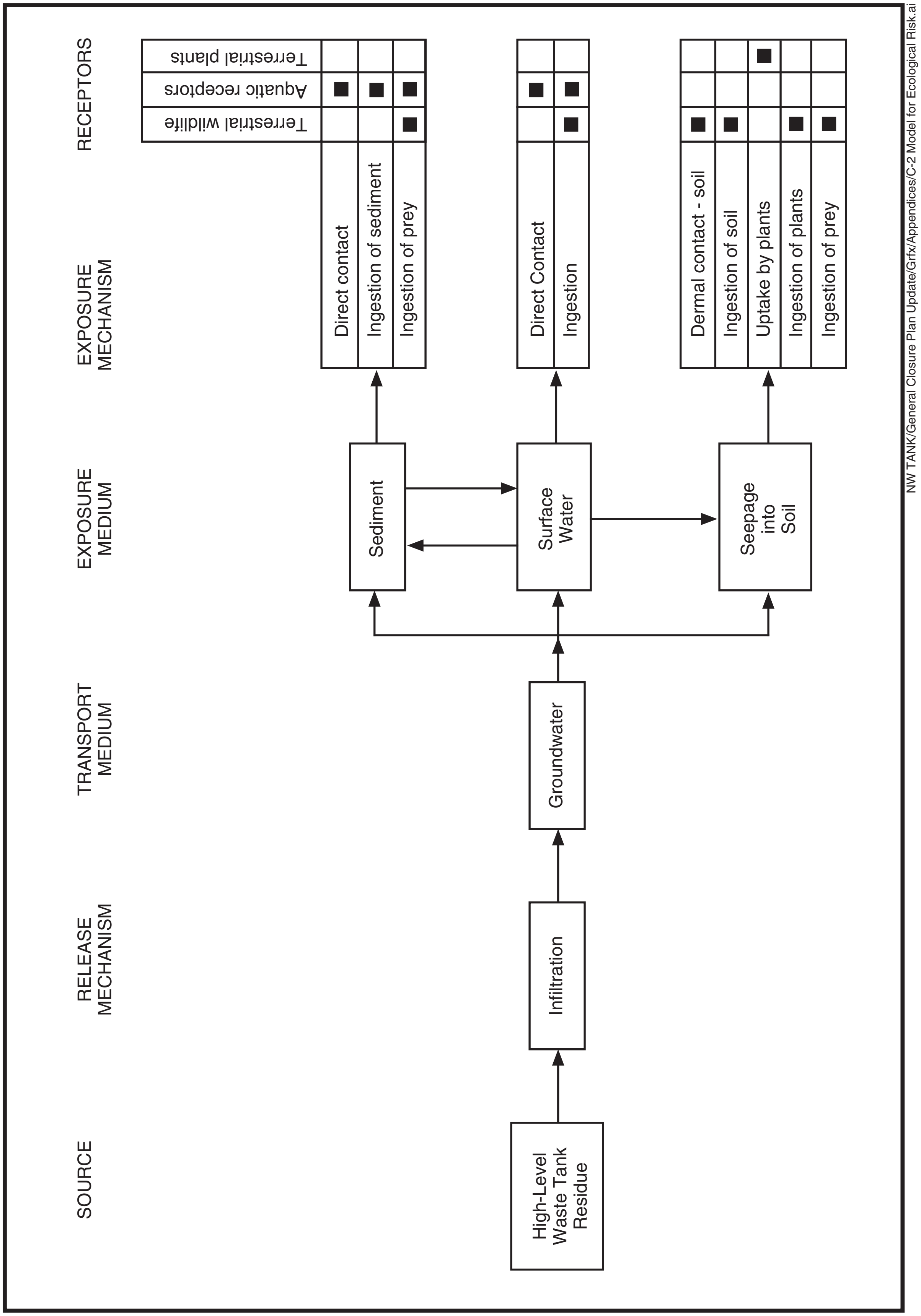


Figure C-2. Conceptual site model for ecological risk assessment.

The seepage areas are estimated to be small, about 0.5 hectare (DOE 1997), so risk to plant populations would be negligible even if individual plants were harmed. The only case in which harm to individual plants might be a concern in such a small area would be if protected plant species are present. Because no protected plant species are known to occur in these areas, risks to terrestrial plants are not treated further in the risk assessment.

The following exposure routes were chosen for calculating absorbed radiation dose to the terrestrial mammals of interest (shrew and mink) located on or near the seeplines: ingestion of food (earthworms, slugs, insects and similar organisms for the shrew, and shrews for the mink); ingestion of soil; and ingestion of water. The following exposure routes were chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper Three Runs: uptake of contaminants from water and direct irradiation from submersion in water.

The exposure factors used in calculating doses to the shrew and mink are listed in Table C-4. An important assumption of the exposure calculation is that no feeding or drinking takes place outside the influence of the seepage, even though the home ranges of the shrew and the mink typically are larger than the seep areas. EPA (1993) presents a range of literature-based home ranges for the short-tailed shrew that vary from 0.03 to 1.8 ha. Home ranges for the mink also vary widely in the literature from 7.8 to 770 ha (EPA 1993). The bioaccumulation factor for soil and soil invertebrates is 1 for all metals, as is the factor for soil invertebrates and shrews. K_d values for estimating-contaminant concentrations in soil due to the influence of seepage are from Baes et al. (1984). Bioconcentration factors for estimating contaminant concentrations in aquatic prey items are from the EPA Region IV water quality criteria table. For contaminants with no listing in the Region IV table for a bioconcentration factor, a factor of 1 is used. The mink was modeled as obtaining half of its diet from shrews at the seep area and the other half from aquatic prey downstream of the seepline.

C.6.2 EXPOSURE AND TOXICITY ASSESSMENT

Exposure for aquatic receptors is simply expressed as the concentration of contaminants in the water surrounding them. This is the surface-water exposure medium shown in the conceptual site model (Figure C-2). The conceptual model also includes sediment as an exposure medium; sediment can become contaminated from the influence of the surface water or from seepage that enters sediment directly. However, this exposure medium was not evaluated because estimating sediment contamination from surface water inputs would be highly speculative and seepage into sediment is not considered in the groundwater model; all of the transported material is assumed to come out at the seepline.

Exposure for terrestrial receptors is based on dose, expressed as milligrams of contaminant ingested per kilogram of body mass per day. The routes of entry (exposure routes) used for estimating dose were ingestion of food and water. Dermal absorption is a possibility, but the fur of shrews and minks was considered to be an effective barrier against this route. The food of shrews is mainly soil invertebrates, and the mink eats small mammals, fish, and a variety of other small animals. Contaminants in seepage water were considered to be directly ingested as drinking water (shrew), ingested as drinking water after dilution in Fourmile Branch (mink), ingested in aquatic prey (mink), and transferred to soil, soil invertebrates, shrews, and mink through a simple terrestrial food chain.

The goal of the toxicity assessment is to derive threshold exposure levels which are protective of the receptors (Table C-5). For aquatic receptors, most of the threshold values are ambient water quality criteria for chronic exposures. Others include the concentration for silver, which is an acute value (no chronic level was available).

Screening for the MCL (10 mg/L as N) in the seepline water is considered protective for nitrate. For terrestrial receptors, toxicity thresholds are based on the lowest oral doses found in

Table C-4. Parameters for foodchain model ecological receptors.

Receptor	Feeding group	Parameter	Value	Notes; Reference
Southern short-tailed shrew (*Blarina carolinensis*)	Insectivore	Body weight	9.7 grams	Mean of 423 adults collected on SRS (Cothran et al. 1991)
		Water ingestion	2.2 grams/day	0.223 g/g/day X 9.7g (EPA 1993)
		Food ingestion	5.2 grams/day	0.541 g/g/day X 9.7g (Richardson 1973 cited in Cothran et al. 1991)
		Soil ingestion	10% of diet	Between vole (2.4%) and armadillo (17%) (Beyer et al. 1994)
		Home range	0.96 ha	Mean value on SRS (Faust et al. 1971 cited in Cothran et al. 1991)
Mink (*Mustela vison*)	Carnivore	Body weight	800 grams	"Body weight averages 0.6 to 1.0 kg" (Cothran et al. 1991)
		Water ingestion	22.4 grams/day	0.028 g/g/day X 800g (EPA 1993)
		Food ingestion	110 grams/day	Mean of male and female estimates (EPA 1993)
		Soil ingestion	5% of diet	Between red fox (2.8%) and raccoon (9.4%); (Beyer et al. 1994)
		Home range	variable	7.8-20.4 ha (Montana);
				259-380 ha (North Dakota) (EPA 1993)
				Females: 6-15 ha, males: 18-24 ha (Kansas) (Bee et al. 1981)

Table C-5. Threshold toxicity values (summarized from values in Tables C-6 and C-7).

Contaminant	Aquatic receptors (milligrams per liter)	Terrestrial receptors (milligrams per kilograms per day) Shrew	Mink
Aluminum	0.087	27.7	6.4
Barium	0.0059	1.78	0.41
Chromium	0.011	11.6	2.7
Copper	0.0014[a]	52.2	12
Fluoride	NA[b]	8.3	2.5
Iron	1.0	NA	NA
Lead	0.00013[a]	0.012	0.003
Manganese	NA	52.9	12.1
Mercury	0.000012	0.082	0.019
Nickel	0.019[a]	29.7	6.8
Nitrate (as N)	NA	(c)	–
Silver	0.000055[a]	0.33	0.077
Uranium	0.00187	4.48	1.01
Zinc[a]	0.0127	14.0	3.17

a. Based on a hardness of 8.2 mg $CaCO_3$/L.
b. NA: Not applicable (normally not a toxin for this type of receptor).
c. Screening for MCL (10μ/L) at seepline considered protective for nitiate.

the literature that are no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) for chronic endpoints that could affect population viability or fitness (Table C-6). Usually the endpoints are adverse effects on reproduction or development. Uncertainty factors are applied to these doses to extrapolate from LOAELs to NOAELs and from subchronic or acute-to-chronic study durations. The derivation of these values is listed in Table C-7. Adjustments for differences in metabolic rates between experimental animals, usually rats or mice, and indicator species are made by applying a factor based on relative differences in estimated body surface area to mass ratios.

C.6.2.1 Chemical Contaminants

For terrestrial receptors, the exposure calculation is a ratio of total contaminant intake to body mass, on a daily basis. This dose is divided by the toxicity threshold value to obtain a hazard quotient. Modeled surface water concentrations in Fourmile Branch and Upper Three Runs were divided by aquatic threshold levels to obtain a hazard quotient.

C.6.2.2 Radioactive Contaminants

Animal ingestion dose conversion factors (DCFs) for both terrestrial animals (shrew and mink) were estimated, for purposes of these calculations, by assuming that the animals possess similar metabolic processes as humans with regard to retention and excretion of radioisotopes; the chemistry of radioisotopes in the animals' bodies is assumed to be similar to that of humans. This assumption is appropriate because much of the data used to determine the chemistry of radioisotopes in the humans' bodies was derived from studies of small mammals. Equations from International Commission on Radiological Protection (ICRP) Publication 2 (ICRP 1959) which provides a more simplified human metabolic model were used to predict the uptake rate and body burden of radioactive material over the life span of the animals. All isotopes were assumed to be uniformly distributed

Table C-6. Toxicological basis of NOAELs for indicator species.

Analyte	Surrogate species	LOAEL (milligrams per kilograms per day)	Duration	Effect	NOAEL (milligrams per kilograms per day)	Reference	Notes
Inorganics							
Aluminum	Mouse	–	13 mo	Reproductive system	19	Ondreicka et al. (1966) in ATSDR (1990)	
Barium	Rat	5.4	16 mo	Systemic	0.54	Perry et al. (1983) in Opresko et al. (1994)	
Chromium VI	Rat	–	1 y	Systemic	3.5	Mackenzie et al. (1958) in ATSDR (1991)	
Copper	Mink	15	50 w	Reproductive	12	Aulerich et al. (1982) in Opresko et al. (1994)	
Fluoride	Rat	5	60 d	Reproductive	–	Araibi et al. (1989) in ATSDR (1993)	
	Mink	5	382 d	Systemic	–	Aulerich et al. (1987) in ATSDR (1993)	Systemic LOAEL < reproductive
Iron							Data inadequate; essential nutrient
Lead	Rat	0.28	30 d	Reproductive	0.014	Hilderbrand et al. (1973)	
Manganese	Rat	–	100-224 d	Reproductive	16	Laskey et al. (1982)	
Mercury	Mink	0.25	3 mo	Death; devel.	0.15	Wobeser et al. (1976) in Opresko et al. (1994)	
Nickel	Rat	18	3 gens	Reproductive	–	Ambrose et al. (1976)	Based on first-generation effects
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	125 d	Behavioral	–	Rungby & Danscher (1984)	
Uranium	Mouse	–	~102 d	Reproductive	3.07	Paternain et al. (1989) in Opresko et al. (1994)	
Zinc	Mouse	96	9-12 mo	Systemic	–	Aughey et al. (1977)	Small data base

Table C-7. Derivation of NOAELs for indicator species.

Contaminant of concern	Surrogate species	NOAEL or LOAEL in surrogate species (milligrams per kilograms per day)	UF[a]	Body surface area conversion factor	Indicator species	Indicator species NOAEL (milligrams per kilograms per day)	Notes
Inorganics							
Aluminum	Mouse	19	1	0.33	Mink	6.4	
	Mouse	19	1	1.46	Shrew	27.7	
Barium	Rat	0.54	1	0.76	Mink	0.41	
	Rat	0.54	1	3.30	Shrew	1.78	
Chromium VI	Rat	3.5	1	0.76	Mink	2.7	
	Rat	3.5	1	3.30	Shrew	11.6	
Copper	Mink	12	1	1.00	Mink	12.0	
	Mink	12	1	4.35	Shrew	52.2	
Fluoride	Mink	5	2	1.00	Mink	2.5	UF from less serious LOAEL
	Rat	5	2	3.30	Shrew	8.3	UF from less serious LOAEL
Iron							Data inadequate; essential nutrient
Lead	Rat	0.014	4	0.76	Mink	0.003	UF for study duration
	Rat	0.014	4	3.30	Shrew	0.012	UF for study duration
Manganese	Rat	16	1	0.76	Mink	12.1	
	Rat	16	1	3.30	Shrew	52.9	
Mercury	Mink	0.15	8	1.00	Mink	0.019	UF for study duration
	Mink	0.15	8	4.35	Shrew	0.082	UF for study duration
Nickel	Rat	18	2	0.76	Mink	6.8	UF from LOAEL: NOAEL in 2nd and 3rd generations
	Rat	18	2	3.30	Shrew	29.7	UF from LOAEL: NOAEL in 2nd and 3rd generations
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	100	0.33	Mink	0.077	UF for LOAEL and nature of study
	Mouse	23	100	1.46	Shrew	0.33	UF for LOAEL and nature of study
Uranium	Mouse	3.07	1	0.33	Mink	1.01	
	Mouse	3.07	1	1.46	Shrew	4.48	
Zinc	Mouse	96	10	0.33	Mink	3.17	UF: LOAEL to NOAEL
	Mouse	96	10	1.46	Shrew	14.0	UF: LOAEL to NOAEL

a. UF = Uncertainty factor.

throughout the body of the animal. Dose conversion factors for the aquatic animal, sunfish, were calculated by assuming a steady-state concentration of radioactive material within the tissues of the animal and a uniform concentration of radioactive material in the water surrounding the sunfish.

The quantity of radioactivity ingested by the organisms of interest was estimated by assuming that the organisms live their entire lives in the contaminated region (the seepline area for the terrestrial organisms and Fourmile Branch and Upper Three Runs near the seepline for the sunfish). The shrews are assumed to drink seepline water at the maximum calculated concentrations of radioactivity and to eat food that lives in the soil/sediments near the seepline. The concentrations of radioactivity in these media were derived from the calculated seepline and Fourmile Branch or Upper Three Runs concentrations. The mink is assumed to drink Fourmile Branch or Upper Three Runs water and eat only shrews that live near the seepline.

The estimated amount of radioactivity that the terrestrial organisms would ingest, through all postulated pathways, was then multiplied by the DCFs to calculate an annual radiation dose to the organism. For the sunfish, the concentration of radioactivity in the surface water was multiplied by the submersion and uptake dose conversion factors to calculate an annual radiation dose. These radiation doses are compared to the limit of 1,000 millirad per day (365,000 millirad per year) (DOE Order 5400.5).

C.7 Hydrogeologic Data In Support of Fate and Transport Modeling

Hydrogeologic parameters required as input for the MEPAS fate and transport modeling were derived from a variety of SRS, State, and Federal documents published between 1987 and 1997. Most of the data were published as part of hydrogeologic framework and groundwater fate and transport studies conducted at several facilities in the General Separations Area (GSA), but were not specific to the F- and H-Area HLW Tank farms. Nevertheless, the data in the documents provided broad coverage and substantial detail for the groundwater flow regimes beneath both tank farms downgradient to the points of groundwater discharge at the seeplines along the major surface water bodies, namely, Fourmile Branch and Upper Three Runs Creek (UTRC). Table C-8, Table C-9, and Table C-10 summarize the data and sources that were used to support the MEPAS modeling at the H-Area and F-Area tank farms.

The hydrogeologic setting of the tank farms dictated that three, vertically stacked aquifer zones (Water Table, Barnwell-McBean, and Congaree) and two confining zones (Tan Clay and Green Clay) would be potentially impacted by a release of contaminants from the HLW tanks.

The selection of modeling parameters was complicated by the presence of a groundwater divide that lies in close proximity to the F-Area tank farm and which cuts through the H-Area tank farm. Because of this feature, tank groups in the H-Area were sorted to distinguish those beneath which shallow groundwater flowed toward Fourmile Branch (south) and those beneath which shallow groundwater flowed toward UTRC (north). A further complication was that groundwater flow in the Water Table and Barnwell-McBean aquifers near the groundwater divide has a strong downward component. Therefore, near the tank farms a substantial portion of the groundwater flow and contaminant transport was downward toward the Congaree aquifer. Once contaminants enter the Congaree aquifer their flow would be northward and their point of discharge would be UTRC, regardless of their shallow flow orientation.

