1.0 EXECUTIVE SUMMARY

This Performance Assessment (PA) for the Savannah River Site (SRS) was prepared to support the eventual removal from service of the H-Area Tank Farm (HTF) underground radioactive waste tanks and ancillary equipment. This PA provides the technical basis and results to be used in subsequent documents to demonstrate compliance with the pertinent requirements identified below for removal from service and eventual final closure of the HTF.

- U.S. Department of Energy (DOE) Order 435.1 Change 1
- Title 10 Code of Federal Regulations (CFR) Part 61 Subpart C as identified in "*Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005,*" Section 3116
- South Carolina Department of Health and Environmental Control (SCDHEC) Regulations Chapter 61, Articles 67 and 82
- *Federal Facility Agreement* (FFA) *for the Savannah River Site,* WSRC-OS-94-42

The key requirements from these documents necessitate development and calculation of the following for the HTF: potential radiological doses to a hypothetical member of the public (MOP), potential radiological doses to a hypothetical inadvertent intruder, radiological dose to a human receptor via the air pathway, radon flux, and water concentrations (Table 1.0-1). All of these calculations were performed to provide results over a minimum of 10,000 years. The water concentrations were calculated for both radioactive and non-radioactive contaminants at multiple locations outside the HTF.

Table 1.0-1: Key Values from Regulatory Documents

Document	All-Pathways Dose	Inadvertent Intruder Dose	Air Pathway Dose	Radon Flux	Groundwater Protection
NDAA Section 3116: 10 CFR 61.41 and 61.42	25 mrem/yr	500 mrem/yr	N/A	N/A	N/A
DOE O 435.1 Chg 1	25 mrem/yr	500 mrem - acute 100 mrem/yr - chronic	10 mrem/yr	20 pCi/m^2/s at ground surface	< MCL
SCDHEC R.61-67 and R.61-82	N/A	N/A	N/A	N/A	< MCL

N/A = Not applicable
MCL = Maximum Contaminant Level

H Area is in the north-central portion of the SRS and occupies approximately 395 acres. The HTF is an active facility consisting of 29 waste tanks and associated ancillary equipment such as transfer lines, evaporators, and pump tanks. The HTF waste tanks are in varying degrees of service or waste removal operations with waste that was generated primarily from the H-Canyon chemical separations processes. The HTF began radioactive operations in 1955. One of the 29 waste tanks (Tank 16) underwent cleaning from 1979 through 1980.

In support of environmental restoration activities at SRS, the DOE, the Environmental Protection Agency (EPA), and SCDHEC signed the FFA pursuant to Section 120 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Sections 3008(h) and 6001 of Resource Conservation and Recovery Act (RCRA). As part of this comprehensive agreement, the DOE has committed to remove from service those liquid radioactive waste tank systems that do not meet the standards set forth in Appendix B of the FFA. Appendix B of the FFA also defines the specific radioactive waste tank systems that are subject to the agreement. [WSRC-OS-94-42]

In accordance with the FFA requirements for high-level radioactive waste tank system(s), a construction and operating permit was obtained from the SCDHEC for the SRS tank farm waste tank systems; the *F and H Area High Level Radioactive Waste Tank Farms Construction Permit No. 17,424-IW* (hereinafter referred to as IWW Construction Permit #17,424-IW). [DHEC_03-03-1993] The FFA requires that waste tank system(s) that have been issued an industrial wastewater (IWW) operating permit under the Pollution Control Act (PCA), shall be removed from service in accordance with S.C. Code Ann., Section 48-1-10, et seq. (1985) and all applicable regulations promulgated pursuant to the PCA. Applicable regulations include SCDHEC Regulation 61-67, *Standards for Wastewater Facility Construction* and SCDHEC Regulation 61-82, *Proper Closeout of Wastewater Treatment Facilities*. [WSRC-OS-94-42 Section IX.E (4)] The SCDHEC has advised that this process will involve two bureaus (Bureau of Water and Bureau of Land and Waste Management).

The regulatory process to complete closure of the HTF requires the development of multiple detailed technical documents with reviews and approvals by multiple state and federal agencies. The documents involved include a Basis for Section 3116 Determination for Closure of the HTF document, which will be used to demonstrate compliance with the criteria set forth in Section 3116 of the *Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005* (hereinafter referred to as NDAA Section 3116). [NDAA_3116] The Basis for Section 3116 Determination for Closure of HTF document is to be reviewed and approved by the DOE, in consultation with the U.S. Nuclear Regulatory Commission (NRC). Approval of the 3116 Waste Determination for Closure of HTF document by the Secretary of Energy is then required to document that the residual waste can be classified as non-high level waste for purposes of on-site disposition. The Secretary of Energy determination under NDAA Section 3116 incorporates by reference 10 CFR 61, Subpart C performance objectives. This HTF PA provides the technical basis that will be used to demonstrate compliance with 10 CFR 61.41 (Protection of the General Population from Releases of Radioactivity), and 61.42 (Protection of Individuals from Inadvertent Intrusion) performance objectives that will be presented in the Basis for Section 3116 Waste Determination for Closure of HTF document. [10 CFR 61] These performance objectives are used in lieu of the comparable performance objectives from DOE O 435.1 Chg 1.

The HTF PA is also prepared to support implementation of applicable DOE O 435.1 Chg 1 requirements including a Tier 1 closure plan, tank-specific special analyses, and Tier 2 closure plans. Compliance with the SCDHEC regulations will be demonstrated using two primary documents that are supported by this HTF PA. The first is to be an HTF IWW General Closure Plan (GCP), which will establish the general protocols, requirements, and processes for closure of the HTF. The second document(s) are the waste tank-specific closure modules that authorize the grouting of a specific waste tank, group of waste tanks, and/or ancillary equipment. Both the HTF GCP and the HTF waste tank-specific closure modules are reviewed and approved by the DOE and SCDHEC.

