APPENDIX A

TANK FARM DESCRIPTION AND CLOSURE PROCESS

TABLE OF CONTENTS

List of Figures

APPENDIX A. TANK FARM DESCRIPTION AND CLOSURE PROCESS

A.1 Introduction

Over the last 45 years, Savannah River Site (SRS) has produced special radioactive isotopes for various national programs. These isotopes were primarily produced in the Site's nuclear reactors, which generated neutrons that bombarded specifically designed targets. The neutrons bombarding the targets result in transmutation of the target atoms to produce the desired radioisotopes. The spent nuclear fuel and the targets were reprocessed to recover unused reactor fuel and the isotopes produced in the reactors. The reprocessing activity involved dissolving the fuel and targets in large, heavily shielded chemical separations facilities in the F and H Areas, known as the F-Canyon and H-Canyon, respectively. These facilities concentrated the valuable materials that the U.S. Department of Energy (DOE) wanted to recover, but produced large quantities of high-level waste (HLW). The HLW has been stored in the tank farms in F and H Areas.

DOE has recently reviewed its HLW management practices in two recent EISs: the *DWPF Supplemental EIS* (DOE 1994) and the *SRS Waste Management EIS* (DOE 1995). This *HLW Tank Closure EIS* is focused on closure of the tank farms after the HLW has been removed. Nevertheless, a discussion on how the tank farms fit into the overall SRS HLW management program is useful to understanding the nature of the residual waste in the tanks and the tanks' current use and history. Therefore, Section A.2 provides an overview of HLW management at SRS. Section A.3 describes the tank farm equipment and operations. Section A.4 describes the activities needed to close the tank farms under the various closure alternatives.

A.2 Overview of SRS HLW Management

The main processes involved in HLW management are generation, storage, evaporation, sludge processing, salt processing, vitrification, and saltstone manufacture and disposal. Figure A-1 shows the process flows among the processes.

Although the F- and H-Canyons are the only facilities at SRS that generate HLW in the regulatory sense, other facilities produce liquid radioactive waste that has characteristics similar to those of HLW. These facilities include the Receiving Basin for Offsite Fuel, the Savannah River Technology Center, the H-Area Maintenance Facility, and the reactor areas. Selected wastes from these facilities are managed at SRS as if they were HLW and are thus sent to the tank farms for storage and ultimate processing. Also, the Defense Waste Processing Facility (DWPF), which is the final treatment for SRS HLW, recycles wastewater back to the tank farms.

The tank farms receive the HLW, immediately isolating it from the environment, SRS workers, and the public. The tank farms provide a sufficiently long period of storage to allow many of the short-lived radionuclides to decay too much lower concentrations. After pH adjustment and introduction into the tanks, the HLW is allowed to settle, separating into a sludge layer at the bottom and a salt solution layer at the top, known as supernate. SRS uses evaporators to concentrate the supernate to produce a third form of HLW in the tank farms, known as crystallized saltcake. As a result of intertank transfers, some of the tanks are now primarily salt tanks, some are primarily sludge tanks, some tanks contain a mixture of salt and sludge, and some tanks are empty.

Before 1994, the Canyons generated two waste streams that were sent to the tank farms. High-radioactivity waste, which contained most of the radionuclides, was aged in a high-radioactivity waste tank before evaporation. Low-radioactivity waste, which contained lower concentrations of radionuclides, was sent directly to an evaporator. This historical practice is shown on Figure A-1. Under current

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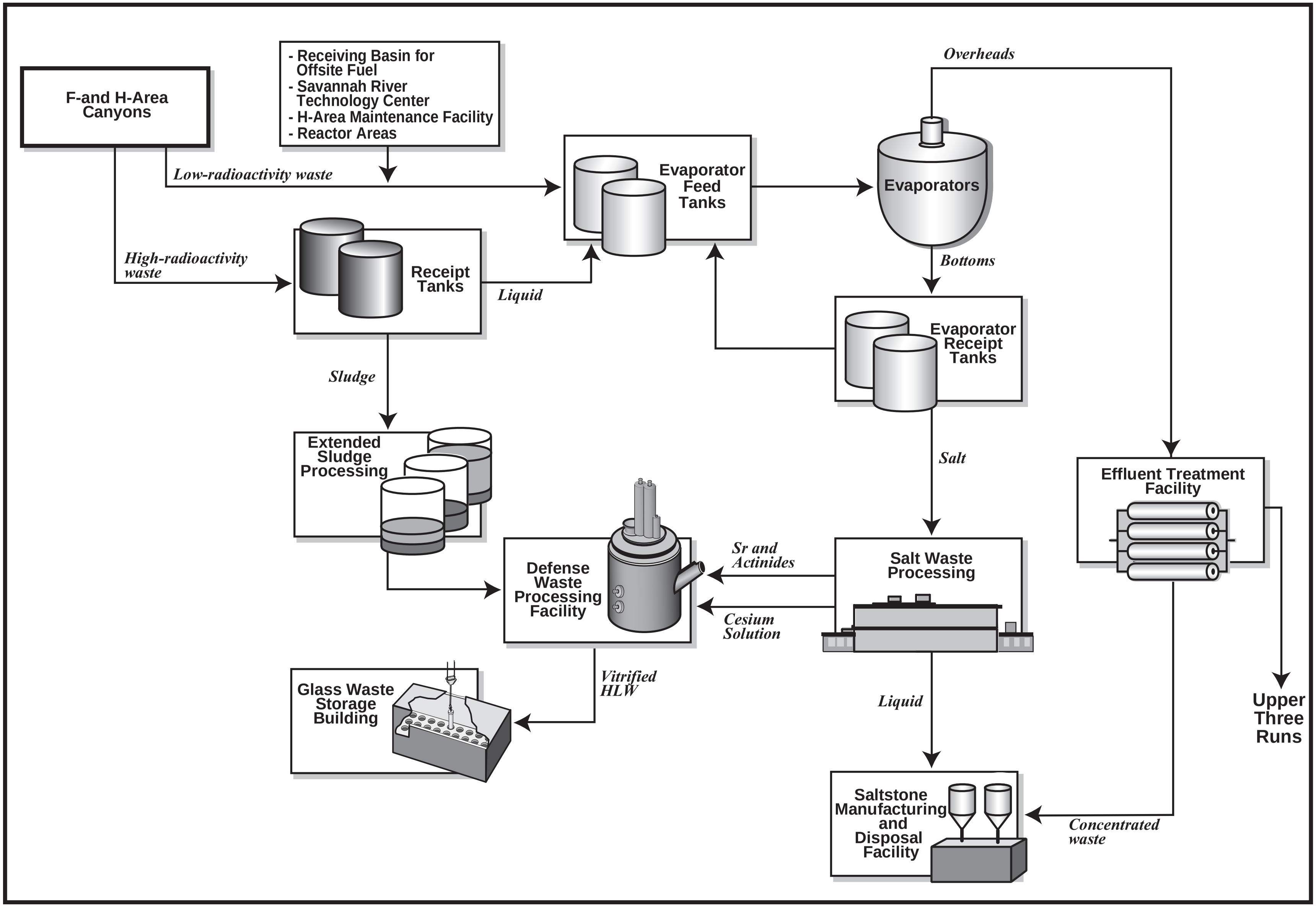

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Figure A-1. Process flows for Savannah River Site high-level waste management system.

SRS operations, high-radioactivity waste is no longer generated because SRS reactors ceased operation in 1988. All incoming waste streams to the tank farms can be directed to the same receipt tanks and evaporator feed tanks.

SRS designed and built a facility using four H-Area Tank Farm tanks, known as the In-Tank Precipitation Facility, to process the saltcake and concentrated supernate. This salt processing facility was designed to receive redissolved saltcake and precipitate the chemical cesium that is responsible for the most prominent and penetrating radiation emitted from the waste. The cesium precipitate was designed to go DWPF for processing in the salt cell, with the aqueous cesium portion to be melted into a glass matrix and the organic portion sent to the Consolidated Incineration Facility. The remaining liquid salt solution was designed to go to the Saltstone Manufacturing and Disposal Facility for solidification and burial in underground vaults. DOE has concluded that the In-Tank Precipitation process, as currently configured, cannot achieve production goals and meet safety requirements. Therefore, in February 1999, DOE issued a Notice of Intent (64 FR 8558, February 22, 1999) to prepare a second Supplemental Environmental Impact Statement (SEIS), *High-Level Waste Salt Processing Alternatives at the Savannah River Site* (DOE/EIS-0082-S2). This SEIS analyzed the impacts of constructing and operating facilities for four alternative processing technologies. The *Final Salt Processing Alternatives SEIS* was issued in July 2001 (66 FR 37957, July 20, 2001) and the Record of Decision in October 2001 (66 FR 52752, October 17, 2001). DOE selected the Caustic Side Solvent Extraction Alternative for separation of radioactive cesium from SRS salt wastes.

The sludge in the tanks, which contains approximately 54 percent of the HLW radioactivity, is treated in a process known as Extended Sludge Processing. Extended Sludge Processing uses existing tanks in the H-Area Tank Farm. The process removes aluminum hydroxide and soluble salts from the sludge before transferring the sludge to the DWPF for vitrification. Aluminum affects the hardness of the glass and the overall volume of glass waste. The soluble salts interfere with the desired chemical composition of the glass. The wastewaters from Extended Sludge Processing and the DWPF are recycled back to the tank farm.

The DWPF receives washed sludge and salt precipitate, mixes it with appropriate additives, and melts it into a glass form in a process known as vitrification. The glass is poured into stainless steel canisters and stored in the Glass Waste Storage Building, a facility containing an underground vault for canister storage. Because the In-Tank Precipitation Facility has been inoperable, the DWPF has been vitrifying only sludge waste. The DWPF will continue sludge-only processing until the feed is available from the salt processing facility. In order to minimize the number of HLW canisters that are produced, SRS planning documents (WSRC 1998a) call for maintaining the sludge and salt precipitate feeds to the DWPF in an acceptable balance to avoid having any precipitate left over when all of the sludge inventory has been vitrified. The ultimate disposition of the HLW glass canisters is a geologic repository. The proposed construction, operation and monitoring, and closure of a geologic repository at the Yucca Mountain site in Nevada is the subject of a separate EIS. As part of that process, DOE issued a Draft EIS for a geologic repository at Yucca Mountain, Nevada, in August 1999 (64 Federal Register [FR] 156), and a Supplement to the Draft EIS in May 2001 (66 FR 22540). The Final EIS was approved and DOE announced the electronic and reading room availability in February 2002 (67 FR 9048). The President has recommended to the Congress that the Yucca Mountain Site is suitable as a geologic repository. If the Yucca Mountain site is licensed by the Nuclear Regulatory Commission (NRC) for development as a geologic repository, current schedules indicate that the repository could begin receiving waste as early as 2010.

The Saltstone Manufacturing and Disposal Facility receives the low-activity salt solution. The salt solution is mixed with cement, slag, and flyash to form a grout having chemical and

EC physical properties designed to retard the leaching of contaminants over time. The grout is poured into disposal vaults and hardens into what is known as saltstone.

EC This is the Final Disposition of the Salt Solution. The Saltstone Manufacturing and Disposal Facility has received salt solution from the In-Tank Precipitation Process demonstration operations and concentrated wastes from the F/H-Area Effluent Treatment Facility and has been producing saltstone from these waste feeds. The Effluent Treatment Facility receives evaporator overheads from the Separations Areas and tank farms evaporators and treats the water for discharge to Upper Three Runs.

A.3 Description of the Tank Farms

EC The F-Area Tank Farm is a 22-acre site that contains 20 active waste tanks, 2 closed waste tanks, evaporator systems, transfer pipelines, diversion boxes, and pump pits. Figure A-2 shows the general layout of the F-Area Tank Farm. The H-Area Tank Farm is a 45-acre site that contains 29 active waste tanks, evaporator systems (including the new Replacement High-level Waste Evaporator), the Extended Sludge Processing Facility, transfer pipelines, diversion boxes, and pump pits. Figure A-3 shows the general layout of the H-Area Tank Farm.

A.3.1 TANKS

The F- and H-Area tanks are of four different designs, all constructed of carbon-steel inside EC reinforced concrete containment vaults. Two designs (Types I and II) have secondary annulus "pans" and active cooling (Figure A-4).

The 12 Type I tanks (Tanks 1 through 12) were TC built in 1952 and 1953; seven of these (Tanks 1, 5, 6, and 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, L-7-56 based upon groundwater monitoring results, there is no evidence that the waste has leaked TC from the secondary containment. The level of waste in these tanks has been lowered to below EC these leak sites. In 1961, the fill line to Tank 8 leaked approximately 1,500 gallons to the soil and potentially to the groundwater. The tank tops are below grade and the bottoms of Tanks 1 through 8 are situated above the seasonal high TC water table. The bottoms of Tanks 9 through 12 are in the water table.

The four Type II tanks (Tanks 13 through 16) EC were built in 1956. All four have known leak sites, in which waste leaked from primary to secondary containment. In 1983, about 100 gallons of waste spilled onto the surface of Tank 13 through a cracked flush water line attached to an evaporator feed pump. No spilled waste reached the subsurface. The spill was cleaned up and the contaminated material returned to the waste tank or disposed (Boore et al., 1986). The contamination remaining is negligible and would affect neither tank closure nor future cleanup of TC the tank farm areas. In Tank 16, in 1962 the waste overflowed the annulus pan (secondary containment) and a few tens of gallons of waste migrated into the surrounding soil, presumably through a construction joint in the concrete encasement. Waste removal from the Tank 16 L-2-17 L-7-61 primary vessel was completed in 1980. DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus. These tanks are above the seasonal high water table.

The eight Type IV tanks (Tanks 17 through 24) were built between 1958 and 1962. These tanks have a single steel wall and do not have active EC cooling (Figure A-4). Tanks 19 and 20 have known cracks that are believed to have been caused by groundwater corrosion of the tank walls. Small amounts of groundwater have L-7-58 leaked into these tanks (WSRC 2000); there is TC no evidence that waste ever leaked out. The level of the waste in Tank 19, which is the next tank scheduled to be closed, is below these cracks. Tanks 17 through 20 are slightly above the water table. 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. Tanks 17 and 20 have already been closed in a manner described in DOE's Preferred Alternative.

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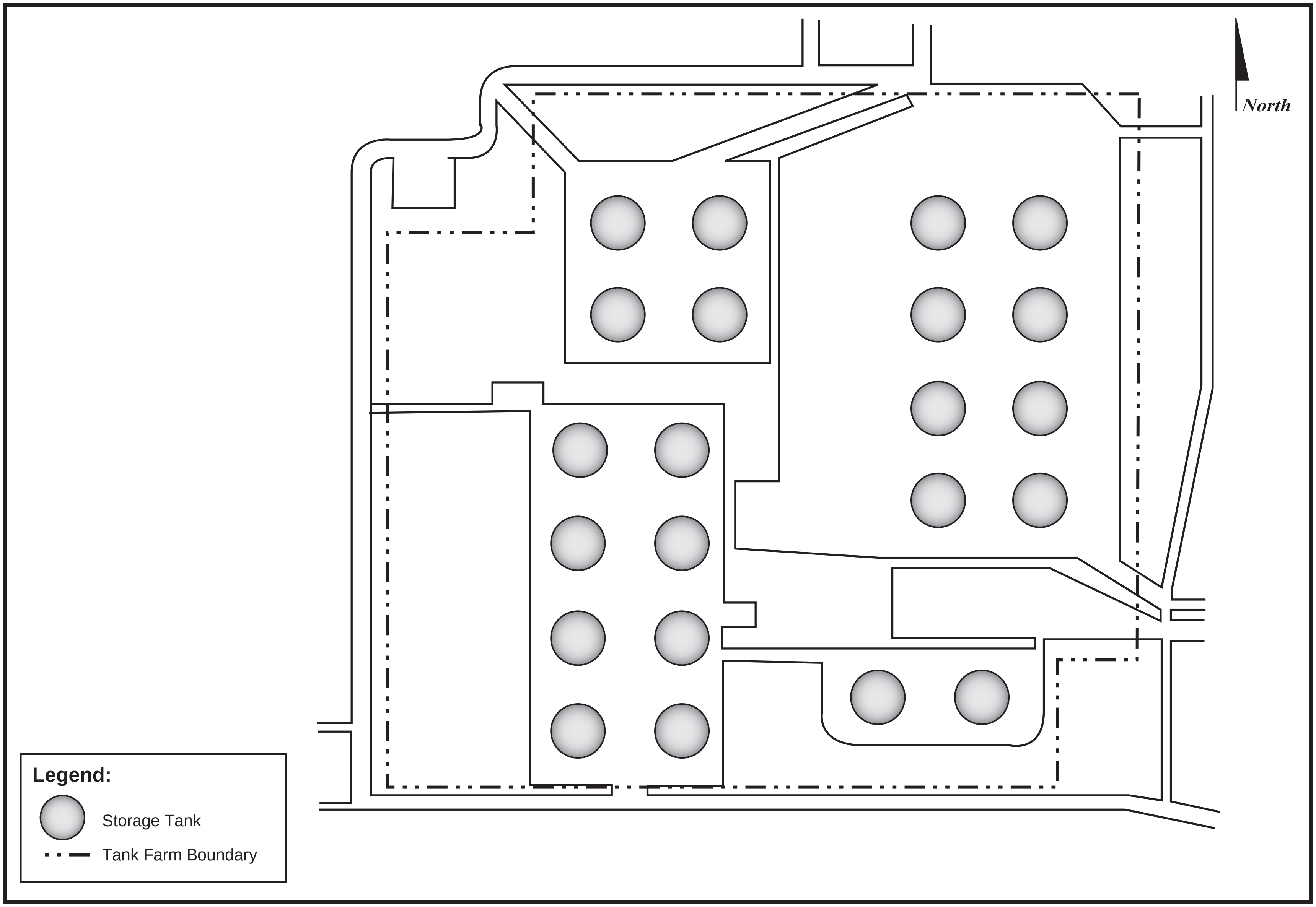

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Figure A-2. General layout of F-Area Tank Farm.

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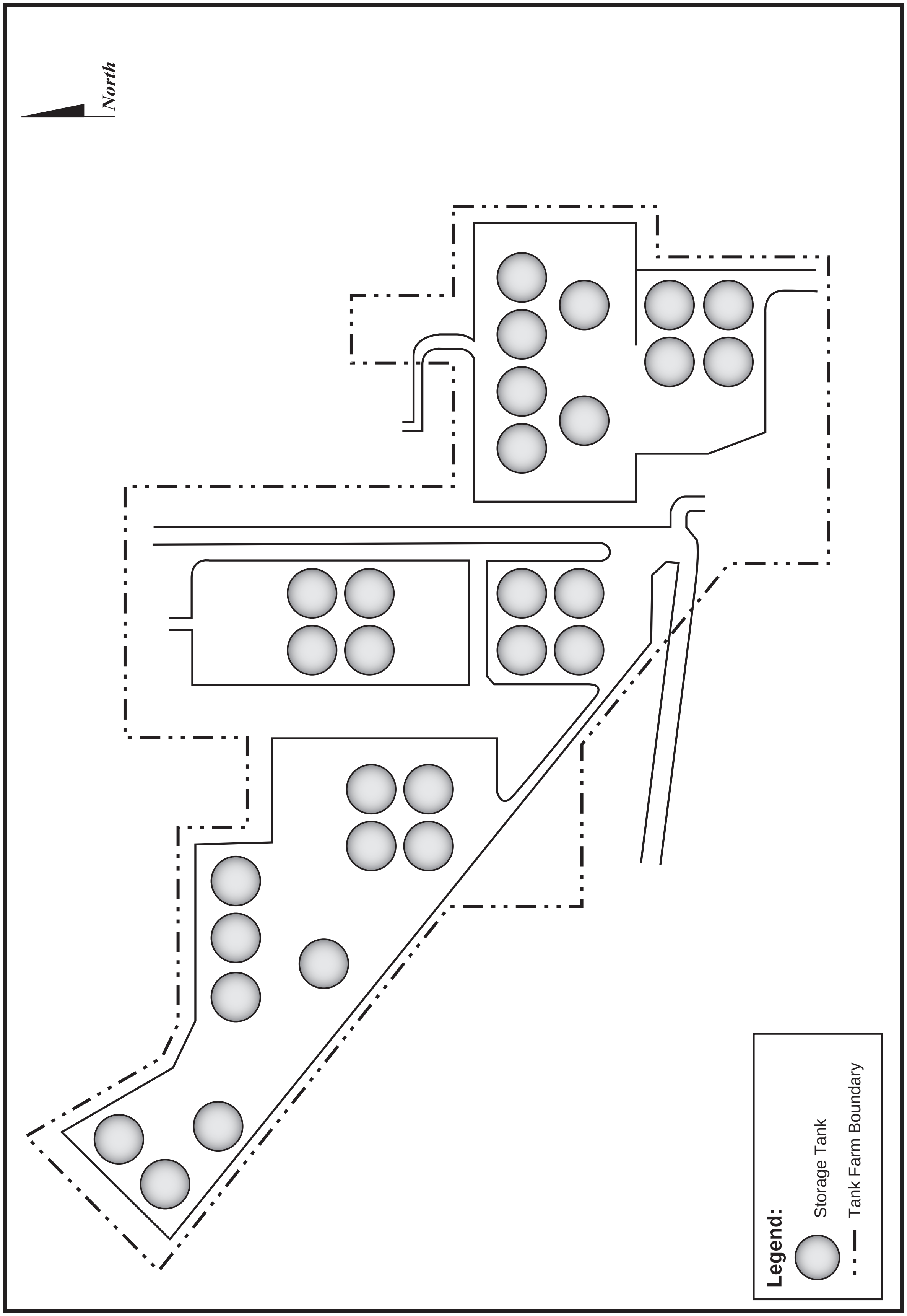

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Figure A-3. General layout of H-Area Tank Farm.

TC

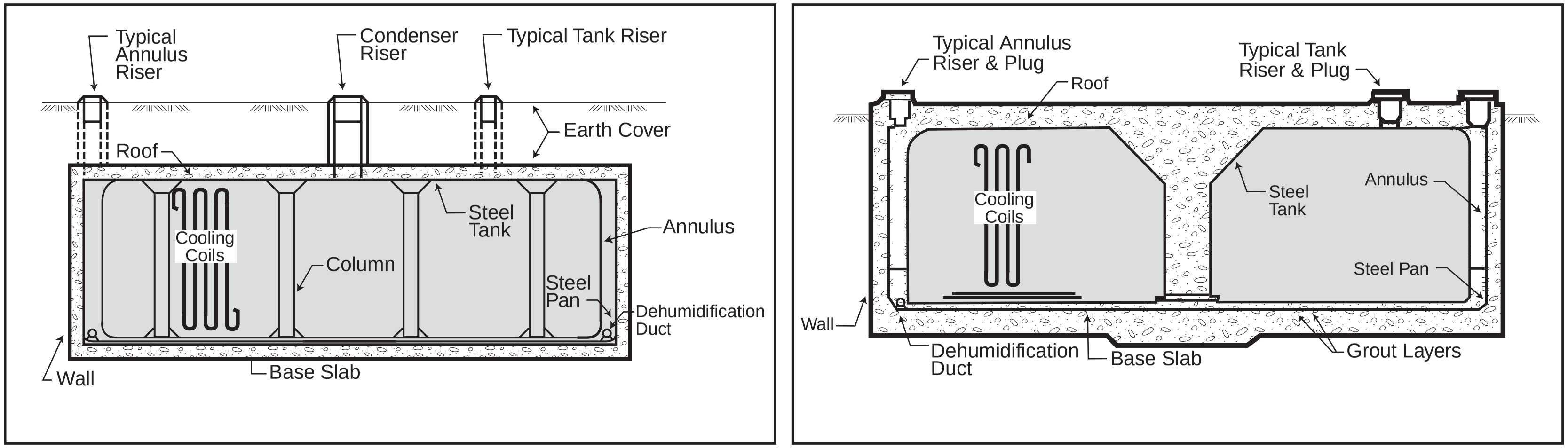

Figure A-4.A. Cooled Waste Storage Tank, Type I

Figure A-4.B. Cooled Waste Storage Tank, Type II

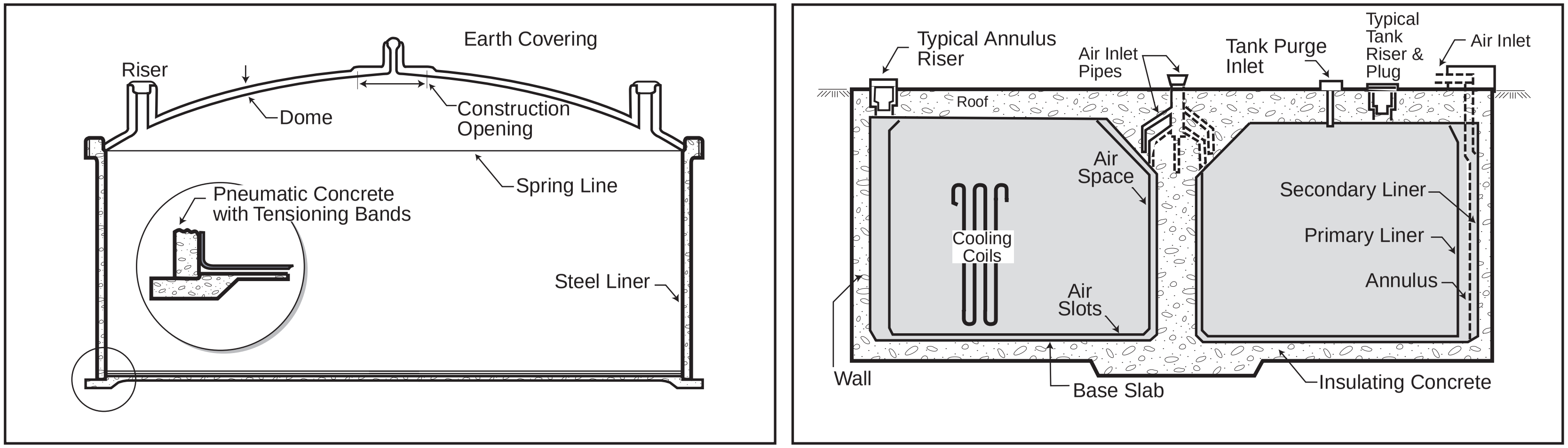

Figure A-4.C. Uncooled Waste Storage Tank, Type IV (Prestressed concrete walls)

Figure A-4.D. Cooled Waste Storage Tank, Type III (Stress Relieved Primary Liner)

NW TANK/Grfx/A-4 Tank config.ai

Figure A-4. Tank configurations.

The newest design (Type III) has a full-height secondary tank and active cooling (Figure A-4). All of the Type III tanks (25 through 51) are above the water table. These tanks were placed EC in service between 1969 and 1986 and none of them has known leak sites. In 1989, a Tank 37 transfer line leaked about 500 pounds of concentrated waste to the environment.

By 2022, DOE is required to remove from service and close all the remaining tank systems that have experienced leaks or do not have full-height secondary containment (WSRC 1998a). The 24 Type I, II, and IV tanks have been or will be removed from service before the 27 Type III tanks. Type III tanks will remain in service until EC there is no further need for the tanks. Areas of contamination in the tank farms have been identified, based on groundwater monitoring past incident reports and contamination surveys. The areas of significant contamination have been identified in the SRS Federal Facility Agreement and have been designated as Resource Conservation and Recovery EC Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) units or Site Evaluation Units. Controls are in place to ensure that any L-7-60 activities performed around these areas are conducted in a manner protective of human health and the environment, and in a way that minimizes the impact on future investigation, EC removal, and remedial action (WSRC 1996).

A total of 17 RCRA/CERCLA units or Site Evaluation Units have been identified in the tank farms. In 14 of the 17 areas, contamination is EC the result of past spills on the surface, and the contamination is on or near the surface (EPA L-7-62 1993). The amount of contamination in these 14 sites appears to be small and will probably not add significantly to the dose reported in this EIS for tank closure, for the following reasons:

L-7-63

1. The sizes of these spills are small, compared to the residual tank contents.
2. The contamination is outside the tanks and would thus transport through the soil and groundwater much more rapidly than those contaminants bound inside the tanks. This would cause their impacts to be noncoincident in time with those from tank closure.
3. Contamination outside the tanks would be addressed in the CERCLA closure of the tank farm areas. Tank closure and CERCLA closure are being coordinated so that L-7-63 cumulative impacts are within limits established with SRS regulators through the risk-based closure process. Therefore, if any spill appears to produce a large contribution, it would be remediated until it produces a small contribution.

In 2 of the 17 areas, the contamination came from pipelines located below grade that leaked EC directly into the ground. The first area was a leak from the secondary containment of a pipeline near Tank 8, which happened in 1961. The leak resulted from an inadvertent overfill of EC Tank 8. The volume leaked to the soil was estimated to be 1,500 gallons (Odum 1976). The second area was a leak from a Concentrate Transfer System near the Tank 37 line, which EC was discovered in 1989 (the actual date of the leak is not known). The volume of this leak was estimated to be a few gallons (d'Entremont L-7-64 1989).

The last area, the Tank 16 RCRA/CERCLA unit, is the only instance at SRS where waste is known to have leaked to the soil from a HLW EC tank. In September 1960, leaks from the Tank 16 primary tank caused the level in the annulus pan (the tank secondary containment) to exceed the top of the pan. EC The waste was still contained in the concrete encasement that surrounds the tank, but surveys indicated that some waste leaked into the soil, presumably through a construction joint on the side of the encasement that is located near the top of the annulus pan. Based on soil borings around the tank, it is EC estimated that some tens of gallons of waste leaked into the soil (Poe 1974). L-7-65 L-7-57 Assuming that the waste did leak from the construction joint, the leaked waste is in the vicinity of the seasonal water table and is at times below the water table.

Because all tanks at SRS have leak detection, it L-7-66 L-7-67 is unlikely that any large leaks have occurred that have not been detected. In eight tanks other than Tank 16, observable amounts of waste have leaked from primary containment into secondary containment. These tanks are managed to ensure that the leaked waste remains dry and immobile. The waste in the annuli of these tanks has been observed carefully over a period of years and minimal movement of the waste has been observed. Other than Tank 16, there is no evidence that waste has leaked from a tank into the soil. L-7-66 L-7-67

A.3.2 EVAPORATOR SYSTEMS

The tank farms had five evaporators that concentrated waste following receipt from the Canyons. At present, three evaporators are operational, one in F-Area Tank Farm and two in H-Area Tank Farm. Each operational evaporator is made of stainless steel with a hastelloy tube bundle, and operates at near-atmospheric pressure under alkaline conditions. 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 remotely operated and maintained. L-7-25 L-7-68

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 for final treatment before being discharged to Upper Three Runs. 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 by successive evaporations of liquid supernate. This concentrated waste crystallizes into a solid saltcake, which reduces its mobility. L-7-71

A.3.3 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.