C.7.1 AQUIFER FLOW DIRECTION, GRADIENT, AND DISTANCE

Because spatial heterogeneity exists across the GSA area the hydrogeologic parameters selected to support the MEPAS modeling at each tank-farm were dependent on the anticipated flowpath of the contaminant plumes. Representative flowpaths were, therefore, selected first so that

Table C-8. Hydrogeologic parameters for H-Area tank farm north of the groundwater divide.

Model layer	Thickness (ft) (Flach 1994)	Porosity %		Horizontal hydraulic conductivity (ft/day) (Flach 1994)	Vertical hydraulic conductivity (ft/day) (Flach 1994)	Hydraulic gradient[d]	Flow distance (ft)	Soil composition		Water budget (%) (WSRC 1994)
		Total[b]	Eff.[c]					Class[b]	Sand / Silt / Clay (%)[g]	
1- Water Table Aquifer	62.5	35	20	3.8	0.1Kh [b]	0.015	3720 [d,e]	Loamy sand	83 / 11 / 6	50
2 - Tan Clay Aquitard	10	40	10	N/A	8.5×10^{-4}	N/A	N/A	Silty clay	7 / 46 / 47	N/A
3 - Barnwell-McBean Aquifer	60	35	20	3.8	0.1Kh [b]	0.009	5820 [d,e]	Loamy sand	83 / 11 / 6	23
4 - Green Clay Aquitard	10	40	10	N/A	1.00×10^{-4}	N/A	N/A	Clay	20 / 20 / 60	N/A
5 - Congaree Aquifer	100 [a]	34	25	40	0.1Kh [b]	0.003	8390 [d,f]	Sand	92 / 5 / 3	27

N/A = Not applicable.
a. Source: (Geotrans 1987; 1993).
b. Total porosity, aquifer vertical conductivity, and soil classification is based on data presented by Aadland (1995).
c. Effective porosity is based on values by EPA (1989) and Aadland (1995).
d. Gradient and flow distance are from tank farm point of entry to point of exit for each aquifer layer (WSRC 1994, Figs. 11,12,13,14)
e. Assumes that the Water Table and Barnwell-McBean aquifers discharge at McQueen Branch.
f. Flow discharges at UTR Creek.
g. MEPAS guidance Table 2.1, PNL-10393, 1997.

Table C-9. Hydrogeologic parameters for H-Area tank farm south of the groundwater divide.

Model layer	Thickness (ft) (Flach 1994)	Porosity %		Horizontal hydraulic conductivity (ft/day) (Flach 1994)	Vertical hydraulic conductivity (ft/day) (Flach 1994)	Hydraulic gradient[d]	Flow distance (ft)	Soil composition		Water budget (%) (WSRC 1994)
		Total[b]	Eff.[c]					Class[b]	Sand / Silt / Clay (%)[f]	
1- Water Table Aquifer	62.5	35	20	4.5	0.1Kh [(b)]	0.014	4520 [(c)]	Loamy Sand	83 / 11 / 6	47
2 - Tan Clay Aquitard	10	40	10	N/A	9.0×10^{-4}	N/A	N/A	Silty Clay	7 / 46 / 47	N/A
3 - Barnwell-McBean Aquifer	65	35	20	4.5	0.1Kh [(b)]	0.011	4840 [(c)]	Loamy Sand	83 / 11 / 6	31
4 - Green Clay Aquitard	10	40	10	N/A	1.00×10^{-4}	N/A	N/A	Clay	20 / 20 / 60	N/A
5 - Congaree Aquifer	100 [(a)]	34	25	40	0.1Kh [(b)]	0.004	11400 [(d,e)]	Sand	92 / 5 / 3	22

N/A = Not applicable.

a. Geotrans (1987, 1993).

b. Total porosity, aquifer vertical conductivity, and soil classification is based on data presented by Aadland (1995).

c. Effective porosity is based on values by EPA (1989) and Aadland (1995).

d. Gradient and flow distance is from tank farm point of entry to point of exit for each aquifer layer (WSRC 1994, Figs. 11,12,13,14)

e. Flow discharges at UTR Creek.

f. MEPAS guidance Table 2.1, PNL-10393, 1997.

Table C-10. Hydrogeologic parameters for F-Area tank farm.[a]

Model layer	Thickness (ft) (Flach 1994)	Porosity %		Horizontal hydraulic conductivity (ft/day) (Flach 1994)	Vertical hydraulic conductivity (ft/day) (Flach 1994)	Hydraulic gradient[d]	Flow distance (ft)	Soil Composition		Water budget (%) (WSRC 1994)
		Total[b]	Eff.[c]					Class[b]	Sand / Silt / Clay (%)[g]	
1- Water Table Aquifer	40	35	20	20	0.1 Kh	0.006	6260	Loamy sand	83 / 11 / 6	31
2 - Tan Clay Aquitard	3	40	10	N/A	4.50×10^{-3}	N/A	N/A	Silty clay	7 / 46 / 47	N/A
3 - Barnwell-McBean Aquifer	60	35	20	16	0.1 Kh	0.004	6135	Loamy sand	83 / 11 / 6	65
4 - Green Clay Aquitard	5	40	10	N/A	1.25×10^{-5}	N/A	N/A	Clay	20 / 20 / 60	N/A
5 - Congaree Aquifer	100	34	25	38	0.1 Kh	0.006	5440	Sand	92 / 5 / 3	4

N/A = Not applicable

a. Total porosity, aquifer vertical conductivity, and soil classification is based on data presented by Aadland (1995).

b. Effective porosity is based on EPA 1989.

c. MEPAS guidance Table 2.1, PNL-10393, 1997

d. Information comes from Figures 20 and 26 of the referenced document.

the remaining parameters could be chosen on a more flowpath-specific basis from the site-wide data and modeling simulations provided in the literature. As indicated above, because of the vertical flow components and leaking confining layers, the contaminant plumes follow lateral flowpaths within three aquifer layers and vertical flowpath across two confining layers. Parameters required for the modeling were therefore selected for each of the five layers.

The gradient and distance are shown in Table C-8 for flow toward UTR Creek and Table C-9 for flow toward Fourmile Branch. The conceptual model in the reference only considered flow toward McQueen Branch, therefore, the direction, gradient, and distance for flow toward Fourmile Branch was graphically extrapolated from the referenced potentiometric surface figures.

The source of groundwater flow direction, gradient, and distance data for the F-Area tank farm was a document by GeoTrans (1993). Model-calibrated, potentiometric surface maps provided in the referenced document were the basis for the aquifer layers. The gradient and distance graphically extrapolated from the figures are shown in Table C-10 for flow toward Fourmile Branch. Groundwater flow in the Water Table and Barnwell-McBean aquifers below the F-Area tank farm was assumed to be south of the groundwater divide and only toward Fourmile Branch; flow in the Congaree aquifer is only toward UTRC.

The flow distance for both tank farms was taken as the distance in feet along a representative groundwater flow line beginning at the approximate center of the tank farm and extending downgradient to the natural point of discharge along a streambed (i.e., seepline). Because of the strong vertical gradients in the vicinity of the tank farms the flow distance for each aquifer layer began at the tank farm. The average gradient across the flow domain was then calculated as the change in elevation along the representative flowline divided by the distance along the flowline.

The flow direction in all confining layers was assumed to be vertical. Flow through the Tan Clay and Green Clay was only simulated as part of the partially saturated zone when flow through the underlying aquifer layers, Barnwell-McBean and Congaree, respectively, was modeled. As such, flow distance and saturated gradient, as used in the context of the saturated aquifer layers, were not required.

C.7.2 LAYER THICKNESS

The source of data for the upper aquifer and confining layers at the H-Area tanks was a document by Flach (1994). Conceptual models for the Water Table and Barnwell-McBean aquifer were used as the basis for the aquifer and confining layer thickness. The thickness of the Congaree aquifer was based on reports by GeoTrans (1987; 1993) that reported a GSA-wide thickness of 100 feet.

The sources of data for all the aquifer and confining layers at the F-Area tanks were two documents by GeoTrans (1987; 1993). These documents were used as the major data references during development of the tank closure methodology. GeoTrans (1987) provided average thicknesses for each of the aquifer and confining layers. These thicknesses were consistent with the model cell-specific thickness ranges used in subsequent work (GeoTrans 1993).

C.7.3 HYDRAULIC CONDUCTIVITY

The source of data hydraulic conductivities for the upper aquifer and confining layers at the H-Area tanks was a document by Flach (1994). The source of data for all the aquifer and confining layers at the F-Area tanks was a document by GeoTrans (1993).

The vertical conductivities for all aquifer layers were assumed to be 1/10 of the horizontal conductivities. This was based on the moderate stratification of the sand beds that make up the aquifer units as described by Aadland (1995). Walton (1987) suggests that a vertical to horizontal ratio of 1/10 is appropriate for sediments with medium stratification ratios. A vertical/horizontal ratio of 1/10 was also used in GeoTrans 1993.

C.7.4 SOIL COMPOSITION

Soil characteristics for each of the aquifer and confining units have been described by Aadland (1995) and are included in the various modeling reports used as data sources for this appendix (GeoTrans 1987, 1993; Flach 1994; Smits 1997). From these descriptions USDA soil classifications were assigned to the various layers with the intent of representing the dominant lithologic types within each layer. The soil classifications and relative percents of sand/silt/clay for each soil class were taken from Table 2.1 in the MEPAS guidance handbook (Buck et al. 1995). The hydraulic conductivity of the aquifer and confining layers were used as a relative discriminator in selecting the soil compositions. A slightly lower sand to silt/clay ratio composition was selected for the Water Table and Barnwell-McBean aquifers compared to the Congaree aquifer based on a seemingly higher incidence of mud layers and intra-aquifer confining beds in the upper aquifer layers (Aadland 1995).

C.7.5 WATER BUDGET

The water budget is used in modeling to track the distribution of water flowing into and out of the model domain. In calibrated steady-state models the total discharge from the system should closely equal the total recharge to the system. For three-dimensional models, the flow into and out of each aquifer layer can be tracked. Because contaminant mass is transported through aquifers predominantly by advective flow, the water budget can be used to approximate the distribution of contaminant mass within the system. Because MEPAS is a single-layer transport model in the saturated zone, previous three-dimensional modeling results were used to apportion the contaminant mass between the three aquifer layers based on the water budget distribution.

The source of data for the aquifer layers at the F- and H-Area tank farms was a document by Flach (1994). The water budget percentages shown in Tables 4, 5, and 6 of this calculation package correspond to the hydraulic conductivities selected.

C.7.6 TOTAL AND EFFECTIVE POROSITY

The basis for the selection of total porosity for aquifer and confining layers was a report by Aadland (1995). Average values for the UTR aquifer (Water Table and Barnwell-McBean) and for the Gordon aquifer (Congaree), 35.2 and 34.6 percent, respectively, were reported in the reference. Values for the Tan and Green Clays were taken from a large set of undifferentiated sandy clay and clayey sand samples reported in the reference (average 40-41 percent).

The effective porosity was based on the dominant lithology of the layer and was selected from default values used by the EPA for time of travel analyses (EPA 1989). The reference lists 20 percent for sand and gravel dominated lithologies (e.g., SW, SP, SM, SC soils) and 10 percent for silt/loam/clay loam lithologies. These values are also consistent with Aadland (1995) who reported a generally accepted, effective porosity range of 20 to 25 percent for the lower sand zone of the UTR aquifer (Barnwell-McBean) and 5 to 12 percent for clay/sandy clay to clayey sand lithologies in the GSA.

C.8 MEPAS ANALYSIS

C.8.1 GENERAL MEPAS METHODOLOGY

The MEPAS code is widely used and accepted throughout the DOE complex and has been presented to and accepted by regulatory agencies, such as the U.S. Environmental Protection Agency (EPA). Examples of its use by DOE include the EH-Environmental Survey Risk Assessment (DOE 1988) and the Complex-Wide Programmatic Waste Management EIS (DOE 1997) Impact Analysis. This code has been used to demonstrate environmental impacts in Resource Conservation and Recovery Act (RCRA)-Subpart X permit applications to various EPA regions.

The modeling results presented in this appendix are based on the amount of contaminants remaining in each tank in the F-Tank Farm and H-Tank Farm after DOE has completed bulk waste removal and additional cleaning as appropriate for the analyzed scenario. For purposes of modeling, the inventory is distributed over a square with area corresponding to that of the tank bottom. The results can generally be scaled to differing amounts of residual contaminants in a tank.

Because MEPAS was not specifically designed to model rainwater runoff efficiencies afforded by engineered caps or thick covers such as the grout fill, analyses were performed specifying infiltration rates that relate to the closure scenario. For example, previous studies by WSRC (1993) showed that an infiltration rate of 2 centimeters per year could be used to simulate an intact engineered cap. Since the grout fill would hinder infiltration but to a lesser degree than a grout and cap combination, an infiltration rate of 4 centimeters per year was chosen to represent conditions for the time interval when the grout remains intact. Similarly, an infiltration rate of 40 centimeters per year (average infiltration rate for SRS soils) would correspond to the infiltration rate occurring after grout and basemat failure (WSRC 1994a).

The impacts at the point of exposure from groups of tanks that are similar in location and structure were calculated. Separate MEPAS calculations were performed for each grouping of tanks. For each calculation, the source term data (in both concentration and total inventory) for the grouping distributed over a square with area equal to that of the tank bottoms in the grouping was entered. For instance, for the Type I tanks in F-Area, the source term for the MEPAS calculation would consist of the total inventory of the affected tanks and the concentration of contaminants in the grouping (i.e., the total inventory of the affected tanks divided by the total solids in these tanks) distributed over a square with area equal to the area of the eight Type I tanks.

To account for overlapping of the contaminant plumes from the separate groupings of tanks within a given tank farm, the calculations were performed assumed that the tank groupings in the same tank farm with similar flow paths were placed along the same centerline. For example, in F-Area, all the tank groupings were modeled as though they had a similar centerline; in H-Area, the tank groups that included tanks 21-24, 29-39, and 35-37 were assumed to lie on a common centerline while the balance of the tank groupings in H-Area were assumed to lie on a common centerline. The centerline concentrations were summed from each plume at the point of exposure to ensure that the highest concentration is reported. Therefore, although the plumes from the groupings may not overlap entirely, this calculation methodology provides an upper estimate for the projected impacts.

MEPAS runs were performed for early (before structural failure) and late (after structural failure) conditions for the tanks. As previously discussed, a failure time was assumed based on the anticipated performance of the tank fill material and concrete basemat. Failure would be catastrophic: that is, the tank fill and basemat would fail simultaneously. For modeling purposes, failure was simulated by increasing the infiltration rate to 40 cm/yr and increasing the hydraulic conductivity of the concrete basemat to that of sand. Because radionuclide and chemical contaminants could leach through imperfections in the concrete before catastrophic failure occurs, the original source term was reduced by an amount equal to the quantities released to the Water Table Aquifer during the prefailure period. In addition, radionuclides continually decay, further diminishing the source term. Thus, for late runs, in addition to changing the infiltration rates and hydraulic conductivities, the source term concentrations were adjusted to reflect losses and decay occurring before failure.

In the groundwater transport pathway, infiltration causes leaching of contaminants from the tank through distinct media below the waste unit down to the groundwater in the three uppermost aquifers. To model the movement of the contaminants from the waste unit to the aquifers, MEPAS requires identification of the distinct strata that the contaminants encounter.

To model the tanks in F-Tank Farm, the residual solids remaining at the bottom of the tank were considered to be the contaminated zone. Between the contaminated zone and the Water Table Aquifer, two discernible layers were identified: the concrete basemat of the tank and the unsaturated (vadose) zone. Parameters describing the concrete layer were defined for both pre- and post-failure conditions because values for such parameters as porosity, field capacity, and hydraulic conductivity change with degradation state. Flow through the vadose zone is complicated in that movement varies with soil-moisture content and wetting and drying conditions. Therefore, soil parameters values (e.g., density, porosity) for the Water Table Aquifer were conservatively used to describe the unsaturated zone as described in Section III of this calculation package.

Once contaminants reach the Water Table Aquifer, they may follow one of three possible routes: (1) they will be transported through the water table and outcrop at the respective seepline; (2) they will leak from the Water Table Aquifer through the underlying Tan Clay layer into the Barnwell-McBean Aquifer which also outcrops at the seepline; or (3) they will continue downward from the Barnwell-McBean Aquifer though the Green Clay layer, into the Congaree, and appear in Upper Three Runs.

In MEPAS, only one of these groundwater paths may be analyzed at a time; thus, three separate runs were performed both for early and late conditions. In MEPAS, the aquifer being analyzed in a particular computer run is considered to be the saturated zone; all the layers between the contaminated zone and this saturated zone are recognized by the code as partially saturated zones. For example, in modeling contaminant transport through the Barnwell-McBean Aquifer, the Barnwell-McBean is identified as the saturated zone while the concrete basemat, vadose zone, Water Table Aquifer, and Tan Clay layer are all modeled as partially saturated zones. The parameters used for modeling the various strata in the model are discussed in Section III of this calculation package.

For each of the eight layers modeled (contaminated zone, concrete basemat, vadose zone, Water Table Aquifer, Tan Clay layer, Barnwell-McBean Aquifer, Green Clay layer, and Congaree Aquifer), soil-water distribution coefficients, Kd values, were selected for each radionuclide and chemical. Because distribution coefficients are a chemical property, the Kd values were not changed for degraded or failed materials. The identification and derivation of the Kd values are described in further detail below.

As contaminants are transported from the contaminated zone to the seepline, they are dispersed longitudinally (along the streamline of fluid flow), vertically, and transversely (out sideways) by the transporting medium. MEPAS incorporates longitudinal dispersivity of contaminants moving downward through the partially saturated zone layers (i.e., concrete basemat and vadose zone) into concentration calculations. In the saturated zone, concentration calculations include the three-dimensional dispersion along the length of travel. Dispersion distances were calculated through each of the layers encountered by the contaminants. As expected, dispersion increases with longer travel distances.