The HTF PA modeling consisted of a hybrid approach of both deterministic modeling for compliance results and probabilistic modeling for uncertainty and sensitivity analyses (UA/SA). A deterministic evaluation was used to assess the Base Case (Case A), perform single parameter sensitivity analyses, and utilized the PORFLOW computer code. The Base Case evaluation yielded a single result utilizing conservative best estimate input parameters. A stochastic evaluation, based on the GoldSim platform, was used for the UA/SA. The PORFLOW deterministic evaluation modeled flow and transport in both the near-field and far field while the flow parameters were utilized in a GoldSim analytical model for stochastic evaluation. The stochastic model results were benchmarked against the deterministic model to ensure consistency in model results. The stochastic evaluation ensured that collective impacts were evaluated in the uncertainty analyses and sensitive parameters were identified in the sensitivity analyses.

The deterministic and probabilistic models both utilize a general HTF Integrated Conceptual Model (ICM) that simulates radiological and chemical contaminant release from the 29 waste tanks and associated ancillary equipment in the HTF. An independent conceptual waste release model was used to simulate stabilized contaminant release from the grouted waste tanks based on various chemical phases in the waste tanks, controlling solubility and thereby affecting the timing and rate of release from the Contamination Zone (CZ). This ICM approach considers the integrity of the waste tank steel liners and cementitious barriers during waste tank modeling.

The modeling results in the HTF PA provides the technical information at different points of assessment that can be utilized in the subsequent decision documents such as the Basis for Section 3116 Waste Determination for Closure of HTF document or the HTF GCP. The MOP doses, consistent with the requirements of 10 CFR 61.41, are provided at 100 meters and the seepline and were calculated using the parameters presented in Sections 4.6 and 4.7. This HTF PA provides groundwater radionuclide concentrations at 1 meter, 100 meters, and exposure points at the two seeplines impacted by the HTF. The groundwater concentrations are provided for each of the three potentially impacted aquifers as applicable, as a part of the HTF groundwater modeling. The HTF PA also provides groundwater concentrations for chemical contaminants at 1 meter and 100 meters. In addition, this HTF PA provides inadvertent intruder doses consistent with the requirements for 10 CFR 61.42, as well as analyses for the air pathways and radon ground surface flux consistent with the requirements for DOE O 435.1 Chg 1. The key radiological results from the HTF PA modeling and dose calculations are shown in Table 1.0-2.

Table 1.0-2: Summary Radiological Results for HTF

Location	Peak Within 10,000 Years		
	All-Pathways Dose (mrem/yr)	**Groundwater Pathway Dose (mrem/yr)**	**Air Pathway Dose (mrem/yr)**
100m from HTF	~ 1.0	~ 1.0	< 0.0001
At Seepline	< 0.1	< 0.1	< 0.0001
	Acute Dose (mrem)	**Chronic Dose (mrem/yr)**	
1m from HTF (Inadvertent Intruder)	< 1 mrem	54 mrem	
	Peak Radon Flux (pCi/m^2/sec)		
Ground Surface	~ 1.8E-15		

The UA/SA can be used to place the deterministic analyses results into context (i.e., to risk inform the deterministic results). The peak of the mean all-pathways doses within 10,000 years using the probabilistic model (e.g., for Case A) was 1.0 mrem/yr from the uncertainty analyses. The median (50th percentile) and 95th percentile values were 0.5 mrem/yr and 3.8 mrem/yr, respectively. The mean value of all peak doses within 10,000 years (regardless of time) using the probabilistic model (e.g., for Case A) was 3.7 mrem/yr from the uncertainty analyses.

The peak groundwater radionuclide concentrations were calculated, and on an individual radionuclide basis, all of the radionuclides were less than the MCL at 100 meters with the MCL values for beta and photon emitters calculated in EPA 815-R-02-001. The total beta-gamma radionuclides when calculated on a per-year basis are less than the total beta-gamma limit. All radionuclides were well below the MCL or Preliminary Remediation Goal (PRG) at the seepline. The peak concentrations for 17 chemicals were calculated, and all were less than the MCL or Regional Screening Level (RSL) at a distance of 100 meters from the HTF. Only Tc-99 and manganese were above the MCL at one meter.

A probabilistic uncertainty analysis was conducted for an all scenario case and for Cases B through E in addition to Case A. A probabilistic sensitivity analysis was conducted for Cases A, D and E. Cases B and C are similar to Cases D and E except for the basemat fast flow zone and therefore sensitive parameters for Cases B and C should be identified in the sensitivity analyses for Cases D and E. Multiple deterministic sensitivity analyses were conducted for the various barriers including the closure cap, waste tank grout (hereinafter referred to as grout), CZ, steel liner, and natural barrier. The results of the UA/SA were used to gain understanding of the system performance, provide confidence in the model results, and indicate areas of sensitivity that may warrant future work.

This HTF PA provides necessary technical basis and information to support development of the regulatory documents required for closure of the HTF waste tanks and waste tank systems. The information from the HTF PA can be utilized to determine compliance with the specific requirements during the development of the various individual documents.

2.0 INTRODUCTION

The potential radiological dose to receptors typically is evaluated with a PA model that simulates the release of radionuclides from the disposal or closure site, transport of radionuclides through the environment, and exposure to potential receptors from residual material. The PA process provides the technical basis for subsequent decision documents to demonstrate compliance with the performance objectives of the 10 CFR 61, DOE O 435.1 Chg 1, SRS FFA, and SCDHEC R.61-82 and R.61-67. The HTF PA utilized an enhanced inter-agency scoping meeting process during the development/planning phases of the HTF PA, which resulted in an increased understanding of the HTF PA modeling approaches and assumptions.