A.3.4 SALT PROCESSING

DOE has concluded that the In-Tank Precipitation Process, as currently configured, cannot achieve production goals and meet safety requirements for processing the salt portion of HLW (64 FR 8558, February 22, 1999). TC

Therefore, in February 1999, DOE issued a Notice of Intent (64 FR 8558, February 22, 1999) to prepare a second SEIS*, High-Level Waste Salt Processing Alternatives at the Savannah River Site* (DOE/EIS-0082-S2). This SEIS analyzed the impacts of constructing and operating facilities for four alternative processing technologies. The *Final Salt Processing Alternatives SEIS* was issued in July 2001 (66 FR 37957, July 20, 2001) and the Record of Decision in October 2001 (66 FR 52752, October 17, 2001). DOE selected the Caustic Side Solvent Extraction Alternative for separation of radioactive cesium from SRS salt wastes. EC

Solvent Extraction is DOE's preferred alternative. The Solvent Extraction Alternative would use a highly specific organic extractant to separate high-activity cesium from the HLW salt solution. The low-activity salt solution could be evaluated for disposal in the Saltstone Disposal Facility. The high-activity cesium would be TC transferred from the aqueous salt solution into an insoluble organic phase, using a centrifugal contactor to provide high surface area contact, followed by centrifugal separation of the two phases. Recovery of the cesium by back extraction from the organic phase in to a secondary aqueous phase would generate a concentrated cesium solution (strip effluent) for vitrification in DWPF. Prior treatment of the HLW salt solution, using monosodium titanate to separate soluble strontium and actinides and filtration to remove the solids and residual sludge, would be required to meet salt solution decontamination requirements and avoid interference in the solvent extraction process. The monosodium titanate solids would be transferred to DWPF for vitrification along with the strip effluent solution. The low-activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal as grout in onsite vaults. EC

A.3.5 SLUDGE WASHING SYSTEM

L-7-73 The waste streams generated by the F- and H-Area Canyons form insoluble and highly radioactive metal hydroxides (manganese, iron, and aluminum) that settle to the bottom of the waste tanks to form a sludge layer. In addition to the fresh waste aging, the accumulated sludge is aged to allow radioactive decay. The aged sludge is transferred to the sludge processing tanks for washing and, if necessary, aluminum dissolution with a sodium hydroxide solution. The sludge processing takes place in two Type III tanks in H Area. The washed sludge slurry is transferred to the DWPF for vitrification into a solid glass matrix that is easier to handle and much more suitable for disposal.

A.4 Tank Farm Closure Activities

A.4.1 WASTE REMOVAL

In the Federal Facility Agreement between EC DOE, the U.S. Environmental Protection Agency (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). DOE has reviewed bulk waste removal from the HLW tanks in the *Waste Management Operations, Savannah River Plant EIS* and the *Long-term Management for Defense High-Level Radioactive Wastes (Research and Development Program for Immobilization) Savannah River Plant EIS* (ERDA 1537). EC In addition, the *SRS Waste Management EIS* (DOE/EIS-0023) discusses HLW management activities as part of the No Action Alternative (continuing the present course of action), and the *Defense Waste Processing Facility Savannah River Plant EIS* (DOE/EIS-0082) and the *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility* (DOE/EIS-0082S) discuss management of HLW after it is removed from the tanks. EC As described in this EIS, however, tank closure activities would comply with the proposed plan and schedule provided under the Agreement. Also, even under the No Action Alternative, DOE would continue to remove waste from the tanks as their missions cease. All tanks would be empty by 2028.

The schedule for removing waste from the tanks is closely linked to salt and sludge processing capacity and the 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. Support the startup and continued operation of the Replacement High-Level Waste Evaporator
10. Remove waste from the remaining tanks.

The general technique for waste removal is hydraulic slurrying. First, slurry pump support structures are installed above the tank top, along with electrical service and motor controls. Then, slurry pumps are installed in the risers of the tank, usually three for salt removal and four for sludge removal. For the salt tanks, the pump discharges are positioned just above the level of the saltcake. Water is added to the tanks and the pumps turned on to agitate and dissolve a layer of salt. When the water becomes saturated with salt, the solution is pumped out. For sludge tanks, the pumps are placed into the top layer of sludge. As with salt removal, water is added and the pumps turned on to agitate the sludge. When the sludge is well mixed, the slurry is pumped out. For both salt and sludge, the pumps are then lowered to continue the process. Pumps may be lowered one or more times before a salt or sludge transfer is made. DOE is also exploring other methods for more efficient waste removal.

A.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 7) 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 an overall closure performance objective that provide a basis for comparison of different closure configurations. The performance objective applies to the completed closure of all 51 tank systems; however, DOE must close the tanks one at a time over a period of decades. (DOE anticipated that the need for HLW tanks will cease some time before 2030. The tanks would be closed as their individual missions end.) Therefore, the Department evaluates the impacts of each tank closure in the context of the entire tank farm. This methodology ensures that, as tanks are closed, the total closure impacts do not exceed the overall performance objective.

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To further ensure that closure of the tank system will be protective of human health and the environment, DOE also evaluates contamination from non-tank-farm-related sources. Studies of groundwater transport (DOE 1996) in the General Separations Area indicate that contaminant plumes from F and H Area tanks would not intersect. Therefore, DOE has established independent Groundwater Transport Segments for the two tank farms that represent the contaminant plumes from the tank farms. DOE requires that contributions from all contaminant sources within a Groundwater Transport Segment, both tank-farm-related and non-tank-farm-related, be considered in comparing modeled impacts to the performance objectives.

EC

A.4.3 TANK CLEANING

If needed, DOE's first method for tank cleaning is spray water washing. In this process, heated water would be sprayed throughout a tank, using spray jets installed in the tank risers. After spraying, the contents of the tank would be agitated with slurry pumps and pumped to another HLW tank still in service.

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After the spray washing, remotely operated video cameras are used to survey the interior of the tank to identify areas needing further cleaning. Based on experience with two tanks that have been spray-washed, DOE has learned that some sludge tends to remain on the bottom of the tank and that the sludge tends to be distributed around the edge of the tank bottom after the single water wash performed as the last phase of waste removal.

To determine the characteristics of the residual material that would remain in the closed HLW tanks, DOE obtained and analyzed sludge samples from waste tanks containing each of the major waste streams that have gone to the tank farms. These samples were washed in the

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L-1-5 laboratory, approximating what might remain after waste removal, and the concentrations of various components in the washed sludge were measured. DOE used the results of these samples in developing the process knowledge database that was used for the modeling described in Appendix C. Samples of the actual residuals that would remain in each tank after waste removal would be collected and analyzed after the completion of waste removal in that tank.

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, 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 (WSRC 2000). DOE has developed 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.

In five of the tanks (Tanks 1, 11, 12, 13, and 15), photographic inspections indicate that the amount of leaked waste is small. The waste is limited to salt deposits on the walls of the tank or perhaps covering part of the floor of the annulus. The leaked waste is virtually all salt because sludge is relatively immobile and will not migrate significantly through hairline cracks. The small amount of salt in these annuli should be relatively easy to remove with water.

In the remaining four tanks (Tanks 9, 10, 14, and 16), enough waste has leaked to completely cover the floor of the annulus. EC The annuli of these four tanks will be the most difficult of all the tanks to clean. Because of the large amount of waste that leaked in these four tanks, some waste may have leaked underneath the primary tanks. Also, waste has entered the ventilation ducts in the annuli. Special waste removal techniques will need to be developed for these tanks to ensure that water penetrates to the locations of the waste.

In three of the four tanks (Tanks 9, 10, and 14), the waste in the annulus is primarily salt, so it should be relatively easy to remove once it is dissolved. The difficulty is primarily getting the water to where it is needed and then removing the salt solution. Since the problem is limited to a few tanks, plans are to develop these techniques when needed. The techniques may differ between tanks (for example, a different annulus cleaning technique would be needed if waste has seeped underneath the primary tank).

Tank 16 is the most badly cracked tank and 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 the 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. Because this will be a one-time operation, plans are to develop the cleaning techniques when needed. EC

It is possible that some tanks may prove to be more difficult to clean than others. To meet performance criteria for tank closure, DOE may need to perform more rigorous cleaning than spray water washing. The method DOE expects to use is oxalic acid cleaning. In this process, hot oxalic acid is sprayed through the nozzles that were used for spray washing. Oxalic acid was selected above other cleaning agents for the following reasons (Bradley and Hill 1977):

- 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 spray washing alone.

- Oxalic acid is only moderately aggressive against carbon steel. Corrosion rates are on the order of 0.001 inch per week. This rate is acceptable for a short-term process such as cleaning. More aggressive agents such as nitric acid would be more effective in tank cleaning, but they could potentially cause release of contaminants to the environment in a mobile form.

- Oxalic acid has been demonstrated in Tank 16 only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity. However, at the present time, potential safety considerations restrict the use of oxalic acid in the HLW tanks. The *Liquid Radioactive Waste Handling Facility Safety Analysis Report* (WSRC 1998b) specifically states that oxalic acid cleaning of any waste tank is prohibited. A Nuclear Criticality Safety Evaluation would be necessary to address oxalic acid use, because oxalic acid would reduce the pH of the cleaning solution to the point where a quantity of fissile materials greater than currently anticipated would go into solution. This could create the potential for a nuclear criticality. In addition, an Unreviewed Safety Question evaluation and subsequent SAR revision would be necessary. TC EC

Between 1978 to 1980, Tank 16 was the subject of a rigorous waste removal, water washing, and oxalic acid cleaning demonstration. More than 99.9 percent of the original volume of sludge was removed during cleaning (approximately 10 kilograms of solid material was left). Based upon sample results, approximately 830 curies of strontium-90 (the predominant radionuclide) remained. The demonstration determined the increased effectiveness of oxalic acid cleaning. However, the process generates large quantities of sodium oxalate that must be disposed in the Saltstone Manufacturing and Disposal Facility. After oxalic acid cleaning is complete, the tank would be spray washed with inhibited water to neutralize the remaining acid. L-7-77

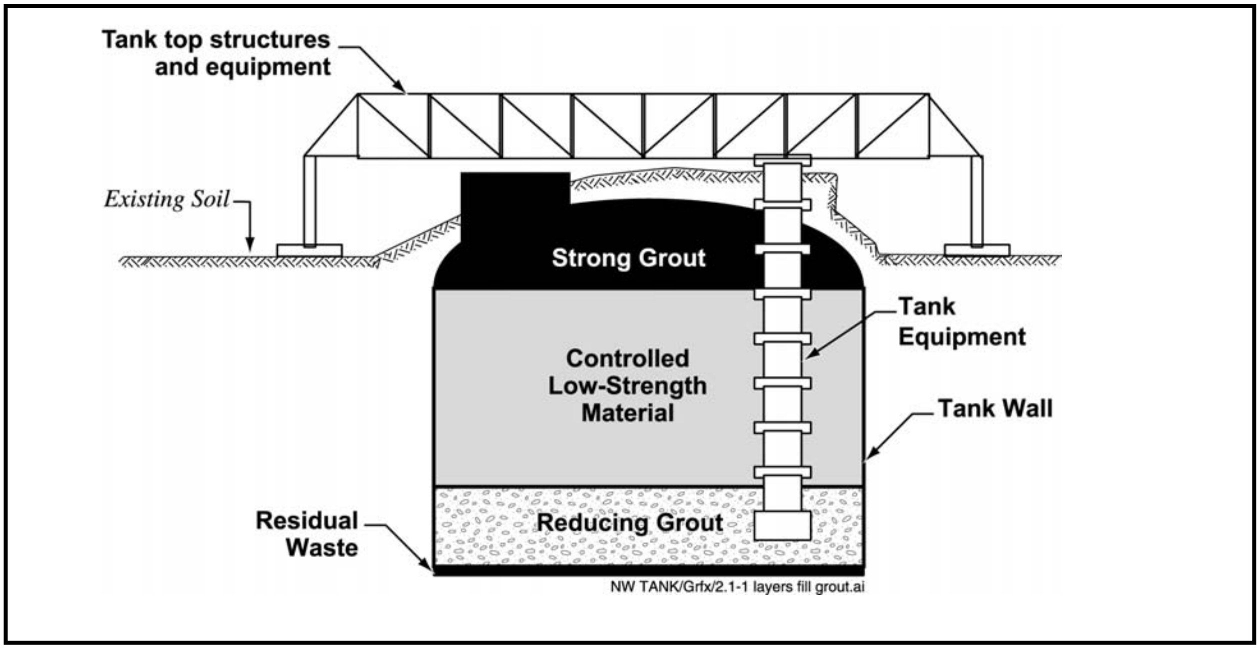
A.4.4 STABILIZATION

DOE has identified three options for tank stabilization under the Stabilize Tanks Alternative described in Chapter 2: grout fill, sand fill, and saltstone fill. In addition, another alternative would not stabilize the tank, but would remove the interior liner (which has been in contact with the HLW) from the concrete vault for disposal in some other location. The sections below describe the activities associated with the action alternatives. TC

Grout Fill

Each tank and its associated piping and ancillary equipment would be filled with a pumpable, self-leveling grout (a concrete-like material). The material would have a high pH to be 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 would be used. They would be mixed at a nearby batch plant constructed for the purpose and pumped to the tank. Figure A-5 shows how the sandwich layers of grout would be poured. DOE could also use an all-in-one grout, if it provided the same performance and protection. The potential combination of layers of grout is as follows: TC TC

- Reducing grout 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. The formulation of the backfill material for each waste tank will be adjusted, based on specific circumstances for each tank. The material is pumped into the waste tank through an available opening (e.g., tank riser). Observations of Tank 20



EC **Figure A-5.** Typical layers of the Fill with Grout Option.

during pouring of the reducing grout indicate that the grout lifts some of the sludge on the bottom of the tank and carries it like a wave until it eventually envelops the sludge in the grout. Nevertheless, DOE's use of the reducing grout is not dependent on fully enveloping the sludge, but upon the grout's ability to chemically alter any water leaching through the grout to the sludge.

EC

- Controlled Low-Strength Material (CLSM) 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 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:
  - The compressive strength of the material can be controlled so it will provide adequate strength for the overlying strata and yet could potentially be 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.

EC

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

- The runny 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.

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. Tank isolation is an activity that must be performed regardless of the closure option. Accessible piping and conduits would be removed and pulled back from each riser so that a physical break is made from the tank. Any transfer lines would be cut and capped.

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.

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 predominantly 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 and CLSM. The amount of bleed water would be minimized during the actual closure operation by limiting the amount of water in the grout and CLSM 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. Any bleed water not absorbed would be removed from the tank and (1) returned to the tank farm systems by siphoning it off and transferring it through a temporary aboveground transfer line to another waste tank or (2) processed at the Effluent Treatment Facility. 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.

EC

Portable concrete batch plants would supply the grout and CLSM backfill needed to fill the tanks. The plants may require a South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Air Quality permit to operate. All process water would be recycled.

EC

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 fences.

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 reducing grout material to ensure that all voids are filled to the fullest extent possible. 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.

EC | Piping and conduit at each riser that is not removed would be entombed in the riser filling operations. Each riser and the lead lining 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 that the associated risers are filled and backfilled.

Sand Fill

This option is similar to the Fill with Grout Option, except that sand would be used instead of grout. There would be no layers for intruder protection or chemical conditioning of leaching water. The sand would be carried by truck to an area near each tank farm and conveyed to the tank. | EC

Sand is readily available and is inexpensive. However, its emplacement is more difficult than grout as it does not flow readily into voids. Over time, sand would settle in the tank, creating additional void spaces. The tank top would then become unsupported and would sag and crack, although there would not be the catastrophic collapse that would be anticipated in the No Action case. Also, the sand would tend to protect the contamination to some extent and prevent winds from spreading the contaminants. However, sand is highly porous and rainwater infiltrates rapidly and does not run off. Also, sand is relatively inert and could not be formulated to retard the migration of radionuclides and chemical constituents. Thus, the expected contamination levels in groundwater would be higher than for the Fill with Grout Option. | EC

A variation of this alternative could involve filling the tanks with contaminated soils excavated during the remediation of SRS waste sites. Placement of soils in the tanks would present similar disadvantages to those described above for sand fill. In addition, handling contaminated soils would complicate the project, resulting in increased costs. Soils could not be readily formulated to retard the migration of radionuclides and chemical constituents; the additional contamination associated with the soil fill would have to be factored into the performance evaluation for the closure configuration. Because of these disadvantages, the use of contaminated soils as a fill material is not evaluated further in this EIS. | EC

Saltstone Fill

This option is the same as the Fill with Grout Option, except that saltstone would replace the reducing grout and the CLSM. Saltstone is a TC low-radioactivity fraction that meets the waste Incidental to Reprocessing requirements and is mixed with cement, flyash, and slag to form a concrete-like mixture. This option has the advantage of reducing the amount of disposal space needed at the Saltstone Manufacturing and Disposal Facility; however, it has several disadvantages:

- Because of the fast saltstone set-up times, two new saltstone mixing facilities (one in F Area and one in H Area) would be required.

- The amount of saltstone to be made is projected to be greater than 160 million gallons. This volume is considerably greater than the capacity of the HLW tanks. Therefore, the existing Saltstone Manufacturing and Disposal Facility in Z Area would still need to be operated.

- Filling the tank with a grout mixture that is contaminated would considerably complicate the project and increase worker radiation exposure, further adding to expense and risk.

- Saltstone grout cannot be poured as fast as CLSM because of its relatively high heat of hydration. Saltstone grout would have to be poured in discrete pours, allowing sufficient time between pours for the grout to cool.

Clean and Remove Tanks

EC This alternative involves cleaning of the tanks beyond that described in Section A.4.3. Such cleaning could include mechanical cleaning or other steps not yet defined. The steel components (including any piping and ancillary equipment) would be sectioned, removed, placed in burial boxes for disposal, and transported to SRS low-level waste disposal facilities.

For tank removal operations, DOE would enclose the tops of the tanks with structures designed to contain airborne contamination. These structures would be fitted with air locks and operate at negative pressure during cutting operations. Air discharges from the tanks and enclosures would be filtered with high-efficiency particulate air filters. DOE would backfill the void created by tank removal with a soil type similar to soils currently surrounding the tank.

The advantages of this option are:

- This alternative has the advantage of allowing disposal of the contaminated tank system in a waste management facility that is already approved for receiving low-level waste.

- This option exposes the surrounding soils such that they could be exhumed. This is the only option that has the potential to leave the waste tank area as an unrestricted area for future uses.

The disadvantages include:

- High radiation exposure to workers during the removal process

- Extremely high cost to remove the tank

- Considerable impact on other SRS operations

- Extremely high cost to dispose of the tank components elsewhere. Also, disposal of the tank could create another zone of restricted use (i.e., the restricted use zone is merely shifted, rather than being eliminated).

A.4.5 ENVIRONMENTAL RESTORATION PROGRAM ACTIVITIES

After a tank is closed, the SRS Environmental Restoration Program will conduct field investigations and remedial actions. The Environmental Restoration Program is concerned with all aspects of assessment and cleanup of both contaminated facilities in use and sites that are no longer a part of active EC 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 Environmental Restoration intrusive sampling. Once an operational grouping is closed, the HLW operations organization and the Environmental Restoration organization will establish a Co-Occupancy Plan to ensure safe and efficient soils assessment and remediation. The HLW organization will be responsible for operational control and the Environmental Restoration organization will be responsible for Environmental Restoration activities. The primary purpose of the Co-Occupancy Plan is to provide the two organizations with a formal process to plan, control, and coordinate the Environmental Restoration activities in the tank farm areas where the existing HLW management and operational procedures can be continuously utilized.

The *High-Level Waste Tank Closure Program Plan* (DOE 1996) provides general information on post-closure activities and tank-specific closure modules will also address post-closure 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 Federal Facility Agreement. The Environmental Restoration 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 Federal Facility Agreement 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 A-6 presents an example of the closure | EC
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 would be established in accordance | EC
with the Environmental Restoration Program
described in the Federal Facility Agreement
(EPA 1993). Figure A-6 shows a conceptual cap | EC
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.

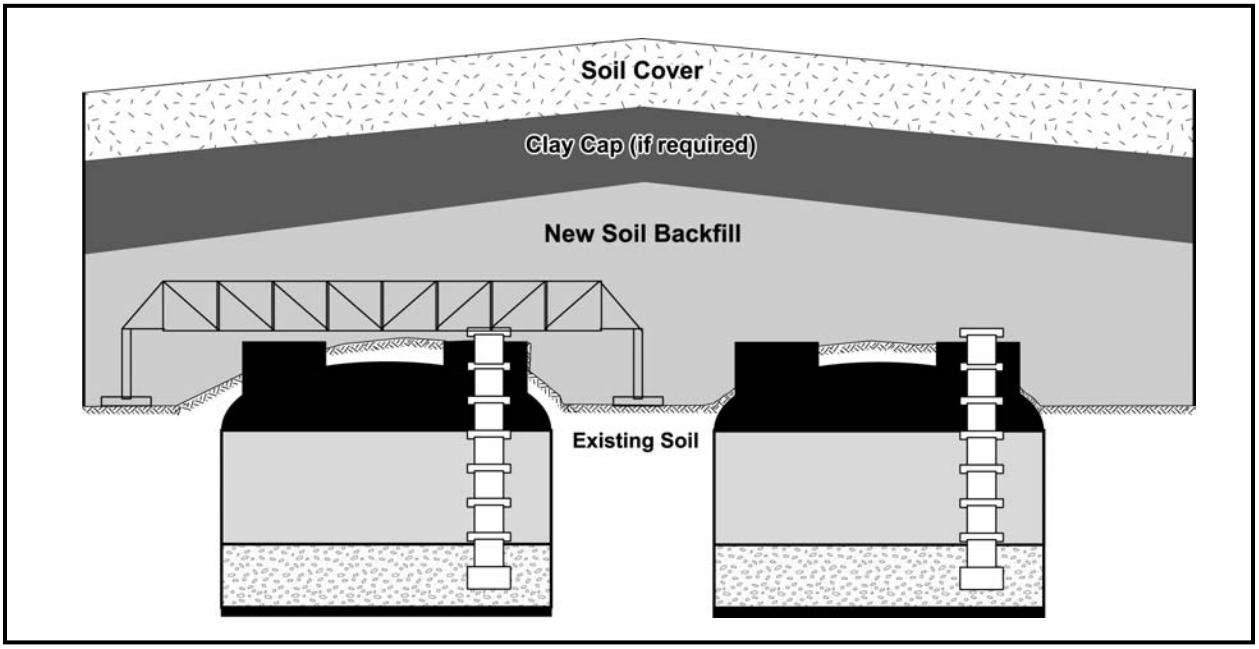


Figure A-6. Area closure example.

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APPENDIX B

ACCIDENT ANALYSIS

TABLE OF CONTENTS

Section Page

List of Tables

Table Page

APPENDIX B. ACCIDENT ANALYSIS

This appendix provides detailed information on potential accident scenarios associated with closure of the high-level waste (HLW) tanks at Savannah River Site (SRS). The appendix provides estimates of the quantity and composition of hazardous materials that could be released in an accident and the consequences to workers and the public, estimated in terms of dose and latent cancer fatalities for radiological releases and of concentration levels for chemical releases.

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EC

The primary sources of information for the accident analyses are a specific calculation (Yeung 1999) and the *Safety Analysis Report - Liquid Radioactive Waste Handling Facility* (WSRC 1998a).

B.1 General Accident Information

An accident, as discussed in this appendix, is an inadvertent release of radiological or chemical hazardous materials as a result of a sequence of one or more probable events. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake. This is followed by a succession of other events (that could be dependent or independent of the initial event) which dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

EC

- *Internal initiators* – normally originate in and around the facility, but are always a result of facility operations. Examples include equipment or structural failures and human errors.
- *External initiators* – are independent of facility operations and normally originate from outside the facility. Some external initiators affect the ability of the facility to maintain its confinement of hazardous materials because of potential structural damage. Examples include aircraft crashes, vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.
- *Natural phenomena initiators* – are natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

The likelihood of an accident occurring and its consequences usually depend on the initiator and the sequence of events and their frequencies or probabilities. Accidents can be grouped into four categories–anticipated, unlikely, extremely unlikely, and beyond extremely unlikely, as described in Table B-1. The U.S. Department of Energy (DOE) based the frequencies of accidents at the liquid radioactive waste handling facility on safety analyses and historical data about event occurrences.

EC

B.2 Accident Analysis Method

For the alternatives for HLW tank closure, Yeung (1999) identified potential accident scenarios that involved the release of both radiological and nonradiological, hazardous materials. Section B.2.1 provides information about the various alternatives for tank closure. Section B.2.2 provides details about the specific analytical methods that were used in this appendix.

EC

EC

The accident sequences analyzed in this environmental impact statement (EIS) would occur at frequencies generally greater than once in 1,000,000 years. However, the analyses considered accident sequences with smaller frequencies, if their impacts could provide information important to decision making.

EC

Table B-1. Accident frequency categories.

Accident frequency category	Frequency range (occurrences per year)	Description
Anticipated	Less than once in 10 years, but greater than once in 100 years	Accidents that might occur several times during facility lifetime
Unlikely	Less than once in 100 years, but greater than once in 10,000 years	Accidents that are not likely to occur during facility lifetime; natural phenomena include Uniform Building Code-level earthquake, maximum wind gust, etc.
Extremely unlikely	Less than once in 10,000 years, but greater than once in 1,000,000 years	Accidents that probably will not occur during facility life cycle; this includes the design basis accidents
Beyond extremely unlikely	Less than once in 1,000,000 years	All other accidents

Source: DOE (1994).

B.2.1 HIGH-LEVEL WASTE TANK CLOSURE ALTERNATIVES

DOE has organized the accident data in this appendix by alternative. DOE has also organized the accident impacts in Chapter 4 by alternative to reflect potential accident occurrences for each associated alternative. EC

Approximately 37 million gallons of HLW are stored in underground tanks in F Area and H Area. DOE intends to remove from service all 51 HLW tanks. Because two of these tanks (Tanks 17 and 20) are already closed, this appendix addresses the potential impacts from accidents associated with the closure of the 49 remaining waste tanks.

The alternatives considered in this EIS include:

- No Action Alternative
- Stabilize Tanks Alternative:
  - Fill with Grout Option (Preferred Alternative)
  - Fill with Sand Option
  - Fill with Saltstone Option
- Clean and Remove Tanks Alternative

TC

B.2.2 RADIOLOGICAL HAZARDS

The accidents identified for HLW tank closure are described in Section B.3. These descriptions include an approximation of the material at risk (MAR) that would potentially be involved in a given accident. Depending on the particular scenario, release fractions have been applied to the MAR to determine the amount of the materials that would be released to the environment. This amount is referred to as the source term. Source terms are provided in Yeung (1999) for airborne, ground surface runoff, and underground releases. The airborne releases are of short duration and could have impacts to the worker and offsite populations. The surface runoff and underground releases, however, would not have short-term impacts to any of the analyzed receptors. In the case of surface runoff, DOE would employ mitigative actions to prevent the release from reaching the Savannah River (i.e., clean-up actions, berms, dams in surface water pathways, etc.). In the unlikely event that radionuclides reached the river, DOE's mitigative actions would include notification of municipalities downstream that use the Savannah River for drinking water supplies. These mitigative actions would preclude any offsite dose from a liquid release pathway. In the case of underground releases, radiological materials released directly into the soil would take a long period of time to reach any of the human receptors evaluated in this analysis. The potential consequences of such

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releases are determined as part of the EIS long-term impacts.

The analysis of airborne releases used the computer code AXAIRQ to model accidental atmospheric radioactive releases from SRS that are of relatively short duration. AXAIRQ strictly follows the guidance in Regulatory Guide 1.145 (NRC 1982) on accidental releases and has been verified and validated (Simpkins 1995a and 1995b). Because all considered accidents would occur at or below ground level, the releases for AXAIRQ assumed ground-level releases with no modification for release height. In accordance with the Regulatory Guide, the code considers plume meander and fumigation under certain conditions. Information on plume rise due to buoyancy or momentum is not available. The program uses a 5-year meteorological database for SRS and determines the shortest distance to the Site boundary in each of the 16 sectors by determining the distance to one of 875 locations along the boundary. The impacts that were derived from the use of this code used the average (50 percent) meteorology. Because these accidents could occur in either F or H Area at SRS, the largest unit dose conversion factor was chosen (applicable to F or H Area), dependent on the receptor being evaluated. The code uses the shortest distance in each sector to calculate the concentration for that sector. DOE used the computer code PRIMUS, which was developed by the Oak Ridge National Laboratory, to consider decay and daughter ingrowth.

Simpkins (1997) provided unit dose conversion factors for a wide list of radionuclides for release locations in F and H Areas. These factors were applied to the airborne source terms to calculate the doses to the various receptors.

The analysis assumes that all tritium released would have the form of tritium oxide and, following International Commission on Radiological Protection methodology, the dose conversion factor for tritium has been increased by 50 percent to account for absorption through the skin. For population dose calculations, age-specific breathing rates are applied, but adult dose conversion factors are used. Radiation doses were calculated to the maximally exposed individual, to the population within 50 miles of the facility, and to a noninvolved worker assumed to be 640 meters downwind of the facility.

After DOE calculated the total radiation dose to the public, it used dose-to-risk conversion factors established by the National Council on Radiation Protection and Measurements (NCRP) to estimate the number of latent cancer fatalities (LCFs) that could result from the calculated exposure. No data indicate that small radiation doses cause cancer; however, to be conservative, the NCRP assumes that any amount of radiation has some risk of inducing cancer. DOE has adopted the NCRP factors of 0.0005 LCF for each person-rem of radiation exposure to the general public and 0.0004 LCF for each person-rem of radiation exposure to radiation workers (NCRP 1993).

B.2.3 CHEMICAL HAZARDS

For chemically toxic materials, the long-term health consequences of human exposure to hazardous materials are not as well understood as those related to radiation exposure. A determination of potential health effects from exposures to chemically hazardous materials, as compared to radiation, is more subjective. Therefore, the consequences from accidents involving hazardous materials are expressed in terms of airborne concentrations at various distances from the accident location, rather than in terms of specific health effects.

To determine the potential health effects to workers and the public that could result from accidents involving hazardous materials, the airborne concentrations of such materials released during an accident at varying distances from the point of release were compared to the Emergency Response Planning Guideline (ERPG) values (AIHA 1991). The American Industrial Hygiene Association established these values, which depend on the chemical substance, for the following general severity levels to ensure that the necessary emergency actions occur to minimize exposures to humans.

- <u>ERPG-1 Values</u>. Exposure to airborne concentrations greater than ERPG-1 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.

- <u>ERPG-2 Values</u>. Exposures to airborne concentrations greater than ERPG-2 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impair a person's ability to take protective action.

- <u>ERPG-3 Values</u>. Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

Not all hazardous materials have ERPG values. For chemicals that do not have ERPG values, a comparison was made to the most restrictive available exposure limits established by other guidelines to control worker accidental exposures to hazardous materials. In this document, the ERPG-2 equivalent that is used is the PEL-TWA (Permissible Exposure Limit – EC Time Weighted Average) from 29 Code of Federal Regulations (CFR) Part 1910.1000, Subpart Z.

B.3 Postulated Accident Scenarios Involving Radioactive Materials

These sections describe the potential accident scenarios associated with each alternative that could involve the release of radioactive materials. The impacts of these scenarios are shown in Section B.4.

B.3.1 STABILIZE TANKS ALTERNATIVE TC

The Stabilize Tanks Alternative, including all of its stabilization options, could require cleaning the inside of the tank. This cleaning could TC involve a two-step process. Initially, after bulk waste removal, the waste tank interiors would be water-washed, using rotary spray jets put down into the tank interior through the tank risers. Water for these jets would be supplied from a skid-mounted tank and pump system. Following water washing, additional cleaning may be required, using a hot oxalic acid solution through the same spray jets.

Six potential accident scenarios associated with the cleaning process that required evaluation EC were identified in Yeung (1999). These included:

- Deflagration
- Transfer errors
- Vehicle impacts
- Chemical (oxalic acid) spill
- Seismic event EC
- Tornado

Criticality was not addressed as a potential accident scenario in Yeung (1999) because DOE considers inadvertent criticality to be beyond extremely unlikely in the HLW tanks (Nomm EC 1995). The criticality safety of the waste sludge was based on the neutron-absorbing characteristics of the iron and manganese contained in the sludge. However, the review assumed that the waste would remain alkaline and did not address the possibility that chemicals wold be used that would dissolve sludge solids. Therefore, the *Safety Analysis Report - Liquid* EC *Radioactive Waste Handling Facility* (WSRC 1998) specifically states that oxalic acid cleaning of any waste tank is prohibited.