Groundwater concentrations and doses due to ingestion of water were calculated at hypothetical wells at 1 meter and 100 meters downgradient from the edge of the respective Tank Farm, at the seeplines of Fourmile Branch and Upper Three Runs, and in Fourmile Branch and Upper Three Runs. No human receptors would be exposed to the groundwater pathway at the 1-meter and 100-meter locations, but the calculations were performed for information purposes.

Impacts to adult and child residential receptors were evaluated at a point 100 meters downstream of the groundwater outcropping in Fourmile Branch and Upper Three Runs. The concentrations of contaminants in Fourmile Branch and Upper Three Runs were also calculated. Based on the dimensions, flow rate, and stream velocity of the surface streams, MEPAS accounts for the mixing of the contaminant-containing water from the aquifer with stream water and other groundwater contributions. For both adult and child residents, ingestion rates were based on site-specific parameters. Parameters and associated assumptions used in calculating human impacts are presented in Table C-3.

In addition to the tank contents, MEPAS runs were performed to determine the impacts of residual contaminants contained in ancillary equipment and piping. The piping and other outside equipment were assumed to be filled with whatever fill material was used for the given closure scenario. For modeling in MEPAS, the ancillary equipment was considered to be the contaminated zone, and the entire distance between the contaminated zone and the upper saturated zone was characterized as one layer of typical SRS soil. Therefore, no credit was taken for the additional reduction of leachate afforded by the tank structure in its closed configuration, thus, providing conservative results.

C.8.2 DETERMINATION OF DISTANCES FOR H-AREA

Distances were based on tank locations. Local flow directions were taken as approximately west for tanks south of the groundwater divide (Tanks 21-24, 29-32, and 35-37) and NE for tanks north of the divide (Tanks 9-12, 13-16, 48-51, and 38-43). For each tank group a centroid was located and the distance (along the flow direction) to the nearest fenceline was measured. These distances were added to 1m to obtain the distance from the tank group to the 1 meter well. The 100 meter well distances were obtained by adding 99m to the 1m well distances. Distances to the seepline were based on the generic distance from the tank farm to the seepline, as shown in Tables C-8 and C-9. The seepline distances were assumed to be from the center of each site (approximated by the centroids of the y or u group, north of the divide and by the centroid of the w group south of the divide). Distances from the other tank groups (Tanks 35-37 and 21-24 south of the divide, and Tanks 9-12 and 48-51 north of the divide) to these central groups were measured and distances to seeplines incremented accordingly. Distances to all H-Area receptors from all tank groups listed in Table C-11 below.

C.8.3 DETERMINATION OF DISTANCES FOR F-AREA

Distances to receptor locations were consistent with those previously used in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996). Distances were estimated at that time from Fig. 2-3 of the referenced document with the general flow direction being SW. Distances to the receptors are listed below in Table C-12.

Table C-11. Distance from H-Area tank groups to receptor locations.

	H-Area Tank Group						
	9-12	13-16	21-24	29-32	48-51	38-43	35-37
Distance to 1-m well (ft):	265.7	646.3	767.7	626.6	610.2	206.7	206.7
Distance to 100-m well (ft):	590.5	971.1	1092.5	951.4	935.0	531.5	531.5
Distance to water table aquifer outcrop (ft):	3330	3720	4828	4520	4147	3720	4130
Distance to Barnwell-McBean aquifer outcrop (ft):	5430	5820	5148	4840	6247	5820	4450
Distance to Congaree aquifer outcrop (ft):	8000	8390	11708	11400	8817	8390	11010

Table C-12. Distance from F-Area tank groups to receptor locations.

	F-Area Tank Group		
	1-8	25-28, 33, 34, 44-47	18, 19
Distance to 1-m well (ft):	761.1	304.8	465.9
Distance to 100-m well (ft):	1086	629.9	790.7
Distance to water table aquifer outcrop (ft):	6529	6102	6266
Distance to Barnwell-McBean aquifer outcrop (ft):	6398	5971	6135
Distance to Congaree aquifer outcrop (ft):	5807	5282	5446

C.8.4 DISTRIBUTION COEFFICIENTS (K_D)

The distribution coefficient, K_d, is defined for two-phased systems as the ratio of the constituent concentration in the solid (soil) to the concentration of the constituent in the interstitial liquid (leachate). For a given element, this parameter may vary over several orders of magnitude depending on such conditions as soil pH and clay content. Experiments have been performed (Bradbury and Sarott 1995) that have demonstrated that pH and oxidizing or reducing environments tend to affect the Kd values markedly. Because this parameter is highly sensitive in relation to breakthrough and peak times (but not necessarily peak concentration), careful selection is imperative to achieve reasonable results. For this reason, several literature sources were used to assure the most current and appropriate Kd values were selected for the example calculation.

For modeling purposes, four distinct strata were used for groundwater contaminant transport for all four closure scenarios (except for ancillary equipment and piping, which used only three, see below). These four strata are identified as (1) contaminated zone (CZ), (2) first partially saturated zone or concrete basemat, (3) second partially saturated zone or vadose zone, and (4) saturated zone. Distribution coefficients for each of these zones differ depending on the closure scenario-specific chemical and physical characteristics.

The models for ancillary equipment/piping and tanks were similar, except the piping model was assumed to have only one partially saturated zone. For this model, the concrete basemat was conservatively assumed to have no effect on reducing the transport rate of contaminants to the saturated zone. The thickness of the vadose zone was increased depending on the tank grouping to reflect the higher elevation of the piping in relation to the saturated zone.

Distribution coefficients for each strata under various conditions are listed in Table C-13. For the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns III, II, I, and I of Table C-13, respectively.

Similarly, for the piping model, K_d values for the CZ, partially saturated zone, and the saturated zone are listed in Columns III, I, and I of Table C-13, respectively.

Table C-13. Radionuclide and chemical groundwater distribution coefficients, cubic centimeters per gram.

	I		II		III	
	SRS Soil	Ref.	Reducing[j] Concrete	Ref.	Reducing[j] CZ	Ref.
Se-79[a]	5	b	0.1	i	0.1	i
Sr-90	10	b	1	i	1	i
Tc-99	0.36	b	1,000	i	1,000	i
Sn-126	130	b	1,000	i	1,000	i
Cs-135, 137	100	b	2	i	2	i
Sm-151	800[d]	c	5,000[m]	i	5,000[m]	i
Eu-154[l]	800[d]	c	5,000[m]	i	5,000[m]	i
Np-237	10	b	5,000	b	5,000	i
Pu-238, 239	100	b	NA	f	NA	f
Iron	15	g	1.5	k	1.5	k
Manganese	16.5	g	100	i	100	i
Nickel	300	b	100	i	100	i
Aluminum	35,300	g	353	k	353	k
Chromium VI[h]	16.8	g	7.9	k	7.9	k
Mercury	322	g	5,280	k	5,280	k
Silver	0.4	g	1	i	1	i
Copper	41.9	g	33.6	k	33.6	k
Zirconium	50	g	5,000	i	5,000	i
Nitrate	0	g	0	k	0	k
Phosphate	50	g	5	k	5	k
Chloride[e]	0	g	20	i	20	i
Fluoride	0	g	0	k	0	k
Lead	234	g	NA	n	NA	n

a. Values also used for chemical contaminants.
b. E-Area RPA (WSRC 1994a), Table 3.3-2, page 3-69.
c. Yu et al. (1993), Table 32.1, page 105.
d. Value used for loam from c.
e. Modeled as chlorate.
f. Solubility limit of 4.4×10^{-13} mols/liter used, WSRC (1994a), page C-32.
g. MEPAS default for soil <10% clay and pH from 5-9.
h. For conservatism, all chromium modeled as VI valence.
i. Bradbury and Sarott (1995), Table 4, Region 1, page 42.
j. Reducing environment assumed for grout fill.
k.

k. MEPAS default used for soil >30% clay and pH >9.
l. Characteristics similar to Sm per Table 3, page 16 of Bradbury and Sarott (1995).
m. Characteristics similar to Am per Table 3, page 16 of Bradbury and Sarott (1995).
n. Lead is outside of reducing environments for all cases. Therefore, value from Column I is used for all cases.

The solubility-limited values for k_d for plutonium and uranium were calculated from the equation K_d = conc-soil/conc-gw = source conc./solubility limit. The molecular weight of uranium was taken as 238, and the molecular weight of plutonium was taken as 239 when converting moles to grams. Plutonium and uranium k_d values are listed in Table C-14.

C.8.5 CONTAMINANTS AND SOURCE TERMS

The beta-gamma contaminants analyzed in detail for long-term impacts are the same ones previously shown to be the important dose contributors in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996). Strontium-90 and isotopes of cesium were also analyzed because of the presence of submerged tanks in H-Area and possible importance of these nuclides at short distances (e.g., 1-m well). Uranium isotopes were not included as alpha-emitters because they have a separate (from α-emitters) drinking water criterion. The nonradiological contaminants were the same as those analyzed previously. The source terms are given in Tables C-15 through C-17.

C.8.6 SURFACE WATER FLOW

The flow rate for Fourmile Branch was taken from USGS Water Resources for Water Year 1993 for the location denoted as Savannah River Basin, 02197340 Site No. 6 at Savannah River Site, SC. Its location is noted as on Fourmile Branch at upstream side of bridge on SRS Road C, and 0.7 mi. southeast of F-Area. The annual mean flow for the water years 1973-1993 was given as 12.4 cfs.

Table C-14. Values of k_d calculated for uranium and plutonium based on solubility limits.

Tank Group		k_d value for uranium	k_d value for plutonium
F-Area	1-8	1.50×10^{9}	1.55×10^{9}
	25-28, 33, 34, 44-47	6.43×10^{8}	2.54×10^{9}
	18, 19	3.55×10^{8}	8.41×10^{8}
H-Area	9-12	4.35×10^{8}	1.91×10^{9}
	13-16	2.50×10^{8}	1.50×10^{9}
	21-24	4.06×10^{6}	8.34×10^{7}
	29-32	1.41×10^{8}	1.62×10^{9}
	48-51	1.86×10^{8}	6.55×10^{8}
	38-43	1.03×10^{8}	3.09×10^{9}
	35-37	1.28×10^{8}	2.47×10^{9}

Table C-15. Total inventory and concentration for beta-gamma emitting radionuclides

Total inventory for beta-gamma emitters						
Tank group	Se-79 (Ci)	Tc-99 (Ci)	C-14 (Ci)	I-129 (Ci)	Sr-90 (Ci)	Cs-137 (Ci)
1-8	7.65×10^{-1}	178	7.44×10^{-4}	6.30×10^{-5}	3.33×10^{4}	2.33×10^{3}
25-28, 33, 34, 44-47	3.84×10^{-1}	89.6	2.66×10^{-2}	3.16×10^{-5}	2.83×10^{4}	1.92×10^{3}
18, 19	1.11×10^{-2}	2.59	2.28×10^{-3}	9.13×10^{-7}	5.76×10^{2}	3.99×10^{1}
9-12	3.55×10^{-1}	82.4	5.01×10^{-4}	2.62×10^{-5}	1.63×10^{4}	1.02×10^{3}
13-16	3.03×10^{-1}	69.7	3.44×10^{-4}	2.03×10^{-5}	1.51×10^{4}	8.94×10^{2}
21-24	4.10×10^{-2}	9.37	1.24×10^{-6}	2.40×10^{-6}	3.41×10^{3}	1.90×10^{2}
29-32	1.77×10^{-1}	40.6	2.97×10^{-4}	1.14×10^{-5}	1.04×10^{4}	5.92×10^{2}
48-51	4.73×10^{-1}	109	8.04×10^{-4}	3.24×10^{-5}	2.31×10^{4}	1.38×10^{3}
38-43	2.04×10^{-1}	46.7	3.94×10^{-4}	1.23×10^{-5}	1.70×10^{4}	9.21×10^{2}
35-37	1.52×10^{-1}	35.0	2.55×10^{-4}	9.65×10^{-6}	1.00×10^{4}	5.62×10^{2}
Concentration of beta-gamma emitters						
	Se-79 (Ci/g)	Tc-99 (Ci/g)	C-14 (Ci/g)	I-129 (Ci/g)	Sr-90 (Ci/g)	Cs-137(Ci/g)
1-8	1.08×10^{-6}	1.87×10^{-5}	1.05×10^{-9}	8.91×10^{-11}	4.71×10^{-2}	3.30×10^{-3}
25-28, 33, 34, 44-47	5.29×10^{-8}	9.16×10^{-7}	3.66×10^{-9}	4.36×10^{-12}	3.91×10^{-3}	2.65×10^{-4}
18, 19	6.27×10^{-9}	1.09×10^{-7}	1.29×10^{-9}	5.16×10^{-13}	3.26×10^{-4}	2.26×10^{-5}
9-12	1.00×10^{-6}	1.72×10^{-5}	1.42×10^{-9}	7.40×10^{-11}	4.61×10^{-2}	2.89×10^{-3}
13-16	8.56×10^{-7}	1.46×10^{-5}	9.72×10^{-10}	5.73×10^{-11}	4.27×10^{-2}	2.53×10^{-3}
21-24	3.57×10^{-8}	6.04×10^{-7}	1.08×10^{-12}	2.09×10^{-12}	2.97×10^{-3}	1.66×10^{-4}
29-32	4.99×10^{-7}	8.50×10^{-6}	8.39×10^{-10}	3.23×10^{-11}	2.93×10^{-2}	1.67×10^{-3}
48-51	4.11×10^{-7}	7.03×10^{-6}	7.00×10^{-10}	2.82×10^{-11}	2.01×10^{-2}	1.20×10^{-3}
38-43	3.84×10^{-7}	6.52×10^{-6}	7.43×10^{-10}	2.32×10^{-11}	3.20×10^{-2}	1.74×10^{-3}
35-37	5.74×10^{-7}	9.76×10^{-6}	9.63×10^{-10}	3.64×10^{-11}	3.78×10^{-2}	2.12×10^{-3}

Table C-16. Total inventory and concentration for alpha-emitting radionuclides.

Total inventory for alpha emitters											
Tank group	Pu-238 (Ci)	Pu-239 (Ci)	Pu-240 (Ci)	Pu-241 (Ci)	Pu-242 (Ci)	Am-241 + Ingrown Am-241[(a)] (Ci)	Am-242m (Ci)	Th-232 (Ci)	Np-237 (Ci)	Cm-244 (Ci)	Cm-245 (Ci)
1-8	0.00	6.71	1.61	4.26	9.63×10^{-4}	1.14×10^{2}	1.29×10^{-1}	0.00	4.36×10^{-2}	2.59×10^{-2}	2.17×10^{-8}
25-28, 33, 34, 44-47	0.00	1.13×10^{2}	2.53×10^{1}	4.95×10^{2}	5.20×10^{-3}	4.38×10^{2}	4.76×10^{-2}	0.00	1.72×10^{-2}	2.94×10^{-2}	1.09×10^{-8}
18, 19	0.00	9.03	2.21	5.22×10^{1}	3.36×10^{-3}	1.17×10^{2}	0.00	0.00	0.00	4.87×10^{-4}	3.18×10^{-10}
9-12	1.51×10^{2}	3.39	1.54	2.65×10^{1}	2.33×10^{-3}	1.01×10^{2}	4.89×10^{-2}	6.44×10^{-4}	2.84×10^{-2}	8.12×10^{-2}	7.85×10^{-6}
13-16	6.41×10^{1}	2.90	1.18	5.38	6.36×10^{-4}	5.15×10^{1}	3.56×10^{-2}	1.48×10^{-3}	1.87×10^{-2}	9.85×10^{-2}	1.18×10^{-5}
21-24	1.07×10^{2}	1.95×10^{-1}	1.27×10^{-1}	7.65	2.22×10^{-4}	1.18×10^{1}	2.94×10^{-3}	7.83×10^{-8}	4.84×10^{-3}	3.70×10^{-2}	2.46×10^{-6}
29-32	1.96×10^{2}	2.52	1.57	5.74×10^{1}	2.75×10^{-3}	1.03×10^{2}	1.96×10^{-2}	1.26×10^{-4}	9.87×10^{-3}	8.44×10^{-2}	7.85×10^{-6}
48-51	1.18×10^{2}	4.01	1.66	9.04	1.10×10^{-3}	8.33×10^{1}	5.61×10^{-2}	5.45×10^{-4}	4.05×10^{-2}	1.43×10^{-1}	1.65×10^{-5}
38-43	7.82×10^{2}	6.43	4.13	3.09×10^{2}	9.64×10^{-3}	3.25×10^{2}	2.41×10^{-2}	4.19×10^{-5}	1.01×10^{-2}	2.50×10^{2}	1.73×10^{-2}
35-37	2.62×10^{2}	2.71	1.86	8.97×10^{1}	3.77×10^{-3}	1.36×10^{2}	1.66×10^{-2}	8.39×10^{-5}	6.86×10^{-3}	9.11×10^{-2}	7.31×10^{-6}
Concentration of alpha emitters											
	Pu-238 (Ci/g)	Pu-239 (Ci/g)	Pu-240 (Ci/g)	Pu-241 (Ci/g)	Pu-242 (Ci/g)	Am-241 + Ingrown Am-241[(a)] (Ci)	Am-242m (Ci/g)	Th-232 (Ci/g)	Np-237 (Ci/g)	Cm-244 (Ci/g)	Cm-245 (Ci/g)
1-8	0.00	9.48×10^{-6}	2.27×10^{-6}	6.03×10^{-6}	1.36×10^{-9}	1.62×10^{-4}	1.82×10^{-7}	0.00	6.16×10^{-8}	3.66×10^{-8}	3.07×10^{-14}
25-28, 33, 34, 44-47	0.00	1.56×10^{-5}	3.49×10^{-6}	6.83×10^{-5}	7.18×10^{-10}	6.04×10^{-5}	6.56×10^{-9}	0.00	2.37×10^{-9}	4.05×10^{-9}	1.51×10^{-15}
18, 19	0.00	5.11×10^{-6}	1.25×10^{-6}	2.95×10^{-5}	1.90×10^{-9}	6.62×10^{-5}	0.00	0.00	0.00	2.76×10^{-10}	1.80×10^{-16}
9-12	4.26×10^{-4}	9.58×10^{-6}	4.35×10^{-6}	7.48×10^{-5}	6.60×10^{-9}	2.86×10^{-4}	1.38×10^{-7}	1.82×10^{-9}	8.03×10^{-8}	2.30×10^{-7}	2.22×10^{-11}
13-16	1.81×10^{-4}	8.21×10^{-6}	3.32×10^{-6}	1.52×10^{-5}	1.80×10^{-9}	1.46×10^{-4}	1.01×10^{-7}	4.18×10^{-9}	5.28×10^{-8}	2.79×10^{-7}	3.34×10^{-11}
21-24	9.34×10^{-5}	1.69×10^{-7}	1.11×10^{-7}	6.65×10^{-6}	1.93×10^{-10}	1.03×10^{-5}	2.56×10^{-9}	6.82×10^{-14}	4.21×10^{-9}	3.22×10^{-8}	2.14×10^{-12}
29-32	5.53×10^{-4}	7.13×10^{-6}	4.43×10^{-6}	1.62×10^{-4}	7.78×10^{-9}	2.90×10^{-4}	5.53×10^{-8}	3.56×10^{-10}	2.79×10^{-8}	2.39×10^{-7}	2.22×10^{-11}
48-51	1.03×10^{-4}	3.49×10^{-6}	1.44×10^{-6}	7.86×10^{-6}	9.58×10^{-10}	7.25×10^{-5}	4.88×10^{-8}	4.75×10^{-10}	3.53×10^{-8}	1.25×10^{-7}	1.43×10^{-11}
38-43	1.47×10^{-3}	1.21×10^{-5}	7.78×10^{-6}	5.83×10^{-4}	1.82×10^{-8}	6.13×10^{-4}	4.54×10^{-8}	7.91×10^{-11}	1.90×10^{-8}	4.71×10^{-4}	3.27×10^{-8}
35-37	9.87×10^{-4}	1.02×10^{-5}	7.00×10^{-6}	3.38×10^{-4}	1.42×10^{-8}	5.11×10^{-4}	6.25×10^{-8}	3.16×10^{-10}	2.59×10^{-8}	3.44×10^{-7}	2.76×10^{-11}

a. Am-241 is present due to direct production in the irradiation and separation process and also due to radioactive decay of Pu-241.