2.1 General Approach

The PAs are used to assess the long-term fate and transport of residual contamination in the environment and provide the DOE with reasonable assurance that the removal from service of the SRS tank farm underground radioactive waste tanks and ancillary equipment will meet defined performance objectives for the protection of human health and the environment into the future.

The HTF PA was completed to support multiple decision documents, including the HTF IWW GCP and tank-specific closure modules. These documents support the closure of waste tanks to meet the FFA commitments. [WSRC-OS-94-42] The HTF PA development process included a public scoping meeting with the interface agencies in the input development stage. The purpose of the scoping meeting held during the development/planning phase of HTF PA inputs was to identify potential issues early, assess the reasonableness of key modeling assumptions, and reduce the risk of significant rework and remodeling after the HTF PA is finalized.

In accordance with the FFA, DOE obtained a wastewater construction and operating permit from SCDHEC for the waste tanks. The DOE is now removing from service the SRS waste tanks that do not meet the standards established in Appendix B of the FFA. [WSRC-OS-94-42]

After waste removal operations, any residual contaminants will be stabilized and the waste tanks shall be removed from service in accordance with the PCA S.C. Code Ann., Section 48-1-10, et seq. (1985) and all applicable regulations promulgated pursuant to the PCA. [WSRC-OS-94-42, Section IX.E.(4)] Applicable regulations include SCDHEC Regulation 61-67, *Standards for Wastewater Facility Construction* and SCDHEC Regulation 61-82, *Proper Closeout of Wastewater Treatment Facilities*. Removal from service includes operational closure of the waste tank systems under, and then removal from, the IWW construction and operating permit, IWW Construction Permit #17,424-IW, and the FFA which will control the subsequent remediation of the HTF. [DHEC_03-03-1993, WSRC-OS-94-42] The DOE followed this process in closure of Tanks 17 and 20, located in the F-Area Tank Farm (FTF).

The general protocol that the DOE is following in closing the underground waste tank systems will appear in a HTF Industrial Wastewater GCP, to be issued in the future. Each waste tank system will have a detailed tank-specific closure module, and after each waste tank system operational closure activities have been satisfactorily completed, the waste tank system will be removed from the conditions of IWW Construction Permit #17,424-IW. [DHEC_03-03-1993] The contents of the HTF GCP and the tank-specific closure modules will be consistent with all regulations implementing the PCA S.C. Code Ann., Section 48-1-10, et seq. (1985). [Title 48_Chapter 1_SC Laws]

Because of previous releases to the environment, the HTF will be closed under provisions of the FFA after all the individual waste tank and ancillary equipment, as applicable, is grouted. In the FFA, each tank farm has been designated as an "operable unit" (OU). The OUs will undergo closure in accordance with the FFA (Sections XI through XVI) and any RCRA/CERCLA response action relating to the waste tank systems. [WSRC-OS-94-42 Appendix C]

Relative to the performance objectives for the tank farms, this closure process facilitates consideration for both single waste tank and collective waste tank system impacts from the closed waste tanks and related ancillary equipment. In the area, in determining the final closure status of the General Separations Area (GSA), the impacts from both the waste tank systems and previous release sites will be considered.

The HTF PA is also prepared in support of the waste determination process to ensure the NDAA Section 3116 criteria are met before the waste tanks are removed from service. The NDAA was passed by congress on October 9, 2004, and signed by the president on October 28, 2004. Section 3116 of the NDAA contains the criteria for DOE to use to classify waste as non-high level waste for on-site disposition purposes and is applicable only to South Carolina and Idaho. The DOE intends to coordinate the waste determination and state closure plan approval efforts to support the waste tank closure schedule provided in the FFA. In addition, the HTF PA is prepared to support implementation of applicable DOE O 435.1 Chg 1 requirements, including the Tier 1 Closure Plan. [NDAA_3116, WSRC-OS-94-42]