A formal Nuclear Criticality Safety Evaluation (Unreviewed Safety Question Evaluation and subsequent Safety Analysis Report revision) must be completed before oxalic acid could be introduced into the tank farms. Oxalic acid can EC dissolve uranium, plutonium, and the two neutron poisons that are credited for preventing a criticality - iron and manganese. The Nuclear Criticality Safety Evaluation would address the relative rates at which each of these species dissolves and would examine potential scenarios that could cause fissile material to concentrate.

The tanks would be back-filled with a pumpable material (grout, sand, or saltstone). Yeung (1999) indicated that the scenarios identified above for the cleaning operations bound all postulated accidents during back-filling the waste tanks with either grout or sand. Because saltstone is a radioactive material, any uncontrolled release of radioactive materials associated with the Fill with Saltstone Option must be evaluated. WSRC (1992a) evaluated a failure of the Salt Solution Hold Tank. Yeung (1999) identified no accident scenarios for the post-closure period for this alternative. TC EC TC

B.3.1.1 Deflagration

Scenario: One postulated accident during cleaning of the waste tanks would be a release of radiological materials due to an explosion inside of the waste tank. The explosion could possibly consist of a deflagration or detonation. The transition from deflagration to detonation would occur only if the deflagration flame front accelerates to sonic speeds. In order for the deflagration to occur, flammable chemicals must be introduced into the waste tanks as a result of human error, and ignition sources must be present (Yeung 1999).

Probability: The determination of the probability of this event was based on the availability of flammable chemicals, the potential that they would be introduced into the waste tanks, and the fact that an ignition source is present. There are no flammable chemicals required for the cleaning process. For a deflagration to occur, multiple operator errors and violation of multiple administrative controls would be required. From Benhardt et al. (1994), the combined probability of violation of an administrative control bringing in the flammable chemical and chemical addition into the tank would be 1.5×10^{-6} per year. Considering that, in addition to the above, a significant amount of flammable material would be required to be introduced into a tank (e.g., 440 kilograms of benzene), by engineering judgment, the additional probability of this event was estimated to be 1×10^{-2} per year (Yeung 1999). Therefore, the probability of a deflagration during the cleaning process was estimated to be 1.5×10^{-8} per year. Because the tanks are relatively free of internal structures, the transition from deflagration to detonation occurs less than one time in a hundred for a near stoichiometric mixture. Therefore, the frequency of a detonation event was estimated to be 1×10^{-10} per year (Yeung 1999). EC EC EC EC

Because the likelihood of these events is well below 1×10^{-7}, they are considered beyond extremely unlikely and are not evaluated further in this EIS. EC

B.3.1.2 Transfer Errors

Scenario: The *Safety Analysis Report - Liquid Radioactive Waste Handling Facility* (WSRC 1998a) reports that all transfer error events in the Liquid Radioactive Waste Handling Facility can be bounded by a waste tank overflow event, which would result in an aboveground spill of 15,600 gallons of waste (520 [gpm] for 30 minutes). A postulated accident during water spray washing of the waste tanks would be a release of diluted waste, due to continuous maximum flow through a transfer line direct to the environment for 30 minutes without operator intervention. WSRC (1998a) assumed that the spill would occur aboveground and result in seepage into the ground and evaporation into the air. This scenario would bound all leak/spill events, including loss of containment. EC L-7-83

Probability: It is considered unlikely that aboveground equipment failures leading to leakage or catastrophic release of the tank contents would go undetected (WSRC 1998a). Therefore, failures of aboveground equipment and the failure of the operators to detect and stop the leaks were considered in Yeung (1999). It was estimated that equipment failures and operator errors to detect and stop the leaks leading to the release of the bounding source terms described below could occur with a frequency of 1×10^{-3} per year (Yeung 1999). This frequency is in the unlikely range.

Source Term: After bulk waste removal and before spray washing, there would be approximately 9,000 gallons of HLW in the form of sludge or sludge slurry left in each tank. Based on the bounding sludge dose potential as given in the *Safety Analysis Report* (WSRC 1998a), it was assumed that the sludge slurry before spray washing would be characterized by the activities of 81,000 curies (Ci) of plutonium-238 (Pu-238) and 2,180,000 Ci of strontium-90 (Sr-90). The volume of the water used for spray cleaning was assumed to be 140,000 gallons (WSRC 1998b). This would result in a total waste volume of 149,000 gallons, with nuclide concentrations in the diluted waste solution estimated at 0.54 Ci/gallons and 14.63 Ci/gallons for Pu-238 and Sr-90, respectively. The instantaneous airborne release for a spill of 15,600 gallons was estimated to be 0.34 Ci of Pu-238 and 9.1 Ci of Sr-90 (Yeung 1999). An additional entrainment source term of 0.34 Ci of Pu-238 and 9.1 Ci of Sr-90 was estimated, assuming no mitigative actions were taken within a 10-hour period following the event.

B.3.1.3 Vehicle Impact

Scenario: Another postulated accident during cleaning of the waste tanks would be a release of diluted waste, due to failure of the aboveground pumping equipment and piping resulting from a construction vehicle impact. It was assumed that the equipment used to pump out the wastewater slurry from the tanks would be damaged to the point where pumping continued, releasing the slurry onto the ground.

Probability: The frequency of a vehicle crash occurring over all the Liquid Radioactive Waste Handling Facilities is bounded between 7.4×10^{-4} and 4.7×10^{-3} events per year (WSRC 1998a). The *Safety Analysis Report* (WSRC 1998a) conservatively assumes that 0.1 percent of the accidents occurring at the H Area and F Area Tank Farms impact aboveground equipment, resulting in an overall frequency of 2.7×10^{-6} per year. The possibility that a fire could occur following a crash was also evaluated. Assuming that 97.7 percent of all truck accidents are minor (WSRC 1992b), and that fires resulting from minor accidents have an extremely low probability, the overall frequency of a fire resulting from a vehicle crash is estimated to be 6.2×10^{-8} per year. Therefore, vehicle impacts involving a coincident fire were considered to be beyond extremely unlikely.

Source Term: The MAR for this scenario was assumed to be the same as that in Section 3.1.2. Because the source term for this scenario is the same as estimated for the transfer errors and the expected frequency is smaller, the risk associated with this scenario would be bounded by the transfer errors accident. No further evaluation of vehicle impacts is required in this appendix.

EC

EC

B.3.1.4 Chemical (Oxalic Acid) Spill

This accident would involve the release of nonradiological hazardous materials, which is addressed in Section B.5.

B.3.1.5 Seismic Event

Scenario: Yeung (1999) postulated that a design basis earthquake could occur during cleaning of the waste tanks, resulting in a release of liquid radiological materials. Only one tank in each tank farm would undergo closure at any one time. It was therefore assumed that the earthquake would occur immediately following water spray washing, which had been performed on two tanks simultaneously (one in each tank farm). The seismic event was assumed to fail the same transfer piping and equipment as was mentioned in the previous scenarios.

Probability: The design basis earthquake has an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the cleaning of two tanks would take approximately 14 days, a release of the bounding source term would occur at an annual probability of 1.9×10^{-5}. This accident would be categorized as extremely unlikely.

Source Term: The aboveground MAR was assumed to be same as in Section 3.1.2, except that the source term would be doubled because two tanks would be involved. Yeung (1999) provided the source term as an instantaneous airborne release of 0.68 Ci of Pu-238 and 18 Ci of Sr-90. If mitigation measures were not taken, entrainment would result in an additional airborne release of 0.68 Ci of Pu-238 and 18 Ci of Sr-90 over a 10-hour period.

B.3.1.6 Tornado

The design basis tornado was postulated to occur during water spray washing of the waste tanks. From WSRC (1998a), it was assumed that administrative controls stipulate the cessation of waste transfer operations at the first instance of a tornado/high wind warning. EC

All waste tanks are underground and are protected by concrete roofs. With all transfer operations stopped, there would be no MAR aboveground. Some aboveground components of the transfer system may fail, but their contributions to the release of radiological materials were considered insignificant (Yeung 1999). As a result, this scenario would be bounded by several other scenarios and is not evaluated further. EC EC

B.3.1.7 Failure of Salt Solution Hold Tank

Scenario: This scenario assumes that a Saltstone Mixing Facility would be built in F Area and H Area, similar to that currently operating in Z Area. This accident would involve a worst-case release of the salt solution contained in a Salt Solution Hold Tank, prior to mixing with cement, flyash, and slag to form the saltstone. The Salt Solution Hold Tank was assumed to contain 45,000 gallons of salt solution. The entire volume was assumed to be released and allowed to evaporate over a 2-hour period (WSRC 1992a). No credit was taken for operator intervention, absorption into the ground, or containment of the spill in the diked area of the tank. In reality, this would significantly reduce the airborne release. It would take an extremely high-energy event to vaporize such a large quantity in such a short period of time (WSRC 1992a). Failure of the Salt Solution Hold Tank was assumed to occur during the design basis earthquake. EC

Probability: The design basis earthquake has an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the Salt Solution Hold Tank has a 10 percent chance of failing during the earthquake, a release of the bounding source term was estimated to occur at an annual probability of 5×10^{-5}. This scenario would be extremely unlikely.

Source Term: The 45,000 gallons of salt solution (1.2 kilograms per liter) in the Salt Solution Hold Tank was assumed to contain the radionuclides in Table B-2 (WSRC 1992a). Table B-2 also contains the assumed release fractions resulting in the final estimated source terms (unmitigated) (WSRC 1992a). This accident would also involve the release of nonradiological hazardous materials. The evaluation of these releases is addressed in Section B.5.

B.3.2 CLEAN AND REMOVE TANKS ALTERNATIVE

Following bulk waste removal, water spray washing, and additional cleaning (including the use of oxalic acid), additional cleaning steps (yet to be defined) would be performed until the tanks are clean enough to remove. The additional cleaning steps would increase worker radiation exposure and contamination. They would also increase the potential for industrial safety accidents. Following cleaning, the tank components would be sectioned, removed, placed in burial boxes for disposal, and transported to onsite waste disposal facilities. EC

The scenarios in Section B.3.1 were assumed to bound any postulated tank accident scenarios associated with this alternative.

B.3.2.1 Flooding

Scenario: Yeung (1999) postulated that abandoning the waste tanks in place following waste removal would lead to long-term tank degradation, failure of the tank roofs, and exposure of the radiological materials to potential flooding and release to the environment. DOE has assumed that institutional control would be maintained for a period of at least 100 years. Beyond institutional control, it has been assumed that the waste tanks would retain their basic structural EC EC

Table B-2. Radiological source term for failure of Salt Solution Hold Tank.

Radionuclide	Activity (curies)[a]	Assumed release fraction	Total airborne activity released (curies)[a]
H-3	380	1.0	380
Co-60	15	1.0×10^{-4}	0.0015
Sr-89	13	1.0×10^{-4}	0.0013
Sr-90	13	1.0×10^{-4}	0.0013
Tc-99	210	1.0×10^{-2}	2.1
Ru-106	130	1.0×10^{-2}	1.3
Sb-125	31	1.0×10^{-2}	0.31
I-129	4.2	3.0×10^{-1}	1.3
Cs-137	21	1.0×10^{-2}	0.21
Ba-137m	21	1.0×10^{-2}	0.21
Eu-154	3.4	1.0×10^{-4}	0.00034
Total alpha	11	1.0×10^{-4}	0.0011
Other beta-gamma	840	1.0×10^{-4}	0.084
Total	1680		383

Source: WSRC (1992a)

a. Values rounded to 2 significant figures.

integrity for another 100 years without catastrophic failure. Therefore, this EIS considers any impacts associated with failure of these waste tanks after a period of 200 years to
EC be long-term impacts and they are not addressed further in this appendix.

B.3.3 NO ACTION ALTERNATIVE

For the No Action Alternative, no action would
EC be taken to remove waste from the tanks beyond that which is included in bulk waste removal. Flooding was the only scenario identified in Yeung (1999), applicable to this alternative, which would result in an airborne release of radiological materials.

B.4 Accident Impacts Involving Radioactive Materials

This section presents the potential impacts associated with the accident scenarios involving the release of radioactive materials identified in Section B.3. Table B-3 provides the accident impacts for each of the scenarios from airborne
EC releases. It also provides the resultant LCFs expected from the offsite impacts.

B.5 Postulated Accidents Involving Nonradioactive Hazardous Materials

This section summarizes the potential accident scenarios involving hazardous chemicals for the various alternatives. Two accidents involving hazardous material releases were identified in Yeung (1999).

B.5.1 OXALIC ACID SPILL

Scenario: A postulated accident during cleaning of the waste tanks would be a worst-case spill of 10,000 gallons of 4 percent (concentration) oxalic acid from any cause (vehicle crash, earthquake, or tornado). It was assumed that oxalic acid used for cleaning would be stored in an aboveground 10,000-gallon stainless steel portable tank. The oxalic acid was assumed to be heated to a temperature of 80°C. This scenario would bound all accidents involving a chemical release of oxalic acid.

Table B-3. Radiological impacts from airborne releases.

Accident	Total curies released	Accident frequency	Non-involved worker (rem)	Maximally exposed individual (rem)	Offsite population (person-rem)	Latent cancer fatalities
Transfer errors	19	Once in 1,000 years	7.3	0.12	5,500	2.8
Seismic (DBE)	38	Once in 53,000 years	14.6	0.24	11,000	5.5
Salt Solution Hold Tank failure	380	Once in 20,000 years	0.015	0.00042	16.7	0.0084

Probability: The annual probability of exceedance for the design basis earthquake is 5.0×10^{-4} (WSRC 1998c). Assuming that the oxalic acid tank would be used for 30 days of the year, the overall frequency was calculated to be 4.1×10^{-5} per year. For the design basis tornado, the annual probability of exceedance is 2×10^{-5} (WSRC 1998c). Combined with the 30-day time at risk, probability resulted in an overall annual probability of 1.6×10^{-6}. If the tank were moved into a shelter or protected by administrative controls (e.g., erect missile barrier and/or tie down the tank), the annual probability for this event could be reduced to 8×10^{-8} (Yeung 1999). If a vehicle crash is considered, the frequency of a vehicle crash occurring over all the Liquid Radioactive Waste Handling Facilities is bounded between 7.4×10^{-4} and 4.7×10^{-3} events per year (WSRC 1998a). Conservatively assuming that 0.1 percent of the accidents occurring at the F- and H-Area Tank Farms (WSRC 1998a) impact the oxalic acid tank resulted in an overall frequency of 2.7×10^{-6} per year. Considering these three different initiating events, the most credible scenario would be a design basis earthquake with an annual probability of 4.1×10^{-5}. This scenario would be extremely unlikely.

Source Term: The chemical release MAR would consist of 10,000 gallons of 4 percent oxalic acid. The oxalic acid source term was conservatively estimated to be an airborne release of 150 grams of 100-percent oxalic acid at a release rate of 168 milligrams per second (Yeung 1999).

B.5.2 FAILURE OF SALT SOLUTION HOLD TANK

Scenario: As described in Section B.3.1.7, this scenario would involve the failure of the Salt Solution Hold Tank, which would be used in one of the options in the Stabilize Tanks Alternative during preparation of the saltstone that would be used to backfill the empty tanks. The Salt Solution Hold Tank would contain both radiological and hazardous materials. The radiological impacts are discussed in Section B.4.

Probability: The initiating event that was assumed to cause the Salt Solution Hold Tank failure was a design basis earthquake with an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the Salt Solution Hold Tank has a 10-percent chance of failing during the earthquake, a release of the bounding source term was estimated to occur at an annual probability of 5×10^{-5}. This scenario would be extremely unlikely.

Source term: The source term for hazardous materials released from the failed Salt Solution Hold Tank is given in Table B-4. It was obtained from the *Safety Analysis Report for the Saltstone Facility* (WSRC 1992a).

Table B-4. Chemical source term for failure of Salt Solution Hold Tank.

Chemical	Total inventory in Salt Solution Hold Tank (kg)	Assumed release fraction	Evaporation release rate (milligrams per second)
Arsenic	170	1.0×10^{-4}	2.4
Barium	170	1.0×10^{-4}	2.4
Cadmium	51	1.0×10^{-4}	0.71
Chromium	340	1.0×10^{-4}	4.7
Lead	170	1.0×10^{-4}	2.4
Mercury	85	1.0×10^{-4}	1.2
Selenium	60	1.0×10^{-4}	0.83
Silver	170	1.0×10^{-4}	2.4
Benzene	0.52	1.0	73
Phenol	170	1.0×10^{-2}	240

Source: Yeung (1999).

B.6 Accident Impacts Involving Nonradioactive Hazardous Materials

As Section B.4 provided for the radiological consequences of identified accidents; this section provides the potential impacts associated with the release of nonradioactive hazardous materials from the two accident scenarios.

B.6.1 OXALIC ACID SPILL

The oxalic acid spill, described in Section B.5.1, would result in the release of 150 grams of oxalic acid at a release rate of 168 milligrams per second. Table B-5 provides atmospheric dispersion factors for the two individual receptors, the uninvolved worker and the maximally exposed offsite individual (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-5.

EC

Because the Permissible Exposure Limit – Time Weighted Average (PEL-TWA), which equates to the ERPG-2 value described in Section B.2.3, is 1.0 milligrams per cubic meter for oxalic acid, there would be no significant impacts to the onsite or offsite receptors from this accident.

B.6.2 FAILURE OF SALT SOLUTION HOLD TANK

The failure of the Salt Solution Hold Tank, described in Section B.5.2, would result in the release of the hazardous chemical inventory provided in Table B-4. Table B-6 provides atmospheric dispersion factors for the two individual receptors, the non-involved worker and the maximally exposed offsite individual (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-6.

EC

Because the most restrictive exposure limits for these hazardous materials is 0.5 milligrams per cubic meter, there would be no significant impacts to the onsite or offsite receptors from this accident.

EC

B.7 Environmental Justice

In the event of an accidental release of radioactive or hazardous chemical substances, the dispersion of such substances would depend on meteorology conditions (such as wind direction) at the time. Given the variability of meteorology conditions, the low probability of accidents, the location of minority and low-income communities in relation to SRS, and the

Table B-5. Chemical concentrations to various receptors for oxalic acid spill accident.

Chemical	Evaporation release rate (milligrams per second)	Atmospheric dispersion factor (seconds per cubic meter)		Resultant concentration (micrograms per cubic meter)	
		Noninvolved worker	Maximally exposed individual	Noninvolved Worker	Maximally exposed individual
4-percent oxalic acid	168	1.7×10^{-4}	5.7×10^{-7}	0.03	0.0001

Table B-6. Chemical concentrations to various receptors for failure of the Salt Solution Hold Tank.

Chemical	Evaporation release rate (milligrams per second)	Atmospheric dispersion factor (seconds per cubic meter)		Resultant concentration (milligrams per cubic meter)	
		Noninvolved worker	Maximally exposed individual	Noninvolved Worker	Maximally exposed individual
Arsenic	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Barium	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Cadmium	0.71	1.7×10^{-4}	5.7×10^{-7}	0.0001	4.0×10^{-7}
Chromium	4.7	1.7×10^{-4}	5.7×10^{-7}	0.0022	2.7×10^{-6}
Lead	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Mercury	1.2	1.7×10^{-4}	5.7×10^{-7}	0.0002	6.7×10^{-7}
Selenium	0.83	1.7×10^{-4}	5.7×10^{-7}	0.0001	4.7×10^{-7}
Silver	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Benzene	73	1.7×10^{-4}	5.7×10^{-7}	0.012	4.2×10^{-5}
Phenol	240	1.7×10^{-4}	5.7×10^{-7}	0.040	1.4×10^{-4}

small magnitude of estimated offsite impacts, disproportionately high or adverse human health and environmental impacts to minorities or low-income populations are not expected to be very likely. EC

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APPENDIX C

LONG-TERM CLOSURE MODELING

TABLE OF CONTENTS

Section Page

TABLE OF CONTENTS (Continued)

List of Tables

TABLE OF CONTENTS (Continued)

List of Tables (Continued)

TABLE OF CONTENTS (Continued)

List of Tables (Continued)

List of Figures

APPENDIX C. LONG-TERM CLOSURE MODELING

This appendix provides a discussion of the fate and transport modeling that was performed to determine the long-term impacts from the alternatives described in Chapter 2 of this EC environmental impact statement (EIS). This modeling estimates the potential human health and ecological impacts of residual EC contamination remaining in closed high-level waste (HLW) tanks for all alternatives and estimates the concentrations and dose levels at the locations where the groundwater outcrops into the environment (i.e., the seeplines).

In the modeling described in this appendix, the F- and H-Area Tank Farms were modeled, assuming conditions that would exist after tank closure for four scenarios as follows: (1) No TC Action Alternative, (2) Fill with Grout Option, (3) Fill with Sand Option, and (4) Fill with Saltstone Option. None of the analyzed scenarios took credit for engineered caps to be placed after completion of closure activities.

L-7-87

Potential impacts to the following hypothetical individuals were analyzed:

- *Worker:* An adult who has authorized access to and works at the tank farms 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 farms 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 EC tank farms and near one of the streams.
- *Nearby child resident:* A child who lives in a dwelling across either Fourmile Branch or Upper Three Runs, downgradient of the tank farms and near the streams.

In addition to the hypothetical individuals identified above, concentrations and dose levels were calculated at the groundwater seepline point of exposure. Concentrations and dose EC levels were also calculated at 1-meter and 100-meters downgradient from the edge of the F- and H-Area Tank Farms, and an estimate of the doses from all pathways at these locations was performed.

Uncertainty in Analysis

In this EIS, the U.S. Department of Energy EC (DOE) has made assumptions on numerical parameters that affect the calculated impacts. There is some uncertainty associated with the values of these parameters, due to unavailable data and the current state of knowledge about closure processes and the long-term behavior of materials.

The principal parameters that affect modeling results are the following:

- **Inventory:** The amount of material in a tank directly affects the concentrations at any given location, unless the amount of material is so great that the solubility limit is exceeded. Once the solubility limit is exceeded, greater amounts of source material do not necessarily result in increased concentrations at receptor locations. In this modeling effort, both plutonium and uranium were assumed to be limited by solubility. Inventory results are based primarily on process knowledge at this time. As each tank is prepared for closure, specific sampling will be conducted EC to determine the inventory.
- **Hydraulic conductivity:** The actual rate of water movement through the material is ultimately affected by the hydraulic conductivity of the strata underneath the

source. Generally, the grout or concrete basemat is the limiting layer, with regard to water infiltration. At the time of structural failure, the hydraulic conductivity is increased dramatically, making more water available to carry contaminants to the aquifer. In general, this will result in greater doses/concentrations, due to the increased movement of material.

- **Distribution coefficient:** The distribution coefficient (K_d) affects the rate at which contaminants move through strata. Large K_d values provide holdup time for short-lived radionuclides.

- **Vadose zone thickness:** The thickness of the strata between the contaminated region and the aquifer does not necessarily reduce the concentration as much as it slows the progress toward the aquifer. Therefore, for shorter-lived radionuclides, extra time granted by thicker strata can decrease the activity before the contaminants reach the aquifer. EC

- **Distance downgradient to receptor location:** The distance to a given receptor location affects (a) the time at which contaminants will arrive at the location and (b) how much dispersion occurs. For greater distances, longer travel times will be encountered, resulting in lower activity values for short-lived radioactive constituents and greater dispersion for all constituents.

DOE recognizes that, over the period of analysis in this EIS, there is also uncertainty in the structural behavior of materials and the geologic and hydrogeologic setting of the Savannah River Site (SRS). DOE realizes that overly conservative assumptions can be used to bound the estimates of impacts; however, DOE believes that this approach could result in a masking of differences of impacts among alternatives. Therefore, DOE has attempted to use assumptions in its modeling analysis that are reasonable, based on current knowledge, so that meaningful comparisons among alternatives can be made. EC

C.1 Analyzed Scenario

The hydrogeology under various areas of the SRS has been modeled several times in the last few years. Most of the modeling has focused on specific locations (e.g., the Saltstone Manufacturing and Disposal Facility in Z Area, the seepage basins in F- and H Areas) and is thus subject to updating as new information becomes available. DOE is continually refining the model for the General Separations Area, based on recent hydrogeologic measurements. DOE has prepared this EIS using the methodology and modeling assumptions presented in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems*. DOE recognizes that future refining of the models described in the closure plan may result in slightly different estimates of impacts. However, DOE believes that using the methodology described in the closure plan provides a consistent basis for evaluating the alternatives. EC

The tank farms were modeled individually to determine the impacts from their respective sources. In the analyzed scenarios, the mobile contaminants in the tanks are assumed to gradually migrate downward through unsaturated soil to the groundwater aquifer. The aquifers underneath F-Area Tank Farm were assumed to discharge primarily to Fourmile Branch, while the aquifers underneath H-Area Tank Farm were assumed to discharge to both Fourmile Branch and Upper Three Runs. Therefore, the contaminants would be transported by the groundwater to the seepline and subsequently to Fourmile Branch or Upper Three Runs. Upon reaching the surface water, some contaminants would migrate to the sediments at the bottom of the streams and the shoreline. Aquatic organisms in the streams and plants along the shorelines would be exposed to the contaminants. Terrestrial organisms might then ingest the contaminated vegetation and also obtain their drinking water from the EC contaminated streams. Humans are assumed to be exposed to contaminants through various pathways associated with the surface water.

The following sections describe specific assumptions incorporated into the modeling calculations for the analyzed alternatives.

C.1.1 SCENARIO 1 – NO ACTION ALTERNATIVE

The No Action Alternative assumes that, for the 100 years of institutional control, the tanks would contain necessary ballast water that would be treated to minimize corrosion. A tank is assumed to have a constant leak rate (simulated and limited by the hydraulic conductivity of the intact concrete basemat), which causes some passage through the tank bottom. At 100 years, the tanks are filled with water and abandoned, but not capped.

At some point in the future, degradation associated with the aging of the tanks would destroy the tanks. The contaminants are then assumed to reside at the bottom of a hole equal to the depth of the tank (generally 30 to 40 feet). Although debris would exist in the hole, it is assumed to play no role in inhibiting infiltration or preventing flow into the soil. Because of the lack of structural support, the tanks and concrete basemats are assumed to fail completely at 100 years, exposing the contaminated media to rainfall with subsequent infiltration to groundwater.

L-4-24 The No Action Alternative is the only alternative that, after tank closure, could conceivably expose individuals by the atmospheric pathway from the tank area, because each of the other alternatives would fill the tanks with material that would cover the contaminants and prevent their escape via atmospheric dispersion. The only foreseeable occurrence of an atmospheric release under No Action would be if the tank structures collapsed, causing the suspension of particulates containing contaminants. However, the likelihood of an atmospheric release is considered to be minimal, at best, for the following reasons:

- The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of debris on top of the contaminated material would prevent release, even if the contents were to dry during a period of drought.
- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

Based on these reasons, no analyses were performed for the atmospheric pathway. Section 4.1.3.2 describes the potential airborne emissions associated with the tank closure activities (i.e., during the short-term tank closure phase). L-4-24

C.1.2 SCENARIO 2 –FILL WITH GROUT OPTION TC

Scenario 2 assumes that the tanks would be filled with grout and engineered structures would not be used to reduce the infiltration of rain water. By analogy with the analysis presented in the *Radiological Performance Assessment for the E-Area Vaults Disposal Facility* (WSRC 1994a), the concrete tank structure could enter a period of degraded performance due to cracking at around 1,400 years. EC Assuming that the approximately 34 feet of grout continue to support the tank roof and provide an additional barrier to infiltration for an indefinite period of time (WSRC 1992), EC water infiltration should occur much later than 1,400 years. However, for this scenario, the assumption is made that the tank tops, grout, and basemats fail at 1,000 years, with a corresponding increase in their respective hydraulic conductivities.

C.1.3 SCENARIO 3 –FILL WITH SAND OPTION TC

Scenario 3 assumes that the tanks would be filled with sand and engineered structures would not be used to reduce the infiltration of rain water. Eventually, the sides and roofs of the tanks would collapse, allowing water to infiltrate the tank and leach the contaminants down to the aquifers. DOE has assumed that a tank fails at 100 years.

TC

C.1.4 SCENARIO 4 –FILL WITH SALTSTONE OPTION

Scenario 4 is similar to Scenario 2 in that a cementitious material is used to fill the tanks. However, in this scenario, the fill material is saltstone, a composite material made of cement, flyash, slag, and slightly contaminated media from HLW processing. Currently, saltstone is disposed in Z Area; under this option, saltstone would be used to fill the tanks and (as in Scenario 2) would be assumed to remain intact for 1,000 years following tank closure. EC

C.1.5 CONSIDERATION OF POST-CLOSURE ACCIDENTS

Because the tanks are assumed to fail after either 100 (Scenarios 1 and 3) or 1,000 years (Scenarios 2 and 4), the probability of a release from the tanks is one (i.e., it is assumed that the tank will fail). If an accident severe enough to cause tank failure were to occur before the 100- to 1,000-year post-closure periods, the impacts would not be significantly different than the calculated long-term impacts for the following reasons. First, the probability of such an accident occurring in the first 100 or 1,000 years post-closure would be much smaller than one. Therefore, any impacts from accidents that cause tank failures to occur prior to 100 or 1,000 years would have to be multiplied by this small probability of premature failure. Second, due to the long transport times of the contaminants in groundwater, the difference between the impacts from an early release would be insignificant compared to the calculated impacts based on releases occurring at 100 or 1,000 years. L-7-80

C.2 Methodology

C.2.1 HUMAN HEALTH ASSESSMENT

C.2.1.1 General Methodology

Utilizing the Multimedia Environmental Pollutant Assessment System (MEPAS) computer code (Buck et al. 1995), a multi-pathway risk model developed by Pacific Northwest Laboratory, calculations were performed to assess the impacts of the leaching of contaminants to the groundwater for each of the four tank closure scenarios. To model the four closure scenarios, infiltration rates were selected for each closure alternative that represent the vertical moisture flux passing through the tanks. These infiltration rates are dependent upon the chemical and physical characteristics of the tank fill material for each scenario. EC

Based on the calculated inventories of chemical and radioactive contaminants remaining in the tanks after bulk waste removal and spray washing, the model was set up to simulate the transport of contaminants from the contaminated zone (residual waste layer), through the concrete basemat (first partially saturated zone), the vadose zone directly beneath the basemat (second partially saturated zone), and into the underlying aquifers (saturated zones). Model runs were completed for both early timeframes (before the assumed failure occurs) and late timeframe (after assumed failure occurs) conditions. Figure C-1 illustrates the conceptual model that DOE used in this analysis. L-4-18

In addition to the four tank closure scenarios, modeling was performed for pollutants remaining in the ancillary equipment and piping above the tanks. In this calculation, the piping and equipment were considered to be the contaminated zone, while the partially saturated zone was the layer of soil extending from the surface to the saturated zones.