Table C-17. Total inventory and concentration for nonradiological constituents.

Total Inventory for Nonradiological Constituents

Tank Group	Ag (g)	Al(g)	Ba (g)	F (g)	Cr (g)	Cu (g)	Fe (g)	Hg (g)	NO_3 (g)	Mn (g)	Ni (g)	Pb (g)	U (g)	Zn (g)
1-8	1.04×10^{3}	2.90×10^{4}	1.65×10^{3}	5.14×10^{2}	1.46×10^{3}	6.87×10^{2}	1.33×10^{5}	7.23×10^{2}	7.52×10^{3}	6.61×10^{4}	4.15×10^{4}	1.84×10^{3}	7.58×10^{4}	1.25×10^{3}
25-28, 33, 34, 44-47	2.00×10^{4}	6.82×10^{5}	1.21×10^{4}	1.06×10^{4}	1.44×10^{4}	1.01×10^{4}	1.63×10^{6}	4.31×10^{3}	1.09×10^{5}	1.52×10^{5}	1.35×10^{4}	1.92×10^{4}	3.33×10^{5}	2.00×10^{4}
18, 19	6.01×10^{3}	1.08×10^{5}	3.50×10^{3}	3.17×10^{3}	4.23×10^{3}	3.01×10^{3}	4.85×10^{5}	1.23×10^{3}	3.25×10^{4}	2.25×10^{4}	0	5.68×10^{3}	4.48×10^{4}	5.99×10^{3}
9-12	3.05×10^{2}	2.87×10^{4}	5.75×10^{2}	3.71×10^{2}	6.07×10^{2}	2.57×10^{2}	5.10×10^{4}	6.30×10^{3}	7.18×10^{3}	4.62×10^{4}	8.94×10^{3}	5.98×10^{2}	1.10×10^{4}	4.11×10^{2}
13-16	3.80×10^{1}	4.36×10^{4}	5.28×10^{2}	2.56×10^{2}	4.97×10^{2}	1.50×10^{2}	5.13×10^{4}	8.69×10^{3}	6.58×10^{3}	2.31×10^{4}	4.11×10^{3}	7.64×10^{2}	6.31×10^{3}	1.46×10^{2}
21-24	0	3.95×10^{3}	5.35×10^{2}	9.75×10^{-1}	2.35×10^{3}	1.07×10^{2}	3.27×10^{5}	8.15×10^{3}	1.27×10^{4}	1.52×10^{2}	0	1.97×10^{3}	3.33×10^{2}	7.06×10^{3}
29-32	4.74×10^{1}	3.10×10^{4}	6.07×10^{2}	3.09×10^{2}	5.64×10^{2}	1.81×10^{2}	7.78×10^{4}	1.22×10^{4}	7.89×10^{3}	1.20×10^{4}	2.24×10^{3}	1.26×10^{3}	3.55×10^{3}	1.44×10^{2}
48-51	2.05×10^{2}	8.74×10^{4}	1.94×10^{3}	4.62×10^{2}	1.49×10^{3}	5.14×10^{2}	2.88×10^{5}	2.96×10^{4}	1.36×10^{4}	4.49×10^{4}	7.98×10^{3}	5.28×10^{3}	1.52×10^{4}	3.62×10^{2}
38-43	2.76×10^{2}	3.54×10^{4}	9.38×10^{2}	2.90×10^{2}	7.53×10^{2}	3.15×10^{2}	1.50×10^{5}	1.37×10^{4}	6.71×10^{3}	7.91×10^{3}	6.14×10^{2}	2.69×10^{3}	3.91×10^{3}	3.22×10^{2}
35-37	3.16×10^{1}	2.33×10^{4}	4.65×10^{2}	2.93×10^{2}	4.67×10^{2}	1.46×10^{2}	5.53×10^{4}	1.03×10^{4}	7.29×10^{3}	8.75×10^{3}	2.12×10^{3}	8.31×10^{2}	2.42×10^{3}	1.22×10^{2}

Concentration of Nonradiological Constituents

Tank Group	Ag (g/g)	Al(g/g)	Ba (g/g)	F (g/g)	Cr (g/g)	Cu (g/g)	Fe (g/g)	Hg (g/g)	NO_3 (g/g)	Mn (g/g)	Ni (g/g)	Pb (g/g)	U (g/g)	Zn (g/g)
1-8	1.47×10^{-3}	4.09×10^{-2}	2.33×10^{-3}	7.30×10^{-4}	2.06×10^{-3}	9.70×10^{-4}	1.88×10^{-1}	1.02×10^{-3}	1.06×10^{-2}	9.35×10^{-2}	5.87×10^{-2}	2.60×10^{-3}	1.07×10^{-1}	1.77×10^{-3}
25-28, 33, 34, 44-47	2.76×10^{-3}	9.41×10^{-2}	1.66×10^{-3}	1.46×10^{-3}	1.98×10^{-3}	1.39×10^{-3}	2.26×10^{-1}	5.90×10^{-4}	1.51×10^{-2}	2.10×10^{-2}	1.86×10^{-3}	2.66×10^{-3}	4.59×10^{-2}	2.76×10^{-3}
18, 19	3.40×10^{-3}	6.09×10^{-2}	1.98×10^{-3}	1.79×10^{-3}	2.39×10^{-3}	1.70×10^{-3}	2.74×10^{-1}	7.00×10^{-4}	1.84×10^{-2}	1.27×10^{-2}	0	3.21×10^{-3}	2.54×10^{-2}	3.39×10^{-3}
9-12	8.60×10^{-4}	8.12×10^{-2}	1.63×10^{-3}	1.05×10^{-3}	1.72×10^{-3}	7.30×10^{-4}	1.44×10^{-1}	1.78×10^{-2}	2.03×10^{-2}	1.31×10^{-1}	2.53×10^{-2}	1.69×10^{-3}	3.11×10^{-2}	1.16×10^{-3}
13-16	1.10×10^{-4}	1.23×10^{-1}	1.49×10^{-3}	7.20×10^{-4}	1.41×10^{-3}	4.20×10^{-4}	1.45×10^{-1}	2.46×10^{-2}	1.86×10^{-2}	6.53×10^{-2}	1.16×10^{-2}	2.16×10^{-3}	1.78×10^{-2}	4.10×10^{-4}
21-24	0	3.44×10^{-3}	4.70×10^{-4}	8.50×10^{-7}	2.05×10^{-3}	9.40×10^{-5}	2.85×10^{-1}	7.09×10^{-3}	1.11×10^{-2}	1.30×10^{-4}	0	1.71×10^{-3}	2.90×10^{-4}	6.15×10^{-3}
29-32	1.30×10^{-4}	8.77×10^{-2}	1.72×10^{-3}	8.70×10^{-4}	1.59×10^{-3}	5.10×10^{-4}	2.20×10^{-1}	3.45×10^{-2}	2.23×10^{-2}	3.39×10^{-2}	6.34×10^{-3}	3.57×10^{-3}	1.01×10^{-2}	4.10×10^{-4}
48-51	1.80×10^{-4}	7.60×10^{-2}	1.69×10^{-3}	4.00×10^{-4}	1.29×10^{-3}	4.50×10^{-4}	2.50×10^{-1}	2.57×10^{-2}	1.19×10^{-2}	3.91×10^{-2}	6.95×10^{-3}	4.59×10^{-3}	1.33×10^{-2}	3.20×10^{-4}
38-43	5.20×10^{-4}	6.68×10^{-2}	1.77×10^{-3}	5.50×10^{-4}	1.42×10^{-3}	5.90×10^{-4}	2.83×10^{-1}	2.59×10^{-2}	1.27×10^{-2}	1.49×10^{-2}	1.16×10^{-3}	5.07×10^{-3}	7.38×10^{-3}	6.10×10^{-4}
35-37	1.20×10^{-4}	8.80×10^{-2}	1.75×10^{-3}	1.11×10^{-3}	1.76×10^{-3}	5.50×10^{-4}	2.09×10^{-1}	3.89×10^{-2}	2.75×10^{-2}	3.30×10^{-2}	8.01×10^{-3}	3.13×10^{-3}	9.12×10^{-3}	4.60×10^{-4}

Upper Three Runs flow rate was taken from a 1997 Environmental Information Document (WSRC-TR-97-0223). Location 2, above Road C, is just downstream of F-Area. The mean flow rate for 1974-1995 was 211 cfs, and this value was therefore used in the analysis.

MEPAS parameters for surface water flow velocity, width, depth and downstream distance were chosen so that the resulting (turbulent) concentrations were for fully mixed conditions. For modeling purposes, all aquifers discharging contaminants from the tank groups south of the groundwater divide in H-Area were modeled as discharging to Fourmile Branch. In reality, the groundwater flow from the Congaree aquifer in this area turns and discharges to Upper Three Runs. However, the assumption of discharge to Fourmile Branch results in conservative estimates of seepline and surface water concentrations because Fourmile Branch is closer to these tanks and the surface water flow in Fourmile is less, thus providing less dilution for contaminants that reach the stream.

C.8.7 INFILTRATION RATES

As discussed earlier, the performance of the fill material in the tanks is reflected by the infiltration rate assigned to the medium. Table C-18 shows infiltration rates for for pre-failure and post-failure conditions. The post-failure infiltration rate is set to be equal to the infiltration rate of SRS soil.,

C.8.8 PIPES AND ANCILLARY EQUIPMENT

Contaminants remaining in the tank piping and ancillary equipment were simulated by assuming the same concentration as that in the tanks (for each group), with 20 percent of the tank group inventory. Infiltration rates were assumed to be the same as the tank, but no concrete basemat was assumed to be present for piping. However, pump tanks, diversion boxes, etc. may have basdemats when available basemats are included. The height of the pipes above the tank basemat is a function of the tank heights. The height of the pipes above the basemat was taken as 26, 31, 37 and 46 feet for tank types I through IV, respectively.

C.8.9 VADOSE DEPTH AND SUBMERGED TANKS

All tank groups were analyzed similarly except for groups containing Tanks 9-12 and 13-16. The "vadose zone" for Tanks 13-16 group is negative but less than the basemat thickness. This means that the basemat is in the water table, but that the source is above the aquifer. This case is, therefore, similar to most of the other groups except that the only "vadose zone" is the basemat (of thickness 3.75-1.8475 ft). The portion of the basemat within the aquifer was conservatively modelled as part of the aquifer (i.e., assumed to allow normal aquifer flow through).

The group with Tanks 9-12 is totally (tank, basemat and pipes) within the water table aquifer. Accordingly, rather than vertical transport by infiltrating water (the initial transport mode for all other tank groups), the contaminants in this group were modelled as releases directly to the water table aquifer. The contaminant release rates were determined by multiplying the flow rate of water passing through the contaminants by the concentration of that water. The flow rate was determined by multiplying the aquifer Darcy velocity (average velocity over the cross-section) by the width and depth of the group. The aquifer Darcy velocity = 0.057 ft/da, except

Table C-18. Infiltration rates assumed for tank closure.

	Early infiltration rate (Cm/Yr)	Late infiltration rate (Cm/Yr)	Failure time (Yr)	Notes
Fill with Grout	4	40	1000	Grout + concrete failure

during the first 1000 years for the grout and saltstone scenarios. In those cases the Darcy velocity is restricted by the grout and the saltstone to the same rate as the infiltration rate, i.e., 4 cm/yr. The width of the tank group is 132.93 ft. (determined by taking the total horizontal cross-section area of the 4 tanks in the group, $A = 4 * \pi * r^2$ and assuming a square, so that $l = w = A^{0.5}$). The thickness of the actual source volume within the tank group was determined by dividing the sludge volume (400 gal) by A, and is equal to 0.003 ft for the grout and sand scenarios and .3 ft for no action. For the saltstone, the depth was determined by dividing the inventory of any radionuclide (Ci) by its concentration (Ci/g) and dividing by saltstone density (1700 kg/m^3); therefore, the saltstone source thickness is 22.5 ft. The concentration of the release was determined from the K_d and the source concentration, i.e., $c_w = c_s / K_d$. A minimum release time of 1 year was set for all contaminants. The release rates and associated release durations for this grouping of tanks into the water table are shown in Table C-19.

The above release rates and durations cover only the first 1000 years (Darcy velocity through waste of 4 cm/yr). The release rates and durations subsequent to the first 1000 years (durations do not include the first 1000 years), after grout failure (darcy velocity = 0.057 ft/day) are shown in Table C-20 below.

Releases from the group with Tanks 9-12 were assumed to be at the water table surface for the water table flow path; this approach is conservative because (1) such a release would encounter less dilution than a submerged discharge and (2) the results are directly additive to the other tank groups. For the other 2 flow paths (Barnwell-McBean aquifer and Congaree aquifer) the release is assumed to occur at the level of the tank bottom within the water table aquifer.

C.8.10 MEPAS ANALYSIS (MECHANICS)

The basic MEPAS release analysis (for all but Tanks 9-12 and 13-16) where the basemat is above water table consists of six separate parts (for one release in one aquifer) as listed below:

1. The model was run with the pre-failure parameters for the time before failure. This run, like all MEPAS runs, extends to 10,000 years.

2. The results of run 1 were used to calculate the released inventory which reaches the aquifer prior to failure (of infiltration barrier and concrete basemat). This modified inventory was used for run 2, with pre-failure parameters and is denoted as the early tank run.

3. The remaining inventory (with source-concentration decreased by the inventory released in run 2 was combined with the post-failure parameters (e.g., increase of infiltration rate and degradation of concrete) and was denoted as the late tank run.

4. These steps are analogous to 1-3, but for the pipes which feed the tank. The pipe parameter changes from the tanks are (a) inventory of 0.2 of the tank, concentration remains the same, (b) no concrete basemat, and (c) release height above vadose determined by the tank type, as discussed earlier.

The early and late tank and pipe runs were combined by adding the concentrations at the same receptors and at the same times. The times of the late runs were offset by the time of failure for the particular scenario.

C.9 Human Health Impacts

The maximum concentration or dose was identified for each receptor and for each contaminant along with the time period during which the maximum occurred within a 10,000-year performance period. In addition, for radiological constituents, the total dose was calculated to allow evaluation of the impact of all radiological constituents. Because the maximum doses for each radionuclide do not necessarily occur simultaneously, it is not appropriate to add the

Table C-19. Release rates and durations (first 1000 years only) for the group containing Tanks 9-12.

Release rates		Release durations	
Contaminant		Contaminant	
Se-79 (Ci/yr)	1.80×10^{-2}	Se-79 (yr)	23.7
Tc-99 (Ci/yr)	3.09×10^{-5}	Tc-99 (yr)	1000.0
C-14 (Ci/yr)	2.54×10^{-5}	C-14 (yr)	23.7
I-125 (Ci/yr)	6.64×10^{-8}	I-125 (yr)	473.1
Sr-90 (Ci/yr)	8.26×10^{1}	Sr-90 (yr)	236.6
Cs-137 (Ci/yr)	2.59	Cs-137 (yr)	473.1
Ag (g/yr)	1.55	Ag (yr)	236.6
Al (g/yr)	4.13×10^{-1}	Al (yr)	1000.0
Ba (g/yr)	2.92	Ba (yr)	236.6
F (g/yr)	4.46×10^{2}	F (yr)	1.0
Cr (g/yr)	3.90×10^{-1}	Cr (yr)	1000.0
Cu (g/yr)	3.88×10^{-2}	Cu (yr)	1000.0
Fe (g/yr)	1.73×10^{2}	Fe (yr)	354.8
Hg (g/yr)	6.05×10^{-3}	Hg (yr)	1000.0
NO_3 (g/yr)	8.61×10^{3}	NO_3 (yr)	1.0
Mn (g/yr)	2.35	Mn (yr)	1000.0
Ni (g/yr)	4.53×10^{-1}	Ni (yr)	1000.0
Pb (g/yr)	6.06×10^{-3}	Pb (yr)	1000.0
U (g/yr)	1.28×10^{-7}	U (yr)	1000.0
Zn (g/yr)	1.43×10^{-3}	Zn (yr)	1000.0
Th-232 (Ci/yr)	6.53×10^{-10}	Th-232 (yr)	1000.0
Np-237 (Ci/yr)	2.88×10^{-8}	Np-237 (yr)	1000.0
Pu-238 (Ci/yr)	4.00×10^{-10}	Pu-238 (yr)	1000.0
Pu-239 (Ci/yr)	9.00×10^{-12}	Pu-239 (yr)	1000.0
Pu-240 (Ci/yr)	4.09×10^{-12}	Pu-240 (yr)	1000.0
Pu-241 (Ci/yr)	7.03×10^{-11}	Pu-241 (yr)	1000.0
Pu-242 (Ci/yr)	6.20×10^{-15}	Pu-242 (yr)	1000.0
Am-241 (Ci/yr)	1.03×10^{-4}	Am-241 (yr)	1000.0
Am-242m (Ci/yr)	4.96×10^{-8}	Am-242m (yr)	1000.0
Cm-244 (Ci/yr)	8.24×10^{-8}	Cm-244 (yr)	1000.0
Cm-245 (Ci/yr)	7.97×10^{-12}	Cm-245 (yr)	1000.0

Table C-20. Release rates and durations after 1000 years for the group containing Tanks 9-12.