2.1.1 Performance Assessment Scoping Meeting

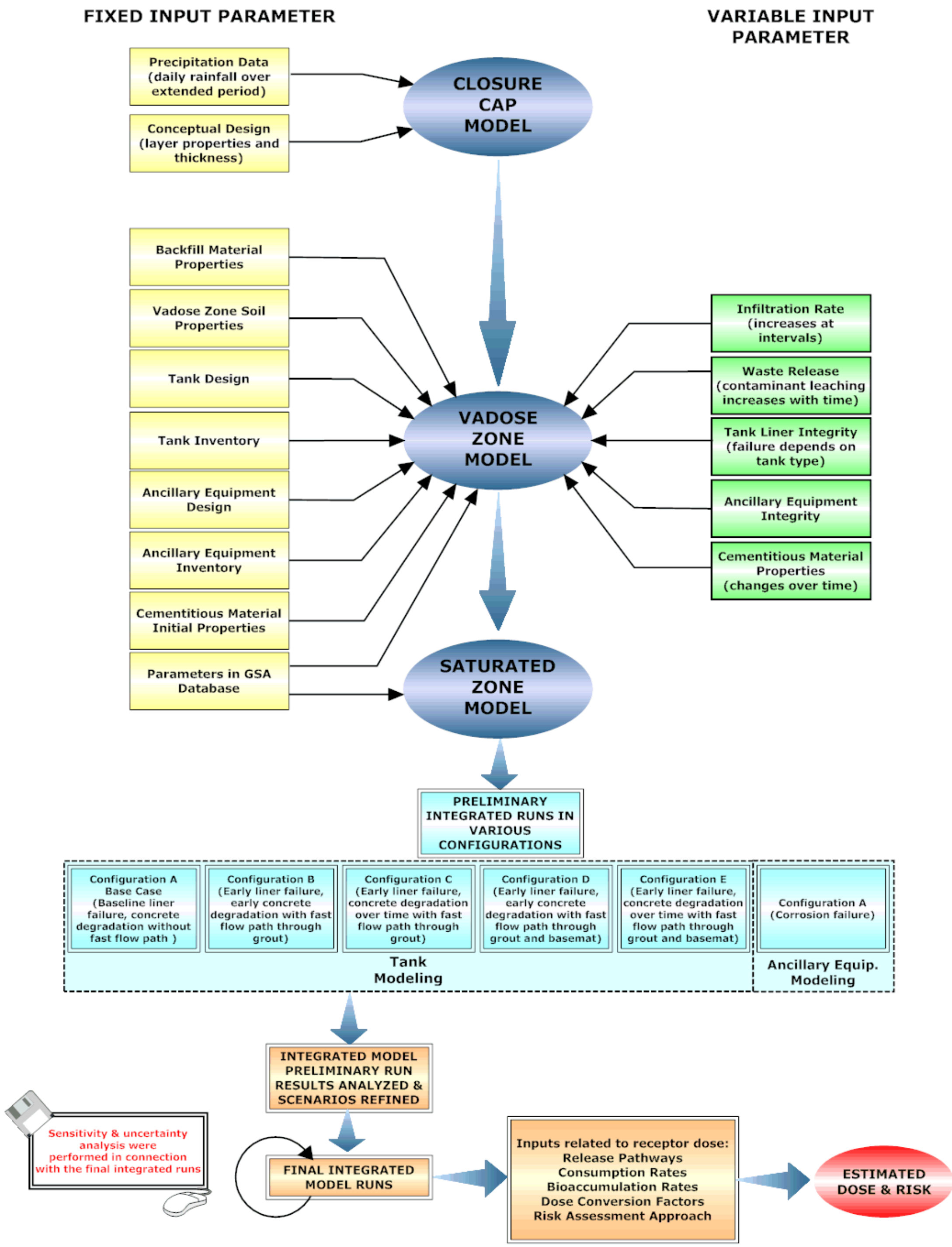
Completion of closure activities such that they meet FFA commitments created the desire to reduce the comment resolution schedule durations and any potential remodeling resulting from the reviews of the HTF PA after completion. It was therefore prudent to have a scoping meeting during HTF PA input data development to obtain up-front understanding, and discuss assumptions to minimize downstream rework and remodeling. While it is recognized that concerns may surface on input parameters utilized after modeling and additional reviews are completed, the up-front review and comments will minimize the risk and severity of concerns after completion of modeling.

The purpose of the scoping meeting was to facilitate candid technical discussion on input parameters related to the HTF PA modeling. To accomplish this goal, on April 20 through 22, 2010, a public meeting with representatives from SCDHEC, EPA, and the NRC was held to discuss and review individual input packages. [ML100970781] This scoping meeting (and the HTF PA process in general) also incorporated improvements from previous PA developments, in particular lessons learned from the FTF PA.

2.1.2 Modeling Process

Figure 2.1-1 illustrates the general process followed in implementing the ICM for the HTF PA. This figure shows the three component models and their key inputs.

Figure 2.1-1: HTF PA Modeling Relationships



Some key inputs involve fixed parameters that do not change over time. These are shown on the left side of Figure 2.1-1 where as the key inputs on the right side do change over time. The manner in which an input changes is described in later sections of this PA. Input packages were prepared as review materials for the scoping meeting. The input package contents and any action items from the scoping meetings are incorporated into the respective HTF PA sections. The enhanced consultation process advantages are further discussed in *Enhanced Consultation Process for Waste Determination Activities Conducted Under the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*, a memo issued by the NRC in June of 2007 concerning the FTF PA scoping meetings process. [ML071550458]

As shown in Figure 2.1-1, five waste tank cases and one ancillary equipment case were identified for the model runs, which were accomplished using the applicable computer codes identified in Section 4.3. These cases were analyzed by running the models using different combinations.

The results of the preliminary model runs were analyzed. Based on this analysis, the model was refined. After these refinements were made, the final model runs were performed. The UA/SAs were performed in connection with the final model runs, with the results being incorporated into the final model runs. The sensitivity analyses included a series of model runs to evaluate the importance of specific barriers to radionuclide release.

The result of this process produced predicted contaminant concentrations in groundwater that could affect a MOP or an intruder. The data for radiological contaminants were used in combination with the inputs related to receptors (Figure 2.1-1) to estimate the potential dose to a hypothetical MOP or an intruder. The data for non-radiological contaminants were used as specified in Section 4.8 to determine the resulting risk to the hypothetical MOP. This risk assessment approach followed the SRS Accelerated Closure Projects (ACP) protocols for human health and ecological risk assessments. [ERD-AG-003_F.17, ERD-AG-003_P.1.4, ERD-AG-003_P.1.5, ERD-AG-003_P.5.2, and ERD-AG-003_P.10.1]

2.2 General Facility Description

2.2.1 Savannah River Site

The SRS is located in south-central South Carolina, approximately 100 miles from the Atlantic Coast. The major physical feature at SRS is the Savannah River, approximately 20 miles of which serves as the southwestern boundary of the site and the South Carolina-Georgia border. The SRS encompasses portions of Aiken, Barnwell, and Allendale counties in South Carolina. The SRS occupies approximately 310 square miles, or 198,000 acres, and contains operations, service, and research and development areas. The developed areas occupy less than 10% of the SRS footprint while the remainder of the site is undeveloped forest or wetlands. [SRS-REG-2007-00002]

2.2.2 H-Area Tank Farm

H Area is in the north-central portion of the SRS and occupies 395 acres. Section 3.1.1 provides detailed location information for H Area and the location of HTF within H Area. The HTF is an active facility consisting of 29 carbon steel waste tanks in varying degrees of service or waste removal operations. The waste was generated primarily from the H-Canyon chemical separations processes.