L-4-18

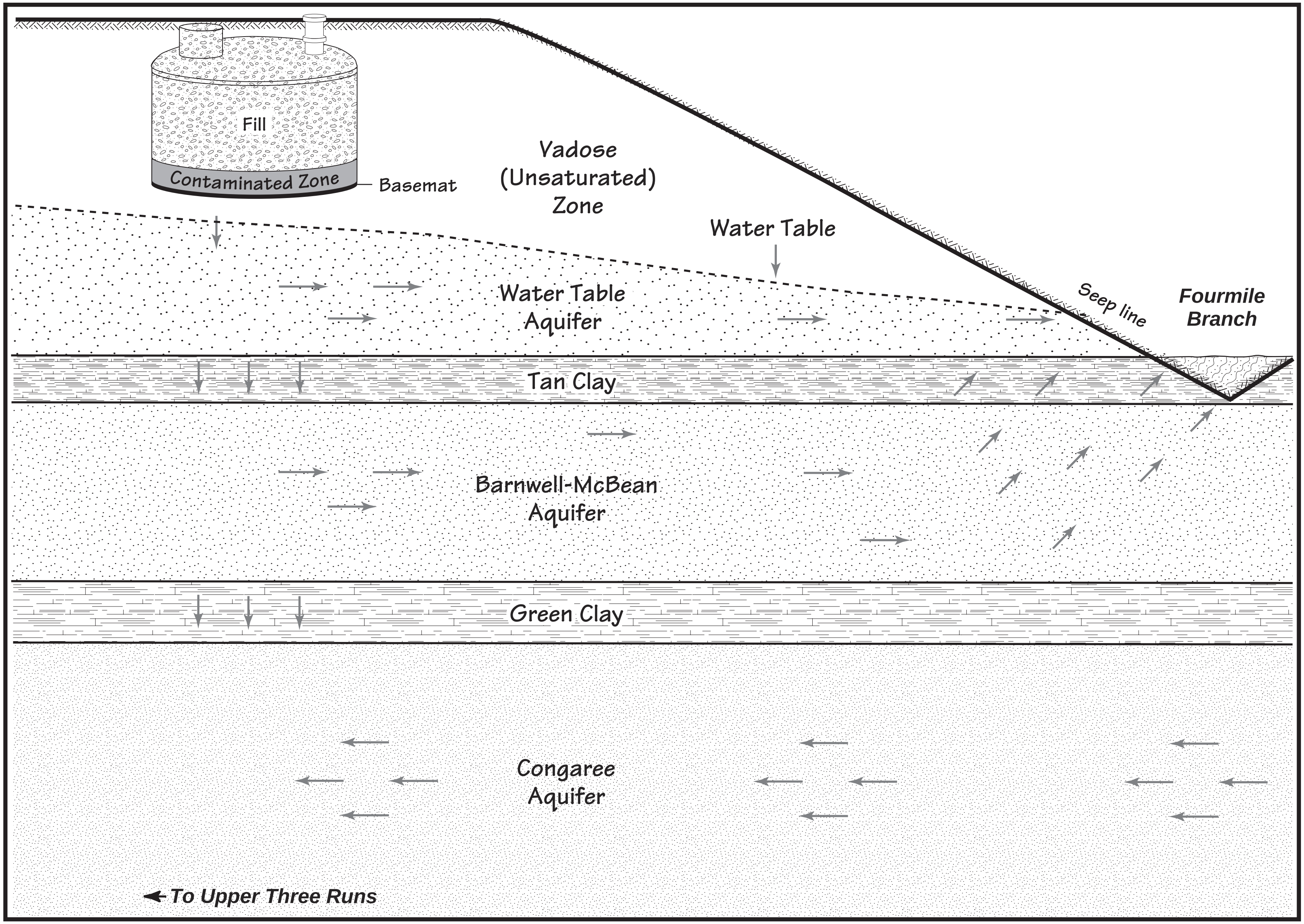

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Figure C-1. Example hydrogeologic conceptual model (F-Area Tank Farm).

Calculated pollutant concentrations and dose levels are provided at 1 meter and 100 meters downgradient from the edges of the tank farms, at the seeplines, and in the surface waters of Fourmile Branch and Upper Three Runs for the hypothetical individuals discussed in Section C.2.1.2. DOE has not calculated groundwater concentrations underneath the tanks because of inherent limitations involved in those calculations. Specifically, the large size of the tank farms and the pattern(s) of groundwater movement make calculations speculative for locations in proximity to the source. EC

C.2.1.2 Receptors

The potential receptors and exposure pathways are identified in the following sections and illustrated in Figure C-2.

Worker

The worker is assumed to be located in the area including and surrounding either of the tank farms. Because institutional controls are in place, the potential for exposure of the worker to the primary source (residual at the bottom of the tanks) is minimal, owing to the structural integrity of the tanks, the lack of any industrial work that would be performed over the tanks, and safety measures that would be taken to further reduce potential exposure. Therefore, this analysis assumes that the worker is located constantly at the nearest place where contaminants would be accessible (i.e., on the bank of 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. However, the fact that he is a worker limits and, hence, eliminates pathways that might be considered if he were considered a resident. The potential exposure pathways for the seepline worker are:

- Direct irradiation from the deposits along the banks of the streams (radioactive contaminants only)
- Ingestion of the soil from the deposits along the banks of the streams
- Dermal contact with dust from the deposits along the banks of the streams.

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 would be minimal.

Intruder

Another potential receptor is the intruder, a person who gains unauthorized access to the tank farm sites and becomes exposed to the contaminants in some manner. The intruder scenario is analyzed for a time period after institutional controls have ceased. Because the intruder is assumed not to have residential habits, he or she would not have exposure pathways like those 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, as noted in Section C.3.2.4). EC EC EC

Nearby Adult Resident/Nearby Child Resident

Nearby residents could also potentially be exposed to contaminants from the tank farms. Members of the public are assumed to construct a dwelling near the tank farms on SRS (but outside the tank farm sites). The location of the residential dwelling is assumed to be downgradient near one of the two main streams (Fourmile Branch or Upper Three Runs) on the side opposite the tank farms at a point 100 meters downstream of the groundwater outcropping in these streams. 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.

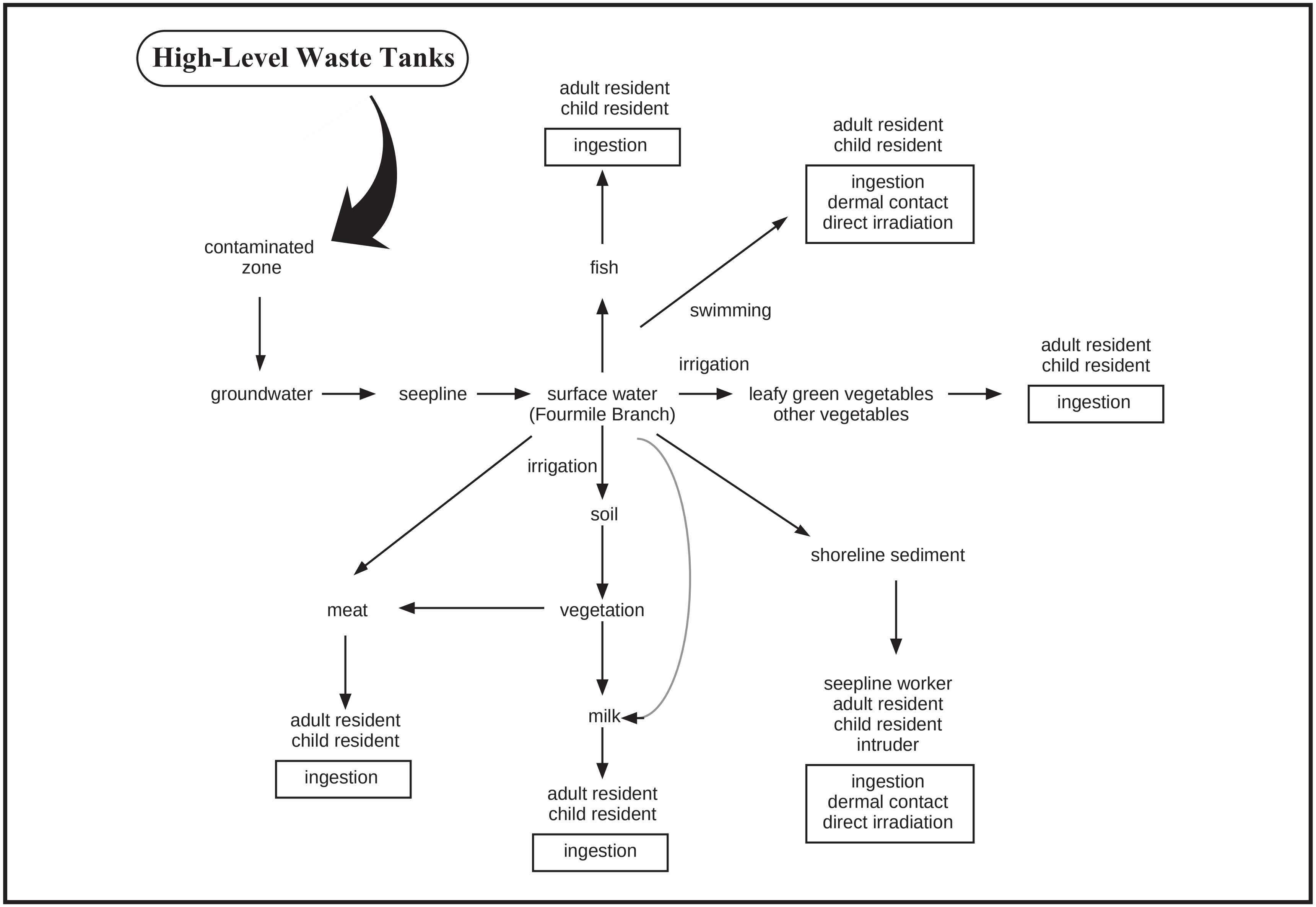

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Figure C-2. Potential exposure pathways for human receptors.

The resident is assumed to use the stream for recreational purposes, to grow and consume produce irrigated with water from the stream, 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 deposits along the banks of the streams
- Inhalation of contaminated soil from deposits along the banks of the streams
- Direct irradiation from deposits along the banks of the streams (radioactive contaminants only)
- Direct irradiation from surface water (radioactive contaminants only - recreation)
- Dermal contact with surface water
- L-7-90 Ingestion of surface water
- Ingestion of contaminated meat
- Ingestion of produce grown on contaminated soil irrigated with water from Fourmile Branch
- Ingestion of milk from cows that are fed contaminated vegetation
- Ingestion of aquatic foods (e.g., fish) from Fourmile Branch.

Because of the physical circumstances of the fate and transport modeling, the most likely locations for soil ingestion are on the shorelines EC of the streams. Figure C-2 shows this pathway, which is identified as "shoreline sediment" along with the appropriate exposure pathways: ingestion, dermal contact, and direct irradiation. While analyses of some waste sites do show that soil ingestion is a dominant pathway, this usually occurs when the residents have direct access to the highly contaminated soils excavated from the waste site. Because of the depth of the waste tanks, so far below grade, and the fill material that would be in place, there is no credible situation by which the residents L-4-11 could have direct access to this material. In this EC EIS, therefore, the soil ingestion pathway is not dominant.

Although the basic assumption for the residents is that they are not located at the tank farms, DOE has nevertheless estimated the impact if residents are allowed access to the tank farms.

Atmospheric Pathway Receptors

Based on the reasoning presented in Sections C.1.1 and C.2.1.2, no analyses were performed for the atmospheric pathway.

C.2.1.3 Computational Code

Groundwater and surface water concentrations and human health impacts were calculated by EC using the MEPAS computer code (Buck et al. 1995). MEPAS was developed by Pacific Northwest National Laboratory under DOE contract and integrates source-term, transport, and exposure models for contaminants. In the MEPAS code, contaminants are transported from a contaminated area to potentially exposed humans through various transport pathways (groundwater, surface water, soils, food, etc.). These exposed individuals then receive doses, both chemical and radiation, through exposure or intake routes (ingestion, dermal contact, inhalation, etc.) and numerous exposure pathways (drinking water, leafy vegetables, meat, etc.).

MEPAS includes models to estimate human health impacts from radiation exposure (radionuclides and direct radiation), carcinogenic chemicals, and noncarcinogenic chemicals. Health effects resulting from radiation and radionuclide exposures are calculated as annual dose (millirem per year). Cancer incidence rates are calculated for carcinogens.

The MEPAS code is widely used (PNL 1999) and accepted throughout the DOE complex and has been presented to and accepted by other regulatory agencies, such as the U.S. Environmental Protection Agency (EPA). Examples of its use by DOE include the EH-Environmental Survey Risk Assessment and the Complex-Wide Programmatic Waste Management EIS 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; these analyses were accepted and permits based on them were issued.

C.2.1.4 Calculational Methodology

The modeling results presented in this appendix are based on the amounts of contaminants remaining in the tanks after bulk waste removal and spray washing (except for No Action, which assumes only bulk waste removal with no spray washing). The results can generally be scaled to differing amounts of residual contaminants left in a tank. Although the waste is present as supernate (salt solution), damp saltcake, and sludge, the total residual waste volume was assumed to be sludge, based on the assumption that all the residual contaminants reside in the sludge (Newman 1999).

Analyses were performed specifying infiltration rates that relate to the four closure scenarios. An infiltration rate of 40 centimeters per year (average infiltration rate for SRS soils) was used to model time periods after tank failure (WSRC 1994a). This value takes into account the average annual precipitation and the amount of rainfall that evaporates, flows to streams and land surface, etc., and is not available for infiltration into soil. An infiltration rate of 122 centimeters per year was used for the No Action Alternative to simulate infiltration of 100 percent of the average annual precipitation, assuming no runoff or evaporation. The latter assumption is considered to be reasonable given the fact that the tanks are located in depressions that could fill with rainwater if the storm drain system fails.

As discussed in Section C.1.1, tank failure for the No Action Alternative would involve an initial release of the ballast water that would be limited by the hydraulic conductivity.

MEPAS calculations were performed for early (before structural failure) and late (after structural failure) conditions for each closure scenario. As discussed above, a failure time was assumed for each closure scenario, based on anticipated performance of the tank fill material and concrete basemat. The tank fill and concrete basemat were assumed to fail simultaneously and completely, in terms of retaining waste. Failure was simulated for modeling purposes by increasing the infiltration rate to 40 centimeters per year (except for No Action, which remains at 122 centimeters per year) and increasing the hydraulic conductivity of the basemat to that of sand. Because radionuclide and chemical pollutants could leach through the concrete before failure occurs, the original source term was reduced by an amount equal to the quantities released to the aquifer during the pre-failure period. In addition, radionuclides continually decay, further changing 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 pollutants from the tanks through distinct media found below the waste unit down to the groundwater aquifer (saturated zone). To model the movement of pollutants from the waste unit to the aquifer, MEPAS requires identifying the distinct strata that the pollutants encounter. For modeling the farms, the residual at the bottom of the tanks was considered to be the contaminated zone.

Between the contaminated zone and the saturated zone, 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 parameters such as porosity, field capacity, and hydraulic conductivity change with degradation state. Analysis of flow through the vadose zone is complicated in that movement varies with soil moisture content and wetting and drying conditions. Therefore, values for saturated zone soil parameters (e.g., density, porosity) were used to describe the unsaturated zone.

For each of the four layers identified for this site (contaminated zone, concrete basemat, vadose zone, and saturated zone), surface distribution coefficients, K_d values, were selected for each radionuclide and chemical for each modeled layer. Because distribution coefficients are a chemical property, the K_d values were not changed for degraded or failed materials. The identification and derivation of the K_d values is discussed in detail in Section C.3.2.1.

As contaminants are transported from the contaminated zone to the seepline, they are longitudinally (along the streamline of fluid flow), vertically, and transversely (out sideways) dispersed by the transporting medium. MEPAS incorporates longitudinal dispersivity of pollutants moving downward through the partially saturated zone layers (i.e., concrete basemat and vadose zone) in concentration calculations. In the saturated zone, MEPAS incorporates into concentration calculations the three-dimensional dispersion along the length of travel. Dispersion distances were calculated through the concrete basemat, the vadose zone, and the groundwater aquifer. Logically, dispersion generally increases with longer travel distances, and it should be noted that the travel distance is determined by the hydraulic gradients and not by linear distance.

Groundwater concentrations and doses due to ingestion of water are calculated at hypothetical wells 1 meter and 100 meters downgradient from the edges of the respective tank farms, at the respective seeplines, and in Fourmile Branch and Upper Three Runs.

As discussed earlier, impacts to adult and child residential receptors are evaluated at a point 100 meters downstream of the groundwater outcroppings in Fourmile Branch and Upper Three Runs. The concentrations of contaminants in the streams were also calculated. Based on the dimensions, flow rate, and stream velocities, MEPAS accounts for 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 Section C.3.2.2. EC

In addition to the four closure scenarios, MEPAS runs were performed to determine the effects of leaving in place the piping, vessels, and other tank-specific systems outside the tanks, all of which contain residual pollutants. It was assumed that an additional 20 percent of the radioactive contaminants remaining in the tanks after bulk cleaning and spray washing would be distributed in the ancillary equipment (d'Entremont 1996). Modeling was performed for two options: (1) leaving the piping and other equipment as they currently exist (assumed for the No Action Alternative and Fill with Sand TC Option), and (2) filling, where possible, the piping and other outside equipment with grout (assumed for the Fill with Grout and Fill with TC Saltstone Options). For modeling in MEPAS, the ancillary equipment was considered to be the contaminated zone, and the entire distance between the contaminated zone and the 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 tanks, thus providing conservative results.

C.2.2 ECOLOGICAL RISK ASSESSMENT

C.2.2.1 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. Each of these migration pathways was evaluated using four methods for tank stabilization, including the Fill with Grout Option, the Fill with Sand Option, the Fill with Saltstone Option, and the No Action Alternative (no stabilization). 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-3).

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 is one of the most common mammals on the SRS; the mink is a small-bodied predator associated with waterways and is also found on SRS (Cothran et al. 1991). Species that are more abundant on SRS than the mink and with similar ecologies 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.

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.

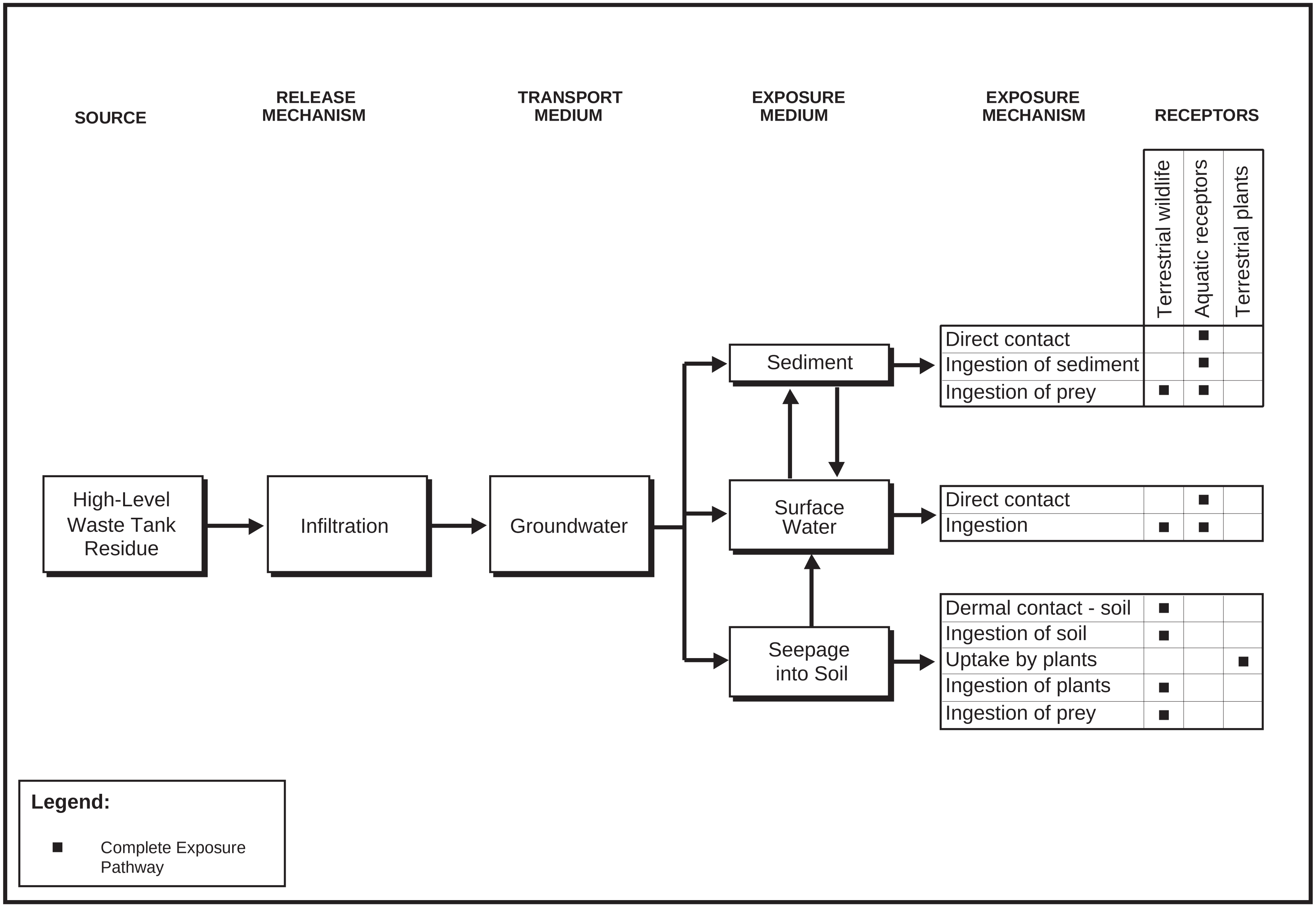

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Figure C-3. Ecological Risk Assessment Conceptual Site Model.

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. EC The exposure routes chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper EC Three Runs were uptake of contaminants from water and direct irradiation from submersion in water. Standard values for parameters such as mass, food ingestion rate, water ingestion rate, soil ingestion rate, and bioaccumulation factors were used (see Section C.3.3).

C.2.2.2 Exposure and Toxicity Assessment

Exposure to Chemical Toxicants

Exposure for aquatic receptors is simply expressed as the concentrations of contaminants in the water surrounding them. This is the surface water exposure medium shown in the EC conceptual site model (Figure C-3). The conceptual model also includes sediment as an exposure medium; sediment can become contaminated from the influence of surface water or from seepage that enters sediment directly. As a result, terrestrial wildlife could L-4-26 incidentally ingest sediment while feeding on aquatic organisms. 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.

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.

Chemical Toxicity Assessment

The goal of the toxicity assessment is to derive threshold exposure levels that are protective of EC the receptors (Table C.2.2-1). 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).

For terrestrial receptors, toxicity thresholds are based on the lowest oral doses found in 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.2.2-2). 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.2.2-3. 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.2.2.3 Calculational Design

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 hazard quotients.

Table C.2.2-1. Threshold toxicity values.

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	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	(b)	(b)
Silver	0.000055[a]	0.33	0.077
Uranium	0.00187	4.48	1.01
Zinc[a]	0.0127	14.0	3.17

TC

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a. Based on a hardness of 8.2 mg $CaCO_3$/L.
b. Screening for MCL (10 mg/L) in seep water considered protective for nitrate.
NA = Not applicable (normally not a toxin for this type of receptor).

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 human body were derived from studies of small mammals. Equations from the International Commission on Radiological Protection (ICRP) Publication 2 (ICRP 1959) 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 throughout the body of the animal. DCFs 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 organism would ingest through all postulated pathways was then multiplied by the DCFs to calculate an annual radiation dose to

Table C.2.2-2. 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 (1992)		
Barium	Rat	5.4	16 mo	Systemic	0.54	Perry et al. (1983) in Opresko, Sample, and Suter (1995)		EC
Chromium VI	Rat	–	1 y	Systemic	3.5	Mackenzie et al. (1958) in ATSDR (1993)		
Copper	Mink	15	50 w	Reproductive	12	Aulerich et al. (1982) in Opresko, Sample, and Suter (1995)		EC
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, Rehnberg, and Hein (1982)		
Mercury	Mink	0.25	3 mo	Death; devel.	0.15	Wobeser et al. (1976) in Opresko, Sample, and Suter (1995)		EC
Nickel	Rat	18	3 gens	Reproductive	–	Ambrose, Larson, and Borzelleca (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 and Danscher (1984)		
Uranium	Mouse	–	~102 d	Reproductive	3.07	Paternain et al. (1989) in Opresko, Sample, and Suter (1995)		EC
Zinc	Mouse	96	9-12 mo	Systemic	–	Aughey et al. (1977)	Small data base	

Table C.2.2-3. 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

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a. UF = Uncertainty factor.

the organism. For the sunfish, the concentration of radioactivity in the surface water was multiplied by the submersion and uptake DCFs 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).

C.3 Assumptions and Inputs

C.3.1 SOURCE TERM

C.3.1.1 Radionuclides

Radioactive material source terms for the tank farms and ancillary piping residual used for the modeling are listed in Table C.3.1-1. L-2-8 L-7-18 L-7-33 L-14-4 Table C.3.1-2 lists the volume of residual material assumed for modeling purposes to remain in the closed HLW tanks and do not represent a commitment or goal for waste removal. The ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Based on experience in removing waste from Tanks 16, 17, and 20, DOE has TC assumed that the volume of material remaining after only bulk waste removal would be 10,000 gallons per tank. Also, the Fill with Saltstone Option would introduce additional radioactive material into the HLW tanks. DOE used inventory estimates from the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional radioactivity.

C.3.1.2 Chemicals

Chemical material source terms used in this modeling are listed in Table C.3.1-3. These TC source terms are based on the volume estimates listed in Table C.3.1-2. As with the radioactive source term, the ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories. In addition, the lead in the tank top risers (500 pounds per riser, 6 risers per tank) was modeled.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Consequently, DOE has assumed that the volume of material remaining after only bulk waste removal would be 10,000 gallons per tank. Also, the Fill with Saltstone Option would introduce additional material into the HLW tanks. DOE used inventory estimates from the TC *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional material.

C.3.2 CALCULATIONAL PARAMETERS

The modeling described in this appendix was designed to be specific to the tank farms. This was accomplished by utilizing site-specific data where available. For the hundreds of MEPAS input parameters, default values were used only for the distribution coefficients for chemical constituents.

For the four closure scenarios modeled, the majority of the MEPAS input parameters remain constant. Examples of constant parameters include contaminants of concern (radionuclide and chemical) and their respective initial source terms, spatial dimensions and elevation of the contaminated zone, strata thicknesses, chemical and physical properties (hydraulic conductivity and gradient, distribution coefficients) of SRS soil, exposure pathways, dose conversion factors and downgradient distances to compliance points.

Input parameters that changed for the various closure scenarios and were shown by sensitivity analyses to markedly affect the breakthrough times and peak concentrations include constituent and strata specific distribution factors, rainwater infiltration factors, and concrete basemat hydraulic conductivities. These and other important parameters are discussed in the following sections.

EC

Table C.3.1-1. Tank farm residual after bulk waste removal.[a]

	F-Area Tank Farm		H-Area Tank Farm	
Radionuclide	Total Curies	Average Concentration (curies/gallon)	Total Curies	Average Concentration (curies/gallon)
Se-79	1.2	8.5×10^{-5}	1.7	3.6×10^{-4}
Sr-90	6.2×10^{4}	4.4	9.5×10^{4}	20
Tc-99	270	0.019	390	0.083
Sn-126	2.2	1.5×10^{-4}	2.2	4.7×10^{-4}
Cs-135	0.013	9.2×10^{-7}	0.02	4.3×10^{-6}
Cs-137	4,300	0.3	5,600	1.2
Eu-154	350	0.025	1,200	0.26
Np-237	0.06	4.2×10^{-6}	0.12	2.6×10^{-5}
Pu-238	0[b]	0[b]	1,680	0.36
Pu-239	130	9.2×10^{-3}	22	4.7×10^{-3}

L-2-8
L-14-4

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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 C.3.1-2. Assumed volume of residual waste remaining in closed HLW tanks.[a]

Tank #	Area	Tank Type	Residual Material Volume (gal)	Tank #	Area	Tank Type	Residual Material Volume (gal)
1	F	I	100	27	F	III	1,000
2	F	I	100	28	F	III	1,000
3	F	I	100	29	H	III	100
4	F	I	100	30	H	III	100
5	F	I	100	31	H	III	100
6	F	I	100	32	H	III	100
7	F	I	100	33	F	III	100
8	F	I	100	34	F	III	100
9	H	I	100	35	H	III	100
10	H	I	100	36	H	III	100
11	H	I	100	37	H	III	100
12	H	I	100	38	H	III	100
13	H	II	100	39	H	III	100
14	H	II	100	40	H	III	100
15	H	II	100	41	H	III	100
16	H	II	100	42	H	III	100
17[b]	F	IV	2,200	43	H	III	100
18	F	IV	1,000	44	F	III	1,000
19	F	IV	1,000	45	F	III	1,000
20[b]	F	IV	1,000	46	F	III	1,000
21	H	IV	100	47	F	III	1,000
22	H	IV	100	48	H	III	100
23	H	IV	1,000	49	H	III	100
24	H	IV	100	50	H	III	1,000
25	F	III	1,000	51	H	III	100
26	F	III	1,000				

L-2-8
L-7-18
L-14-4
L-7-33

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a. These volumes are an assumption for modeling purposes only and do not represent a commitment or goal for waste removal.

b. Tank has been closed.

Table C.3.1-3. Tank farm residual after bulk waste removal and spray washing (kilograms).[a]

Constituent	F-Area Tank Farm	H-Area Tank Farm
Iron	2,300	1,000
Manganese	240	140
Nickel	55	26
Aluminum	820	250
Chromium VI	20[b]	6.7[b]
Mercury	6.3	89
Silver	27	0.9
Copper	14	1.7
Uranium	450	4.3
Nitrate	150	62
Zinc	27	8.6
Fluoride	14.2	2
Lead [c]	24	12

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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.

C.3.2.1 Distribution Coefficients

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 pHand clay content. Experiments have been performed (Bradbury and Sarott 1995) that have demonstrated that strong oxidizing or reducing environments tend to affect the K_d 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 K_d 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 to 45 feet 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.3.2-1. A detailed discussion of the selection process is provided for each closure scenario.

Scenario 1 – No Action Alternative

For this scenario, K_d values for the CZ were assumed to behave similarly to that of clay found in the vicinity of the SRS tank farms. For the radionuclides and chemicals of interest, these K_d values are listed in Column V of Table C.3.2-1.

For the first partially saturated zone (concrete basemat), K_d values were selected for concrete in a non-reducing environment and are listed in Column II of Table C.3.2-1. K_d values for the second partially saturated zone (vadose zone) and the saturated zone are the same and were selected to reflect characteristics of SRS soil. These values are listed in Column I of Table C.3.2-1. For the ancillary equipment and piping, K_d values for the CZ are presented in Column V, partially saturated and saturated zones are listed in Column I of Table C.3.2-1.

Table C.3.2-1. Radionuclide and chemical groundwater distribution coefficients, cubic centimeters per gram.

	I		II		III		IV		V		VI	
	SRS Soil	Ref.	Non-Reducing Concrete[l]	Ref.	Reducing[j] Concrete	Ref.	Reducing[j] CZ	Ref.	Non-Reducing CZ	Ref.	Saltstone	Ref.
Se-79[a]	5	b	0	b	0.1	i	0.1	i	740[m]	b	7	s
Sr-90	10	b	10	b	1	i	1	i	110[m]	b	10	s
Tc-99	0.36	b	700	b	1,000	i	1,000	i	1[m]	b	700	s
Sn-126	130	b	200	b	1,000	i	1,000	i	670[m]	b	t	
Cs-135, 137	100	b	20	b	2	i	2	i	1,900[m]	b	t	s
Eu-154[p]	800[d]	c	1,300	e	5,000[q]	i	5,000[q]	i	1,300	e	t	
Np-237	10	b	5,000	b	5,000	b	5,000	i	55	b	t	
Pu-238, 239	100	b	5,000	b	NA	f	NA	f	5,100[m]	b	t	
Iron	15	g	15	n	1.5	o	1.5	o	15	n	t	
Manganese	16.5	g	36.9	n	100	i	100	i	36.9	n	t	
Nickel	300	b	650	n	100	i	100	i	650	n	t	
Aluminum	35,300	g	35,300	n	353	o	353	o	35,300	n	t	
Chromium VI[h]	16.8	g	360	n	7.9	o	7.9	o	360	n	t	
Mercury	322	g	5,280	n	5,280	o	5,280	o	5,280	n	t	
Silver	0.4	g	40	n	1	i	1	i	40	n	t	
Copper	41.9	g	336	n	33.6	o	33.6	o	336	n	t	
Uranium	50	b	1,000	n	NA	u	NA	u	1,600	b	t	
Nitrate	0	g	0	n	0	o	0	o	0	n	0	s
Zinc	12.7	g	50	n	5	o	5	o	50	n	t	
Fluoride	0	g	0	n	0	o	0	o	0	n	t	
Lead	234	g	NA	r	NA	r	NA	r	NA	r	NA	r

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a. Values also used for chemical contaminants.
b. E-Area RPA (WSRC 1994a), Table 3.3-2, page 3-69.
c. (Yu 1993), Table 32.1, page 105.
d. Value used for loam from c.
e. Value used for clay from c.
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. Non-reducing environments assumed for No Action and sand fill option.
l. Values used for basemat concrete for No Action and sand fill option.
m. Value used for clay from WSRC (1994a).
n. MEPAS default used for soil >30% clay and pH from 5-9.
o. MEPAS default used for soil >30% clay and pH >9.
p. Characteristics similar to Sm per Table 3, page 16 of Bradbury and Scott (1995).
q. Characteristics similar to Am per Table 3, page 16 of Bradbury and Scott (1995).
r. Lead is outside of reducing environments for all cases. Therefore, value from Column I is used for all cases.
s. Z-Area Saltstone Radiological Performance Assessment (WSRC 1992), page A-13.
t. Values of K_d for these contaminants were based on non-reducing concrete.
u. Solubility limit of 3.0×10^{-10} μ/liter used to determine K_d, E-Area (WSRC 1994a) p. D-34.