Release rate		Release duration	
Contaminant		Contaminant	
Se-79 (Ci/yr)	1.00×10^{-25}	Se-79 (yr)	0
Tc-99 (Ci/yr)	4.90×10^{-3}	Tc-99 (yr)	1485.9
C-14 (Ci/yr)	1.00×10^{-25}	C-14 (yr)	0
I-125(Ci/yr)	1.00×10^{-25}	I-125 (yr)	0
Sr-90 (Ci/yr)	1.00×10^{-25}	Sr-90 (yr)	0
Cs-137(Ci/yr)	1.00×10^{-25}	Cs-137 (yr)	0
Ag (g/yr)	1.00×10^{-25}	Ag (yr)	0
Al (g/yr)	6.54×10^{1}	Al (yr)	520.4
Ba (g/yr)	1.00×10^{-25}	Ba (yr)	0
F (g/yr)	1.00×10^{-25}	F (yr)	0
Cr (g/yr)	6.18×10^{1}	Cr (yr)	5.5
Cu (g/yr)	6.15	Cu (yr)	43.8
Fe (g/yr)	1.00×10^{-25}	Fe (yr)	0
Hg (g/yr)	9.60×10^{-1}	Hg (yr)	7872.4
NO3 (g/yr)	1.00×10^{-25}	NO3 (yr)	0
Mn (g/yr)	3.72×10^{2}	Mn (yr)	142.9
Ni (g/yr)	7.19×10^{1}	Ni (yr)	142.9
Pb (g/yr)	9.61×10^{-1}	Pb (yr)	739.8
U (g/yr)	2.03×10^{-5}	U (yr)	6.5×10^{8}
Zn (g/yr)	2.26×10^{-1}	Zn (yr)	2172.3
Th-232 (Ci/yr)	1.04×10^{-7}	Th-232 (yr)	7.45×10^{3}
Np-237 (Ci/yr)	4.57×10^{-6}	Np-237 (yr)	7.45×10^{3}
Pu-238 (Ci/yr)	6.34×10^{-8}	Pu-238 (yr)	2.85×10^{9}
Pu-239 (Ci/yr)	1.43×10^{-9}	Pu-239 (yr)	2.85×10^{9}
Pu-240 (Ci/yr)	6.48×10^{-10}	Pu-240 (yr)	2.85×10^{9}
Pu-241 (Ci/yr)	1.11×10^{-8}	Pu-241 (yr)	2.85×10^{9}
Pu-242 (Ci/yr)	9.83×10^{-13}	Pu-242 (yr)	2.85×10^{9}
Am-241 (Ci/yr)	1.63×10^{-2}	Am-241 (yr)	7454.6
Am-242m (Ci/yr)	7.86×10^{-6}	Am-242m (yr)	7454.6
Cm-244 (Ci/yr)	1.31×10^{-5}	Cm-244 (yr)	7454.6
Cm-245 (Ci/yr)	1.26×10^{-9}	Cm-245 (yr)	7454.6

maximum doses for each radionuclide. Rather, it is more appropriate to assess the doses as a function of time, sum the doses from all radionuclides for each time increment, and then select the maximum total dose from this compilation. Therefore, the total dose reported in the following tables for radiological constituents may not necessarily correlate to the maximum dose or time period for any individual radionuclide because of the contributions from all radionuclides at a given time. In addition to total dose, the gross alpha concentration and the beta-gamma dose were calculated

Non-radiological constituent concentrations in the various water bodies were calculated. For each constituent, the maximum concentration was calculated along with the time period during which the maximum concentration occurred. None of the non-radiological constituents are known ingestion carcinogens; therefore cancer risk was not calculated for these contaminants.

Tables C-21 through C-39 list impact estimates for the closure of the Tank Farms. Table C-21 presents a summary of the impacts at the seepline. Tables C-22 through C-30 present doses for postulated individuals (i.e., Adult Resident, Child Resident, Seepline Worker, and Intruder) and at the seepline. Additional calculations were performed at groundwater locations close to the tank farm for informational purposes. For tables (Tables C-31 through C-39) for nonradiological constituents, the maximum concentration of each contaminant is reported for each water location. The results are for each tank farm and by aquifer. Although more than one aquifer may outcrop to the same point on the seepline, the concentration values at the seepline are not additive. Therefore, Tables C-21 through C-39 show only the maximum seepline concentration for Fourmile Branch and Upper Three Runs.

C.10 Ecological Impacts

C.10.1 NONRADIOLOGICAL ANALYSIS

C.10.1.1 H-Area: Upper Three Runs – Barnwell McBean, Water Table, and Congaree Aquifers

Aquatic Hazard Quotients (HQs) for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0. All terrestrial HQs for the shrew and the mink were less than 1.0 (TableC-40). Thus potential risks to ecological receptors at and downgradient of the Upper Three Runs seeps (from all aquifers under H-Area) are negligible.

C.10.1.2 H-Area: Fourmile Branch – Barnwell McBean and Water Table Aquifers, Upper Three Runs – Congaree Aquifers

Aquatic HQs for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0 All terrestrial HQs for the shrew and the mink were less than 1.0 (C-41). Thus potential risks to ecological receptors at and downgradient of the Fourmile Branch seep (from the Barnwell McBean and Water Table Aquifers and under H-Area) are negligible, as are those for the Congaree at Upper Three Runs.

C.10.1.3 F-Area: Fourmile Branch – Barnwell McBean and Water Table Aquifers; Upper Three Runs – Congaree Aquifer

Aquatic HQs for each contaminant were summed to obtain an aquatic Hazard Index (HI). This suggests some potential risks, although the relatively low HI value suggest that these risks are generally low. HQs for the shrew and the mink were less than 1.0 (Table C-42).

C.10.2 RADIOLOGICAL ANALYSIS

Calculated absorbed doses to the referenced organisms are presented in Tables C-43 through C--45. All calculated doses are below the regulatory limit of 365,000 mrad per year (365 rad per year).

Table C-21. Summary of radiological impacts at the seepline.

		Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aquifer
F-Area	Total radiation dose (mrem/yr)	1.0	1.9	6.5×10^{-3}
	Time of maximum (years)	385	875	5495
	Beta-gamma dose (mrem/yr)	1.0	1.9	6.5×10^{-3}
	Time of maximum (years)	385	875	5495
	Alpha concentration (pCi/L)	0.03	0.04	3.7×10^{-5}
	Time of maximum (years)	3885	6405	9345
H-Area North of Groundwater Divide	Total radiation dose (mrem/yr)	2.5	0.75	0.098
	Time of maximum (years)	455	4515	5005
	Beta-gamma dose (mrem/yr)	2.5	0.75	0.098
	Time of maximum (years)	455	4515	5005
	Alpha concentration (pCi/L)	0.15	0.01	6.7×10^{-9}
	Time of maximum (years)	4655	9975	9975
H-Area South of Groundwater Divide	Total radiation dose (mrem/yr)	0.95	0.35	0.019
	Time of maximum (years)	455	4445	5285
	Beta-gamma dose (mrem/yr)	0.95	0.35	0.019
	Time of maximum (years)	455	4445	5285
	Alpha concentration (pCi/L)	0.02	0.01	7.8×10^{-10}
	Time of maximum (years)	4585	9205	9975

Table C-22. F-Tank Farm radiological results due to contaminant transport in the Water Table Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	1.9×10^{-2}	(a)	(a)	(a)	N/A	1.9×10^{-2}	4.1×10^{-7}	N/A
	Time of maximum (yr)	(a)	385	(a)	(a)	(a)	N/A	385		N/A
Child resident	Maximum value	(a)	1.7×10^{-2}	(a)	(a)	(a)	N/A	1.7×10^{-2}	1.3×10^{-7}	N/A
	Time of maximum (yr)	(a)	385	(a)	(a)	(a)	N/A	385		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.2×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	5.9×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	8.9	4.3×10^{1}	1.8×10^{-1}	4.6×10^{-2}	(a)	4.3×10^{1}	4.3×10^{1}	9.5×10^{-4}	5.22
	Time of maximum (yr)	1225	385	1085	1015	(a)	385	385		1855
100-meter well	Maximum value	1.8	1.6×10^{1}	3.1×10^{-2}	1.2×10^{-2}	(a)	1.6×10^{1}	1.6×10^{1}	3.5×10^{-4}	1.91
	Time of maximum (yr)	1295	315	1085	1015	(a)	315	315		1995
Seepline	Maximum value	3.4×10^{-2}	1.0	(a)	(a)	(a)	1.0	1.0	2.2×10^{-5}	2.64×10^{-2}
	Time of maximum (yr)	2205	385	(a)	(a)	(a)	385	385		3885
Surface water	Maximum value	(a)	6.9×10^{-3}	(a)	(a)	(a)	6.9×10^{-3}	6.9×10^{-3}	1.5×10^{-7}	1.83×10^{-4}
(Drinking)	Time of maximum (yr)	(a)	385	(a)	(a)	(a)	385	385		3885

a. Radiation dose is less than 0.001 mrem/yr.

Table C-23. F-Tank Farm radiological results due to contaminant transport in the Barnwell McBean Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	2.7×10^{-2}	(a)	(a)	(a)	N/A	2.7×10^{-2}	5.8×10^{-7}	N/A
	Time of maximum (yr)	(a)	875	(a)	(a)	(a)	N/A	875		N/A
Child resident	Maximum value	(a)	2.4×10^{-2}	(a)	(a)	(a)	N/A	2.4×10^{-2}	1.8×10^{-7}	N/A
	Time of maximum (yr)	(a)	875	(a)	(a)	(a)	N/A	875		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.7×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	8.4×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	3.2	1.3×10^{2}	4.1×10^{-1}	1.7×10^{-1}	(a)	1.3×10^{2}	1.3×10^{2}	2.9×10^{-3}	1.31×10^{1}
	Time of maximum (yr)	3745	665	1225	1085	(a)	665	665		2695
100-meter well	Maximum value	1.0	5.1×10^{1}	7.3×10^{-2}	4.4×10^{-2}	(a)	5.1×10^{1}	5.1×10^{1}	1.1×10^{-3}	4.75
	Time of maximum (yr)	3815	665	1225	1085	(a)	665	665		2905
Seepline	Maximum value	3.6×10^{-2}	1.9	(a)	(a)	(a)	1.9	1.9	4.1×10^{-5}	3.93×10^{-2}
	Time of maximum (yr)	5705	875	(a)	(a)	(a)	875	875		6405
Surface water	Maximum value	(a)	9.8×10^{-3}	(a)	(a)	(a)	9.8×10^{-3}	9.8×10^{-3}	2.1×10^{-7}	2.17×10^{-4}
(Drinking)	Time of maximum (yr)	(a)	875	(a)	(a)	(a)	875	875		6265

a. Radiation dose is less than 0.001 mrem/yr.

Table C-24 F-Tank Farm radiological results due to contaminant transport in the Congaree Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.0×10^{-8}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Child resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	3.1×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	3.0×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.5×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	(a)	9.1×10^{-1}	1.2×10^{-3}	(a)	(a)	9.1×10^{-1}	9.1×10^{-1}	2.0×10^{-5}	3.15×10^{-3}
	Time of maximum (yr)	(a)	4935	1505	(a)	(a)	4935	4935		8295
100-meter well	Maximum value	(a)	2.2×10^{-1}	(a)	(a)	(a)	2.2×10^{-1}	2.2×10^{-1}	4.7×10^{-6}	1.26×10^{-3}
	Time of maximum (yr)	(a)	1225	(a)	(a)	(a)	1225	1225		8225
Seepline	Maximum value	(a)	6.5×10^{-3}	(a)	(a)	(a)	6.5×10^{-3}	6.5×10^{-3}	1.4×10^{-7}	3.70×10^{-5}
	Time of maximum (yr)	(a)	5495	(a)	(a)	(a)	5495	5495		9345
Surface water	Maximum value	(a)	(a)	(a)	(a)	(a)	(a)	(a)	3.8×10^{-9}	1.03×10^{-6}
(Drinking)	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		8365

a. Radiation dose is less than 0.001 mrem/yr.

Table C-25. H-Tank Farm (North of the Groundwater Divide) radiological results due to contaminant transport in the Water Table Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	1.4×10^{-3}	(a)	(a)	(a)	N/A	1.4×10^{-3}	3.2×10^{-8}	N/A
	Time of maximum (yr)	(a)	455	(a)	(a)	(a)	N/A	455		N/A
Child resident	Maximum value	(a)	1.3×10^{-3}	(a)	(a)	(a)	N/A	1.3×10^{-3}	9.7×10^{-9}	N/A
	Time of maximum (yr)	(a)	455	(a)	(a)	(a)	N/A	455		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	9.1×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	4.6×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	4.3×10^{1}	1.7×10^{2}	1.8×10^{-2}	1.0×10^{-1}	(a)	1.0×10^{5}	1.0×10^{5}	2.3	2.41×10^{1}
	Time of maximum (yr)	105	315	35	1015	(a)	175	175		1925
100-meter well	Maximum value	5.8	5.6×10^{1}	4.0×10^{-3}	1.9×10^{-2}	(a)	3.0×10^{2}	3.0×10^{2}	6.6×10^{-3}	6.95
	Time of maximum (yr)	245	385	105	1015	(a)	245	245		2205
Seepline	Maximum value	7.0×10^{-2}	2.5	(a)	(a)	(a)	2.5	2.5	5.4×10^{-5}	1.54×10^{-1}
	Time of maximum (yr)	1225	455	(a)	(a)	(a)	455	455		4655
Surface water	Maximum value	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.2×10^{-8}	3.07×10^{-5}
(Drinking)	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		4585

a. Radiation dose is less than 0.001 mrem/yr.

Table C-26. H-Tank Farm (North of the Groundwater Divide) radiological results due to contaminant transport in the Barnwell McBean Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross alphaconcentration (pCi/L)
Adult resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	8.2×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Child resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	2.5×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	2.4×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.2×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	(a)	9.7×10^{1}	1.1×10^{-2}	1.1×10^{-1}	(a)	9.7×10^{1}	9.7×10^{1}	2.1×10^{-3}	3.80
	Time of maximum (yr)	(a)	1155	1295	1155	(a)	1155	1155		5355
100-meter well	Maximum value	(a)	3.2×10^{1}	2.0×10^{-3}	1.8×10^{-2}	(a)	3.2×10^{1}	3.2×10^{1}	7.0×10^{-4}	1.24
	Time of maximum (yr)	(a)	1155	1435	1225	(a)	1155	1155		5845
Seepline	Maximum value	(a)	7.5×10^{-1}	(a)	(a)	(a)	7.5×10^{-1}	7.5×10^{-1}	1.6×10^{-5}	1.01×10^{-2}
	Time of maximum (yr)	(a)	4515	(a)	(a)	(a)	4515	4515		9975
Surface water	Maximum value	(a)	(a)	(a)	(a)	(a)	(a)	(a)	3.0×10^{-9}	2.02×10^{-6}
(Drinking)	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		9975

a. Radiation dose is less than 0.001 mrem/yr.

Table C-27. H-Tank Farm (North of the Groundwater Divide) radiological results due to contaminant transport in the Congaree Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	7.4×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Child resident	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	2.3×10^{-9}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	2.1×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.1×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	(a)	3.2×10^{1}	(a)	8.7×10^{-3}	(a)	3.2×10^{1}	3.2×10^{1}	7.0×10^{-4}	7.35×10^{-4}
	Time of maximum (yr)	(a)	5005	(a)	1715	(a)	5005	5005		9975
100-meter well	Maximum value	(a)	5.6	(a)	1.9×10^{-3}	(a)	5.6	5.6	1.2×10^{-4}	1.92×10^{-4}
	Time of maximum (yr)	(a)	4935	(a)	1715	(a)	4935	4935		9975
Seepline	Maximum value	(a)	9.8×10^{-2}	(a)	(a)	(a)	9.8×10^{-2}	9.8×10^{-2}	2.2×10^{-6}	6.70×10^{-9}
	Time of maximum (yr)	(a)	5005	(a)	(a)	(a)	5005	5005		9975
Surface water	Maximum value	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.7×10^{-9}	2.55×10^{-11}
(Drinking)	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		9975

a. Radiation dose is less than 0.001 mrem/yr.