The proposed sequence of events for closure of the HTF is as follows:

- Remove from service the Types I, II, and IV waste tanks and finally the Type III/IIIA waste tanks. The ancillary equipment, such as transfer lines, pump tanks and pump pits (PP), diversion boxes (DBs) and valve boxes, will be removed from service as appropriate with a goal of closing geographic sections of the HTF in stages.
- Following closure of a geographic section, that section will be left in an interim state in preparation for final closure of the HTF OU. For example, the section may be filled in with backfill after removal from service of the individual waste tanks and ancillary equipment to establish an even-grade elevation with the remainder of the HTF.
- Following removal from service of all the HTF waste tanks and ancillary equipment, the HTF will undergo final closure of the HTF OU in accordance with the FFA and any RCRA/CERCLA response action related to any of the HTF waste tank systems. [WSRC-OS-94-42]

2.3 Facility Life Cycle

The HTF waste tanks were built during five separate construction periods, with a different waste tank design for each period, leading to the designation of the following five different waste tank groups:

- Tanks 9 through 12 are Type I waste tanks and were constructed in the early 1950's
- Tanks 13 through 16 are Type II waste tanks and were constructed between 1955 and 1956
- Tanks 21 through 24 are Type IV waste tanks and were constructed between 1958 and 1962
- Tanks 29 through 32 are Type III waste tanks and were constructed between 1967 and 1970
- The fifth group of 13 waste tanks, which consists of Tanks 35 through 43 and 48 through 51 are Type IIIA waste tanks and they were constructed between 1974 and 1981.

The listed waste tank types and numbers identified above are located in the HTF and are not sequential because waste tank numbers 1 through 8, 17 through 20, 25 through 28, 33 and 34, and 44 through 47 are all located in the FTF and they are addressed in the FTF PA issued previously. [SRS-REG-2007-00002] The history of the construction periods for the waste tanks is documented in the *Annual Radioactive Waste Tank Inspection Program - 2009*. [SRR-STI-2010-00283] Waste tank liner and ancillary equipment integrity is discussed in Section 4.2.2.2.6.

The HTF is currently in the operational period during which waste transfers into the HTF are still permitted. Waste removal from the waste tanks is also in progress during the operational period. Once the HTF waste tanks and ancillary equipment have been grouted and closed, it is anticipated that a closure cap will be installed (for the purpose of this PA, a 100-year period of institutional control is assumed to begin after the closure cap is installed. Receipt operations will end several years prior to final closure (i.e., the beginning of 100-year period of institutional control), which is currently anticipated in 2032.

The closure cap will be monitored, maintained, and repaired as necessary during the institutional control period.

2.4 Related Documents

The HTF PA was prepared within the regulatory context of low-level waste (LLW) management per DOE O 435.1 Chg 1 and the associated implementation manual (DOE M 435.1-1). Additional context has been added to address NDAA Section 3116, SCDHEC wastewater construction and operations permit regulations, and the SRS FFA pursuant to Section 120 of CERCLA and Sections 3008(h) and 6001 of RCRA. [SCDHEC R.61-67, SCDHEC R.61-82, DHEC_03-03-1993, WSRC-OS-94-42] The *Radioactive Waste Management Manual* and *Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses - DRAFT* were also relied on for guidance. [DOE M 435.1-1, DOE Format Guide] This PA was influenced by, and has an influence on, other documents that are discussed in this section.

2.4.1 Groundwater Protection Management Program

In accordance with the FFA, DOE obtained the IWW Construction Permit #17,424-IW from SCDHEC for the underground liquid waste tanks. The HTF GCP and tank-specific closure modules will document requirements for protection of water resources. These documents support the removal from service of waste tanks to meet FFA commitments. [WSRC-OS-94-42] The FFA requires SRS to comply with all applicable federal, state, and local regulations for the operation, closure, and any RCRA/CERCLA remediation of the HTF OU. The appropriate measures for protection of water resources have been determined to be the State Primary Drinking Water Regulations (SCDHEC R.61-58) MCLs. The MCLs for the radionuclides is based on 4 mrem/yr for beta-gamma emitting nuclides, 15 pCi/L for alpha-emitting nuclides, and 5 pCi/L for radium. The MCLs are listed with the 100-meter results in Section 5.2.

The plan for protection of groundwater at SRS is documented in the *Savannah River Site Groundwater Protection Program* (SRNS-TR-2009-00076). The hydrogeologic information utilized in this HTF PA is consistent with that in the groundwater protection program. The *Savannah River Site Groundwater Protection Program* is focused on those activities regulated by external agencies (i.e., SCDHEC and EPA). Consistent with guidance for preparing the HTF PA, the requirement of DOE O 435.1 Chg 1 to identify impacts to water resources has been addressed by assessing the concentrations of radioactive or chemical contaminants against standards for public drinking water supplies established by SCDHEC. [SRNS-TR-2009-00076, DOE O 435.1 Chg 1]

2.4.2 Savannah River Site End State Vision

The *Savannah River Site End State Vision* focuses on-site facilities and areas that are the responsibility of the DOE Office of Environmental Management, which includes the HTF. [PIT-MISC-0089] This document describes planned end states for these facilities and areas. It indicates that each of the 29 underground waste tanks in the HTF will be cleaned, filled with grout to stabilize residual material, and removed from service. Like the *Savannah River Site Long Range Comprehensive Plan*, which is addressed below, the *Savannah River Site End State Vision* is founded on the following basic assumptions about land ownership and use. [PIT-MISC-0041, PIT-MISC-0089]

- The entire site will be owned and controlled by the federal government in perpetuity
- The property will be used only for industrial purposes
- Site boundaries will remain unchanged
- Residential use will not be allowed on-site

The DOE solicited public input into the *Savannah River Site End State Vision*. The document contains an appendix that addresses public comments received, including recommendations/endorsement from the SRS Citizens Advisory Board (CAB). [PIT-MISC-0089]