TC **Scenario 2 – Fill With Grout Option**

This scenario assumes that the tanks and ancillary piping would be filled with a strongly reducing grout. Therefore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns IV, III, I, and I of Table C.3.2-1, respectively.

Similarly, for the piping model, K_d values for the CZ, partially saturated zone, and the saturated zone are listed in Columns IV, I, and I of Table C.3.2-1, respectively.

TC **Scenario 3 – Fill With Sand Option**

This scenario uses the same K_d values as for scenario 1.

TC **Scenario 4 – Fill With Saltstone Option**

This scenario assumes that the tanks and ancillary piping would be filled with saltstone with composition like that in the Z-Area Saltstone Manufacturing and Disposal Facility. Therefore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns VI, III, I, and I of Table C.3.2-1, respectively.

C.3.2.2 MEPAS Groundwater Input Parameters

Table C.3.2-2 lists input parameters used for the partially saturated zones for the various closure scenarios, and Table C.3.2-3 lists input parameters for the saturated zone. The values used for the concrete basemat and vadose layer for the partially saturated zone were constant for all tank groups within both tank farms with the exception of the vadose zone thickness. Because there are significant differences in the bottom elevation between the various tank groups, the thickness of the vadose zone was modeled specifically for each tank group. Some tank groups in the H Area were modeled without a vadose zone because the tanks are situated in the Water Table Aquifer. When horizontal flow was modeled in each of the aquifer layers, all of the overlying layers were treated as part of the partially saturated zone (i.e., vertical transport only) for that simulation.

The values for the remaining partially saturated zone layers and for all of the saturated zone layers are constant for all tank groups within either the F or H Area that have groundwater flow to the same point of discharge (i.e., to Fourmile Branch or Upper Three Runs). The parameters do vary, however, among the different layers and along different groundwater flow paths. For this reason, Tables C.3.2-2 and C.3.2-3 contain three sets of input parameters: flow from the F-Area Tank Farm toward Fourmile Branch (all tank groups); flow from the H-Area Tank Farm toward Fourmile Branch (four tank groups); and flow from the H-Area Tank Farm toward Upper Three Runs (three tank groups). Because only one-dimensional vertical flow was considered for the Tan Clay and Green Clay layers in both the partially saturated and saturated conditions, the input parameters were the same for these layers for each of the groupings shown in the tables.

C.3.2.3 Hydraulic Conductivities

Because leach rate is ultimately limited by the lowest hydraulic conductivity of the strata and structures above and below the contaminated zone, this parameter is highly sensitive in its effect on breakthrough times and peak concentrations at the receptor locations. For modeling purposes, it was assumed that excess water has a place to run off (over the sides of the basemat) and that ponding above the contaminated zone does not occur.

C.3.2.4 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

Table C.3.2-2. Partially saturated zone MEPAS input parameters.

	Concrete basemat		Vadose Zone layer	Water Table layer	Tan clay layer	Barnwell-McBean layer	Green clay layer
	Intact	Failed					
F-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,200[c]	91[c]	1,800[c]	150[c]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field Capacity	15%[d]	9%[e]	12%[e]	35%[e]	33.4%[e]	35%[e]	32.5%[e]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	12	0.91	18	1.5
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	7.1×10^{-4}[h]	7.1×10^{-4}[h]	1.6×10^{-6}[h]	5.6×10^{-4}[h]	4.4×10^{-9}[h]
H-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	2,000[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	20	3.0
Vertical hydraulic conductivity (centimeters per second)	$9.\times10^{-9}$[d]	6.6×10^{-3}[e]	1.6×10^{-4}[i]	1.6×10^{-4}[i]	3.2×10^{-7}[i]	1.6×10^{-4}[i]	3.5×10^{-8}[i]
H-Area Tank Farm, flow toward Upper Three Runs							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	1,800[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	18	3.0
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	1.3×10^{-4}[i]	1.3×10^{-4}[i]	3.0×10^{-7}[i]	1.3×10^{-4}[i]	3.5×10^{-8}[i]

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a. Type IV tank shown; Type I = 3.54, Type III = 2.74.
b. Distance between tank bottom elevation (see a. above) and historic groundwater elevation.
c. GeoTrans (1987).
d. WSRC (1994a). Radiological Performance Assessment for the E-Area Vaults Disposal Facility (U), WSRC-RP-94-218.
e. Buck et al. (1995), MEPAS Table 2.1.
f. Aadland et al. (1995). EC
g. Buck et al. (1995); calculated using MEPAS formula for longitudinal dispersivity, based on total travel distance.
h. GeoTrans (1993); where Kz = 0.1 Kx for aquifer layers.
i. WSRC (1994b). WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.
j. Buck et al. (1995), MEPAS Table 2.1; assumes aquifer layers are saturated and clay layers nearly saturated.

Table C.3.2-3. MEPAS input parameters for the saturated zone.

	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aquifer
F-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,200	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20th of the flow distance	
Hydraulic conductivity (centimeters per second)	7.1×10^{-3}	5.6×10^{-3}	0.013
Hydraulic gradient [a]	0.006	0.004	0.006
H-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,900	2,000	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20th of the flow distance	
Hydraulic conductivity (centimeters per second)	1.6×10^{-3}	1.6×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.014	0.011	0.004
H-Area Tank Farm, flow toward Upper Three Runs			
Thickness (centimeters) [a]	1,900	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20th of the flow distance	
Hydraulic conductivity (centimeters per second)	1.3×10^{-3}	1.3×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.015	0.009	0.003

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a. GeoTrans (1987 and 1993).
b. Buck et al. (1995), MEPAS Table 2.1.
c. Aadland et al. (1995).
d. EPA (1989) and WSRC (1994b) WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.

values in MEPAS; however, others must be specified so 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.3.2-4 lists the major parameters that were used in assigning characteristics to the receptors used in the calculations.

Table C.3.2-4. 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 9 years of age has 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 in 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 for maximum individuals in 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).

C.3.3 ECOLOGICAL RISK ASSESSMENT

The exposure factors used in calculating doses to the shrew and mink are listed in Table C.3.3-1. 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 hectare. Home ranges for the mink also vary widely in the literature from 7.8 to 770 Hectare (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.4 Results

C.4.1 HUMAN HEALTH ASSESSMENT

For each scenario, 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 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 was calculated to enable comparison among the alternatives

Nonradiological constituent concentrations in the various water bodies were calculated to allow direct comparison among the alternatives. For each constituent, the maximum concentration was calculated along with the time period during which the maximum concentration occurred. None of the nonradiological constituents are known ingestion carcinogens; therefore cancer risk was not calculated for these contaminants.

Tables C.4.1-1 through C.4.1-26 list impact estimates for the four scenarios described in Section C.2. For those tables describing radiological impacts, doses are presented 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 and are reported as drinking water doses to allow comparison to the appropriate maximum contaminant level. DOE estimates that the total dose at the locations would not exceed the drinking water doses by more than 20%. For nonradiological constituents, the maximum concentration of each contaminant is reported for each water location. | EC

For the case of No Action, the reported doses are those arising strictly from the water pathways; impacts from air pathways, in principle, would increase the total dose to a given receptor. It is expected, however, that atmospheric release of the tanks' contents would not be appreciable because:

The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of

Table C.3.3-1. 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)

debris on top of the contaminated material would prevent release even if the contents were to dry during a period of drought.

- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

As discussed in Chapters 3 and 4 of this EIS, DOE performed groundwater modeling calculations for the three uppermost aquifers underneath the tank farms: the Water Table Aquifer, the Barnwell-McBean Aquifer, and the Congaree Aquifer. Tables C.4.1-1 through C.4.1-26 present results 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, DOE uses only the maximum seepline concentration for Fourmile Branch and Upper Three Runs from the alternatives in its comparison of impacts among the alternatives.

Table C.4.1-1. Radiological results for F-Area Tank Farm in the Water Table Aquifer (millirem per year).

TC

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	1.9×10^{-2}	2.9×10^{-2}	1.7×10^{-1}	3.3
	Time of maximum (yrs)	385	175	7035	1155
Child resident (total dose)	Maximum value	1.7×10^{-2}	2.7×10^{-2}	1.6×10^{-1}	3.1
	Time of maximum (yrs)	385	175	7035	1155
Seepline worker (total dose)	Maximum value	(a)	(a)	(a)	9.6×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	105
Intruder (total dose)	Maximum value	(a)	(a)	(a)	4.8×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	105
1-meter well (drinking water dose)	Maximum value	4.3×10^{1}	1.3×10^{2}	3.0×10^{2}	3.6×10^{5}
	Time of maximum (yrs)	385	35	5705	245
100-meter well (drinking water dose)	Maximum value	1.6×10^{1}	5.1×10^{1}	1.4×10^{2}	6.0×10^{3}
	Time of maximum (yrs)	315	35	7035	315
Seepline (drinking water dose)	Maximum value	1.0	1.4	9.5	1.8×10^{2}
	Time of maximum (yrs)	385	175	7455	1155
Surface water (drinking water dose)	Maximum value	6.9×10^{-3}	1.1×10^{-2}	6.3×10^{-2}	1.2
	Time of maximum (yrs)	385	175	7035	1155

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-2. Radiological results for F-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

TC

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	2.7×10^{-2}	5.1×10^{-2}	3.7×10^{-1}	6.2
	Time of maximum (yrs)	875	245	7525	1225
Child resident (total dose)	Maximum value	2.4×10^{-2}	4.7×10^{-2}	3.4×10^{-1}	5.7
	Time of maximum (yrs)	875	245	7525	1225
Seepline worker (total dose)	Maximum value	(a)	(a)	1.0×10^{-3}	1.8×10^{-2}
	Time of maximum (yrs)	(a)	(a)	7525	1225
Intruder (total dose)	Maximum value	(a)	(a)	(a)	9.0×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	1225
1-meter well (drinking water dose)	Maximum value	1.3×10^{2}	4.2×10^{2}	7.9×10^{2}	3.5×10^{4}
	Time of maximum (yrs)	665	105	6965	35
100-meter well (drinking water dose)	Maximum value	5.1×10^{1}	1.9×10^{2}	5.1×10^{2}	1.4×10^{4}
	Time of maximum (yrs)	665	105	6685	35
Seepline (drinking water dose)	Maximum value	1.9	3.5	2.5×10^{1}	4.3×10^{2}
	Time of maximum (yrs)	875	245	6475	1225
Surface water (drinking water dose)	Maximum value	9.8×10^{-3}	1.9×10^{-2}	1.3×10^{-1}	2.3
	Time of maximum (yrs)	875	245	7525	1225

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a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-3. Radiological results for F-Area Tank Farm in the Congaree Aquifer (millirem per year).

EC

TC

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	(a)	(a)	1.4×10^{-2}	1.1×10^{-1}
	Time of maximum (yrs)	(a)	(a)	8855	1365
Child resident (total dose)	Maximum value	(a)	(a)	1.3×10^{-2}	1.0×10^{-1}
	Time of maximum (yrs)	(a)	(a)	8855	1365
Seepline worker (total dose)	Maximum value	(a)	(a)	(a)	(a)
	Time of maximum (yrs)	(a)	(a)	(a)	(a)
Intruder (total dose)	Maximum value	(a)	(a)	(a)	(a)
	Time of maximum (yrs)	(a)	(a)	(a)	(a)
1-meter well (drinking water dose)	Maximum value	9.1×10^{-1}	1.2	3.0×10^{1}	1.7×10^{2}
	Time of maximum (yrs)	4935	2905	6615	1155
100-meter well (drinking water dose)	Maximum value	2.2×10^{-1}	2.5×10^{-1}	6.4	4.2×10^{1}
	Time of maximum (yrs)	1225	3115	8435	1295
Seepline (drinking water dose)	Maximum value	6.5×10^{-3}	8.7×10^{-3}	1.9×10^{-1}	1.6
	Time of maximum (yrs)	5495	3325	7805	1295
Surface water (drinking water dose)	Maximum value	(a)	(a)	5.0×10^{-3}	4.2×10^{-2}
	Time of maximum (yrs)	(a)	(a)	8855	1365

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a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-4. Radiological results for H-Area Tank Farm in the Water Table Aquifer (millirem per year).

EC

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.2×10^{-2}	2.6×10^{-2}	1.2
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{-2}	1.6×10^{-2}	1.9×10^{-1}	2.4
		Time of maximum (years)	455	175	6125	1015
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.3×10^{-3}	1.1×10^{-2}	2.4×10^{-2}	1.1
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.3×10^{-3}	1.5×10^{-2}	1.8×10^{-1}	2.2
		Time of maximum (years)	455	175	6125	1015
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	7.0×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.7×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
1-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{5}	1.3×10^{5}	1.0×10^{5}	9.3×10^{6}
		Time of maximum (years)	175	175	175	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{2}	2.5×10^{2}	5.5×10^{2}	8.3×10^{5}
		Time of maximum (years)	315	385	4725	245
100-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	3.0×10^{2}	9.2×10^{2}	8.7×10^{2}	9.0×10^{4}
		Time of maximum (years)	245	35	5915	35
	South of Groundwater Divide	Maximum value (mrem/yr)	2.9×10^{1}	6.1×10^{1}	2.9×10^{2}	6.1×10^{3}
		Time of maximum (years)	315	35	5635	35
Seepline (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	2.5	2.5×10^{1}	4.6×10^{1}	2.5×10^{3}
		Time of maximum (years)	455	105	5635	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.5×10^{-1}	1.4	1.6×10^{1}	2.0×10^{2}
		Time of maximum (years)	455	175	5425	1015
Surface water (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	4.3×10^{-3}	9.6×10^{-3}	4.5×10^{-1}
		Time of maximum (years)	(a)	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	3.7×10^{-3}	6.0×10^{-3}	7.1×10^{-2}	9.0×10^{-1}
		Time of maximum (years)	455	175	6125	1015

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a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-5. Radiological results for H-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.1×10^{-3}	1.1×10^{-2}	2.4×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.4×10^{-3}	7.8×10^{-3}	1.2×10^{-1}	1.4
		Time of maximum (years)	4515	385	6335	1155
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.0×10^{-3}	1.0×10^{-2}	2.2×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.1×10^{-3}	7.2×10^{-3}	1.1×10^{-1}	1.3
		Time of maximum (years)	4515	385	6335	1155
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	4.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	2.1×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.7×10^{1}	1.9×10^{3}	1.7×10^{3}	1.7×10^{5}
		Time of maximum (years)	1155	105	4165	105
	South of Groundwater Divide	Maximum value (mrem/yr)	5.3×10^{1}	1.4×10^{2}	4.3×10^{2}	2.5×10^{4}
		Time of maximum (years)	4445	245	5005	945
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	4.6×10^{2}	6.4×10^{2}	5.8×10^{4}
		Time of maximum (years)	1155	105	5845	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{1}	5.1×10^{1}	2.7×10^{2}	4.9×10^{3}
		Time of maximum (years)	1155	245	6405	105
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	7.5×10^{-1}	4.5	2.3×10^{1}	4.9×10^{2}
		Time of maximum (years)	4515	385	6125	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.5×10^{-1}	8.4×10^{-1}	1.3×10^{1}	1.6×10^{2}
		Time of maximum (years)	4445	385	6895	1155
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.2×10^{-3}	8.8×10^{-2}
		Time of maximum (years)	(a)	(a)	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{-3}	2.9×10^{-3}	4.6×10^{-2}	5.3×10^{-1}
		Time of maximum (years)	4515	385	6265	1155

---

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

EC

TC

Table C.4.1-6. Radiological results for H-Area Tank Farm in the Congaree Aquifer (millirem per year).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.1×10^{-2}	8.6×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{-3}	2.0×10^{-3}	6.6×10^{-2}	4.3×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.0×10^{-2}	7.9×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.8×10^{-3}	6.1×10^{-2}	4.0×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1645
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	9.8×10^{1}	7.7×10^{2}	9.7×10^{3}
		Time of maximum (years)	5005	595	5145	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{1}	1.6×10^{1}	2.0×10^{2}	3.2×10^{3}
		Time of maximum (years)	5215	3115	5355	1505
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	5.6	2.5×10^{1}	2.5×10^{2}	2.5×10^{3}
		Time of maximum (years)	4935	665	6475	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.7	2.3	6.4×10^{1}	4.6×10^{2}
		Time of maximum (years)	4935	3185	7105	1435
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.8×10^{-2}	2.7×10^{-1}	3.2	2.5×10^{1}
		Time of maximum (years)	5005	805	6755	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.9×10^{-2}	2.3×10^{-2}	7.7×10^{-1}	4.8
		Time of maximum (years)	5285	3325	7665	1645
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.0×10^{-3}	3.2×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	2.4×10^{-2}	1.6×10^{-1}
		Time of maximum (years)	(a)	(a)	6755	1645

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a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-7. Alpha concentration for F-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

TC

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	5.2	5.3	5.2	7.6×10^{2}
	Time of maximum (yrs)	1855	945	1855	455
100-meter well	Maximum value	1.9	1.9	1.9	2.4×10^{2}
	Time of maximum (yrs)	1995	1085	1995	595
Seepline	Maximum value	2.6×10^{-2}	2.6×10^{-2}	2.6×10^{-2}	5.6
	Time of maximum (yrs)	3885	2905	3885	9555
Surface water	Maximum value	1.8×10^{-4}	1.8×10^{-4}	1.8×10^{-4}	4.1×10^{-2}
	Time of maximum (yrs)	3885	2975	3885	9555

Table C.4.1-8. Alpha concentration for F-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

TC

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	1.3×10^{1}	1.3×10^{1}	1.3×10^{1}	1.7×10^{3}
	Time of maximum (yrs)	2695	1785	2695	875
100-meter well	Maximum value	4.7	4.6	4.7	5.3×10^{2}
	Time of maximum (yrs)	2905	1995	2905	1085
Seepline	Maximum value	3.9×10^{-2}	3.9×10^{-2}	3.9×10^{-2}	9.2
	Time of maximum (yrs)	6405	5495	6405	9975
Surface water	Maximum value	2.2×10^{-4}	2.2×10^{-4}	2.2×10^{-4}	4.8×10^{-2}
	Time of maximum (yrs)	6265	5355	6265	9975

Table C.4.1-9. Alpha concentration for F-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

TC

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	3.1×10^{-3}	3.1×10^{-3}	3.1×10^{-3}	1.7
	Time of maximum (yrs)	8295	7315	8295	9975
100-meter well	Maximum value	1.3×10^{-3}	1.2×10^{-3}	1.3×10^{-3}	3.6×10^{-1}
	Time of maximum (yrs)	8225	8225	8225	9975
Seepline	Maximum value	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	9.4×10^{-3}
	Time of maximum (yrs)	9345	8435	9345	9975
Surface water	Maximum value	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	2.6×10^{-4}
	Time of maximum (yrs)	8365	7455	8365	9975

Table C.4.1-10. Alpha concentration for H-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	2.4×10^{1}	2.9×10^{2}	2.4×10^{1}	1.3×10^{4}
		Time of maximum (years)	1925	175	1925	1715
	South of Groundwater Divide	Maximum value	8.6	8.6	8.6	1.1×10^{3}
		Time of maximum (years)	1855	945	1855	455
100-meter well	North of Groundwater Divide	Maximum value	7.0	3.8×10^{1}	7.0	3.8×10^{3}
		Time of maximum (years)	2205	455	2205	455
	South of Groundwater Divide	Maximum value	2.0	2.0	2.0	2.0×10^{2}
		Time of maximum (years)	2065	1155	2065	665
Seepline	North of Groundwater Divide	Maximum value	1.5×10^{-1}	3.3×10^{-1}	1.5×10^{-1}	3.4×10^{1}
		Time of maximum (years)	4655	2695	4655	2345
	South of Groundwater Divide	Maximum value	1.9×10^{-2}	1.9×10^{-2}	1.9×10^{-2}	4.9
		Time of maximum (years)	4585	3675	4585	8925
Surface water	North of Groundwater Divide	Maximum value	3.1×10^{-5}	6.1×10^{-5}	3.1×10^{-5}	6.2×10^{-3}
		Time of maximum (years)	4585	2765	4585	2695
	South of Groundwater Divide	Maximum value	7.9×10^{-5}	7.9×10^{-5}	7.9×10^{-5}	2.2×10^{-2}
		Time of maximum (years)	4655	3745	4655	8855

Table C.4.1-11. Alpha concentration for H-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	3.8	2.1×10^{1}	3.8	2.2×10^{3}
		Time of maximum (years)	5355	3185	5355	2975
	South of Groundwater Divide	Maximum value	1.9	1.9	1.9	6.6×10^{2}
		Time of maximum (years)	5005	4095	5005	8435
100-meter well	North of Groundwater Divide	Maximum value	1.2	5.7	1.2	6.0×10^{2}
		Time of maximum (years)	5845	3605	5845	3325
	South of Groundwater Divide	Maximum value	5.2×10^{-1}	5.2×10^{-1}	5.2×10^{-1}	1.2×10^{2}
		Time of maximum (years)	5355	4445	5355	8785
Seepline	North of Groundwater Divide	Maximum value	1.0×10^{-2}	6.4×10^{-2}	1.0×10^{-2}	6.0
		Time of maximum (years)	9975	9975	9975	9625
	South of Groundwater Divide	Maximum value	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.7
		Time of maximum (years)	9205	8295	9205	7875
Surface water	North of Groundwater Divide	Maximum value	2.0×10^{-6}	1.2×10^{-5}	2.0×10^{-6}	1.1×10^{-3}
		Time of maximum (years)	9975	9975	9975	9765
	South of Groundwater Divide	Maximum value	3.8×10^{-5}	3.8×10^{-5}	3.8×10^{-5}	6.4×10^{-3}
		Time of maximum (years)	9555	8645	9555	7735

TC

Table C.4.1-12. Alpha concentration for H-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	7.3×10^{-4}	7.2×10^{-2}	7.3×10^{-4}	9.5
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	2.5×10^{-4}	1.2×10^{-3}	2.5×10^{-4}	4.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
100-meter well	North of Groundwater Divide	Maximum value	1.9×10^{-4}	1.6×10^{-2}	1.9×10^{-4}	2.1
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	5.2×10^{-5}	2.8×10^{-4}	5.2×10^{-5}	1.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
Seepline	North of Groundwater Divide	Maximum value	6.7×10^{-9}	4.4×10^{-6}	6.7×10^{-9}	7.8×10^{-4}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	7.8×10^{-10}	1.6×10^{-8}	7.8×10^{-10}	1.8×10^{-5}
		Time of maximum (years)	9975	9975	9975	9975
Surface water	North of Groundwater Divide	Maximum value	2.6×10^{-11}	6.4×10^{-9}	2.6×10^{-11}	1.1×10^{-6}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	8.0×10^{-11}	9.3×10^{-10}	8.0×10^{-11}	8.8×10^{-7}
		Time of maximum (years)	9975	9975	9975	9975

Table C.4.1-13. Concentrations in groundwater and surface water of silver (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.2×10^{-1}	7.9×10^{-2}	1.2×10^{-1}	8.2×10^{-1}	8.6×10^{-3}	6.3×10^{-3}	8.6×10^{-3}	5.3×10^{-1}	9.7×10^{-4}	7.2×10^{-4}	9.7×10^{-4}	4.9×10^{-2}
	Time (yr)	1015	245	1015	105	1015	245	1015	105	1015	245	1015	105
	Barnwell -McBean	3.2×10^{-1}	2.0×10^{-1}	3.2×10^{-1}	3.4	7.1×10^{-4}	9.4×10^{-4}	7.1×10^{-4}	9.3×10^{-2}	8.8×10^{-5}	8.9×10^{-5}	8.8×10^{-5}	9.0×10^{-3}
	Time (yr)	1155	385	1155	245	2695	1855	2695	1785	2765	1715	2765	1645
	Congaree	3.1×10^{-5}	3.1×10^{-5}	3.1×10^{-5}	3.3×10^{-4}	2.0×10^{-5}	2.4×10^{-5}	2.0×10^{-5}	2.3×10^{-3}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-4}
	Time (yr)	4165	3325	4165	3115	9975	9765	9975	9555	9975	9205	9975	9205
100-meter well	Water Table	2.3×10^{-2}	1.4×10^{-2}	2.3×10^{-2}	1.8×10^{-1}	1.5×10^{-3}	1.9×10^{-3}	1.5×10^{-3}	1.5×10^{-1}	2.0×10^{-4}	1.7×10^{-4}	2.0×10^{-4}	1.1×10^{-2}
	Time (yr)	1015	245	1015	105	1015	35	1015	35	1015	245	1015	175
	Barnwell -McBean	6.5×10^{-2}	3.9×10^{-2}	6.5×10^{-2}	9.0×10^{-1}	1.2×10^{-4}	1.9×10^{-4}	1.2×10^{-4}	1.8×10^{-2}	1.7×10^{-5}	1.6×10^{-5}	1.7×10^{-5}	1.7×10^{-3}
	Time (yr)	1155	385	1155	245	2625	1785	2625	1785	2765	1645	2765	1645
	Congaree	5.7×10^{-6}	5.7×10^{-6}	5.7×10^{-6}	6.7×10^{-5}	3.1×10^{-6}	4.0×10^{-6}	3.1×10^{-6}	3.7×10^{-4}	(a)	(a)	(a)	2.0×10^{-5}
	Time (yr)	4235	3325	4235	3115	9905	9695	9905	9835	(a)	(a)	(a)	9415
Seepline	Water Table	7.1×10^{-4}	5.8×10^{-4}	7.1×10^{-4}	1.1×10^{-2}	4.5×10^{-5}	5.8×10^{-5}	4.5×10^{-5}	6.0×10^{-3}	5.2×10^{-6}	5.1×10^{-6}	5.2×10^{-6}	5.5×10^{-4}
	Time (yr)	1085	315	1085	245	1155	175	1155	175	1155	385	1155	245
	Barnwell -McBean	1.7×10^{-3}	1.2×10^{-3}	1.7×10^{-3}	2.1×10^{-2}	3.9×10^{-6}	5.7×10^{-6}	3.9×10^{-6}	4.8×10^{-4}	(a)	(a)	(a)	6.7×10^{-5}
	Time (yr)	1365	525	1365	455	3115	2275	3115	2065	(a)	(a)	(a)	1925
	Congaree	(a)	(a)	(a)	1.9×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	3185	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)
Surface Water	Water Table	4.5×10^{-6}	3.8×10^{-6}	4.5×10^{-6}	7.8×10^{-5}	(a)	(a)	(a)	1.2×10^{-6}	(a)	(a)	(a)	2.4×10^{-6}
	Time (yr)	1085	315	1085	245	(a)	(a)	(a)	245	(a)	(a)	(a)	245
	Barnwell -McBean	8.8×10^{-6}	6.5×10^{-6}	8.8×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	1365	595	1365	455	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-14. Concentrations in groundwater and surface water of aluminum (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-15. Concentrations in groundwater and surface water of barium (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	6.3×10^{-5}	(a)	6.3×10^{-5}	2.9×10^{-4}	1.9×10^{-4}	2.2×10^{-5}	1.9×10^{-4}	7.2×10^{-4}	(a)	(a)	(a)	(a)
	Time (yr)	9975	(a)	9975	9975	7945	8435	7945	6475	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	2.6×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-16. Concentrations in groundwater and surface water of fluoride (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.1×10^{-2}	6.5×10^{-2}	1.1×10^{-2}	4.2×10^{-1}	1.2×10^{-2}	1.3×10^{-2}	1.2×10^{-2}	7.4×10^{-1}	2.6×10^{-3}	9.1×10^{-3}	2.6×10^{-3}	5.1×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	2.0×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	1.9	1.2×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	9.5×10^{-1}	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.0
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.1×10^{-3}	1.2×10^{-3}	1.1×10^{-3}	1.0×10^{-2}	2.2×10^{-3}	3.1×10^{-3}	2.2×10^{-3}	2.7×10^{-1}	1.2×10^{-3}	1.3×10^{-3}	1.2×10^{-3}	1.4×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.8×10^{-3}	1.2×10^{-2}	3.8×10^{-3}	1.1×10^{-1}	3.2×10^{-3}	3.6×10^{-3}	3.2×10^{-3}	3.3×10^{-1}	6.0×10^{-4}	1.8×10^{-3}	6.0×10^{-4}	1.3×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	4.5×10^{-2}	4.7×10^{-2}	4.5×10^{-2}	5.0×10^{-1}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	2.2×10^{-1}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-1}
	Time (yr)	1015	105	1015	105	1015	35	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-4}	2.2×10^{-4}	2.0×10^{-4}	2.1×10^{-3}	3.5×10^{-4}	6.0×10^{-4}	3.5×10^{-4}	4.8×10^{-2}	1.7×10^{-4}	2.0×10^{-4}	1.7×10^{-4}	2.1×10^{-2}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-4}	7.0×10^{-4}	1.8×10^{-4}	8.4×10^{-3}	1.5×10^{-4}	1.7×10^{-4}	1.5×10^{-4}	1.6×10^{-2}	1.9×10^{-5}	8.4×10^{-5}	1.9×10^{-5}	7.8×10^{-3}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	1.1×10^{-3}	1.4×10^{-3}	1.1×10^{-3}	2.0×10^{-2}	6.3×10^{-5}	8.0×10^{-5}	6.3×10^{-5}	5.9×10^{-3}	5.5×10^{-5}	5.5×10^{-5}	5.5×10^{-5}	4.1×10^{-3}
	Time (yr)	1015	105	1015	105	1085	175	1085	175	1085	175	1085	105
	Congaree	5.8×10^{-6}	6.3×10^{-6}	5.8×10^{-6}	6.8×10^{-5}	5.6×10^{-6}	8.1×10^{-6}	5.6×10^{-6}	5.5×10^{-4}	1.6×10^{-6}	1.9×10^{-6}	1.6×10^{-6}	1.8×10^{-4}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-6}	4.8×10^{-6}	1.2×10^{-6}	6.1×10^{-5}	(a)	(a)	(a)	3.0×10^{-6}	(a)	(a)	(a)	3.5×10^{-5}
	Time (yr)	105	105	105	105	(a)	(a)	(a)	35	(a)	(a)	(a)	105
	Barnwell-McBean	5.7×10^{-6}	7.3×10^{-6}	5.7×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	1.4×10^{-5}
	Time (yr)	1015	105	1015	105	(a)	(a)	(a)	175	(a)	(a)	(a)	105
	Congaree	(a)	(a)	(a)	1.8×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	5.8×10^{-6}
	Time (yr)	(a)	(a)	(a)	175	(a)	(a)	(a)	(a)	(a)	(a)	(a)	315