Table C-28. H-Tank Farm (South of the Groundwater Divide) radiological results due to contaminant transport in the Water Table Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross alphaconcentration (pCi/L)
Adult resident	Maximum value	(a)	1.0×10^{-2}	(a)	(a)	(a)	N/A	1.0×10^{-2}	2.2×10^{-7}	N/A
	Time of maximum (yr)	(a)	455	(a)	(a)	(a)	N/A	455		N/A
Child resident	Maximum value	(a)	9.3×10^{-3}	(a)	(a)	(a)	N/A	9.3×10^{-3}	6.8×10^{-8}	N/A
	Time of maximum (yr)	(a)	455	(a)	(a)	(a)	N/A	455		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	6.4×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	3.2×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	2.0×10^{1}	1.2×10^{2}	7.5×10^{-3}	6.3×10^{-2}	(a)	1.2×10^{2}	1.2×10^{2}	2.6×10^{-3}	8.64
	Time of maximum (yr)	1155	315	1085	1015	(a)	315	315		1855
100-meter well	Maximum value	2.1	2.9×10^{1}	1.2×10^{-3}	1.1×10^{-2}	(a)	2.9×10^{1}	2.9×10^{1}	6.3×10^{-4}	2.01
	Time of maximum (yr)	1295	315	1085	1015	(a)	315	315		2065
Seepline	Maximum value	2.3×10^{-2}	9.5×10^{-1}	(a)	(a)	(a)	9.5×10^{-1}	9.5×10^{-1}	2.1×10^{-5}	1.94×10^{-2}
	Time of maximum (yr)	2485	455	(a)	(a)	(a)	455	455		4585
Surface water	Maximum value	(a)	3.7×10^{-3}	(a)	(a)	(a)	3.7×10^{-3}	3.7×10^{-3}	8.2×10^{-8}	7.86×10^{-5}
(Drinking)	Time of maximum (yr)	(a)	455	(a)	(a)	(a)	455	455		4655

a. Radiation dose is less than 0.001 mrem/yr.

Table C-29. H-Tank Farm (South of the Groundwater Divide) radiological results due to contaminant transport in the Barnwell McBean Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	3.4×10^{-3}	(a)	(a)	(a)	N/A	3.4×10^{-3}	7.3×10^{-8}	N/A
	Time of maximum (yr)	(a)	4515	(a)	(a)	(a)	N/A	4515		N/A
Child resident	Maximum value	(a)	3.1×10^{-3}	(a)	(a)	(a)	N/A	3.1×10^{-3}	2.3×10^{-8}	N/A
	Time of maximum (yr)	(a)	4515	(a)	(a)	(a)	N/A	4515		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	2.1×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	1.1×10^{-10}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	(a)	5.3×10^{1}	7.8×10^{-3}	6.5×10^{-2}	(a)	5.3×10^{1}	5.3×10^{1}	1.2×10^{-3}	1.94
	Time of maximum (yr)	(a)	4445	1295	1155	(a)	4445	4445		5005
100-meter well	Maximum value	(a)	1.6×10^{1}	1.0×10^{-3}	1.2×10^{-2}	(a)	1.6×10^{1}	1.6×10^{1}	3.5×10^{-4}	5.23×10^{-1}
	Time of maximum (yr)	(a)	1155	1365	1155	(a)	1155	1155		5355
Seepline	Maximum value	(a)	3.5×10^{-1}	(a)	(a)	(a)	3.5×10^{-1}	3.5×10^{-1}	7.6×10^{-6}	1.04×10^{-2}
	Time of maximum (yr)	(a)	4445	(a)	(a)	(a)	4445	4445		9205
Surface water	Maximum value	(a)	1.2×10^{-3}	(a)	(a)	(a)	1.2×10^{-3}	1.2×10^{-3}	2.7×10^{-8}	3.81×10^{-5}
(Drinking)	Time of maximum (yr)	(a)	4515	(a)	(a)	(a)	4515	4515		9555

a. Radiation dose is less than 0.001 mrem/yr.

Table C-30. H-Tank Farm (South of the Groundwater Divide) radiological results due to contaminant transport in the Congaree Aquifer.

Location		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Sr-90 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Lifetime risk	Gross al-phaconcentra-tion (pCi/L)
Adult resident	Maximum value	(a)	1.6×10^{-3}	(a)	(a)	(a)	N/A	1.6×10^{-3}	3.4×10^{-8}	N/A
	Time of maximum (yr)	(a)	5285	(a)	(a)	(a)	N/A	5285		N/A
Child resident	Maximum value	(a)	1.4×10^{-3}	(a)	(a)	(a)	N/A	1.4×10^{-3}	1.0×10^{-8}	N/A
	Time of maximum (yr)	(a)	5285	(a)	(a)	(a)	N/A	5285		N/A
Seepline worker	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	9.8×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
Intruder	Maximum value	(a)	(a)	(a)	(a)	(a)	N/A	(a)	4.9×10^{-11}	N/A
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	N/A	(a)		N/A
1-meter well	Maximum value	(a)	1.2×10^{1}	(a)	2.2×10^{-3}	(a)	1.2×10^{1}	1.2×10^{1}	2.7×10^{-4}	2.45×10^{-4}
	Time of maximum (yr)	(a)	5215	(a)	1715	(a)	5215	5215		9975
100-meter well	Maximum value	(a)	1.7	(a)	(a)	(a)	1.7	1.7	3.8×10^{-5}	5.22×10^{-5}
	Time of maximum (yr)	(a)	4935	(a)	(a)	(a)	4935	4935		9975
Seepline	Maximum value	(a)	1.9×10^{-2}	(a)	(a)	(a)	1.9×10^{-2}	1.9×10^{-2}	4.1×10^{-7}	7.77×10^{-10}
	Time of maximum (yr)	(a)	5285	(a)	(a)	(a)	5285	5285		9975
Surface water	Maximum value	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.3×10^{-8}	7.98×10^{-11}
(Drinking)	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		9975

a. Radiation dose is less than 0.001 mrem/yr.

Table C-31. F-Tank Farm nonradiological results due to contaminant transport in the Water Table Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	1.2×10^{-1}	(a)	6.3×10^{-5}	1.1×10^{-2}	2.1×10^{-2}	6.0×10^{-3}	2.6	2.6×10^{-5}	1.2×10^{-1}	1.9×10^{-1}	1.0×10^{-4}	5.2×10^{-4}	1.7×10^{-5}	4.4×10^{-3}
	Time of maximum (yr)	1015	(a)	9975	105	1715	2765	1575	9975	105	1995	9975	9975	8365	2135
100-meter well	Maximum concentration (mg/L)	2.3×10^{-2}	(a)	(a)	3.8×10^{-3}	2.7×10^{-3}	7.6×10^{-4}	3.4×10^{-1}	(a)	3.9×10^{-2}	2.8×10^{-2}	(a)	8.3×10^{-5}	6.4×10^{-6}	1.5×10^{-3}
	Time of maximum (yr)	1015	(a)	(a)	105	1855	3255	1785	(a)	105	2205	(a)	8575	8995	2205
Seepline well	Maximum concentration (mg/L)	7.1×10^{-4}	(a)	(a)	1.8×10^{-4}	3.1×10^{-5}	7.9×10^{-6}	3.9×10^{-3}	(a)	1.8×10^{-3}	3.8×10^{-4}	(a)	(a)	(a)	2.3×10^{-5}
	Time of maximum (yr)	1085	(a)	(a)	105	4865	9975	4585	(a)	105	5215	(a)	(a)	(a)	8855
Surface Water	Maximum concentration (mg/L)	4.5×10^{-6}	(a)	(a)	1.2×10^{-6}	(a)	(a)	2.5×10^{-5}	(a)	1.2×10^{-5}	2.5×10^{-6}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	1085	(a)	(a)	105	(a)	(a)	4445	(a)	105	5215	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-32. F-Tank Farm nonradiological results due to contaminant transport in the Barnwell McBean Aquifer .

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	3.2×10^{-1}	(a)	(a)	2.0×10^{-1}	2.3×10^{-2}	9.4×10^{-3}	4.7	(a)	2.1	3.6×10^{-1}	(a)	(a)	(a)	3.3×10^{-3}
	Time of maximum (yr)	1155	(a)	(a)	1015	3745	6195	2485	(a)	1015	3115	(a)	(a)	(a)	9975
100-meter well	Maximum concentration (mg/L)	6.5×10^{-2}	(a)	(a)	4.5×10^{-2}	4.4×10^{-3}	1.5×10^{-3}	7.4×10^{-1}	(a)	4.7×10^{-1}	6.2×10^{-2}	(a)	(a)	(a)	1.2×10^{-3}
	Time of maximum (yr)	1155	(a)	(a)	1015	4165	6895	2835	(a)	1015	3535	(a)	(a)	(a)	7315
Seepline well	Maximum concentration (mg/L)	1.7×10^{-3}	(a)	(a)	1.1×10^{-3}	4.6×10^{-5}	(a)	5.8×10^{-3}	(a)	1.2×10^{-2}	5.6×10^{-4}	(a)	(a)	(a)	9.3×10^{-6}
	Time of maximum (yr)	1365	(a)	(a)	1015	9625	(a)	7665	(a)	1015	8855	(a)	(a)	(a)	9975
Surface Water	Maximum concentration (mg/L)	8.8×10^{-6}	(a)	(a)	5.7×10^{-6}	(a)	(a)	3.0×10^{-5}	(a)	5.9×10^{-5}	2.9×10^{-6}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	1365	(a)	(a)	1015	(a)	(a)	7665	(a)	1015	8785	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-33. F-Tank Farm nonradiological results due to contaminant transport in the Congaree Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum Concentration (mg/L)	3.1×10^{-5}	(a)	(a)	1.1×10^{-3}	(a)	(a)	5.9×10^{-3}	(a)	1.2×10^{-2}	2.4×10^{-4}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	4165	(a)	(a)	1085	(a)	(a)	4795	(a)	1085	6405	(a)	(a)	(a)	(a)
100-meter well	Maximum concentration (mg/L)	5.7×10^{-6}	(a)	(a)	2.0×10^{-4}	(a)	(a)	1.1×10^{-3}	(a)	2.0×10^{-3}	4.6×10^{-5}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	4235	(a)	(a)	1085	(a)	(a)	4865	(a)	1085	6755	(a)	(a)	(a)	(a)
Seepline well	Maximum concentration (mg/L)	(a)	(a)	(a)	5.8×10^{-6}	(a)	(a)	2.5×10^{-5}	(a)	6.1×10^{-5}	1.2×10^{-6}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	1085	(a)	(a)	6405	(a)	1085	8225	(a)	(a)	(a)	(a)
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.6×10^{-6}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1085	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-34. H-Tank Farm (North of the Groundwater Divide) nonradiological results due to contaminant transport in the Water Table Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	8.6×10^{-3}	(a)	1.9×10^{-4}	1.2×10^{-2}	5.4×10^{-3}	9.0×10^{-4}	1.1	1.4×10^{-3}	2.3×10^{-1}	2.9×10^{-1}	4.8×10^{-3}	7.3×10^{-4}	4.0×10^{-5}	6.7×10^{-4}
	Time of maximum (yr)	1015	(a)	7945	35	1645	2695	1575	9835	35	1295	5495	9975	9975	2135
100-meter well	Maximum concentration (mg/L)	1.5×10^{-3}	(a)	(a)	3.2×10^{-3}	7.6×10^{-4}	1.2×10^{-4}	1.3×10^{-1}	3.0×10^{-5}	6.5×10^{-2}	4.3×10^{-2}	2.9×10^{-4}	3.7×10^{-5}	1.3×10^{-5}	1.6×10^{-4}
	Time of maximum (yr)	1015	(a)	(a)	35	1995	3465	1995	9975	35	1715	9975	9975	9485	2345
Seepline well	Maximum concentration (mg/L)	4.5×10^{-5}	(a)	(a)	1.5×10^{-4}	1.5×10^{-5}	1.5×10^{-6}	2.3×10^{-3}	(a)	3.1×10^{-3}	5.4×10^{-4}	(a)	(a)	(a)	3.7×10^{-6}
	Time of maximum (yr)	1155	(a)	(a)	35	5495	9835	5145	(a)	35	5215	(a)	(a)	(a)	5005
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-35. H-Tank Farm (North of the Groundwater Divide) nonradiological results due to contaminant transport in the Barnwell McBean Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	7.1×10^{-4}	(a)	(a)	1.2×10^{-2}	2.9×10^{-6}	(a)	4.5×10^{-1}	(a)	2.8×10^{-1}	2.2×10^{-2}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	2695	(a)	(a)	1015	9975	(a)	3605	(a)	1015	5145	(a)	(a)	(a)	(a)
100-meter well	Maximum concentration (mg/L)	1.2×10^{-4}	(a)	(a)	2.3×10^{-3}	(a)	(a)	6.2×10^{-2}	(a)	6.1×10^{-2}	6.2×10^{-3}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	2625	(a)	(a)	1015	(a)	(a)	4445	(a)	1015	6125	(a)	(a)	(a)	(a)
Seepline well	Maximum concentration (mg/L)	3.9×10^{-6}	(a)	(a)	6.3×10^{-5}	(a)	(a)	1.7×10^{-4}	(a)	1.7×10^{-3}	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	3115	(a)	(a)	1085	(a)	(a)	9975	(a)	1085	9975	(a)	(a)	(a)	(a)
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-36. H-Tank Farm (North of the Groundwater Divide) nonradiological results due to contaminant transport in the Congaree Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	2.0×10^{-5}	(a)	(a)	2.2×10^{-3}	(a)	(a)	1.5×10^{-2}	(a)	5.2×10^{-2}	1.3×10^{-6}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	9975	(a)	(a)	1155	(a)	(a)	9975	(a)	1155	9975	(a)	(a)	(a)	(a)
100-meter well	Maximum concentration (mg/L)	3.1×10^{-6}	(a)	(a)	3.5×10^{-4}	(a)	(a)	2.1×10^{-3}	(a)	8.9×10^{-3}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	9905	(a)	(a)	1155	(a)	(a)	9975	(a)	1155	(a)	(a)	(a)	(a)	(a)
Seepline well	Maximum concentration (mg/L)	(a)	(a)	(a)	5.6×10^{-6}	(a)	(a)	(a)	(a)	1.5×10^{-4}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	1225	(a)	(a)	(a)	(a)	1225	(a)	(a)	(a)	(a)	(a)
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C37. H-Tank Farm (South of the Groundwater Divide) nonradiological results due to contaminant transport in the Water Table Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	9.7×10^{-4}	(a)	(a)	2.6×10^{-3}	3.6×10^{-3}	4.5×10^{-4}	4.8×10^{-1}	(a)	7.5×10^{-2}	5.5×10^{-2}	5.8×10^{-4}	3.9×10^{-4}	3.7×10^{-5}	1.5×10^{-3}
	Time of maximum (yr)	1015	(a)	(a)	105	1575	2555	1505	(a)	105	1925	9975	9975	9695	2555
100-meter well	Maximum concentration (mg/L)	2.0×10^{-4}	(a)	(a)	6.0×10^{-4}	5.2×10^{-4}	4.5×10^{-5}	7.4×10^{-2}	(a)	2.1×10^{-2}	6.4×10^{-3}	(a)	(a)	1.3×10^{-5}	7.4×10^{-4}
	Time of maximum (yr)	1015	(a)	(a)	105	2065	3465	1925	(a)	105	2345	(a)	(a)	9975	2975
Seepline well	Maximum concentration (mg/L)	5.2×10^{-6}	(a)	(a)	1.9×10^{-5}	9.2×10^{-6}	(a)	1.4×10^{-3}	(a)	9.8×10^{-4}	6.8×10^{-5}	(a)	(a)	(a)	2.3×10^{-5}
	Time of maximum (yr)	1155	(a)	(a)	105	6265	(a)	5425	(a)	1015	6195	(a)	(a)	(a)	5775
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	6.2×10^{-6}	(a)	4.4×10^{-6}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	5635	(a)	1015	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-38. H-Tank Farm (South of the Groundwater Divide) nonradiological results due to contaminant transport in the Barnwell McBean Aquifer.

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	8.8×10^{-5}	(a)	(a)	1.0×10^{-2}	1.4×10^{-6}	(a)	2.2×10^{-1}	(a)	2.9×10^{-1}	1.8×10^{-2}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	2765	(a)	(a)	1015	9975	(a)	3465	(a)	1015	4445	(a)	(a)	(a)	(a)
100-meter well	Maximum concentration (mg/L)	1.7×10^{-5}	(a)	(a)	1.7×10^{-3}	(a)	(a)	4.7×10^{-2}	(a)	5.9×10^{-2}	2.8×10^{-3}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	2765	(a)	(a)	1015	(a)	(a)	4095	(a)	1015	5215	(a)	(a)	(a)	(a)
Seepline well	Maximum concentration (mg/L)	(a)	(a)	(a)	5.5×10^{-5}	(a)	(a)	7.9×10^{-4}	(a)	2.5×10^{-3}	3.4×10^{-5}	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	1085	(a)	(a)	9065	(a)	1085	9905	(a)	(a)	(a)	(a)
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	3.0×10^{-6}	(a)	9.3×10^{-6}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	8785	(a)	1085	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C39. H-Tank Farm (South of the Groundwater Divide) nonradiological results due to contaminant transport in the Congaree Aquifer .

Receptor		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
1-meter well	Maximum concentration (mg/L)	1.2×10^{-6}	(a)	(a)	1.2×10^{-3}	(a)	(a)	4.1×10^{-3}	(a)	3.2×10^{-2}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	9975	(a)	(a)	1155	(a)	(a)	9975	(a)	1155	(a)	(a)	(a)	(a)	(a)
100-meter well	Maximum concentration (mg/L)	(a)	(a)	(a)	1.7×10^{-4}	(a)	(a)	9.2×10^{-4}	(a)	5.6×10^{-3}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	1155	(a)	(a)	9975	(a)	1155	(a)	(a)	(a)	(a)	(a)
Seepline well	Maximum concentration (mg/L)	(a)	(a)	(a)	1.6×10^{-6}	(a)	(a)	(a)	(a)	7.0×10^{-5}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	1225	(a)	(a)	(a)	(a)	1225	(a)	(a)	(a)	(a)	(a)
Surface Water	Maximum concentration (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.3×10^{-6}	(a)	(a)	(a)	(a)	(a)
	Time of maximum (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1225	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C-40. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Water Table, and Congaree Aquifers),.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
Analyte	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C-41. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers),.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum	Maximum HQ		Time of maximum	Maximum HQ		Time of maximum
Analyte	Mink	Shrew	HQ[a]	Mink	Shrew	HQ	Mink	Shrew	HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C-42. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers),.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
Analyte	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	1.14×10^{-2}	2.05×10^{-2}	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,015	b	b	NA	3.47×10^{-2}	8.2×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	4.42×10^{-1}	8.12×10^{-1}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C--43. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm.