2.4.3 Savannah River Site Long Range Comprehensive Plan

The *Savannah River Site Long Range Comprehensive Plan* provides the framework for integrating the SRS mission and vision with ecological, economic, cultural, and social factors in a regional context to support decision-making for near-term and long-term use of the site. This plan reflects a cooperative working relationship between the DOE and the State of South Carolina. [PIT-MISC-0041]

The *Savannah River Site Long Range Comprehensive Plan* describes the current site conditions, defines a vision for the evolution of the site over the next 50 years, outlines actions to achieve the vision, and guides the allocation of resources toward attainment of that vision. This plan provides guidance and direction for the future physical development of the site and provides a framework within which detailed analyses will be conducted to determine the courses of action required to reach optimum site configuration. The plan is based on specific assumptions. If these assumptions were to change, the plan would be updated to reflect the changed conditions. Chapter 3 of the *Savannah River Site Long Range Comprehensive Plan* contains the Future Land Use Plan. [PIT-MISC-0041] Guidelines on which the SRS land use is based include:

- Giving priority to protection of workers and the public
- Maintaining site security
- Maintaining other appropriate institutional controls
- Considering worker, public, and environmental risks, benefits, and costs
- Restricted use programs for units regulated under CERCLA or under RCRA
- Maintaining existing SRS boundaries
- Continuing federal ownership of the land
- Prohibiting residential use of any SRS land

The DOE considered stakeholder input on future use of the site property, as was solicited in development of the *Savannah River Site End State Vision*. Chapter 3 of the *Savannah River Site Long Range Comprehensive Plan* describes future use of the site that was developed with input from public meetings, workshops, and consultation with state and federal agencies. [PIT-MISC-0041, PIT-MISC-0089]

2.4.4 High-Level Waste Environmental Impact Statement

In May 2002, the DOE issued the *High-Level Waste Tank Closure Final Environmental Impact Statement* (EIS) on waste tank cleaning and stabilization alternatives. [DOE-EIS-0303] The DOE studied five alternatives:

1. Empty, clean and fill waste tank with grout
2. Empty, clean and fill waste tank with sand
3. Empty, clean and fill waste tank with saltstone
4. Clean and remove waste tanks
5. No action

The EIS concluded the "empty, clean, and fill with grout" option was preferred. The DOE also issued an EIS Record of Decision (ROD) selecting the "empty, clean, and fill with grout" alternative for SRS waste tank closure. [DOE-EIS-0303 ROD]

Evaluations described in the EIS showed the "empty, clean and fill with grout" alternative to be the best approach to minimize human health and safety risks associated with closure of the waste tanks. [DOE-EIS-0303 ROD] This alternative offers several advantages over the other alternatives evaluated such as:

- Provides greater long-term stability of the waste tanks and their residual waste than the "empty, clean, and fill waste tank with sand" approach
- Provides for retaining radionuclides within the waste tanks by use of reducing agents in a fashion that the "empty, clean, and fill waste tank with sand" would not
- Avoids the technical complexities and additional worker radiation exposure of the "empty, clean, and fill with waste tank with saltstone" approach
- Produces smaller impacts due to radiological contaminant transport than the "empty, clean, and fill with waste tank with sand/saltstone" alternatives
- Avoids the excessive personnel radiation exposure and greater occupational safety impact that would be associated with the "clean and remove waste tanks" alternative

2.4.5 Federal Facility Agreement for the Savannah River Site

The FFA entered into agreement by SCDHEC, the DOE, and the EPA "*governs the corrective/remedial action process from site investigation through site remediation and describes procedures… for that process*." [WSRC-OS-94-42] The FFA results in enforceable timetables for the closure of waste tanks as well as provisions for prevention and mitigation of releases or potential releases from the waste tank systems. Pursuant to the FFA, Section IX, SRS received construction and operating approval from SCDHEC on March 3, 1993 (IWW Construction Permit #17,424-IW) for the HTF with the exception of Tank 16 and Tank 50. [DHEC_03-03-1993] The primary vessel for Tank 16 has been cleaned and is not available for service. Tank 50 received operating approval from SCDHEC on September 12, 1988 (Permit #14520). [DHEC_09-12-1988] The FFA, Section IX.E, addresses the eventual removal of waste tanks and ancillary equipment from service and the final closure of the waste tanks. For waste tanks and systems that are governed under a wastewater-operating permit, the closure must be performed in accordance with the South Carolina PCA, and all regulations implementing that Act. [WSRC-OS-94-42, Title 48_Chapter 1_SC Laws]

The SRS waste tanks that do not meet secondary containment standards, as established in the FFA, must be operationally closed per the FFA schedule. There are 24 waste tanks at SRS that do not meet the secondary containment standards and all waste tanks are scheduled for operational closure by 2032. Twelve of these waste tanks are located in HTF. Within the FTF, Tanks 17 and 20 have been previously operationally closed, and Tanks 18 and 19 in FTF are the next two waste tanks planned for operational closure.

The DOE has determined that there are previous release sites in the waste tank systems that may require response actions under the FFA. These release sites were previously included in the FFA by DOE at the time of approval for evaluation and possible remediation under a separate schedule. [WSRC-OS-94-42]

2.5 Performance Criteria

The PA objectives are identified in 10 CFR 61 referenced by the NDAA. Section 3116 of the NDAA specifies the criteria for DOE to classify residual waste as non-high level waste for purposes of onsite disposition. The NDAA is applicable only to South Carolina and Idaho. The DOE intends to coordinate the waste determination and state closure plan approval efforts to support the waste tank closure schedule provided in the FFA. [NDAA_3116, WSRC-OS-94-42]

2.5.1 10 CFR 61 Performance Objectives

Subpart C of 10 CFR 61 lists the five performance objectives, which are reproduced below:

> *"**Section 61.40 General requirement.***
>
> *Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in Sections 61.41 through 61.44."*

> *"**Section 61.41 Protection of the general population from releases of radioactivity.***
>
> *Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable."*

The NRC acknowledged that using a performance objective of 25 mrem/yr effective dose is acceptable versus considering individual organ doses. [NUREG-1854]

*"**Section 61.42 Protection of individuals from inadvertent intrusion.***

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."