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

TC

Table C.4.1-17. Concentrations in groundwater and surface water of chromium (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	2.1×10^{-2}	8.5×10^{-3}	2.1×10^{-2}	1.9×10^{-1}	5.4×10^{-3}	2.7×10^{-3}	5.4×10^{-3}	3.2×10^{-1}	3.6×10^{-3}	1.8×10^{-3}	3.6×10^{-3}	2.1×10^{-1}
	Time (yr)	1715	1925	1715	805	1645	1855	1645	805	1575	1785	1575	805
	Barnwell-McBean	2.3×10^{-2}	1.9×10^{-2}	2.3×10^{-2}	3.8×10^{-1}	2.9×10^{-6}	1.1×10^{-5}	2.9×10^{-6}	3.8×10^{-3}	1.4×10^{-6}	1.4×10^{-5}	1.4×10^{-6}	3.7×10^{-3}
	Time (yr)	3745	4025	3745	2065	9975	9975	9975	9975	9975	9975	9975	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	2.7×10^{-3}	1.5×10^{-3}	2.7×10^{-3}	3.5×10^{-2}	7.6×10^{-4}	5.4×10^{-4}	7.6×10^{-4}	7.4×10^{-2}	5.2×10^{-4}	4.1×10^{-4}	5.2×10^{-4}	3.4×10^{-2}
	Time (yr)	1855	2065	1855	945	1995	2415	1995	1155	2065	2065	2065	1155
	Barnwell-McBean	4.4×10^{-3}	3.7×10^{-3}	4.4×10^{-3}	8.1×10^{-2}	(a)	1.2×10^{-6}	(a)	3.8×10^{-4}	(a)	1.4×10^{-6}	(a)	4.3×10^{-4}
	Time (yr)	4165	4305	4165	2485	(a)	9975	(a)	9975	(a)	9975	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	3.1×10^{-5}	2.9×10^{-5}	3.1×10^{-5}	5.2×10^{-4}	1.5×10^{-5}	1.3×10^{-5}	1.5×10^{-5}	1.0×10^{-3}	9.2×10^{-6}	9.2×10^{-6}	9.2×10^{-6}	4.4×10^{-4}
	Time (yr)	4865	4865	4865	3955	5495	5565	5495	4235	6265	5775	6265	4935
	Barnwell-McBean	4.6×10^{-5}	4.5×10^{-5}	4.6×10^{-5}	8.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9625	9625	9625	8015	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.0×10^{-6}
	Time (yr)	(a)	(a)	(a)	4095	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4935
	Barnwell-McBean	(a)	(a)	(a)	4.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	7945	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

TC

Table C.4.1-18. Concentrations in groundwater and surface water of copper (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	6.0×10^{-3}	4.6×10^{-3}	6.0×10^{-3}	6.2×10^{-2}	9.0×10^{-4}	7.1×10^{-4}	9.0×10^{-4}	6.6×10^{-2}	4.5×10^{-4}	3.4×10^{-4}	4.5×10^{-4}	2.9×10^{-2}
	Time (yr)	2765	2905	2765	1295	2695	2835	2695	1295	2555	2695	2555	1295
	Barnwell-McBean	9.4×10^{-3}	8.8×10^{-3}	9.4×10^{-3}	1.5×10^{-1}	(a)	(a)	(a)	8.0×10^{-4}	(a)	(a)	(a)	6.5×10^{-4}
	Time (yr)	6195	6405	6195	3115	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	5.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	7.6×10^{-4}	6.8×10^{-4}	7.6×10^{-4}	1.1×10^{-2}	1.2×10^{-4}	1.1×10^{-4}	1.2×10^{-4}	1.4×10^{-2}	4.5×10^{-5}	4.7×10^{-5}	4.5×10^{-5}	4.2×10^{-3}
	Time (yr)	3255	3465	3255	1785	3465	4025	3465	2135	3465	3745	3465	2345
	Barnwell-McBean	1.5×10^{-3}	1.6×10^{-3}	1.5×10^{-3}	2.7×10^{-2}	(a)	(a)	(a)	2.0×10^{-5}	(a)	(a)	(a)	2.4×10^{-5}
	Time (yr)	6895	7385	6895	4095	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	7.9×10^{-6}	8.1×10^{-6}	7.9×10^{-6}	1.2×10^{-4}	1.5×10^{-6}	1.6×10^{-6}	1.5×10^{-6}	1.6×10^{-4}	(a)	(a)	(a)	4.0×10^{-5}
	Time (yr)	9975	9975	9975	8505	9835	9975	9835	9835	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9905	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-19. Concentrations in groundwater and surface water of iron (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	2.6	2.7	2.6	3.0×10^{1}	1.1	1.1	1.1	8.2×10^{1}	4.8×10^{-1}	4.8×10^{-1}	4.8×10^{-1}	2.9×10^{1}
	Time (yr)	1575	735	1575	385	1575	665	1575	385	1505	665	1505	385
	Barnwell-McBean	4.7	4.7	4.7	7.4×10^{1}	4.5×10^{-1}	4.5×10^{-1}	4.5×10^{-1}	6.2×10^{1}	2.2×10^{-1}	2.1×10^{-1}	2.2×10^{-1}	2.6×10^{1}
	Time (yr)	2485	1645	2485	805	3605	2695	3605	1575	3465	2485	3465	1435
	Congaree	5.9×10^{-3}	6.0×10^{-3}	5.9×10^{-3}	7.6×10^{-2}	1.5×10^{-2}	2.5×10^{-2}	1.5×10^{-2}	2.6	4.1×10^{-3}	6.2×10^{-3}	4.1×10^{-3}	6.1×10^{-1}
	Time (yr)	4795	4095	4795	2695	9975	9905	9975	9345	9975	9975	9975	9835
100-meter well	Water Table	3.4×10^{-1}	3.3×10^{-1}	3.4×10^{-1}	4.7	1.3×10^{-1}	1.4×10^{-1}	1.3×10^{-1}	1.1×10^{1}	7.4×10^{-2}	7.6×10^{-2}	7.4×10^{-2}	4.6
	Time (yr)	1785	875	1785	595	1995	1085	1995	735	1925	1085	1925	875
	Barnwell-McBean	7.4×10^{-1}	7.2×10^{-1}	7.4×10^{-1}	1.3×10^{1}	6.2×10^{-2}	6.4×10^{-2}	6.2×10^{-2}	7.1	4.7×10^{-2}	4.5×10^{-2}	4.7×10^{-2}	3.7
	Time (yr)	2835	1925	2835	1225	4445	3535	4445	2275	4095	3185	4095	1995
	Congaree	1.1×10^{-3}	1.1×10^{-3}	1.1×10^{-3}	1.6×10^{-2}	2.1×10^{-3}	4.2×10^{-3}	2.1×10^{-3}	3.9×10^{-1}	9.2×10^{-4}	1.5×10^{-3}	9.2×10^{-4}	1.2×10^{-1}
	Time (yr)	4865	3955	4865	2695	9975	9975	9975	9695	9975	9905	9975	9345
Seepline	Water Table	3.9×10^{-3}	3.9×10^{-3}	3.9×10^{-3}	6.0×10^{-2}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	1.6×10^{-1}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	7.7×10^{-2}
	Time (yr)	4585	3605	4585	3255	5145	4165	5145	3675	5425	4585	5425	4305
	Barnwell-McBean	5.8×10^{-3}	5.8×10^{-3}	5.8×10^{-3}	9.2×10^{-2}	1.7×10^{-4}	3.3×10^{-4}	1.7×10^{-4}	3.1×10^{-2}	7.9×10^{-4}	7.9×10^{-4}	7.9×10^{-4}	4.6×10^{-2}
	Time (yr)	7665	6825	7665	6055	9975	9975	9975	9975	9065	8225	9065	6895
	Congaree	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.1×10^{-4}	(a)	(a)	(a)	2.8×10^{-4}	(a)	(a)	(a)	7.3×10^{-5}
	Time (yr)	6405	5495	6405	4445	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
Surface Water	Water Table	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.2×10^{-4}	(a)	(a)	(a)	3.7×10^{-5}	6.2×10^{-6}	6.2×10^{-6}	6.2×10^{-6}	3.5×10^{-4}
	Time (yr)	4445	3535	4445	3255	(a)	(a)	(a)	3815	5635	4725	5635	4235
	Barnwell-McBean	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	4.9×10^{-4}	(a)	(a)	(a)	5.6×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	1.7×10^{-4}
	Time (yr)	7665	6825	7665	6195	(a)	(a)	(a)	9905	8785	7945	8785	6615
	Congaree	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.6×10^{-6}
	Time (yr)	(a)	(a)	(a)	4585	(a)	(a)	(a)	(a)	(a)	(a)	(a)	9975

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

Table C.4.1-20. Concentrations in groundwater and surface water of mercury (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	2.6×10^{-5}	3.6×10^{-5}	2.6×10^{-5}	1.6×10^{-3}	1.4×10^{-3}	7.4×10^{-4}	1.4×10^{-3}	1.2×10^{-1}	(a)	(a)	(a)	1.2×10^{-1}
	Time (yr)	9975	9975	9975	9975	9835	5285	9835	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	2.7×10^{-6}	(a)	1.3×10^{-4}	3.0×10^{-5}	5.3×10^{-5}	3.0×10^{-5}	5.3×10^{-3}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	(a)	9975	(a)	9905	9975	9975	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-21. Concentrations in groundwater and surface water of nitrate (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.2×10^{-1}	6.7×10^{-1}	4.2×10^{3}	4.8	2.3×10^{-1}	2.7×10^{-1}	2.4×10^{4}	1.5×10^{1}	7.5×10^{-2}	2.5×10^{-1}	8.7×10^{3}	1.3×10^{1}
	Time (yr)	105	105	385	105	35	35	35	35	105	105	245	105
	Barnwell-McBean	2.1	2.2	4.4×10^{4}	2.2×10^{1}	2.8×10^{-1}	2.8×10^{-1}	3.5×10^{4}	2.3×10^{1}	2.9×10^{-1}	2.9×10^{-1}	3.4×10^{4}	2.7×10^{1}
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.2×10^{-2}	1.2×10^{-2}	4.2×10^{2}	1.2×10^{-1}	5.2×10^{-2}	7.2×10^{-2}	1.6×10^{4}	6.2	3.2×10^{-2}	3.7×10^{-2}	5.3×10^{3}	3.4
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.9×10^{-2}	1.3×10^{-1}	1.0×10^{3}	1.3	6.5×10^{-2}	7.6×10^{-2}	6.8×10^{3}	6.9	2.1×10^{-2}	6.0×10^{-2}	2.3×10^{3}	3.6
	Time (yr)	105	105	1015	105	35	35	35	35	105	105	1015	105
	Barnwell-McBean	4.7×10^{-1}	4.9×10^{-1}	1.8×10^{4}	5.8	6.1×10^{-2}	6.1×10^{-2}	1.4×10^{4}	4.6	5.9×10^{-2}	5.9×10^{-2}	9.9×10^{3}	4.6
	Time (yr)	1015	105	1015	105	1015	105	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-3}	2.3×10^{-3}	7.1×10^{1}	2.4×10^{-2}	8.9×10^{-3}	1.4×10^{-2}	2.1×10^{3}	1.1	5.6×10^{-3}	6.9×10^{-3}	9.3×10^{2}	5.6×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-3}	7.4×10^{-3}	5.8×10^{1}	1.0×10^{-1}	3.1×10^{-3}	4.2×10^{-3}	3.0×10^{2}	3.4×10^{-1}	9.8×10^{-4}	3.5×10^{-3}	1.5×10^{2}	2.2×10^{-1}
	Time (yr)	105	105	1015	105	35	105	35	35	1015	105	1015	105
	Barnwell-McBean	1.2×10^{-2}	1.5×10^{-2}	4.2×10^{2}	2.4×10^{-1}	1.7×10^{-3}	2.1×10^{-3}	3.3×10^{2}	1.5×10^{-1}	2.5×10^{-3}	2.5×10^{-3}	4.2×10^{2}	1.1×10^{-1}
	Time (yr)	1015	105	1085	105	1085	175	1085	175	1085	175	1085	105
	Congaree	6.1×10^{-5}	6.5×10^{-5}	2.3	8.1×10^{-4}	1.5×10^{-4}	2.0×10^{-4}	3.0×10^{1}	1.3×10^{-2}	7.0×10^{-5}	8.5×10^{-5}	1.2×10^{1}	5.1×10^{-3}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-5}	5.0×10^{-5}	3.9×10^{-1}	7.3×10^{-4}	(a)	(a)	5.5×10^{-2}	6.5×10^{-5}	4.4×10^{-6}	1.5×10^{-5}	6.6×10^{-1}	9.9×10^{-4}
	Time (yr)	105	105	1015	105	(a)	(a)	35	35	1015	105	1015	105
	Barnwell-McBean	5.9×10^{-5}	7.7×10^{-5}	2.3	1.3×10^{-3}	(a)	(a)	6.0×10^{-2}	2.7×10^{-5}	9.3×10^{-6}	9.4×10^{-6}	1.6	4.1×10^{-4}
	Time (yr)	1015	105	1085	105	(a)	(a)	1085	175	1085	175	1085	105
	Congaree	1.6×10^{-6}	1.7×10^{-6}	5.9×10^{-2}	2.2×10^{-5}	(a)	(a)	3.8×10^{-2}	1.7×10^{-5}	2.3×10^{-6}	2.8×10^{-6}	3.8×10^{-1}	1.7×10^{-4}
	Time (yr)	1085	175	1085	175	(a)	(a)	1225	315	1225	315	1225	315

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

Table C.4.1-22. Concentrations in groundwater and surface water of manganese (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.9×10^{-1}	2.2×10^{-1}	1.9×10^{-1}	2.2	2.9×10^{-1}	3.5×10^{-1}	2.9×10^{-1}	2.5×10^{1}	5.5×10^{-2}	6.2×10^{-2}	5.5×10^{-2}	4.0
	Time (yr)	1995	875	1995	455	1295	245	1295	245	1925	805	1925	455
	Barnwell-McBean	3.6×10^{-1}	3.8×10^{-1}	3.6×10^{-1}	5.5	2.2×10^{-2}	4.5×10^{-2}	2.2×10^{-2}	6.0	1.8×10^{-2}	2.0×10^{-2}	1.8×10^{-2}	2.2
	Time (yr)	3115	1925	3115	945	5145	2765	5145	2415	4445	3885	4445	2415
	Congaree	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	3.6×10^{-3}	1.3×10^{-6}	1.6×10^{-4}	1.3×10^{-6}	3.1×10^{-2}	(a)	8.7×10^{-6}	(a)	4.9×10^{-3}
	Time (yr)	6405	5425	6405	4795	9975	9975	9975	9975	(a)	9975	(a)	9975
100-meter well	Water Table	2.8×10^{-2}	3.1×10^{-2}	2.8×10^{-2}	7.0×10^{-1}	4.3×10^{-2}	3.9×10^{-2}	4.3×10^{-2}	4.1	6.4×10^{-3}	6.5×10^{-3}	6.4×10^{-3}	5.6×10^{-1}
	Time (yr)	2205	1085	2205	805	1715	665	1715	665	2345	1155	2345	875
	Barnwell-McBean	6.2×10^{-2}	6.1×10^{-2}	6.2×10^{-2}	1.6	6.2×10^{-3}	1.1×10^{-2}	6.2×10^{-3}	1.3	2.8×10^{-3}	3.2×10^{-3}	2.8×10^{-3}	3.5×10^{-1}
	Time (yr)	3535	2345	3535	1505	6125	3675	6125	3045	5215	4445	5215	3115
	Congaree	4.6×10^{-5}	4.6×10^{-5}	4.6×10^{-5}	1.1×10^{-3}	(a)	3.0×10^{-5}	(a)	6.0×10^{-3}	(a)	(a)	(a)	6.3×10^{-4}
	Time (yr)	6755	5705	6755	4585	(a)	9975	(a)	9975	(a)	(a)	(a)	9975
Seepline	Water Table	3.8×10^{-4}	3.8×10^{-4}	3.8×10^{-4}	1.2×10^{-2}	5.4×10^{-4}	5.5×10^{-4}	5.4×10^{-4}	4.7×10^{-2}	6.8×10^{-5}	6.7×10^{-5}	6.8×10^{-5}	6.4×10^{-3}
	Time (yr)	5215	4165	5215	3535	5215	4305	5215	3815	6195	5005	6195	4585
	Barnwell-McBean	5.6×10^{-4}	5.6×10^{-4}	5.6×10^{-4}	1.8×10^{-2}	4.0×10^{-6}	4.2×10^{-5}	4.0×10^{-6}	5.4×10^{-3}	3.4×10^{-5}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-3}
	Time (yr)	8855	7805	8855	6545	9975	9975	9975	9975	9905	9485	9905	8155
	Congaree	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	8225	7175	8225	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	2.5×10^{-6}	2.5×10^{-6}	2.5×10^{-6}	8.5×10^{-5}	(a)	(a)	(a)	9.5×10^{-6}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	5215	4165	5215	3745	(a)	(a)	(a)	4025	(a)	(a)	(a)	4515
	Barnwell-McBean	2.9×10^{-6}	2.9×10^{-6}	2.9×10^{-6}	9.8×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.3×10^{-5}
	Time (yr)	8785	7735	8785	7035	(a)	(a)	(a)	(a)	(a)	(a)	(a)	7875
	Congaree	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

TC

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

Table C.4.1-23. Concentrations in groundwater and surface water of nickel (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.0×10^{-4}	2.2×10^{-5}	1.0×10^{-4}	1.1×10^{-1}	4.8×10^{-3}	4.7×10^{-3}	4.8×10^{-3}	2.9×10^{-1}	5.8×10^{-4}	2.4×10^{-4}	5.8×10^{-4}	5.9×10^{-2}
	Time (yr)	9975	9975	9975	6335	5495	4725	5495	5285	9975	9975	9975	6335
	Barnwell-McBean	(a)	(a)	(a)	6.7×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	1.9×10^{-2}	2.9×10^{-4}	3.4×10^{-4}	2.9×10^{-4}	3.4×10^{-2}	(a)	(a)	(a)	3.4×10^{-3}
	Time (yr)	(a)	(a)	(a)	9905	9975	9975	9975	9905	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

TC

Table C.4.1-24. Concentrations in groundwater and surface water of lead (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	5.2×10^{-4}	2.9×10^{-4}	5.2×10^{-4}	2.3×10^{-2}	7.3×10^{-4}	2.0×10^{-4}	7.3×10^{-4}	8.5×10^{-2}	3.9×10^{-4}	1.4×10^{-5}	3.9×10^{-4}	3.0×10^{-2}
	Time (yr)	9975	6055	9975	6475	9975	3745	9975	6965	9975	9975	9975	6545
	Barnwell-McBean	(a)	(a)	(a)	1.3×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	8.3×10^{-5}	8.0×10^{-5}	8.3×10^{-5}	4.2×10^{-3}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-5}	8.1×10^{-3}	(a)	(a)	(a)	2.9×10^{-3}
	Time (yr)	8575	8505	8575	9765	9975	9765	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-25. Concentrations in groundwater and surface water of uranium (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	7.6×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	1.7×10^{-4}	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	2.2×10^{-4}
	Time (yr)	8365	7035	8365	9975	9975	8925	9975	9695	9695	8785	9695	9345
	Barnwell-McBean	(a)	1.4×10^{-6}	(a)	1.5×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	9975	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	6.4×10^{-6}	6.5×10^{-6}	6.4×10^{-6}	4.5×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.0×10^{-4}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-4}
	Time (yr)	8995	8435	8995	9695	9485	8505	9485	9485	9975	9065	9975	9135
	Barnwell-McBean	(a)	(a)	(a)	6.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

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

Table C.4.1-26. Concentrations in groundwater and surface water of zinc (milligrams per liter).

TC

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	4.4×10^{-3}	4.4×10^{-3}	4.4×10^{-3}	8.7×10^{-2}	6.7×10^{-4}	4.8×10^{-4}	6.7×10^{-4}	5.4×10^{-2}	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.4×10^{-2}
	Time (yr)	2135	1155	2135	595	2135	1225	2135	1925	2555	1645	2555	1015
	Barnwell-McBean	3.3×10^{-3}	5.7×10^{-3}	3.3×10^{-3}	1.3×10^{-1}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	5425	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.8×10^{-2}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.5×10^{-2}	7.4×10^{-4}	7.4×10^{-4}	7.4×10^{-4}	1.1×10^{-2}
	Time (yr)	2205	1295	2205	735	2345	1435	2345	2205	2975	2065	2975	1295
	Barnwell-McBean	1.2×10^{-3}	1.2×10^{-3}	1.2×10^{-3}	3.2×10^{-2}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	7315	6335	7315	5845	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	5.5×10^{-4}	3.7×10^{-6}	3.7×10^{-6}	3.7×10^{-6}	5.3×10^{-4}	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	3.1×10^{-4}
	Time (yr)	8855	7875	8855	4375	5005	4165	5005	4375	5775	4865	5775	4515
	Barnwell-McBean	9.3×10^{-6}	1.8×10^{-5}	9.3×10^{-6}	9.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.9×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.4×10^{-6}
	Time (yr)	(a)	(a)	(a)	4375	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4165
	Barnwell-McBean	(a)	(a)	(a)	4.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

---

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

C.4.2 ECOLOGICAL RISK ASSESSMENT

C.4.2.1 Nonradiological Analysis

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

Aquatic Hazard Quotients (HQs) for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0 for all four alternatives. All terrestrial HQs for the shrew and the mink were less than 1.0 for all four scenarios: (Tables C.4.2-1 through C.4.2-4). Thus potential risks to ecological receptors at and downgradient of the Upper Three Runs seeps (from all aquifers under H Area) are negligible.

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 HI. All HIs were less than 1.0 for the four scenarios. All terrestrial HQs for the shrew and the mink were less than 1.0 for these alternatives and options (Tables C.4.2-5 through C.4.2-8). 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.

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 HI. All aquatic HIs were less than 1.0 for the Fill with Sand and Fill with Saltstone Options. The maximum HI for the Fill with Grout Option with the Water Table Aquifer was 1.42. In addition, HIs for the No Action Alternative with the Barnwell-McBean and Water Table Aquifers were greater than 1.0: 2.0 and 1.42, respectively. This suggests some potential risks, although the relatively low HI values suggest that these risks are generally low. HQs for the shrew and the mink were less than 1.0 for all four scenarios (Tables C.4.2-9 through C.4.2-12). The exception was a silver HQ of 1.55 for the shrew under the No Action Alternative (Barnwell-McBean Aquifer). Although this indicates that risks are possible at the Fourmile Branch seep (via groundwater under F Area), the relatively low HQ suggests that these risks are somewhat low.

C.4.2.2 Radiological Analysis

Calculated absorbed doses to the referenced organisms are presented in Tables C.4-2-13 through C.4.2-21. All calculated doses are below the regulatory limit of 365,000 mrad per year (365 rad per year).

C.5 Ecological Risk Assessment Uncertainties

Most of the data and assumptions used in the exposure calculations (exclusive of the exposure concentrations, which were calculated by the groundwater model) are average or midpoint values. Uncertainty for these values is largely a question of precision in measurement or variability about these points. However, two assumptions are conservative, meaning that they are likely to overestimate risk.

The relationship between seep area and home range has already been mentioned; the lack of correction for home range is likely to overestimate risk to an individual shrew by a factor of two and to an individual mink by a factor greater than ten. The other assumption is that when contaminants in seepage adsorb to the soil, they are not removed from the water. In other words, the seepage concentration is used to predict soil concentrations and downstream water concentrations without adjustment for losses.

Table C.4.2-1. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

TC

	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}. 1×10^{-2}
NA = Not applicable.

Table C.4.2-2. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

TC

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum 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}.
NA = Not applicable.

TC

Table C.4.2-3. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum 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}.
NA = Not applicable.

Table C.4.2-4. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

	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	2.19×10^{-2}	3.94×10^{-2}	4,235
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	2.43×10^{-2}	5.76×10^{-2}	175	b	b	NA	6.6×10^{-2}	1.56×10^{-1}	35
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	1.93×10^{-2}	3.54×10^{-2}	2,065	b	b	NA	2.41×10^{-1}	4.43×10^{-1}	175
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.4.2-5. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

TC

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum 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.

TC

Table C.4.2-6. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

	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	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.4.2-7. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

TC

	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	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.4.2-8. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

	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	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	1.69×10^{-2}	4.0×10^{-2}	105	b	b	NA	3.22×10^{-2}	7.61×10^{-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	b	b	NA	b	b	NA	2.21×10^{-2}	4.06×10^{-2}	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.

TC

Table C.4.2-9. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

	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}	8.12×0^{-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.

TC

Table C.4.2-10. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum 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	1.37×10^{-2}	105	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	4.82×10^{-2}	8.85×10^{-2}	525	b	b	NA	2.33×10^{-2}	4.28×10^{-2}	315
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.4.2-11. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

TC

	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	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,105	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	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	2.85×10^{-2}	5.24×10^{-2}	1,085
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.4.2-12. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	1.76×10^{-2}	3.15×10^{-2}	8,015	b	b	NA	1.14×10^{-2}	2.05×10^{-2}	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	8.25×10^{-2}	1.95×10^{-1}	105	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	8.44×10^{-1}	1.55	455	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.4.2-13. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Water Table Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0027	0.0016	0.025	0.49
Shrew dose	10.1	6.3	94.9	2,530
Mink dose	1.1	0.9	9.9	1,690

Table C.4.2-14. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Area Tank Farm – Barnwell-McBean Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0038	0.0072	0.053	0.89
Shrew dose	18.7	34.5	372	4,320
Mink dose	2.0	3.6	265	452

Table C.4.2-15. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Congaree Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	6.7×10^{-5}	8.9×10^{-5}	0.002	0.016
Shrew dose	0.1	0.1	1.9	15.8
Mink dose	0	0	0.2	1.7

Table C.4.2-16. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Water Table Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0014	0.0023	0.027	0.35
Shrew dose	9.5	14.4	158.9	2,260
Mink dose	1.0	1.5	17.8	669.1

Table C.4.2-17. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Barnwell-McBean Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.2×10^{-4}	0.0011	0.018	0.21
Shrew dose	0.2	8.3	126.6	1,580
Mink dose	0	0.9	13.3	165.7

Table C.4.2-18. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Congaree Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-4}	2.8×10^{-4}	0.0095	0.061
Shrew dose	3.5	0.2	7.6	47.5
Mink dose	0.4	0	0.8	5.0

TC

Table C.4.2-19. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Water Table Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.1×10^{-4}	0.0017	0.0037	0.039
Shrew dose	24.8	244.5	460.5	24,450
Mink dose	3.3	25.6	48.7	2,560

TC

Table C.4.2-20. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Barnwell-McBean Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	5.4×10^{-5}	3.1×10^{-4}	0.0016	0.014
Shrew dose	7.5	44.6	230.1	4,890
Mink dose	0.8	4.7	24.1	512

TC

Table C.4.2-21. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Congaree Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-5}	1.3×10^{-4}	0.0016	0.012
Shrew dose	1.0	2.7	31.6	244.5
Mink dose	0.1	0.3	3.3	25.6

TC

Uncertainty in the toxicity assessment includes the selection of a particular dose and the factors applied to ensure that it is protective. The fluoride dose selected as a threshold, a LOAEL of 5 milligram per kilogram per day associated with relatively less serious effects in rats and minks, could have been a higher dose based on effects more likely to cause decreased fitness. The data base available for silver toxicity is not good, and this is reflected in the high uncertainty factor (100X) used to lower the selected dose.

Because toxicity data is mostly limited to individual responses, a risk assessment is usually limited to the probability of risk to an individual. This makes the evaluation of risk to populations, communities, and ecosystems a speculative and uncertain undertaking, even though characterization of risks to populations is the typical goal of an ecological risk assessment. In the case of the seep, it is reasonable to assume that terrestrial effects will be limited to this area because the contaminants have not been shown to bioaccumulate in terrestrial systems. Surface water is the only likely pathway for contaminants to exit the seep area. [Mercury is known to accumulate in aquatic food chains, but only a minimal amount of mercury is transported to the seepline during the 10,000 year modeled time period.]

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APPENDIX D

PUBLIC COMMENTS AND DOE RESPONSES

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX D. PUBLIC COMMENTS AND DOE RESPONSES

In November 2000, the Department of Energy (DOE) published the *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D)* and invited public comment on the document. DOE held public hearings on the Draft Environmental Impact Statement (EIS) in North Augusta and Columbia, South Carolina, respectively, on January 9 and 11, 2001. The public comment period ended on January 23, 2001. DOE received written comments from 18 individuals and organizations and 8 people who spoke at the public hearings. DOE considered all comments in preparing this Final EIS.

This appendix provides the comments received and DOE's responses. Written comments and their responses are summarized in D.1. In Section D.2, each written comment letter is reproduced, with individual comments, questions, and suggestions labeled; responses to them are provided on the pages that follow each comment letter. If a comment prompted DOE to modify the EIS, the response describes the change and identifies its location in the Final EIS.

In Section D.3, comments made during the public hearings are summarized, followed by DOE's responses. Transcripts from the hearings are available at the DOE public reading rooms:

DOE Freedom of Information Reading Room
Forrestal Building, Room 1E-190
1000 Independence Ave., SW
Washington, DC 20585
Phone: 202-586-6020

and DOE Public Document Room
University of South Carolina, Aiken Campus
University Library, 2nd Floor
171 University Pkwy.
Aiken, SC 29801
Phone: 803-648-6851

D.1 Summary of Comments

Several of the major points made by commenters are summarized below, together with DOE's responses. More detailed responses are provided in Sections D.2 and D.3

Alternatives

Several comments questioned DOE's choice of alternatives for analysis or suggested additional alternatives that DOE should have considered. Specific topics included requests for clarification of the intent of the No Action Alternative, consideration of offsite disposal of tanks under the Clean and Remove Tanks Alternative, and a suggestion that DOE should cut up some of the tanks and place the components inside other intact tanks before grouting them. Several comments expressed concern or requested clarification about specific elements of the alternatives, including how transfer lines would be treated under the various alternatives and whether removed tank components would be disposed in the Savannah River Site (SRS) E-Area Vaults under the Clean and Remove Tanks Alternative.

Response:

DOE finds that the suggested new and modified alternatives either are not reasonable or were effectively addressed by the analysis presented in the EIS. Therefore, DOE did not change the alternatives considered in the EIS (other than modifying the Clean and Stabilize Tanks Alternative). However, clarifying information was added to the EIS as a result of several of these comments, as described in the responses to individual comments.

Use of Oxalic Acid

Several comments questioned the use of oxalic acid in cleaning tanks: whether other products could be used to remove residual material in the tanks, and whether DOE expects to use oxalic acid in view of technical concerns, particularly about the potential for nuclear criticality. Comments pointed out apparent contradictions between statements that oxalic acid cleaning would be used in the Clean and Stabilize Tanks Alternative and other statements that oxalic acid cleaning would not be practicable in the context of the Clean and Remove Tanks Alternative.

Response:

DOE revised the EIS to clarify DOE's position regarding the use of oxalic acid. Following bulk waste removal, DOE would clean the tanks, if necessary, to meet the performance objectives contained in the General Closure Plan and the tank-specific Closure Module. In accordance with the General Closure Plan, the need for and the extent of any tank cleaning would be determined based on the analysis presented in the tank-specific Closure Module. Concern about potential criticality would not preclude using oxalic acid for tank cleaning. However, a thorough, tank-specific evaluation for criticality would need to be done before using oxalic acid in any tank. The evaluation may result in the identification of additional tank-specific controls to ensure prevention of criticality. As discussed in the EIS, DOE identified oxalic acid as the preferred chemical cleaning agent after studying numerous other potential cleaning agents. Concerns about the effect of oxalic acid on the quality of the Defense Waste Processing Facility (DWPF) waste feed would be resolved by special handling of batches of waste feed that contained oxalates as a result of tank cleaning activities.