	Preferred Alternative		
	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aq-uifer
Sunfish dose	0.0027	0.0038	6.7×10^{-5}
Shrew dose	10.1	18.7	0.1
Mink dose	1.1	2.0	0

Table C-44. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Four Mile Branch.

	Preferred Alternative		
	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aq-uifer
Sunfish dose	0.0014	2.2×10^{-4}	4.8×10^{-4}
Shrew dose	9.5	0.2	3.5
Mink dose	1.0	0	0.4

Table C-45. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs.

	Preferred Alternative		
	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aq-uifer
Sunfish dose	2.1×10^{-4}	5.4×10^{-5}	4.8×10^{-5}
Shrew dose	24.8	7.5	1.0
Mink dose	3.3	0.8	0.1

References

Aadland, R. K., J. A. Gellici, and P. A. Thayer, 1995, *Hydrogeologic Framework of West-Central South Carolina*, Report 5, State of South Carolina Department of Natural Resources – Water Resources Division, Columbia, South Carolina.

Ambrose, A. M., P. S. Larson, J. F. Borzelleca. 1976, "Long-Term Toxicologic Assessment of Nickel in Rats and Dogs," *Journal of Food Science Technology*, 13, pp. 181-187.

ATSDR (Agency for Toxic Substances and Disease Registry), 1990, *Draft Toxicological Profile for Aluminum*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1991, *Draft Toxicological Profile for Chromium*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1993, *Toxicological Profile for Fluoride*, U.S. Public Health Service, Atlanta, Georgia.

Aughey, E., L. Grant, B. L. Furman, et al., 1977, *The Effects of Oral Zinc Supplementation in the Mouse*, Journal of Comparative Pathology, 87, pp. 1-14.

Baes III, C. F., R. A. Sharp, A. L. Sjoreen, R. W. Shor, 1984, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Bee, J. W., G. Glass, R. S. Hoffman, and R. R. Patterson, 1981, *Mammals in Kansas*, University of Kansas Publications, Lawrence, Kansas.

Beyer, W. N., E. E. Conner, and S. Gerould, 1994, "Estimates of Soil Ingestion by Wildlife," *Journal Wildlife Management*, 58(2), pp. 375-382.

Bradbury, M. H., and F. Sarott, 1995, Sorption Database for the Cementitious Near-Field of a L/ILW Repository for Performance Assessment, ISSN 1019-0643, Paul Scherrer Institute, Switzerland.

Buck, J. W., G. Whelan, J. G. Droppo, Jr., D. L. Strenge, K. J. Castleton, J. P. McDonald, C. Sato, G. P. Streile, 1995, Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance: Guidance for Evaluating MEPAS Parameters for Version 3.1, PNL-10395, Pacific Northwest Laboratory, Richland, Washington, February.

Cothran, E. G., M. H. Smith, J. O. Wolff, and J. B. Gentry, 1991, *Mammals of the Savannah River Site*, SRO-NERP-21, Savannah River Ecology Laboratory, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1994, Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility, DOE/EIS-0082, Savannah River Operations Office, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1996, Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina, July.

DOE (U.S. Department of Energy), 1997, Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems Revision 2, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina, August.

DOE (U.S. Department of Energy), 1999, Preliminary Draft Environmental Impact Statement for High-Level Waste Tank Closure, DOE/EIS-0303D, Savannah River Operations Office, Aiken, South Carolina.

EPA (U.S. Environmental Protection Agency), 1989, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance*, EPA/530-SW-89-026, Office of Solid Waste, Washington, D.C., April.

EPA (U.S. Environmental Protection Agency), 1993, *Wildlife Exposure Factors Handbook*, EPA/600/R-93/187, Office of Research and Development, Washington, D.C.

Flach, G., 1994, Calculation Q-CLC-H-00055, Rev. 0, Westinghouse Savannah River Company Savannah River Site, Aiken, South Carolina.

GeoTrans Inc. 1993, Groundwater Model Calibration and Review of Remedial Alternatives at the F – and H-Area Seepage Basins, WSRC-TR-93-384, prepared for Westinghouse Savannah River Company Environmental Restoration Group, Aiken, South Carolina, July.

GeoTrans, Inc., 1987, Characterization of Ground Water Flow and Transport in the General Separations Area, Savannah River Plant: Evaluation of Closure Cap Effectiveness Mixed Waste Management Facility (643-28G), Phase I Report, Prepared for E.I. duPont de Nemours & Co., Atomic Energy Division, Aiken, South Carolina, May.

Halverson, N. V., L. D. Wike, K. K. Patterson, J. A. Bowers, A. L. Bryan, K. F. Chen, C. L. Cummins, B. R. del Carmen, K. L. Dixon, D. L. Dunn, G. P. Friday, J. E. Irwin, R. K. Kolka, H. E. Mackey, Jr., J. J. Mayer, E. A. Nelson, M. H. Paller, V. A. Rogers, W. L. Specht, H. M. Westbury, and E. W. Wilde 1997, *SRS Ecology Environmental Information Document*, WSRC-TR-97-0223, Westinghouse Savannah River Company, Aiken, South Carolina.

Hamby, D. M., 1993, Soil Concentration Guidelines for the Savannah River Site Using the DOE/RESRAD Methodology (U), WSRC-TC-93-304, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, South Carolina.

Hilderbrand, A. C., et al., 1973, "Effect of Lead Acetate on Reproduction," *American Journal of Obstetrics and Gynecology*, Volume 115, pp. 1058-1065.

ICRP (International Commission on Radiological Protection), 1959.

ICRP (International Commission on Radiological Protection), 1975, Report of the Task Group on Reference Man, Publication No. 23, Pergamon Press, New York.

Laskey, J. W., G. L. Rehnberg, and J. F. Hein, 1982, "Effects of Chronic Manganese (Mn_3O_4) Exposure on Selected Reproductive Parameters in Rats," *Journal of Toxicology Environmental Health*, 9: pp. 677-687.

Newman, J. L., 1999, Westinghouse Savannah River Company, "WCS Database" electronic message to P. Young, Tetra Tech NUS.

NRC (U.S. Nuclear Regulatory Commission), 1977, Regulatory Guide 1.109, Calculation of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Washington, D.C.

Opresko, A. M., B. E. Sample, and G. W. Suter II, 1994, *Toxicological Benchmarks for Wildlife: 1994 Revision*, ES/ER/TM-86/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Rungby, J. and G. Danscher, 1984, “Hypoactivity in Silver

Smits, A. D., M. K. Harris, K. L. Hawkins, G. P. Flach, 1997Exposed Mice,” *Acta Pharmacol et Toxicol.*, 55, pp. 398-401., Integrated Hydrogeological Model of the General Separations Area (U), Volume 1: Hydrogeological Framework (U), WSRC-TR-96-0399, Westinghouse Savannah River Company, Aiken, South Carolina.

Walton, W. C., 1987, Groundwater Pumping Tests, Design and Analysis, Lewis Publishers, Chelsea, Michigan.

WSRC (Westinghouse Savannah River Company), 1992, Radiological Performance Assessment for the Z-Area Saltstone Disposal Facility (U), WSRC-RP-92-1360, Savannah River Site, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1993, *1992 Renewal Application for a RCRA Part B Permit*, Volume IV, *F-Area HWMF Postclosure*, WSRC-IM-91-53, Savannah River Site, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1994a, Radiological Performance Assessment for the E-Area Vaults Disposal Facility (U), WSRC-RP-94-218, Savannah River Site, Aiken, South Carolina, April 15.

WSRC (Westinghouse Savannah River Company), 1999, High Level Waste System Plan, Revision 10 (U), HLW-OVP-98-0037, High-Level Waste Management Division, Savannah River Site, Aiken, South Carolina, April.

Yu, C., 1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAO/LD-2, Argonne National Laboratory, Argonne, Illinois, September.

APPENDIX D

EXAMPLE OF ACCOUNTING FOR TANK IMPACTS AGAINST PERFORMANCE OBJECTIVES

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APPENDIX D

EXAMPLE OF ACCOUNTING FOR TANK IMPACTS AGAINST PERFORMANCE OBJECTIVES

The U.S. Department of Energy (DOE) has developed a method to budget performance objectives applicable to groundwater in the F- and H-Area Tank Farms at the Savannah River Site (SRS). This appendix provides an example of the application of this method. The example presented in this appendix is the accounting used to support closure of Tank 17 in the F-Tank Farm. The modeling methods used to develop this appendix are based on the hydrogeological model presented in Appendix C.

Under the concept of the groundwater transport segments (GTSs) described in Section 6.3 of the Program Plan, DOE has performed four types of calculations for the F-Area GTS pertaining to the high-level waste tanks:

- An a priori calculation of the projected impact of the entire GTS using assumptions on the degree of tank cleaning achievable, sample results from previous tank closures, and sample results for Task 17
- An evaluation of the contribution of non-tank-farm sources to groundwater impacts
- An evaluation of the contribution from previous tank closures (i.e., Tank 20)
- A tank-specific calculation for Tank 17 using sampling results available following cleaning

The *a priori* calculational results are used to project whether the GTS will meet the overall performance objectives. This process helps to address the cumulative effect of all the tanks in the tank farm whose plumes may intersect. In the following sections, results of the F-Area GTS modeling, the non-tank-farm source evaluation, and the results of previous tank closures will be used with the Tank 17 results presented in Appendix A of the Tank 17 module (DOE 1996) to ensure that the performance objective “budget” is not exceeded.

D.1 F-Area *A Priori* GTS Impacts

D.1.1 SOURCE TERM IDENTIFICATION

To determine the source term for the *a priori* calculation of F-Area GTS impacts, DOE reviewed information pertaining to transfers of liquids to the high-level waste tanks since their placement in the tank farms. This includes log books showing the data regarding transfers as well as sampling results, reel tape measurements, and photographs that provided information on the solids content in the tanks. Based on all this information, DOE estimated the current inventory of solids in each tank and the concentrations of radiological and nonradiological constituents in the solids. For Tanks 17 and 20, sample results were used to augment these estimates.

To determine the inventory of contaminants after cleaning of the tanks is accomplished, DOE assumed that the concentration of constituents in the solids remains unchanged. This assumption is realistic based on the fact that the presence of constituents in the solids indicates that the constituents are relatively insoluble and would be expected to remain insoluble throughout the tank cleaning process, which includes bulk removal of solids followed by water washing. Thus, the cleaning actions are expected to remove the more soluble constituents and reduce the volume of solids in the tanks; however, the cleaning may not necessarily change the concentration of constituents in the solids.

Based on available cleaning technology, DOE assumed that the cleaning process would still leave behind a nominal amount of solids in each tank. The density of the solids is relatively low (1.95 lbs./gal.); this value is used to determine the total inventory of constituents in each tank.

Based on this discussion, the process of quantifying the source term concentration and total inventory can be summarized as follows:

1. Concentrations in the solids in each tank are estimated based on sampling results, logs of transfers, and other measurements.

2. Concentrations in the solids remain constant after the tank cleaning process.

3. Each tank is cleaned with a nominal amount of solids remaining in each tank with a density of 1.95 lbs./gal.

4. The total inventory in each tank is based on the assumed concentration and the calculated mass per unit tank based on the information in Step 3 above.

Based on the assumptions given above, DOE estimated the radiological and nonradiological constituent inventories as presented in Tables D-1 and D-2.

DOE assumed that an additional 20 percent of the radioactive contaminants remaining in the tank farm after bulk waste removal and spray washing will be distributed in the ancillary equipment and piping associated with the tank system.

As tanks are closed, sampling and analysis of the residual contamination provides a more accurate source term for these tanks. Since tanks may contain more or less contamination than assumed for the *a priori* F-Area GTS calculation, after each tank is characterized for closure, the impacts of all the tanks in the GTS will be recalculated to ensure all performance objectives are satisfied.

Table D-1. F-Area Tank Farm residual inventory of radionuclides after waste removal followed by cleaning prior to closure (curies).[a]

Radionuclide	Residual remaining after waste removal and cleaning
Se-79	1.2
Sr-90	6.2×10^{4}
Tc-99	270
Sn-126	2.2
Cs-135	0.013
Cs-137	4,300
Eu-154	350
Np-237	0.06
Pu-238	0[b]
Pu-239	130

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. Only trace amounts of Pu-238 are present in F-Area Tank Farm.

Table D-2. F-Area Tank Farm residual inventory of chemicals after waste removal followed by cleaning prior to closure (kilograms).[a]

Constituent	Residual remaining after waste removal and cleaning
Iron	2,300
Manganese	240
Nickel	55
Aluminum	820
Chromium VI[b]	20
Mercury	6.3
Silver	27
Copper	14
Uranium	450
Nitrate	150
Zinc	27
Fluoride	14.2
Lead [c]	24

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. All chromium was modeled as Chromium VI.
c. Additional lead from risers are not included in this value.

D.1.2 SOURCE CONFIGURATION

For the F-Area GTS *a priori* calculation, DOE calculated the impacts at the point of exposure from groups of tanks that were similar in location and structure. In F-Area, all Type I tanks (Tanks 1-8) were grouped together, all the Type III tanks (Tanks 25-28, 33,34, and 44-47) were grouped together, and all the Type IV tanks (Tanks 17-20) were grouped together. These groupings were appropriate because the tanks in each grouping have approximately the same basemat thickness (an important consideration in calculating the retardation effects on contaminants). DOE also performed a sensitivity analysis to ensure that the distance between tanks within a grouping (e.g., all the Type III tanks in F-Area Tank Farm are not adjacent to each other) did not affect substantially the projected results at the point of exposure for a given GTS. The results of this analysis indicate that the distance from F-Area Tank Farm to the point of exposure is relatively large compared to the dimensions of the tank farm so that projected impacts at the point of exposure vary little as the source term is moved within F-Area Tank Farm.

DOE performed a separate MEPAS calculation for each grouping of tanks. For each calculation, DOE entered the source term data (in both concentration and total inventory) for the grouping distributed over a square with area equal to that of the tank bottoms in the grouping. For instance, for the Type I tanks, the source term for the MEPAS calculation would consist of the total inventory of the affected tanks and the concentration of contaminants in the grouping (i.e., the total inventory of the affected tanks divided by the total solids in these tanks) distributed over a square with area equal to the area of the eight Type I tanks.

To account for overlapping of the contaminant plumes from the three separate groupings of tanks, DOE performed the calculations with the three groupings at the same initial physical location (as discussed above, location of the source within the F-Tank Farm boundary has little influence on the calculated concentration at the point of exposure). DOE also summed the centerline concentrations from each plume at the point of exposure to ensure that the highest concentration is reported. Therefore, although the plumes from the groupings may not overlap entirely, DOE's calculation methodology provides an upper estimate for the projected impacts.

D.1.3 RESULTS OF F-AREA GTS *A PRIORI* CALCULATION

As discussed in Section D.1.2, DOE summed the concentrations of each constituent at the centerline of the plume for the F-Area GTS at the point of exposure. Then DOE identified the maximum concentration during the 10,000 year period following closure to determine compliance with performance objectives. For nonradiological constituents, these concentrations can be compared directly to the performance objectives. For the radiological constituents, the total effective dose equivalent is reported in addition to gross alpha concentration. The results of the F-Area GTS *a priori* calculation are provided in Tables D-3 and D-4.

D.2 Contribution of Nontank Sources

DOE used the F-Area GTS represented in Figures 6-2, 6-3, and 6-4 to identify non-tank-farm sources with potential to impact groundwater at the point of exposure (seepline). The F-Area Seepage Basin proved to be the only non-tank-farm source with potentially significant and quantifiable impacts within the GTS.

DOE performed a performance assessment (PA) (Cook 1997) for the F-Area Seepage Basin to evaluate potential contributions of radiological and nonradiological constituents to the peak doses for the F-Area GTS presented in Tables D-3 and D-4. This PA was performed to model current conditions at the seepage basin (excluding effects of the pump-and-treat activities) using best currently available source term and hydrogeologic data. The results of this PA for constituents identified in the seepage basin are presented in Tables D-5 and D-6 for the radiological and nonradiological constituents, respectively.

Table D-5 shows that of the radionuclides that have been identified as present in the seepage basin, only Tc-99 and H-3 have peaks within the 10,000 year period of interest for tank closure. Because of its relatively short radiological hal-flife (12.3 years) and the fact that it does not exist in measurable quantities in tank residuals, groundwater impacts of H-3 resulting from tank closure activities are expected to be inconsequential.

Of the nonradiological constituents with defined performance objectives identified in the F-Area Seepage Basin, only nitrate, nickel, and lead were determined to also exist in significant quantities in the F-Area Tank Farm GTS. The F-Area Tank Farm fate and transport modeling demonstrates that residual nickel and lead would not appear at the point of exposure (Fourmile Branch seepline) in appreciable concentrations within the 10,000 year period of interest. Further, because these two constituents have large distribution coefficients in SRS soil, the peak concentrations at the seepline would not be expected to occur for several hundred thousand years after tank closure.

However, Table D-3 shows that Tc-99 has been determined to be the limiting radionuclide with respect to tank closure impacts at the point of exposure (Barnwell-McBean Aquifer at the Fourmile Branch seepline). The F-Area GTS *a priori* calculation has predicted a Tc-99 peak dose of 1.9 mrem per year occurring 875 years after tank closure. Table D-5 shows that Tc-99 resulting from closure of the seepage basin is expected to peak at 0.18 mrem per year in 1,495 years. Since the F-Area GTS Tc-99 peak has been determined to be the limiting radiological impact, the time-dependent behavior of the seepage basin Tc-99 was reviewed to determine if meaningful quantities would be expected to be present during the GTS peak (875 years). This review determined that the dose contribution from Tc-99 at year 875 for groundwater located 490 meters from the seepage basin (distance to

Table D-3. F-Area GTS *a priori* radiological results at the seepline due to contaminant transport in the three aquifers.