The NRC acknowledged that using a whole body dose equivalent limit of 500 mrem/yr effective dose is appropriate to assess intruder scenarios. [NUREG-1854]

*"**Section 61.43 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 is reasonably achievable."

*"**Section 61.44 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."

2.5.2 DOE O 435.1 Change 1 Performance Objectives and Requirements

The DOE LLW disposal performance objectives are defined in DOE M 435.1-1 IV.P (1). DOE Headquarters (DOE-HQ) issued a letter from Mr. Rispoli to Mr. Allison, *Compliance with DOE M 435.1-1 Waste Incidental to Reprocessing Requirements and Implementation of Section 3116(a) of the National Defense Authorization Act for Fiscal Year 2005 (NDAA)*, which offers guidance and clarification concerning the requirements in DOE O 435.1 Chg 1 when the requirements of NDAA Section 3116 are also applicable to avoid duplication of efforts. [DOE_02-09-2006]

The DOE LLW disposal performance objectives (DOE M 435.1-1 IV.P (1)) are:

> *"Low-level waste disposal facilities shall be sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives will be met for waste disposed of after September 26, 1988:*

(a) Dose to representative members of the public shall not exceed 25 mrem (0.25 mSv) in a year Total Effective Dose Equivalent (TEDE) from all exposure pathways, excluding the dose from radon and its progeny in air.

(b) Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year TEDE, excluding the dose from radon and its progeny.

(c) Release of radon shall be less than an average flux of 20 pCi/m^2/s (0.74 Bq/m^2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/l (0.0185 Bq/l) of air may be applied at the boundary of the facility."

Item *(a)* is similar to 10 CFR 61.41 and this PA provides the information relative to items *(b)* and *(c)* for completeness.

In addition to the DOE LLW disposal performance objectives cited above, the following information from DOE M 435.1-1 IV.P (2) is considered.

(g) For purposes of establishing limits on radionuclides that may be disposed of near-surface, the performance assessment shall include an assessment of impacts to water resources.

(h) For purposes of establishing limits on the concentration of radionuclides that may be disposed of near-surface, the performance assessment shall include an assessment of impacts calculated for a hypothetical person assumed to inadvertently intrude for a temporary period into the low-level waste disposal facility. For intruder analyses, institutional controls shall be assumed to be effective in deterring intrusion for at least 100 years following closure. The intruder analyses shall use performance measures for chronic and acute exposure scenarios, respectively, of 100 mrem in a year and 500 mrem total effective dose equivalent excluding radon in air.

Item *(g)* is similar to the SCDHEC groundwater protection requirement and the acute exposure performance measure from item *(h)* is similar to 10 CFR 61.42. Information on the chronic exposure performance measure from item *(h)* is included for completeness.

2.6 Summary of Key Assessment Assumptions

Numerous assumptions were made in assessing the performance of HTF and are noted and discussed in subsequent sections. A summary of the key assumptions in the analyses prepared in support of the HTF PA are listed below. Assumptions pertaining to models used in support of the HTF PA refer to the deterministic Base Case model. Assumptions pertaining to alternative model cases are discussed in Section 4.2.2.

2.6.1 General Facility Description Assumptions

The *Long Range Comprehensive Plan* assumes that the entire site will be owned and controlled by the federal government in perpetuity. [PIT-MISC-0041] However, for the purpose of this PA, no federal protection is assumed beyond the 100-year period of institutional control. The period of compliance will be 10,000 years following facility closure in accordance with NUREG-1854, Section 4.1.1.1 guidance. The 100-year period of institutional control is assumed to begin in year 2032. A list of specific key model assumptions can be found in Table 5.2-1.

2.6.2 Site Characteristics Assumptions

Infiltration rates and aquifer depths can vary naturally over long periods. Short-term changes in these parameters (e.g., seasonal, annual fluctuations, etc.) are not simulated in the conceptual model due to extended time ranges involved in the model. A steady-state model was used to approximate the flow field and the groundwater divide between the two streams, for example, Upper Three Runs (UTR) and Fourmile Branch, remained constant over the course of the modeling.

The HTF flow model uses available data to simulate a future precipitation rate and the resulting infiltration rate is expected to change over time as the closure cap degrades. The characterization and monitoring data for the SRS GSA is extensive, and provides a clear understanding of hydrogeology of the HTF and is a reasonable data set to represent long-term conditions.

2.6.3 Facility Design Assumptions

The PA assumes no significant structural changes to the waste tanks or ancillary equipment during the closure process. Significant additions or changes to these features could alter the performance assessment results.

Erosion control is maintained via the closure cap as detailed in Section 3.2.4.4. The erosion barrier maintains a minimum 10 feet of clean material above the HTF to act as an intruder deterrent (Table 3.2-12). Infiltration control of the HTF is expected to operate as estimated in Section 3.2.4. Tables 3.2-11 and 3.2-14 and Figure 3.2-91 provide specific design and performance values.

2.6.4 Stabilized Contaminant Characteristics Assumptions

2.6.4.1 Inventory

The estimate of residual activity in the waste tanks and ancillary equipment is expected to bound the actual inventory sufficiently and is described in Section 3.4. An initial radionuclide screening process was developed and performed to support characterization efforts and is applicable to the HTF PA modeling as described in Section 3.3. *H-Area Tank Farm Closure Inventory for use in Performance Assessment Modeling* (SRR-CWDA-2010-00023) Appendix A describes the detailed screening from CBU-PIT-2005-00228 (*High-Level Waste Tank Farm Closure, Radionuclide Screening Process (First-Level), Development and Application)* to reduce an initial list of 849 radionuclides to 159. SRR-CWDA-2010-00023 Appendix B further screens the 159 radionuclides down to the 63 radionuclides of concern.