Cleaning of Tank Annulus

Several comments asked about the status of and plans for efforts to remove waste found in the annuli of some tanks, including the status of waste removal from the annulus of Tank 16.

Response:

In Chapter 2, a new paragraph was added on cleaning of the secondary containment, stating that waste would most likely be removed from the annulus using water and/or steam sprays, possibly combined with a chemical cleaning agent, such as oxalic acid. The Summary and Appendix A have been revised to clarify the status of waste removal from the Tank 16 annulus, specifically to state that some waste has been removed from the annulus, although some waste still remains.

Residual Waste

Several comments requested information on the residual waste inventories assumed for individual tanks or asked how DOE would measure or estimate the quantity and characteristics of residual waste remaining after tank cleaning is complete. Several comments requested additional discussion of the process by which the DOE determines that residual waste is "incidental to reprocessing."

Response:

In response to these comments, a table listing the assumed volume of residual waste if the tanks are cleaned remaining in each closed high-level waste (HLW) tank has been added to Appendix C. These volume estimates are based on previous experience with cleaning of Tanks 16, 17, and 20 and on judgments of the effectiveness of the cleaning method. Also, additional information on the approach used to estimate residual waste characteristics has been provided in Appendix A. For modeling purposes, the EIS assumes that the composition of the residual waste would be approximately the same as the sludge currently in the tanks. Before each tank is closed, DOE will collect and analyze samples of the residual waste remaining after tank closure and would conduct camera inspections to obtain visual evidence of the volume of residual waste in that tank. DOE has expanded the discussion of the three criteria for determining that waste is incidental to reprocessing, as specified in DOE Manual 435.1-1, Radioactive Waste Management.

Institutional Control and Future Land Use

Several questions addressed institutional control and future land use. Commenters said that DOE should not assume that institutional control would be retained for the entire duration of modeling analysis or that the land around the Tank Farms would remain in commercial/industrial use. Some expressed concern about whether the selected alternative for HLW tanks closure would restrict potential future land use.

Response:

No changes were made to the EIS as a result of these comments. DOE's *Savannah River Site Future Use Plan* calls for the land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) to remain in industrial use indefinitely. This future use designation would not be affected by the choice of a tank closure alternative. Although DOE does not envision relinquishing control of the area, it does recognize that there is uncertainty in projecting future land use and effectiveness of institutional controls. Therefore, in this EIS, DOE assumes direct physical control in the General Separations Area only for the next 100 years from the date of tank closure. In addition to reporting estimated human health impacts based at a regulatory point of compliance that is at the seepline (about a mile from the tank farms) DOE has provided estimates of human health implications of doses that would be received by persons obtaining drinking water from a well directly adjacent to the boundary of the tank farm.

Regulatory Standard and Point of Compliance

Several comments questioned the regulatory point of compliance (i.e., the seepline) or the application of the U.S. Environmental Protection Agency (EPA) drinking water standard of 4 mrem/year at that location. One viewpoint was that the seepline should not be used as the point of compliance unless institutional controls prevent groundwater use at locations closer to the tank farm. Another viewpoint was that the seepline point of compliance is overly conservative because people would obtain water from the nearby stream rather than at the seepline. Several commenters stated that the 4 mrem/year limit is overly conservative and suggested adopting a less stringent standard. Another concern expressed was that a more stringent standard might be applied under a future Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulatory process.

Response:

The performance objective of 4 mrem/year at the seepline was established by South Carolina Department of Health and Environmental Control (SCDHEC), after discussions with DOE and EPA Region 4 and following an evaluation of all applicable or relevant and appropriate requirements.

EIS Summary

Several comments specifically addressed the EIS Summary, often requesting clarification on topics that were covered in the EIS text or appendices, but not in the EIS Summary. Some commenters suggested that the Summary should be made an integral part of the EIS instead of being published as a separate volume.

Response:

In response to several comments, DOE incorporated additional information from the EIS into the EIS Summary. As allowed and encouraged in the Council on Environmental Quality National Environmental Policy Act (NEPA) implementing regulations (40 Code of Federal Regulations (CFR) 1500.4), DOE publishes the Summary separately as a service to readers, many of whom only read the Summary.

D.2 Comment Letters and DOE Responses

In the following section, DOE has reproduced the written comments received and provides a response to each. Table D-1 lists the comment letters and provides the letter numbers and commenter names.

Table D-1. Written Comments on the SRS High-Level Waste Tank Closure Draft EIS.

Comment Source Number*	Commenter	Page Number
L-1	Mr. Wade Waters	D-5
L-2	Mr. William F. Lawless	D-11
L-3	Mr. R. P. Borsody	D-17
L-4	Mr. Heinz J. Mueller, U.S. Environmental Protection Agency	D-25
L-5	Mr. Peter French	D-34
L-6	Mr. Thomas H. Essig, U.S. Nuclear Regulatory Commission	D-37
L-7	Mr. W. Lee Poe	D-43
L-8	Mr. Jim Hardeman, Georgia Department of Natural Resources	D-65
L-9	Mr. Frank Watters	D-68
L-10	Mr. Ernest S. Chaput	D-70
L-11	Mr. Kenneth W. Holt, Centers for Disease Control and Prevention	D-73
L-12	Mr. Andreas Mager, Jr., National Marine Fisheries Service	D-78
L-13	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-81
L-14	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-85
L-15	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-89
L-16	Mr. James H. Lee, U.S. Department of the Interior	D-92
L-17	Mr. Eric G. Hawk, National Marine Fisheries Service	D-94
L-18	Ms. Angela Stoner, South Carolina State Budget and Control Board	D-97

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*Unique codes were given to each of the letters received. Individual comments are coded L-1-1, etc.

Rec.
FEB 14 2001

February 8, 2001

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

Subject: **Comments on the November 2000 Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement**

Dear Mr. Grainger:

At the request of the Savannah River Site (SRS) Citizens Advisory Board (CAB) Waste Management Committee, the Salt Team Focus Group (FG) has been asked to review and comment on the November 2000 High-Level Waste (HLW) Draft Environmental Impact Statement (DEIS). We are aware that the official public comment period ends on January 23, 2001 but DOE had stated during public meetings that comments received after this date would be, to the extent practicable, reviewed and addressed.

The primary point the Salt Team FG wishes to stress is the need to maintain the current HLW Tank closure schedule. Any deviation in the Federal Facility Agreement closure schedule is considered unacceptable. In addition, we offer the following comments for your review and consideration: L-1-1

1. Based upon a review of the data in this DEIS, the most logical proposed action is to Clean and Stabilize the Tanks. This action provides the best protection to human health and the environment at an acceptable cost. The Salt Team FG agrees with the tank stabilization preferred option to fill with grout and believes this alternative should be the action selected in the final Record of Decision. The Salt Team FG sees the other alternatives as unacceptable. L-1-2
2. The Salt Team FG believes the performance objective of 4 mrem/year at a seepline is overly conservative and not realistic. The Salt Team FG can not see how anyone could realistically drink from the seepline. A more realistic point of compliance would be the centerline of the stream receiving surface runoff from the seepline. The Salt Team FG requests a modification to the proposed point of compliance. Furthermore, consistent with DOE Order 435.1, the projected dose attributable to any single source, practice, or activity should be some fraction less than the applicable overall dose limit (e.g. 100 mrem/year criteria stated in the order DOE 5400.5). L-1-3

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Page 2

To provide a realistic protection of human health and the environment, the Salt Team FG believes the composite analysis limit of 30 mrem/year should be used at the centerline of the stream receiving water from the seepline. This limit is normally applied at the site boundary but by using it at a location far within the site boundary a more than adequate level of protection will be provided. In addition, a greater level of protection will be utilized as the SRS begins to use institutional controls as part of its long-term stewardship program. By using this higher, but very protective, limit, tank closures will meet the performance objective at considerable cost savings to DOE and the taxpayer. L-1-4

3. One of the most important aspects of modeling the long-term closure scenarios is an accurate radioactive material source term. The DEIS appears to use process knowledge and reliance on past performance activities to assume a source term. No actual sampling data is used. The Salt Team FG believes representative sampling should be performed to verify the predicted levels and the approach should be documented in the DEIS. L-1-5

4. As individual private citizens, several members of the Salt Team FG submitted comments on the DEIS. Many of these comments address the Summary, which is a separate publication from the DEIS. The Salt Team FG believes that the Summary is considered to be part of the DEIS and merely pulls from specific sections of the DEIS to make a more condense version for the general public to read. However, neither the Foreword nor the Table Of Contents specifically address the Summary as being part of the DEIS. The Salt Team FG suggests that the Summary be listed and incorporated as an integral part of the DEIS. L-1-6

5. In the DEIS, DOE estimates that oxalic acid cleaning could be required on as many as three-quarters of the tanks to meet performance objectives and DOE plans to use the acid wash as part of the Clean and Stabilize Alternative. However, under the Clean and Remove Alternative, oxalic acid cleaning is considered not to be "technically and economically practical" because of critically safety concerns, potential interference with DWPF, and high cost. The Salt Team FG believes that safety and process uncertainties should be resolved and the results included in the DEIS. Additional discussion is needed to clarify the conflicts between using oxalic acid cleaning in one case and then discounting it in another. L-1-7

6. The Salt Team FG believes further explanation is required to address potential generation of HLW from new missions at SRS. Currently, the DEIS has a blanket statement suggesting that new missions targeted for SRS will not add HLW to the current SRS inventory. DOE has previously identified new waste streams resulting from the Pit Disassembly & Conversion Facility (PDCF), the MOX facility (including a liquid "polishing" process), and SNF treatment and storage facility. All of these waste streams have the potential for including high level L-1-8

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Page 3

liquid waste. The final EIS should discuss this apparent inconsistency. If some high level liquid wastes are expected to be received by the SRS tank farms from these new facilities, the amounts and constituents should be identified in the final EIS. L-1-8

7. Under the long-term closure modeling, one aspect not discussed nor explored is the potential for the No Action Alternative to release contaminated media from the filling and overflowing of the failed tanks from rainfall events. The DEIS only assumes that rainfall will fill the tanks and infiltrate to the groundwater, which understates the potential health and environmental impacts from this scenario. The Salt Team FG suggest that the potential for the failed tanks to release contaminated media to surface run-off be addressed. L-1-9

8. During its review, the Salt Team FG noted several inconsistencies between the body of the DEIS and the Appendices. Some of these were specifically addressed in individual comments from the FG members. The Salt Team FG requests the inconsistencies be corrected and a thorough review be performed to removed any errors. One such error noted was the description of HLW as a "highly corrosive and radioactive waste" in the Summary and in the DEIS. Highly radioactive is correct but highly corrosive is not and the word should be deleted. L-1-10

The Salt Team FG requests clarification on these comments whether they are incorporated in the High-Level Waste Draft Environmental Impact Statement or not. Thank you for the opportunity to offer our comments.

Sincerely,
Wade Waters

Mr. Wade Waters, Chair
Waste Management Committee
308 Pinewood Drive
Pooler, GA 31322

Response to comment L-1-1 and L-1-2: Comment noted.

Response to comment L-1-3: The comment is correct in that it is not probable that someone would drink 2 liters per day from the seepline; rather, they would drink from the free-flowing waters of the creek. However, this conservative point of compliance and the 4 mrem/year standard were established by the State regulators and DOE does not have a need to change the point of compliance. Use of the 4 mrem/year performance objective also helps ensure that the 100 mrem/year all-pathways dose limit would be met. Also see response to comment L-5-4 (first paragraph).

Response to comment L-1-4: See response to comment L-1-3.

Response to comment L-1-5: The inventory that is needed for modeling is the inventory of the residual left after waste removal. For tanks that have not undergone waste removal, this residual does not yet exist. If spray water washing was used, the residual would be lower in soluble components than the salt solution because water washing removes most soluble components, but would be higher in insoluble components. For the purposes of the modeling in the EIS, it was assumed that the composition of the residual would be approximately the same as the sludge currently in the tanks, which DOE believes is conservative. Section A.4.3 has been revised to provide more information on residual waste sampling/characterization. "To determine the characteristics of the residual material that would remain in the closed HLW tanks, DOE obtained and analyzed sludge samples from waste tanks containing each of the major waste streams that have gone to the tank farms. These samples were washed in the laboratory, approximating what might remain after waste removal, and the concentrations of various components in the washed sludge were measured. DOE used the results of these samples in developing the process knowledge database that was used for the modeling described in Appendix C. Samples of the actual residuals that would remain in each tank after waste removal would be collected and analyzed after the completion of waste removal in that tank."

Response to comment L-1-6: The Foreword and the Table of Contents in the Final EIS indicate that the Summary is published as a separate volume. DOE publishes the Summary separately as a service to readers, many of whom only read the Summary. Publication of an EIS in several volumes is a common practice consistent with the Council on Environmental Quality guidelines on the content of an EIS.

Response to comment L-1-7: See response to comment L-4-23.

Response to comment L-1-8: DOE believes that the facilities listed in the last paragraph of Section S-3 on page S-13 of the Draft EIS would not substantially affect the current SRS HLW inventory. This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document.

The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

Response to comment L-1-9: As discussed in Section C.1.1, the performance assessment modeling presented in the EIS assumes that, at some point in the future, degradation associated with the aging of the tanks would destroy the tanks. The contaminants are then assumed to reside at the bottom of a hole equal to the depth of the tank (generally 30 to 40 feet). Because of the lack of structural support, the tanks and concrete basemat are assumed to fail completely at 100 years, exposing the contaminated media to rain-fall with subsequent infiltration to groundwater. At 100 years, the tanks and concrete basemat are assumed to have the same hydraulic conductivity and infiltration rate as the surrounding soil. DOE does not believe the tanks would fill with rainwater and overflow, releasing contaminants to the land surface.

However, if the top of the tanks fail before the base of the tanks fail or before the concrete basemats disintegrate, water from precipitation could leak into the tanks and cause them to overflow at the ground surface. In response to similar public comments on the analysis of the No Action Alternative in the Salt Processing Alternatives Supplemental EIS (DOE/EIS-0082-S2), DOE modeled the potential impacts of a scenario in which the tanks overflow and spill their contents onto the ground surface, from which contaminants flow overland to nearby streams. The potential consequences of this type of event would be smaller for the No Action Alternative in this EIS than for the No Action Alternative in the Salt Processing SEIS, because the residual sludge that would remain in the tanks following bulk waste removal is largely insoluble, in contrast to the salt solution, which would contain a large inventory of dissolved radioactivity. It is unlikely that rainwater overflowing from the tanks could transport appreciable quantities of radioactivity from the sludge phase.

Nevertheless, the scenario addressed in the Salt Processing Alternatives Supplemental EIS places a conservative upper bound on the potential consequences of this scenario to persons who might consume water from SRS streams for the No Action Alternative considered in this EIS. To conservatively estimate the consequences of this scenario for water users, DOE modeled the eventual release of the salt waste to surface water at SRS, assuming no loss of contaminants during overland flow. This modeling was performed for both onsite streams that flow near the tank farm areas (Fourmile Branch and Upper Three Runs), as well as the Savannah River, into which these streams flow. The modeling showed that an individual consuming 2 liters per day of water from Fourmile Branch would receive a dose of 640 millirem per year. This dose is more than 160 times the drinking water regulatory limit of 4 millirem per year and would result in an increased probability of contracting a latent cancer fatality from a 70-year lifetime exposure of 0.022. The probability of contracting a latent cancer fatality under the No Action Alternative would be about 13,000 times greater than that of any of the action alternatives. Similarly, an individual consuming the same amount of water from Upper Three Runs would receive a dose of 295 millirem per year, and an individual consuming the same amount of water from the Savannah River would receive a dose of 14.5 millirem per year. These doses also exceed the drinking water limit and would incrementally increase the probability of contracting a latent cancer fatality from a 70-year lifetime exposure by 0.01 and 5.1×10^{-4}, respectively.

For the No Action Alternative in the Final Salt Processing Alternatives SEIS, DOE also considered potential external radiation exposure from the tank overflow scenario described above for a resident in the tank farm area, conservatively assuming that all contamination is deposited on the ground surface rather than flowing to streams or entering the underlying soil. The modeling showed that an individual living in the tank farm would receive an external direct gamma irradiation) dose of about 2,320 rem in the first year following the event, which would result in a prompt fatality.

<u>Response to comment L-1-10</u>: The word "corrosive" has been deleted in Sections S.1 and 1.1.

1

Rec. JAN 25 2001

PAINE COLLEGE

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January 22, 2001

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

Subject: Comments on the November 2000 Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement

Dear Mr. Grainger:

I would like to take this opportunity to offer my comments on the November 2000 High-Level Waste Draft Environmental Impact Statement (DEIS). As a citizen living near the Savannah River Site (SRS), I have been active in monitoring the waste management activities of SRS and in past years, I have volunteered my time on the Savannah River Site (SRS) Citizens Advisory Board (CAB). Currently, I am a volunteer member of several Focus Groups formed by the SRS CAB.

One of those groups is the Salt Team Focus Group (FG), which has been tasked to review and comment on the DEIS. Comments from the FG will not be available until after the official period ends. DOE assured this group that its comments would be reviewed and addressed to the extent possible if they are received after January 23, 2001; that has encouraged me to provide my comments as a private citizen now, and again later when the group submits its formal comments. I have reviewed the DEIS and I attended the public meeting held in North Augusta, South Carolina on January 9, 2001. My general comments and specific comments are provided as an attachment to this letter.

First, I do not want to see additional delays in the publication of a Final EIS or the Record of Decision. I believe that the HLW Tanks need to be closed to meet the current schedule as agreed to by the three agencies (DOE, EPA, and South Carolina-DHEC) in the Federal Facilities Agreement (FFA) for the Savannah River Site. However, I offer the following general comments and attached specific comments to provide clarification and identify deficiencies:

1. Where relevant, correlating the text with CAB motions will convey to the average reader that some of the ideas in the DEIS have already been reviewed by stakeholders. It will provide some level of assurance to readers unfamiliar with SRS and tank closure that L-2-1

citizens with a stake in the outcome for tank closure have reviewed many of the issues underlying this document. L-2-1

2. Considering the performance time span of 10,000 years, the closure criteria of 4 millirem is overly conservative. Given a background of around 300 mrem, the 4 mrem standard amounts to 4/300 or 1/75th of background. The DEIS should make this point in the very beginning and throughout the DEIS. Comparisons with common radioactive doses should be made so that the reader understands the conservative nature of this standard. L-2-2

3. The DEIS should include a fuller discussion of the importance to stakeholders of the resolution of the issue of tank closure. As it stands, tank closure comes across as a technical benefit with little or no health or environmental consequences. But tank closure is much more. Closing the tanks establishes the social and political precedent of closing the fuel cycle from the point of view of SRS stakeholders. This point was made in the DEIS, but it was buried in the text and not very clear; it should be placed front and center. From my perspective as a professional engineer, the tank closures at SRS have served as an example of an excellent engineering practice to all sites across the DOE complex. L-2-3

4. The No Action alternative as discussed during the January 9, 2001 Public Meeting would lead to tank collapse, subsidence, and inflows of water and animal intrusion. This scenario could potentially result in the widespread dispersion of radioactivity across the surface. L-2-4

5. The No Action alternative as discussed during the January 9, 2001 Public Meeting assumes nearly complete removal of radioactive high-level wastes from the tanks. Has a safety analysis considered whether this alternative may leave uncovered sufficient waste residues in the annuli to generate hydrogen gas and pose a dispersion hazard? L-2-5

I respectfully request that DOE consider these general comments and the attached specific comments in the final High-Level Waste Draft Environmental Impact Statement. Thank you for the opportunity to offer my comments.

Sincerely,

William F. Lawless, Ph.D., P.E.
Technical Lead, CIF Focus Group
Paine College, Departments of Mathematics and Psychology
Augusta, GA 30901-3182

Attachment

cc: Salt Team Focus Group

HIGH-LEVEL WASTE DRAFT ENVIRONMENTAL IMPACT STATEMENT SPECIFIC COMMENTS

HLW Tank Closure DEIS-Summary
1. Page S-8: If it is the case, add no known leaks have occurred in the Type III tanks. L-2-6
2. Page S-9: The goal "to remove as much waste as can reasonably be removed" seems insufficiently rigorous. It would be better to add "consistent with the approved closure criteria in the General Closure Plan". Also, on page S-10, last paragraph, to the phrase "constitutes the limit of what is economically and technically practicable for waste removal", add "consistent with the approved closure criteria in the General Closure Plan". L-2-7
3. Page S-10: Please provide estimated curies per gallon for the gallons to be left as residue. L-2-8
4. Page S-12, last paragraph: Failed tanks could lead to surface subsidence, which would open the tanks to water, plant, and animal intrusion. L-2-9
5. Page S-16: The likelihood of the State of SC allowing removed HLW tanks to buried in the waste management facility seems unlikely. A more likely arrangement would be to transport the removed tanks for disposal to an offsite facility, which would substantially increase the costs of the removal alternative, exposure to workers and the public, and increase the possibility of transportation accidents. L-2-10
6. Page S-18: The assumption of zero cancer fatalities for the No Action alternative appears to assume that discontinued tanks containing uncovered residue wastes, especially in their annuli, will not generate hydrogen gas. L-2-11
7. Table S-2: In addition to the utility and energy costs, please provide the convenience of listing the average and total costs for each option; e.g., on page S-21, the total costs for the removal alternative is stated in the text, but the others are not. L-2-12
8. Figure S-7: To assist the reader in being able to quickly see when the closure criteria is estimated to become exceeded and by how much, please draw a horizontal line in the figure at 4 mrem to represent the closure criteria. L-2-13
9. Page S-25: It would help readers to know that stakeholders reviewed the composite analyses method and the zoning processes (i.e., cite the relevant CAB motions). L-2-14

HLW Tank Closure DEIS Text
1. Page D-5, Figure A-5: The possibility of reusing HLW tanks formerly considered to be retired should be noted. L-2-15
2. Figure A-5: The illustration of the tanks that have already been closed (Numbers 20 and 17) is not clear from the figure. Maybe drawing a line through them or separating them from the pack would be clearer. L-2-16
3. Page 1-7: The discussion states that much of the leaked waste was removed from the annulus of Tank 16; however, page A-5 states that waste in the annulus of Tank 16 has not been removed. If page 1-7 is correct, the discrepancy on page A-5 needs to be corrected. L-2-17

4. Page 1-10: It might help for the reader to know that the CAB conducted a cursory ISPR (Ratib Karam from ERDA visited the site for the closure of Tank 17; and Tom Pigford reviewed the Closure Plan). L-2-18

5. Page 1-11: It might be helpful for the reader to know that the CAB reviewed DOE Order 435.1 while it was in draft. L-2-19

6. Page 1-13: Section 1.4.3 would be an ideal location to review the CAB's participation in the tank closure process. L-2-20

7. Page A-21: While helpful, Figure A-7 seems unclear. Describe the different elements inside of the tanks (viz., currently, the tanks are divided into four unnamed sections; contrast this figure with the clearer Figure 2.1-1). L-2-21

8. Table 2-5, p. 2-25: the percent of MCL is confusing. It would help the reader to give an example from the data presented; e.g., 320 under Cr means 320%, or 3.2 times greater than the MCL. L-2-22

9. Table 3.3-5 uses Becquerels in a footnote and curies in the table. It might be more helpful to include becquerels and curies in the relevant tables. Conversions should be provided. Also, other tables use rem instead of sieverts. Both should be provided along with convenient conversions. L-2-23

Response to comment L-2-1: Chapter 1 of the EIS (Section 1.4.3) has been revised to present a more comprehensive discussion of stakeholder involvement in the SRS High-Level Waste Tank Closure Program. The following text has been added: "The public and the State of South Carolina have been and continue to be involved in the closure of HLW facilities at the SRS. Additional public meetings were conducted in North Augusta, South Carolina (January 9, 2001) and Columbia, South Carolina (January 11, 2001) to present the Draft EIS for public comments.

The Citizens Advisory Board (CAB) for SRS is very interested in the closure of HLW facilities. As such, the CAB has been briefed quarterly and the CAB Waste Management Committee is briefed bi-monthly on closure activities. The CAB has issued several recommendations related to HLW tank closure. DOE has carefully reviewed these recommendations in establishing and implementing the SRS HLW tank closure program, and will continue to do so in the future."

As an example, the SRS CAB Recommendation (January 23, 2001) regarding annulus cleaning stated the Board's concern that SRS appears to be placing a low priority on annulus cleaning. DOE responded to this recommendation (February 8, 2001) stating, "the Savannah River Operations Office considers the issue of removal of waste from the tank annulus to be important to the long-term success of the HLW Tank Closure Program." The response further states, "However, the development of methods for removal of waste from the tank annulus as part of the longer term effort to close Tank 14 reflects a balanced and responsive approach to solving this important challenge." This conclusion is valid for closure of all tanks that have annuli.

Response to comment L-2-2: Section 3.8.1 explains background radiation exposure and Section 4.2.5 presents a comparison of the calculated radiation doses to the average U.S. background radiation exposure.

Response to comment L-2-3: Comment noted. Comparing the impacts of no action to those with the action alternatives shows the beneficial consequences.

Response to comment L-2-4: The Summary (Section S.4) and Chapter 1 (Section 1.2) have been modified to acknowledge the possibility of intrusion and releases from failed tanks in the long term. The long-term impacts of the No Action Alternative are discussed in Section 4.2 of the EIS, and the modeling basis for the results is presented in Appendix C (Section C.1.1). For purposes of the analysis DOE assumed that structural failure of the tanks and subsidence would not result in atmospheric releases, because of the depth of the tanks below grade and the likelihood that water and debris in the tanks would tend to reduce the potential for atmospheric releases. The groundwater release pathway is dominant in the calculation of doses, which are described in Section 4.2. See response to L-1-9 regarding surface dispersion of radioactivity under the no action alternative.

Response to comment L-2-5: Because DOE has not selected an alternative for tank closure at this time, the safety analysis the commenter suggests has not been performed. However, current safety analyses and surveillance programs account for the presence of waste in some of the tank annuli. Following selection of an alternative, and approval of a tank specific closure module (in the case of all alternatives except no action), DOE would perform the appropriate safety analyses based on the selected closure method.

In-tank generation of hydrogen may be an issue in the highly concentrated radioactive waste contained in the tanks prior to bulk waste removal; however, that condition is not in the scope of this EIS. The impacts from each alternative are evaluated assuming bulk removal has already been done. Under these conditions, the amount of hydrogen that could be generated internally would be insufficient to support combustion.

Response to comment L-2-6: At the end of the last paragraph before S.2.4, the text, "No leaks have been observed in the Type III tanks" has been added.

Response to comment L-2-7: The text boxes in Section S.2.4 of the Summary and Section 1.1.4.2 of the EIS have been revised to include all of waste incidental to reprocessing criteria. Section S.2.4 of the Summary and Section 2.1 of the EIS have been revised to more completely address meeting DOE Order 435.1 requirements relative to the waste incidental to reprocessing determination - specifically additional discussion of economic and technical considerations for removal of waste. The section labeled "Performance Objective" does refer to the overall performance standard in the General Closure Plan, and states that closure of individual tanks must occur in such a way that overall performance objectives can be met.

Response to comment L-2-8: Appendix C has been revised to present a new table, as Table C.3.1-2, which lists the assumed volume of residual waste if the tanks are cleaned remaining in each closed HLW tank. Table C.3.1-1 has been revised to present the average concentration in each tank farm for each listed radionuclide (curies/gallon).

Response to comment L-2-9: See response to comment L-2-4.

Response to comment L-2-10: DOE would follow the permitting procedures of the SCDHEC for disposal of the removed HLW tanks if the Clean and Remove Tanks Alternative were selected and implemented. The residual material would meet the criteria for low level waste and would be managed as such. It is DOE's practice that LLW generated at SRS is disposed of at SRS. Therefore, transportation and disposal of this material at an offsite location was not considered to be a reasonable alternative. DOE acknowledges the commenter's conclusions regarding increased cost, exposure to workers, and increased risk of transportation accidents if removed HLW tanks were transported offsite for disposal.

Response to comment L-2-11: Under the No Action Alternative during the short term DOE would continue to manage the tank farms but not close any tanks. This means that normal operations would be conducted in accordance with approved safety analyses. During this period of time the tanks would not be abandoned but actively managed to ensure worker and public health and safety. See response to comment L-7-82 regarding hydrogen generation.

Response to comment L-2-12: Further information on the costs of each alternative (that presented in Section 2.3 of the Final EIS) has been added to the Summary in Section S.8.1.

Response to comment L-2-13: Both figures S-7 and 4.2.2-1 have been modified accordingly.

Response to comment L-2-14, L-2-18, L-2-19, and L-2-20: See response to L-2-1.

Response to comment L-2-15: Appendix E, Description of the Savannah River Site High-Level Waste Tank Farms, which is for Official Use Only, contains detailed information about the location, physical dimensions, and content of the HLW tank systems. Due to increased concerns about operational security following the events of September 11, 2001, Appendix E will be made available upon request to those who have a need to review this information. Consistent with the direction of the Attorney General of the United States, this information is not releasable under the Freedom of Information Act. Figure E-4 (which was Figure A-5 in the Draft EIS) has been modified to account for the future storage use of some Type I tanks.

Response to comment L-2-16: Figure E-4 (which was Figure A-5 in the Draft EIS) has been revised to show an "X" through Tanks 17 and 20.

Response to comment L-2-17: Section 1.1.3 is correct. Sections A.3.1 and E.2, third paragraph, second-to-last line, have been revised to read, "DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

Response to comment L-2-21: Figure A-6 is provided to present an environmental restoration concept with backfill material and a RCRA/CERCLA type cap shown over the closed tanks. See Figure A-5, Section A.4.4 (which is the same base figure as Figure 2.1-1) for more detail.

Response to comment L-2-22: DOE believes that the existing note at the bottom of the table provides sufficient guidance for interpreting "percent of MCL." There are many tables in the EIS that contain a similar construct.

Response to comment L-2-23: The purpose of footnote "B" was to provide a conversion from curies to becquerels. DOE believes that using dual sets of units would make this table (and other tables in the EIS) less reader-friendly and understandable.

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Rec.
JAN 16 2001

To: Andrew R. Grainger - NEPA Compliance Officer
Savannah River Site, Building 742-A, Room 185
Aiken, SC 29802

1/10/2001

Sir:

After lightly reading the High-Level Waste Tank Closure (F + H Areas) Draft Environmental Impact Statement over a series of weeks, I was impressed by the depth and presentation of the information. However, I was left with questions, comments, and suggestions, some of which are contained below. I was going to follow the order of the text sent, but quickly found many areas overlapped if using that format, therefore, I will start off with the most deeply related data and then proceed to broader, less focused (on this one work) info.