Aquifer		Se-79 dose (mrem/yr)	Tc-99 dose (mrem/yr)	C-14 dose (mrem/yr)	I-129 dose (mrem/yr)	Beta-Gamma dose (mrem/yr)	Total dose (mrem/yr)	Gross alpha concentration (pCi/L)	Lifetime risk
Water Table	Maximum Value	3.4×10^{-2}	1.0	(a)	(a)	1.0	1.0	2.6×10^{-2}	2.2×10^{-5}
	Time of Maximum (yr)	2205	385	(a)	(a)	385	385	3885	
Barnwell-McBean	Maximum Value	3.6×10^{-2}	1.9	(a)	(a)	1.9	1.9	3.9×10^{-2}	4.1×10^{-5}
	Time of Maximum (yr)	5705	875	(a)	(a)	875	875	6405	
Congaree	Maximum Value	(a)	6.5×10^{-3}	(a)	(a)	6.5×10^{-3}	6.5×10^{-3}	3.7×10^{-5}	1.4×10^{-7}
	Time of Maximum (yr)	(a)	5495	(a)	(a)	5495	5495	9345	

a. Value is less than 0.001 mrem/yr.

Table D-4. F-Area *a priori* nonradiological results at the seepline due to contaminant transport in the three aquifers.

Aquifer		Silver	Aluminum	Barium	Fluoride	Chromium	Copper	Iron	Mercury	Nitrate	Manganese	Nickel	Lead	Uranium	Zinc
Water Table	Maximum concentration (mg/L)	7.1×10^{-4}	(a)	(a)	1.8×10^{-4}	3.1×10^{-5}	7.9×10^{-6}	3.9×10^{-3}	(a)	1.8×10^{-3}	3.8×10^{-4}	(a)	(a)	(a)	2.3×10^{-5}
	Time of Maximum (yr)	1085	(a)	(a)	105	4865	9975	4585	(a)	105	5215	(a)	(a)	(a)	8855
Barnwell-McBean	Maximum concentration (mg/L)	1.7×10^{-3}	(a)	(a)	1.1×10^{-3}	4.6×10^{-5}	(a)	5.8×10^{-3}	(a)	1.2×10^{-2}	5.6×10^{-4}	(a)	(a)	(a)	9.3×10^{-6}
	Time of Maximum (yr)	1365	(a)	(a)	1015	9625	(a)	7665	(a)	1015	8855	(a)	(a)	(a)	9975
Congaree	Maximum concentration (mg/L)	(a)	(a)	(a)	5.8×10^{-6}	(a)	(a)	2.5×10^{-5}	(a)	6.1×10^{-5}	1.2×10^{-6}	(a)	(a)	(a)	(a)
	Time of Maximum (yr)	(a)	(a)	(a)	1085	(a)	(a)	6405	(a)	1085	8225	(a)	(a)	(a)	(a)

a. Concentration is less than 0.000001 mg/L.

Table D-5. F-Area Seepage Basin performance assessment results for radiological constituents of concern.

Nuclide	Maximum concentration (pCi/L)	Time of maximum concentration (years)	Average dose at peak time (mrem/yr)
Cs-137	~0	>1,700,000	~0
I-129	25	37,785	0.51
Tc-99	190	1,495	0.18
H-3	1.7	180	7.8×10^{-5}
U-234	0.65	150,496	0.12
U-235	0.35	150,567	0.063
U-238	1.7	150,567	0.29
Pu-239	2.1×10^{-6}	368,726	6.5×10^{-6}
Am-241	~0	345,152	~0
Sr-90	~0	27,674	~0
Y-90	~0	27,674	~0

Table D-6. F-Area Seepage Basin performance assessment results for nonradiological constituents of concern.

	Maximum concentration (mg/L)	Time of maximum concentration (years)	Average dose at time of maximum concentration (mg/kg/day)
Cadmium	1.1×10^{-4}	22,783	3.3×10^{-6}
Chromium	~0	>101,000	~0
Lead	~0	>101,000	~0
Mercury	~0	>101,000	~0
Nitrate	7.0	198	0.2
Phosphate	1.5	13,370	0.044
Sodium	14	198	0.4

point of exposure) was insignificant. Therefore, because the seepage basin peak occurs much later than the tank farm peak, the Tc-99 releases from the F-Area Seepage Basin do not effect the radiological performance objectives of the F Area GTS.

Nitrate is the only nonradiological constituent of concern common to both the F-Area GTS and the F-Area Seepage Basin that is expected to peak within the 10,000 year period of interest. The temporal relationship is similar to that for Tc-99. Although the F-Area GTS and the seepage basin have overlapping peaks at 200 years, the GTS peak is much less than 1 percent of the seepage basin maximum value of 7 milligram per liter. Therefore, the GTS nitrate peak, whenever it occurs, will not affect the seepage basin maximum value appreciably.

Because of the reasons given above, fate and transport modeling of the seepage basin and the

GTS has determined that the impacts of all common constituents of concern within the two waste units are separated in time or magnitude to such an extent that they are not additive in nature.

D.3 Adjusted Performance Objectives

DOE evaluated performance standards to determine the overall performance objectives. Table D-7 lists the GSA overall performance objectives at the seepline and stream, which are the points of exposure.

DOE calculated adjusted performance objectives based on the contributions of sources within the GTS upgradient from the seepline. Based on the source identification, the sources used to calculate adjusted performance objectives were the HLW tank systems and F-Area Seepage Basin.

As discussed in Section D.2, due to differences in peak times or relative magnitudes, DOE assumes that the seepage basin does not contribute constituents during the F-Area GTS peaks at the seepline in the limiting aquifer (Barnwell-McBean). Therefore, the adjusted performance objectives for the point of exposure are equal to the overall performance objectives listed in Table D-7. The following equation expresses this determination:

$$PO_a = PO - C_{os}$$

where: PO_a = Adjusted performance objective
PO = Overall performance objective

Table D-7. Seepline and stream performance objectives for the F-Area GTS.

Constituent	Units	Seepline	Stream
Radiological			
Beta-gamma dose	mrem/yr	4	4
Alpha concentration	pCi/L	15	15
Total dose[a]	mrem/yr	4	4
Nonradiological			
Iron	mg/L	-	1
Aluminum	mg/L	-	0.087
Nickel	mg/L	0.1	0.088
Chromium[b]	mg/L	0.1	0.011
Mercury	mg/L	0.002	1.20×10^{-5}
Silver	mg/L	0.05	0.0012
Copper	mg/L	1.3	0.0065
Nitrate (as N)	mg/L	10	-
Fluoride	mg/L	4.0	-
Lead	mg/L	0.015	0.0013
Barium	mg/L	2.0	50
Manganese	mg/L	-	1.0
Zinc	mg/L	-	0.059

a. Total dose (combined alpha and beta-gamma radioactivity) limit used for comparison with performance standards in Appendix C.
b. Total chromium (chromium III and VI).

C_{os} = Contribution of other sources at peak contribution from the HLW tank system

Since C_{os} = 0 (zero):

PO_a = PO - 0 (zero)

PO_a = PO

The adjusted performance objective is analogous with the performance objective for all tank systems in F-Area GTS.

D.4 Previous Closures

DOE must also account for the projected impacts from previous tank closure. The only tank that has undergone closure prior to Tank 17 is Tank 20 in the F-Area Tank Farm. Fate and transport modeling of the residual contamination remaining in the Tank 20 system was performed by DOE and documented in the *Industrial Wastewater Closure for the High-Level Waste Tank 20 System* (DOE 1997). Table D-8 lists the results of the Tank 20 modeling under the "Previous Closures" column. The values listed in this column for each constituent represent the Tank 20 impacts at the time of the GTS peak for that constituent.

D.5 Calculation of Remaining Performance Objectives

Fate and transport modeling of the F-Area Tank Farm *a priori* calculation has determined that the overall performance objectives for the GSA will be satisfied. Therefore, DOE must calculate impacts due to closure of Tank 17 for individual constituent contribution at the GTS constituent peak times and subtract this impact from the adjusted performance objectives to determine the remaining overall performance objective. For example, the GTS radiological peak has been predicted to occur in the limiting aquifer (Barnwell-McBean) 875 years after tank farm closure (Table D-3) but the Tank 17 peak in this aquifer has been predicted to occur 1,855 years after closure. The 875 year peak is limiting because the Tank 17 peak is two orders of magnitude smaller (1.9 versus 0.007 mrem per year) and, therefore, the Tank 17 contribution to the GTS peak at 875 years post closure must be calculated and subtracted from the adjusted performance objective to determine the remaining performance objective. The same calculation must be performed for nonradiological constituents.

The remaining performance objective relationship for the F-Area GTS is given by the following expression:

$$PO_r = PO_a - D_{pC} - D_{17}$$

where: PO_r = Remaining performance objective

PO_a = Adjusted performance objective

D_{pc} = Contribution from previous closures (i.e., Tank 20) at time of peak contribution from the F-Area Tank Farm

D_{17} = Contribution of Tank 17 at time of peak contribution from the F-Area Tank Farm

The performance objectives (based on dose equivalent limits) for radiological constituents are additive for different radionuclides. Therefore, the remaining performance objective calculation must consider the contribution of each radionuclide at the time the total peak from all radionuclides reaches each point of exposure.

This is done by examining the MEPAS output results for each radionuclide and determining the fraction of the total peak attributable to each radionuclide.

To determine the remaining performance objectives, the Tank 17-specific modeling results (evaluated at the time of maximum GTS impacts) were subtracted from the adjusted performance objective (provided in Tables D-8 for the Barnwell-McBean Aquifer). Table D-8 lists these results for the seepline location in the Barnwell-McBean Aquifer.

Table D-8. Tank 17 impacts and remaining performance objectives for the F-Area GTS.

		Seepline				Stream			
	Units	Adjusted PO	Previous Closures[a]	Tank 17	Remaining PO	Adjusted PO	Previous Closures[a]	Tank 17	Remaining PO
Radiological									
Beta-gamma dose	mrem/yr	4.0	0.0055	0.022	3.99	4.0	3.0×10^{-5}	1.2×10^{-4}	4.0
Alpha concentration	pCi/L	15	(b)	(b)	15	15	(b)	(b)	15
Total dose	mrem/yr	4.0	0.0055	0.022	3.99	4.0	3.0×10^{-5}	1.2×10^{-4}	4.0
Nonradiological[c]									
Iron	mg/L	-	-	1.4×10^{-4}	-	1	3.5×10^{-6}	7.5×10^{-6}	1
Nickel	mg/L	0.1	0	(d)	0.1	0.088	0	(d)	0.088
Chromium[e]	mg/L	0.1	5.0×10^{-6}	1.1×10^{-6}	0.1	0.011	2.7×10^{-8}	5.7×10^{-8}	0.011
Mercury	mg/L	0.002	0	(d)	0.002	1.2×10^{-5}	0	(d)	1.2×10^{-5}
Silver	mg/L	0.05	1.9×10^{-4}	4.1×10^{-4}	0.049	0.0012	1.0×10^{-6}	2.3×10^{-6}	0.0012
Copper	mg/L	1.3	0	(d)	1.3	0.0065	0	(d)	0.0065
Nitrate	mg/L	10	1.3×10^{-3}	7.5×10^{-3}	10	-	-	4.1×10^{-5}	-
Lead	mg/L	0.015	0	(d)	0.015	0.0013	0	(d)	0.0013
Fluoride	mg/L	4.0	1.3×10^{-4}	2.7×10^{-5}	4	-	-	1.5×10^{-6}	-
Manganese	mg/L	-	-	1.1×10^{-5}	-	1.0	1.5×10^{-7}	6.0×10^{-7}	1.0
Zinc	mg/L	-	-	5.9×10^{-6}	-	0.059	1.5×10^{-8}	3.1×10^{-8}	0.059
Barium	mg/L	2.0	0	(d)	2	50	0	(d)	50

a. Tank 20.
b. Concentration is less than 1.0×10^{-13} pCi/L.
c. Aluminum does not reach seepline in 10,000 years.
d. Concentration is less than 1.0×10^{-6} mg/L.
e. Total chromium (chromium III and VI).

To determine the Tank 17 impacts and the remainder performance objective for chemical constituents, DOE had to determine the relative contribution to the F-Area GTS peak concentration attributable to Tank 17. DOE used a method similar to that described for radiological constituents, except it derived peak contributions for each contaminant because concentrations of the different contaminants are not additive.

DOE derived the GTS remaining chemical constituent performance objectives by subtracting the Tank 17 peak impact from the adjusted GTS performance objective. For example, the chromium contribution attributable to Tank 17 at the GTS peak time is 3.4×10^{-6} milligram per liter. Therefore, the remaining GTS performance objective is 0.1 minus 3.4×10^{-6} or 0.0999966 or effectively 0.1. Table D-8 lists the Tank 17 impacts results for all chemical constituents of concern.

D.6 Summary

The iterative nature of the GTS calculation, using continually refined source term data will provide reasonable assurance that the impacts of future closure activities do not exceed overall performance objectives. As tanks are closed, sampling and analysis of the residual contamination provides a more accurate source term for these tanks. Since tanks may contain more or less contamination than assumed for the *a priori* F-Area GTS calculation, after each tank is characterized for closure, the impacts of all the tanks in the GTS will be calculated to ensure all performance objectives are satisfied. The information from these calculations will be updated with each subsequent tank closure.

In using this method, DOE takes credit for the fact that constituents of concern from various areas impact compliance points at different times due to varying closure scenarios and geological conditions. In addition, the method can determine the level of resources required for future site remediation activities.

References

Cook, J. R., 1997, *Recalculation of Releases from Closed F-Area Seepage Basins*, SRT-WED-96-0256, Westinghouse Savannah River Company, Aiken, South Carolina, January.

DOE (U.S. Department of Energy), 1996, *Industrial Wastewater Closure Module for the High-Level Waste Tank 17 System*, Savannah River Site Construction Permit Number 17,424-IW, Revision 1, Savannah River Operations Office, Aiken, South Carolina, April 2.

DOE (U.S. Department of Energy), 1997, *Industrial Wastewater Closure Module for the High-Level Waste Tank 20 System*, Revision 1, Savannah River Operation Office, Aiken, South Carolina, January 8.

Hester, J.R., 1999, Westinghouse Savannah River Company, “Tank Surrogates,” electronic message to P. Fulmer, Tetra Tech NUS, May 5.

Newman, J.L., 1999, Westinghouse Savannah River Company, “WCS Database” electronic message to P. Young, Tetra Tech NUS.

APPENDIX E

APPROVED FFA WASTE REMOVAL PLAN AND SCHEDULE

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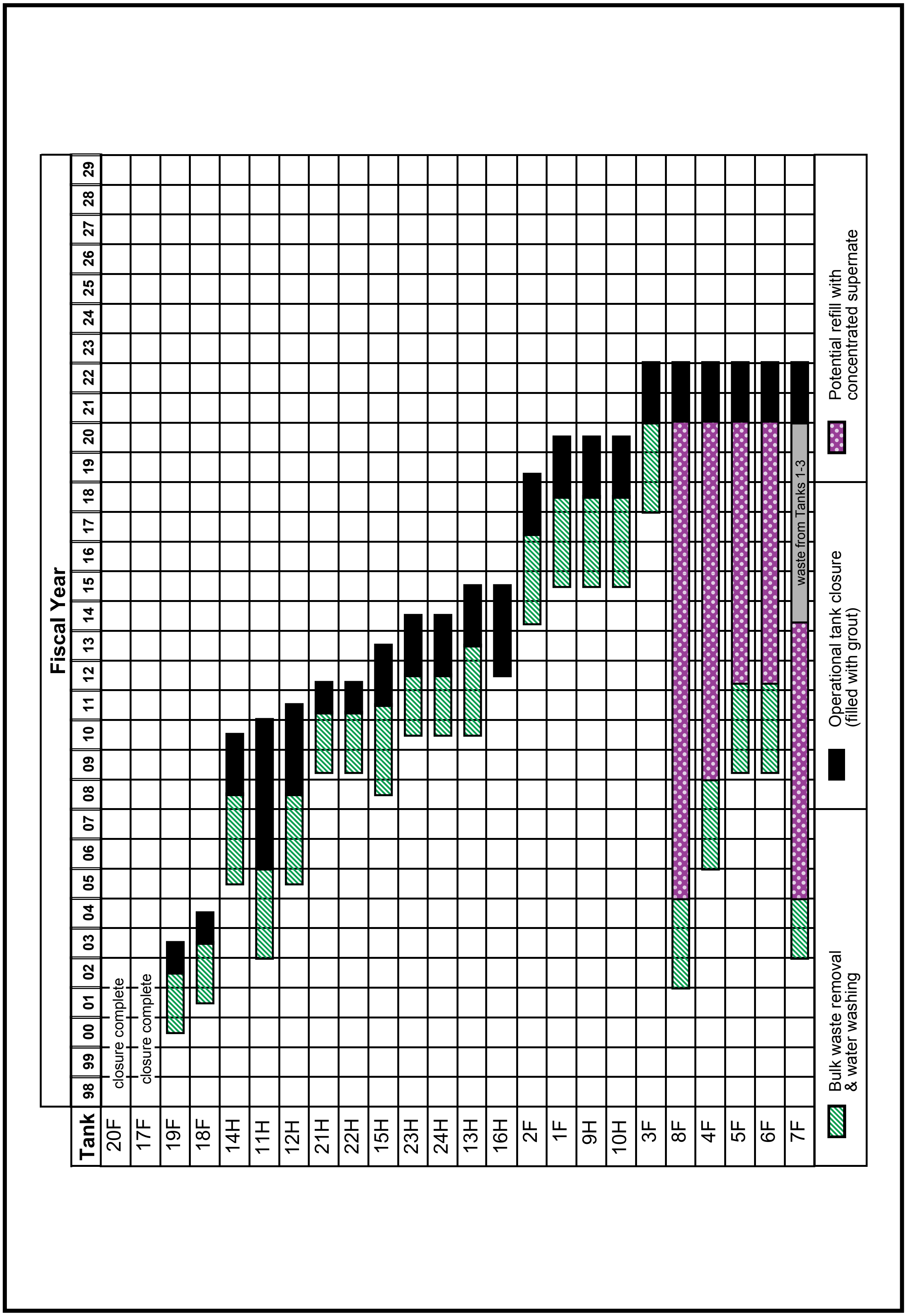

NW TANK/General Closure Plan Update/Grfx/E-1 App FFA Waste Rem Plan&Sch.ai

Figure E-1. Approved FFA Waste Removal Plan and Schedule.

APPENDIX F

PUBLIC COMMENTS AND RESPONSES