2.6.4.2 Grout Fill

Prior to waste tank closure, each waste tank will be emptied, cleaned, and filled with a stabilizing grout. [DOE-EIS-0303, DOE-EIS-0303 ROD] Ancillary equipment such as DBs, PPs, and pump tanks will also be grouted to prevent subsidence (Section 3.2.3.1). The purpose of this stabilization is to maintain waste tank structure and minimize water infiltration over an extended period, thereby impeding release of stabilized contaminants into the environment.

The grout will have a specific formulation, designed to meet certain mechanical and chemical performance requirements. The mechanical requirements of the grout consist of adequate hydraulic conductivity to slow/minimize infiltration and radionuclide movement, adequate compressive strength to withstand the overburden load and provide a physical barrier to discourage intruders. The chemical requirements of grout include high pH (pH) and a low oxidation potential (E_h). The chemical requirements ensure the reducing capability of the grout recipe, which is an assumption used in the waste release model (e.g., Table 4.2-17). Section 3.2.3 discusses and Table 3.2-9 outlines the key requirements for the grout.

2.6.4.3 Contamination Zone

The residual waste tank inventory is modeled as a discrete layer at the bottom of the waste tanks, below the grout fill. Referred to as the CZ, this discrete layer includes the entire modeled inventory.

2.6.5 Integrated Conceptual Model Assumptions

2.6.5.1 Liner Failure

The time of potential initial waste release from the closed waste tanks is upon failure of the carbon steel waste tank liners. The waste tank and ancillary equipment failure times are therefore important assumptions used in the ICM. The failure times vary with waste tank design, owing to differences in liner properties and current liner conditions. The bases for the liner failure times used in the ICM are discussed in Section 4.2.2, which summarizes the conclusions from the liner degradation analyses reported in WSRC-STI-2007-00061 and SRNL-STI-2010-00047. The Base Case model assumptions use these conclusions and include:

- As documented in C-ESR-G-00003, Tanks 9 through 16 all currently have documented leak sites, while all other waste tanks in HTF do not have any documented leak sites. While Tanks 9 through 16 have documented leak sites, based upon present leak site numbers and physical locations, it is assumed that at the time of HTF closure, liners are not a barrier to flow for Type I Tank 12, and Type II Tanks 14, 15, and 16. The leak sites on the other waste tanks are small in number and located near the top of the waste tank liner away from the CZ. [C-ESR-G-00003]
- All Type IV tanks are assumed to have liner failure within the compliance period.
- The remaining Type I and Type II tanks (excluding those identified above), and all Type III/IIIA tanks have intact steel liners at HTF closure and do not fail within the 10,000-year compliance period.

The probabilistic model, described in Section 4.4.4.2 and 5.6.3, applies waste tank liner failure times according to distributions determined from the steel liner degradation analyses reports, WSRC-STI-2007-00061 and SRNL-STI-2010-00047.

2.6.5.2 Contaminant Release and Movement

The rates of contaminant release and movement from the waste tanks and ancillary equipment (where applicable) are principally controlled by these factors:

- Moisture infiltration to the HTF from the overlying soil (Table 3.2-14)
- Physical properties (e.g., hydraulic conductivity), state (e.g., integrity) of the waste form (including grout, CZ, cementitious materials), and soil (Section 4.2 tables and figures)
- Chemical properties and state (e.g., oxidation potential and pH) of the grout and CZ (Figures 4.2-9, 4.2-10 and Table 4.2-18)

The waste release conceptual model assumes water infiltrates from the ground surface, through the closure cap, and into the waste tank grout providing the pore fluids necessary to leach contaminants from the CZ. The release of contaminants from the CZ is based on solubility controls described in Section 4.2.1. Solubility controls applied to submerged waste tanks are handled differently than those applied to non-submerged waste tanks (Table 4.2-5 and 4.2-6).

The cementitious materials (e.g., waste tank grout, roof, walls, grouted annulus, and basemat) are assumed to degrade over time as described in Section 4.2.2.2, and will influence the HTF contaminant transport processes in cementitious materials and soils including advection, diffusion, dispersion, and sorption. Colloidal transport is not modeled. Contaminant transport through the cementitious materials and soils is impeded by sorption, as represented through the distribution coefficient (K_d) of the soils (Section 4.2.2.2.2 and Table 4.2-29) and cementitious materials (Section 4.2.2.2.4 and Table 4.2-33).

The concrete material properties are based on concrete surrogate samples obtained from a P-Area Reactor wastewater tank foundation basemat. The assumption is they are representative of the waste tanks basemats/concrete. The results of basemat testing are in WSRC-STI-2007-00369 and presented in Section 4.2.2.2.4. The P-Area Reactor basemat was selected based on similar function (foundation support to a waste tank) and strength properties (3,000 pounds per square inch compressive strength) to basemats used under HTF waste tanks.

Based on the contaminant plume evidence in Figures 5.2-3 through 5.2-5 and the discussion in Section 5.2.1, the groundwater concentrations are the highest concentration at 100 meters or further from the HTF.

2.6.5.3 Multiple Cases

Five waste tank cases and one ancillary equipment case are assumed to cover conditions in the groundwater model that represent what may occur within the 10,000-year compliance period. While only one case (Case A) was simulated in the baseline analysis (e.g., Base Case), the five different cases were considered in the probabilistic analyses (Section 5.6.4 and 5.6.5) and in the deterministic sensitivity analyses (Section 5.6.7).