A - <u>TANK</u> <u>OPERATIONS</u>

I must agree with the basic plans for tank closure by filling the emptied tanks with a grout-mixture, however, several points relating to this procedure deserve some consideration. First and foremost, filling the tanks with grout limits future activities should a new plan of action be decided as preferable to the current options. Any new process would find the tanks themselves to be a nearly insurmountable problem as any method to handle the waste would require the structures be cut up which would spread the now-solid masses of contaminated materials into the air, land, and water. Some other areas of worry are... L-3-1

A1 - 1: Grout Rather then worrying about fully emptying the tanks, could only sufficient material, likely LLW, be removed so the tanks could be grout-filled with much of the HLW in place? Not only would this require processing less of the waste products, but would prevent the collapse of the tanks as mentioned as a problem in the No Action proposition. However, how dangerous the remaining structures radioactivity would be was not discussed in the text, especially as regard to the heat buildup within the tanks, should this in-place method be used. L-3-2

A1 - 2 Will the grout contain a neutron modifier as part of its composition to help limit possible radioactive processes that will continue in wastes that are left in the tanks? Also, does the grout have an expansion factor as it hardens? If not, will it settle allowing the tank to crack wherever the grout has pulled away from the wall? If so, could the expansion factor exert enough pressure to crack the tank or push existing defects apart even as the grout fills them? L-3-3

A1 - 3 The heat generation of the grout was discussed in regards to it hardening without layers, but will the residual heat in the materials coating the wall (or the walls themselves) be sufficient to set-up the grout touching the walls quicker than the rest of the mass, thus forming layers which would diminish the overall strength of the structure? L-3-4

A1 - 4 Rather than use "new" water, once the water from the tanks is treated, can it not be mixed with the grout thus preventing the tank water from being released into the environment? And would the water have to be as cleaned as much if it was planned to be reused in this manner? Would one holding tank to hold the water from existing tanks until it can be used be enough or would there have to be many tanks due to multiple cleaning projects? L-3-5

A2 -1 Water (also see A1 - 4) The evaporators generate a lot of pressure in the system prior to filtering the mist so could this cause an explosion? What is the heat source for these units and will their failure to continue to evaporate (such as in an accident) cause the radioactive material in suspension to fall back over the equipment thus rendering it useless? How micro-fine are the filters as the smaller the "mesh", the quicker the holes become plugged, and will these HEPA filters become HLW? L-3-6

A2 - 2 As direct boring to water supplies in the aquifer could contaminate them via reverse pressure or other accidents, what precautions are being taken to protect this direct link? Equally importantly, should drought conditions continue, will the removal of millions of gallons of ground water create sink holes that could undermine the tanks? L-3-7

A3 - 1: Cleaning In the tanks, under the pump-able fluids and surreys, the materials coating the walls may be a sludge or solid mass due to the heat and pressure generated by the wastes, and normal settling factors in an gravity field.. Has there been any wall scrapings or cores taken to determine how thick the settled materials are? L-3-8

A3 -2 As water is removed and cleaned, some of it will remain radioactive. Has anyone suggested using electric currents to separate the molecules of the water into their component atoms, which if then processed through gaseous diffusion, could separate out the abnormal atoms that contain extra mass prior to the now-gaseous materials release? L-3-9

A3 - 3 The chemicals to be used for cleaning are to be adjusted so they will not directly react with the linings of the tanks, however, as the tank walls have been in contact with radioactive materials over a long period, are tests planed to see if the composition of the surface (or deeper) layers of the stainless steel walls has changed and will be able to resist the chemicals and/or pressure effects from the spray itself? (A degrading of metals used in nuclear reactors, in a similar environment with heat, radiation, and pressure, often renders the metals brittle or otherwise susceptible to failure.) Under the assumption the walls will withstand cleaning, the contaminated materials coating them may peel away from the walls interface layer (as the solution undermines the contaminates) in large masses. Can the filtration system and pumping pipes handle chunks and plates of the waste material without blockages? Can the cleaning materials themselves be cleaned and used in more than one tank or will the acidic action dissolve the contaminates so the wastes are locked in the cleaning agents? L-3-10

A4 -1: Cooling Many tanks have, and so are presumed to need, cooling units. As the fluid is withdrawn for processing, will the temperature in the tanks so equipped become dangerously high? Indeed, as the circulation fluid grows less, will the cooling system become permanently inoperative? How high will the temperature in these tanks rise and will this reach a level which would boil water thus increasing tank pressure or create the need for atmospheric releases that may not be treated first? L-3-11

B - LONG TERM STORAGE

If the first tanks were left empty after processing, subsequent tanks could be cut up and stored within these repository tanks before grout is poured in them.. This would limit the number of sites left as well as provide a volume reduction in the total capacity of all the tanks. L-3-12

C - BIOLOGICAL:

Viruses have simple genetic structures and mutate rather easily, as demonstrated by the swamps in Canada which have been shown to be the breeding ground of diseases that are carried world-wide by nesting birds. Has there been any tests to see if SRS, with all the possible radiation sources, could be a similar breeding area? Are fish, fowl, and animals taken within or that exit the SRS grounds safely consumable for humans? L-3-13

D - GEOPHYSICAL

D1 - 1: Atmosphere: The prevailing winds of the coastal plain in the area of SRS is toward the east and the ocean, however, a weather condition called "the wedge" seems to be a more current phenomena then in the recent past. This condition occurs when a high pressure system in New England forces surface winds down the eastern slope of the Appalachians toward Atlanta. Are monitoring stations setup to monitor possible atmospheric radionuclides releases that travel in directions other than are considered norm and for what distance? The possibility of a tornado hitting SRS was considered very low in the text, as was hurricane damage, however, as tornados are often spawned by hurricanes, have these weather problems been considered as a unit situation rather than always separately? L-3-14

D2: Earthquakes Although this topic was touched upon in the text, much of the true picture of this problem was ignored. The eastern half of the USA, due to the subsurface structure, has a tendency for even minor quakes to travel to distant points, unlike the Pacific coast where major quakes affect relatively limited areas. The last 100-year quake (now overdue) near Charleston, SC rang church bells in Atlanta, and the last major New Madrid fault (Kansas) quake broke walls in Atlanta. Due to these conditions, the odds of a major quake anywhere from Eastern Canada to the Mississippi River to the Gulf Coast could cause destruction at SRS, especially with the unstable upper land structures of clay and dirt over bedrock as found at SRS. This issue deserves much more consideration to prevent accidents during critical operations. Recently, the collapse of the Atlantic submerged coastal plain wall, along the junction of it with the deeper ocean depths, is suspected to create massive land slides that could trigger seismic events, and has been determined to be a greater threat than previously thought. Has this potential problem been calculated for its affects on SRS? L-3-15

D3: Ocean: With the greenhouse effect now somewhat shown to be affecting the polar caps, not to mention the other changes possible, the submersion of coastal lands may bring the waters within miles of SRS if not covering parts of SRS altogether sometime in the not-so-distant future. Due to this, the 10,000-year proposed safety by current plans is nowhere near long enough. In whatever form the tanks are left, sealing the structures with liquid glass and then coating them with concrete into giant heavily shielded egg-shaped structures may prove reasonably safe for may more years. L-3-16

EXPECTATIONS

First, clean and process all LLW + HLW from above grade tanks that are in the best condition. Keeping temperatures from raising in the tanks without introducing materials that would stabilize the temperature without damaging the tanks may be difficult. Presuming the tanks are easily cleanable, removing the presumed coatings on the inner walls of the tanks should be treated off-site and placed in glass for repositories. This combined product could then be replaced in the tanks for long term storage. If the coating proves as difficult to remove as the temperatures and pressures seem likely to have caused, the coating should be left in place rather than risk damage to the tank walls. These walls then should be coated with liquid glass materials to completely seal them before anything else is placed in the tanks. L-3-17

Tanks below grade should be decommissioned next and after processing, these tanks should be disassembled and the first tanks used as repositories for them. After all possible materials are loosely stored in a tank, it should be filled with grout that contains a neutron modifier and that is mixed with LLW waster - presuming the possible expansion and temperature rise of a grout can be introduced that will not adversely effect the tanks. L-3-17

After this, the tanks need to be steel reenforced all over, including the lower surfaces, and then mounds of concrete be poured all over the remaining structures, including tunnels to coat the lower surfaces. These mega-mounds would keep water from all sources from penetration as well as making 25,000 year storage facilities that could resist major earth shifts, being covered by oceans, or other local major factors. New submergence of earth masses, space related collusions, and such planet wide catastrophes are capable of causing destructions at such a level that radioactive areas and storage will be the least of humanity's problems and are beyond coping with at our current level of technology.. L-3-18

CLOSING

Thank you for the opportunity to comment of a problem that is a long way from being solved. Because of my schedule in the close of the year, I was unable to devote the time I wished to the text, and due to frequent interruptions, some of the points I have raised may have been addressed, however, I hope those situations were few if at all. I look forward to hearing the results of the public comments and if any of my questions and the like prove useful.

Response to comment L-3-1: Comment noted.

Response to comment L-3-2: The waste is somewhat homogeneous during waste removal operations and is not amenable to segregation. Therefore, DOE cannot consider selectively removing only some of the residual waste. Heat of hydration would be managed during grout placement. Upon completion of grout placement heat of hydration would not be an issue.

Response to comment L-3-3: The grout would not be formulated to contain a neutron modifier. Concentrations in the waste are at levels that criticality should not be a concern though it is evaluated. Minimal shrinkage and cracking is expected but is not anticipated to have adverse effects on the tank wall.

Response to comment L-3-4: The residual decay heat from any residual material on the tank wall would be insignificant and would not impact grout placement or strength.

Response to comment L-3-5: Contaminated water would be reused during the tank waste slurry and waste removal activities. It may be necessary to process the water through existing evaporators to maintain adequate tank space and reduce the risk of leaks to the environment until the grout is placed in the tank. Additional storage/holding tanks would not be needed. Any water released to the environment must satisfy strict permit requirements and criteria.

Response to comment L-3-6: Operation of the HLW evaporators is outside the scope of the EIS. This type of information is addressed in the Safety Analysis Report for the tank farms, which is referenced in Appendix B of the EIS.

Response to comment L-3-7: Production wells are placed into the deep aquifers of Cretaceous age in locations away from known contaminant plumes. The deep aquifer and the upper aquifers are isolated by the thick Meyers Branch Confining system. This same hydrologic isolation along with the great thickness of the Cretaceous aquifer limits the impact of water withdrawal from the deep aquifer on the shallow aquifers and sediments, which would ensure that the integrity of the tanks is not compromised (i.e., sinkholes would not be created).

Response to comment L-3-8: Samples of the residual material in the tanks are collected and analyzed to characterize the waste residuals. SRS would use camera inspections of the interior surfaces of the tanks to verify that the tank walls are clean. In the two tanks that DOE closed (Tanks 17 and 20), the residual material was about one-half to one-inch thick.

Response to comment L-3-9: The water generated from tank cleaning activities is managed as HLW (e.g., sent through evaporators for volume reduction). Treatment of the high level waste is outside the scope of this EIS (see DOE/EIS-0082S, DOE/EIS-0082S-2, and DOE/EIS-0217). This EIS addresses stabilizing the tank and remaining residual material after removal of as much of the residual waste as possible.

Response to comment L-3-10: As noted in Section 2.1, DOE selected oxalic acid as the preferred chemical cleaning agent after examining several cleaning agents that would not aggressively attack carbon steel and would be compatible with HLW processes. These studies included tests with waste simulants and also actual Tank 16 sludge. In tanks for which DOE has performed spray water washing, DOE has not noted any negative effects from the pressure of the water washing. The waste removal equipment would be designed to be robust enough to remove the waste in each particular tank. If situations arise such that blockages occur, then steps would be taken to remedy the situation. Typically waste removal equipment would remain in the tank. DOE would recycle tank cleaning materials to the maximum extent practicable.

Response to comment L-3-11: Waste and tank temperatures would be monitored and managed during waste removal from the tank to prevent abnormal emissions from the tank. The tank cooling system would be isolated within the tank following waste removal and the cooling coils would be filled/entombed with grout. Temperature and pressure within the tank would be managed during grout placement (using a ventilation system).

Response to comment L-3-12: Cutting up and storing tanks within other tanks would not be allowable under the current operating permit for the tanks. However, the EIS analyzes two alternatives that include aspects of the alternative proposed in the comment. The Clean and Remove Tanks Alternative includes the cutting and removal of the tanks while the Fill with Saltstone Option of the Stabilize Tanks Alternative includes the disposal of waste in the closed HLW tanks. As shown in the EIS, the radiation dose received by SRS workers performing the tank removal activities under the Remove Tanks Alternative would be substantially higher than for any of the other alternatives analyzed in the EIS.

Response to comment L-3-13: There have been no tests for viruses in birds nesting at SRS. A radionuclide monitoring surveillance program is in place to monitor animals that are taken offsite for consumption (primarily deer and feral hogs). Any animals that exceed the DOE radioactivity limit would be confiscated.

Response to comment L-3-14: Thirteen radionuclide air surveillance stations are continuously monitored at SRS. There are 12 stations located around the site perimeter and one station located between F and H areas. Releases resulting from tank closure activities would be adequately characterized from information from these monitoring stations. As discussed in Section B.2.2 of the EIS, the consequences from postulated accidents were assessed using average measured meteorological values for the Savannah River Site.

The postulated accidents analyzed in Appendix B include consideration of a tornado as an initiating event. Since the wind velocity during a tornado would be larger than a hurricane, its impacts would bound those from a hurricane. The changes in accident frequency if hurricane initiated tornadoes were also included would be so small that it would not alter the conclusions in the EIS.

Response to comment L-3-15: The probable consequences of an earthquake are assessed as part of the accident analysis in Appendix B. Additional information and analysis are found in the Safety Analysis Report for the tank farms.

Response to comment L-3-16: The accuracy of projections decreases with the length of the projection into the future. The value of projecting beyond 10,000 years is low. The 10,000-year period of analysis was selected to conform to relevant regulatory guidance. Current projections of a sea level rise associated with greenhouse warming do not indicate a potential for submergence of the SRS area.

Response to comment L-3-17: Waste removed from the tanks will be treated at DWPF. The walls would be cleaned and verified by visual inspections using cameras. All HLW tanks are below grade. DOE does not believe that coating the interior tank walls with liquid glass material as suggested in the comment is technically practicable, nor would its use be necessary for the closed HLW tanks to meet the performance objectives. See response to comment L-3-12 regarding the use of tanks to dispose of structural material scrap from other tanks.

Response to comment L-3-18: As discussed in Section A.4.5 of the EIS, decisions regarding the need for a cap over the closed HLW tanks would be made as part of the Environmental Restoration Program.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

February 6, 2001

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Rec.
FEB 12 2001

Mr. Andrew R. Grainger, NEPA Compliance Officer
U.S. Department of Energy
Building 742 A, Room 183
Aiken, SC 29802
ATTN: Tank Closure EIS

RE: EPA Review of
Draft Environmental Impact Statement (DEIS) for
High-Level Waste Tank Closure (DOE/EIS-0303D)
CEQ No. 000401

Dear Mr. Grainger:

Thank you for submitting the above-referenced Draft Environmental Impact Statement (DEIS) for our review. Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) reviewed the subject DEIS. The document provides information to educate the public regarding general and project-specific environmental impacts and analysis procedures. The purpose of this letter is to provide you with our comments on the project, based on our review of the document.

Overall, the document is detailed and clearly written. EPA evaluated the information in the DEIS, with regard to potential impacts of the proposed mission to close additional high-level waste (HLW) tanks at the Savannah River Site near Aiken, South Carolina. Alternatives presented in the DEIS include the following: (1) Clean and stabilize the tanks; (2) Clean and remove the tanks; and the (3) No Action Alternative. Under the Clean and Stabilize the tanks alternative, DOE is considering three options for tank stabilization: Fill with grout (preferred alternative); fill with sand; and fill with saltstone. As a result of this review, our comments regarding potential project impacts are attached.

Based on our review, the DEIS received a rating of "EC-2," that is, there are environmental concerns, and more information is needed to clarify the potential impacts. Our concerns focus on how all the project elements will ultimately function together, and the number of refinements that will be necessary to accomplish all the desired purposes. In particular, clarification of potential impacts, tank closure procedures, and schedule for tank closure warrant further discussion in the Final EIS. L-4-1

Please note that, while we are fully supportive of the overall goals of the project, we are concerned that the preferred alternative has long-term ramifications which will prevent redevelopment of the land at a later date. However, in order to make the land available for future use or redevelopment, the tanks would need to be removed and disposed of at an appropriate facility off-site. We realize that, at the current time, safety issues, cost and transportation issues, and disposal issues prevent this from being a viable alternative. L-4-2

Conversely, filling the tanks with grout will make their removal more difficult in the future, when this land could be needed for redevelopment, and removal of the tanks may be more feasible and desirable. At a minimum, the current project should include an interim plan for removing the tanks to an appropriate alternate location, such as a high level waste repository, if Maximum Contaminant Levels (MCLs) of radionuclides are exceeded by a predetermined amount. L-4-3

As additional details become available, they should be shared with the involved parties. A list of information which we believe would help clarify the document is attached. We appreciate the opportunity to review this project. If you have any questions or require technical assistance, you may contact Ramona McConney of my staff at (404)562-9615.

Sincerely,

Heinz J. Mueller, Chief
Office of Environmental Assessment

EPA Comments on
Draft Environmental Impact Statement (DEIS) for
High-Level Waste Tank Closure (DOE/EIS-0303D)

1. Page 2-4, Column 1, Tank Stabilization, 1st paragraph, 7th line: text states that each tank would be filled with a self-leveling material. Sand, in the sand fill option, is not self-leveling. Please clarify. L-4-4

2. Page 2-5, Column 1, 3rd section, 1st line: text states that the amount of saltstone required would exceed 160 million gallons. Page A-19, Column 2, 1st line mentions saltstone made would be greater than 160 million gallons. If the amount required to fill the tanks and the amount planned to be made exceeds tank capacity, then requirements should be reconsidered. L-4-5

3. Page 2-7, Column 1, 3rd line from top: this section compares the number of workers under the No Action alternative with only one of the other alternatives, the Stabilize Tank alternative, leaving out the Tank Removal alternative comparison. L-4-6

4. Page 2-11, Table 2-2, Saltstone Option for Particulate Matter and Carbon Monoxide: values in this chart 1.7 and 8.0 do not match the Table S-2 values of 3.6 and 16.0 in the Executive Summary, page S-19. L-4-7

5. Page 4-16, Column 2, 2nd section, 1st line: the text references the post-closure activities in Table 4.1.8-2. Table 4.1.8-2 on page 4-18 does not mention post-closure activities impacts to workers. The text on page 4-16 states that the collective dose of the other alternatives is less than the No Action alternative. Table 4.1.8-2 does not show this (if the reference is to footnote "d", even 1.2 mrem/year x 1000 years is still less than the other alternatives). Please clarify. L-4-8

6. Page 5-3, Column 1, CEQ Cumulative Effects Guidance, 3rd section, last line: text mentions five identified resources of concern. This does not match the paragraph above which lists <u>six</u> areas (see numbered resources in CEQ Cumulative Effects Guidance, 2nd section, lines 6-9). L-4-9

7. Page 6-1, Column 1, line 14: text mentions minimal short-term adverse impact to cultural resources. However, chapter 4, page 4-14 does not list any further cultural resources being impacted by any of the alternatives. See page 4-14, Column 1, 1st section, last line and Column 1, 2nd section, last line. L-4-10

8. Page C-7, Column 1,1st section, line 14: letter '<u>n</u>' stands alone. Typo? L-4-11

9. Page S-1, Column 2, section S.1, 2nd to last sentence: text mentions 'issues that remain to be resolved,' but this is not separately addressed in the Executive Summary (as listed). If it is included within other sections, a separate breakout of pending actions and/or outstanding issues (i.e. pending EIS's and Environmental Restoration Programs) would help the reader. L-4-12

10. Page S-2, Column 1, 3rd section, 4th line: The text mentions a geologic repository but no estimated time frame for approval of the geologic repository is given. This may give the reader a misleading L-4-13

impression of the disposal process. A mention of this issue earlier in the text, (along with page S-2 information), or in a separate section of unresolved issues, (see #1 above), would help. L-4-13

11. Page S-2, Column 2, 1st section, 8th line: DOE is preparing an EIS for the HLW Salt Disposition procedure. However, there is no mention of potential impact(s), if any, if the proposed action gets approved. L-4-14

12. Pages S19-S20, Table S-2 & page 2-11, Table 2-2: Please explain why cost is not included in these charts (cost is mentioned on page S-18, Column 2 last section, lines 3-5; page 2-6, Column 2, last section, 3rd to last sentence; and page 2-9, Column 2). L-4-15

13. Page 3-45, Column 2, last section, first line: DOE committed to close 24 tanks by 2022 (leaving 25 tanks for the next 8 years). Please show a schedule of closure plans in the Final EIS. L-4-16

14. Page 4-25, Column 2, 3rd line: 'the tank closure plan may need to be extended if the salt disposition process start-up is delayed'. Please show a schedule, and issues to be resolved, that may impact the tank closure. L-4-17

15. Page C-4, Column 1, last section, line 4: Please show a graphic depiction of the model mentioned in this section, which delineates the referenced zones. L-4-18

16. Page C-3, Column 2, last section, last two lines: Please explain why tanks (under all alternatives) are not capped to prevent water from entering, thus allowing contaminants to spread out. With the understanding that engineered caps may be a major undertaking (page S-25, Column 2, 2nd section, line 14 and page C-1, Column 1, 2nd section, line 9), it is still not apparent why a simple impermeable layer was not considered to help keep water out of the tanks. If there is a reason why the top of the tanks cannot be sealed, please explain this. L-4-19

17. Page S-24, Column 1, 2nd section, lines 4-7: The text states the probability of limited contamination under the No Action Alternative, but on same page, Column 2, 1st section, line 3-4, it states that contamination would be very large under the No Action alternative. Please clarify. L-4-20

18. Page S-24, Column 1, 2nd section, lines 4-6: The text states there would be limited movement of contaminants to groundwater under the No Action alternative (long-term). This does not match page 2-7, Column 1, section 2, lines 5-7, which states that movement of contaminants would be rapid under the No Action alternative. If time is the factor, then compare each to page S-18, Column 1, last section, which states the No Action alternative has the least impact in the short term. L-4-21

19. Page 2-19, Column 2, 2nd section, lines 6-9: text states all options are better than the No Action alternative for contamination into groundwater. Page S-24, Column 1, 2nd section lists the No Action alternative as 'limited movement', grout option as 'almost no' movement and 'intermediate amount' under the sand and saltstone alternatives. Please clarify. L-4-22

20. Page 2-10, Column 1, last section, lines 17-19: text mentions each alternative, and includes oxalic acid cleaning (which is only to be used "if needed"). Page 4-24, Column 2, 1st line mentions the L-4-23

oxalic acid cleaning solutions from all the alternatives (again, not a part of all cleaning options if hot water rinse is sufficient). Page 6-3, Column 2, 2nd section, lines 16-19: text again mentions oxalic acid cleaning for each alternative. Please add modifying text to each of these places to show oxalic acid will be used only as needed (still not an approved option). L-4-23

21. Page C-3, Column 1, last section, 1st line: Please clarify whether the Clean and Remove alternative would also potentially expose individuals, via the atmospheric pathway from the tank area, during destruction. L-4-24

22. Page C-6, Column 2, middle (inhalation of contaminated soils from banks of streams): if this pathway is feasible for the residents, then why couldn't we assume the same for the workers? Page C-3, Column 1, middle, states that exposure from inhalation of suspended soils was not evaluated. This appears to be the same pathway. L-4-25

23. Page C-10, Figure C-2, Terrestrial Wildlife Column: When eating, the animals selected could also ingest sediment as well as soils. As a result, clarification is needed on page C-11, Column 2, last section regarding exposure routes. L-4-26

24. Page D-3, Column 2, subsistence sportsmen: Fish consumption for residents is addressed, but please clarify the source of the data regarding the amount of fish consumed. Are warning signs posted as Institutional Controls? L-4-27

<u>Response to comment L-4-1</u>: Portions of this EIS have been rewritten or expanded concerning potential impacts, closure procedures, and schedule. Please refer to the specific DOE responses to the other EPA comments, dealing with these topics.

<u>Response to comment L-4-2</u>: As described in Section 4.2.4, the SRS Future Use Plan does not envision releasing the area from federal control. The tank farms are located in an area that will be zoned "industrial" as described by the Land Use Plan, and as such, any proposed redevelopment of the area would need to consider the closed tanks. The EIS, under the Clean and Remove Tanks Alternative, analyzed the impacts of removing the tanks and transporting the tank components to an onsite disposal facility.

<u>Response to comment L-4-3</u>: The SRS Future Use Plan and Section 4.2.4 of the EIS state that the integrity of site security shall be maintained, SRS boundaries shall remain unchanged, land will remain under ownership of the Federal Government, and residential uses of all SRS land shall be prohibited. Filling the tanks would not preclude tank removal in the future, if found to be necessary, but would make tank removal more difficult than removing an empty tank. The EIS, under the Clean and Remove Tanks Alternative, analyzed the impacts of removing empty tanks and transporting the tank components to an onsite disposal facility.

<u>Response to comment L-4-4</u>: The last sentence in the first paragraph of the Section "Tank Stabilization" in Section 2.1.1 has been revised to say"…material (grout or saltstone), or sand."

<u>Response to comment L-4-5</u>: The volume of saltstone generated from salt processing will occur regardless of what decision is made concerning tank closure. If tanks were to be filled with saltstone from salt processing, the excess saltstone, beyond tank capacity, would be disposed of in the Saltstone Disposal Facility.

<u>Response to comment L-4-6</u>: The third paragraph of Section 2.1.3 has been revised to include a comparison to the number of workers under the Clean and Remove Tanks Alternative.

<u>Response to comment L-4-7</u>: The values in the Summary (Table S-2) have been corrected.

<u>Response to comment L-4-8</u>: The second to last paragraph of Section 4.1.8.1 of the Draft EIS has been deleted as it refers to post-closure impacts that are not presented in Table 4.1.8-2. Those impacts are presented in Tables C.4.1-1 through C.4.1-6.

<u>Response to comment L-4-9</u>: The third paragraph of the CEQ Cumulative Effects Guidance Section has been changed to "six" areas of concern.

<u>Response to comment L-4-10</u>: In the first paragraph of Section 6.1, the phrase "cultural resources" has been removed from the sentence and a new sentence has been added: "These actions are not expected to impact cultural resources."

<u>Response to comment L-4-11</u>: In the second to last paragraph of Section C.2.1.2, the "n" has been changed to the word "no."

<u>Response to comment L-4-12</u>: This paragraph has been added after the second paragraph in Section S.2.4 and at the end of Section 1.1.4.1: "Several issues related to the HLW tank closure program will be resolved after DOE selects an overall tank closure approach based on this EIS. These issues will be addressed during the tank-by-tank implementation of the closure decision, and include: (1) performance objectives for each tank that allow the cumulative closure to meet the overall performance standard; (2) the regulatory status of residual waste in each tank, through a determination whether it is 'waste incidental to reprocessing;' (3) use of cleaning methods such as spray water washing or oxalic acid cleaning, if needed to meet a tank's performance objective; and (4) cleaning methods for tank secondary containment (annulus), if needed. These issues are discussed in greater detail below. (In addition, DOE is assessing the contributions to risk from non-tank sources in the H-Area Tank Farm. Although the long-term impacts presented in this EIS consider the contributions of non-tank sources, further characterization and modeling of contributions

from other sources may result in the refinement of performance objectives. An issue to be addressed after tank closure is the long-term management of the area, which DOE will consider under the RCRA/ CERCLA processes as part of its environmental restoration program.)"

<u>Response to comment L-4-13</u>: The following text has been added in the Summary (Section S.2.2) and Section 1.1.2 of the EIS: "The proposed construction, operation and monitoring, and closure of a geologic repository at the Yucca Mountain site in Nevada is the subject of a separate EIS. As part of that process, DOE issued a Draft EIS for a geologic repository at Yucca Mountain, Nevada, in August 1999 (64 FR 156), and a Supplement to the Draft EIS in May 2001 (66 FR 22540). The Final EIS was approved and DOE announced the electronic and reading room availability in February 2002 (67 FR 9048). The President has recommended to the Congress that the Yucca Mountain site is suitable as a geologic repository. If the Yucca Mountain Site is licensed by the Nuclear Regulatory Commission (NRC) for development as a geologic repository, current schedules indicate that the repository could begin receiving waste as early as 2010. DOE has not yet developed schedules for sending specific wastes, such as the glass-filled canisters, to the repository."

<u>Response to comment L-4-14</u>: Sections S.2.2 and 1.1.2 were updated to reflect the current status of the Salt Processing Alternatives EIS and its Record of Decision. In addition, the following sentence was added to those sections: "Selecting a salt processing technology was necessary in order to empty the tanks and allow tank closure to proceed."

<u>Response to comment L-4-15</u>: Further information on the costs of each alternative (that presented in Section 2.3 of the Final EIS) has been added to the Summary (Section S.8.1).

<u>Response to comment L-4-16</u>: Schedule is included in the EIS in Section 3.9.1.3.

<u>Response to comment L-4-17</u>: The Salt Processing Alternatives project is currently on schedule. As shown in Figure 3.9-1 of the EIS, a technology needs to be on-line by 2010 in order to support the FFA schedule for tank closure. As with any large project, there are technical and budget issues that may arise that would have to be successfully managed to achieve operation by 2010.

<u>Response to comment L-4-18</u>: DOE agrees and has added a figure (Figure C-1) to improve the explanation of the conceptual model.

<u>Response to comment L-4-19</u>: DOE would make decisions regarding the need for a cap over the closed HLW tanks as part of the Environmental Restoration Program, as described in Section A.4.5. An engineered cap might reduce or delay the long-term impacts that are presented in this EIS. However, because decisions on capping could not be made until after all of the tanks in a group were closed, it would be premature to assume that an engineered cap would help reduce or delay long-term impacts from tank closure. Therefore, for the long-term contaminant transport modeling presented in the EIS, DOE conservatively assumed that there would be no cap over the closed tanks. As described in Appendix C, for the Stabilize Tanks Alternative, DOE assumed that the tank top, fill material, and basemat fail simultaneously at 1,000 years, with a corresponding increase in the hydraulic conductivity and infiltration rates. Prior to 1,000 years, the rate of infiltration of water is assumed to be controlled by the hydraulic conductivity of the intact concrete. For the No Action Alternative, the tank top and basemat are assumed to fail at 100 years.

<u>Response to comment L-4-20, L-4-21, and L-4-22</u>: Section S.8.2 has been revised as follows: "The fate and transport modeling indicates that movement of residual radiological contaminants from closed HLW tanks to nearby surface waters via groundwater would also be limited by the three stabilization options under the Stabilize Tanks Alternative. Based on the

modeling results, all three stabilization options under the Stabilize Tanks Alternative would be more effective than the No Action Alternative. The Fill with Grout Option would be the most effective of the three tank stabilization options, as far as minimizing long-term movement of residual radiological contaminants."

Response to comment L-4-23: Following bulk waste removal, DOE would clean the tanks, if necessary, to meet the performance objectives contained in the General Closure Plan and the tank-specific Closure Module. In accordance with the General Closure Plan, the need for and the extent of any tank cleaning would be determined based on the analysis presented in the tank-specific Closure Module.

On a tank-by-tank basis, using performance and historical data, DOE would determine whether bulk waste removal, with water washing as appropriate, would meet Criterion 1 for removal of key radionuclides to the extent "technically and economically practical" (DOE Manual 435.1-1). If any criterion could not be met, cleaning methods, such as spray water washes or oxalic acid cleaning, could be employed. On a tank-by-tank basis, DOE will evaluate the long-term human health impacts of further waste removal versus the additional economic costs.

Tank cleaning by spray water washing involves washing each tank, using hot water in rotary spray jets. The spray nozzles can remove waste near the edges of the tank that is not readily removed by slurry pumps. After spraying, the contents of the tank would be agitated with slurry pumps and the subsequent liquid pumped out of the tank. This process has been demonstrated on Tanks 16 (which has not been closed) and 17 (which has been closed). If modeling evaluations showed that performance objectives could not be met after an initial spray water washing, additional spray water washes would be used prior to employing other cleaning techniques.

If Criteria 2 and 3 could not be met using spray water washing, other cleaning techniques could be employed. These techniques could include mechanical methods, oxalic acid cleaning, or other chemical cleaning methods. If oxalic acid cleaning were chosen, hot oxalic acid would be sprayed through the spray nozzles that were used for spray water washing. Oxalic acid has been demonstrated in Tank 16 only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity (See Table S-1). However, oxalic acid cleaning costs far more than water washing, and there are important technical constraints on its use. Use of oxalic acid in an HLW tank would require successfully demonstrating that dissolution of HLW sludge solids by the acid would not create a potential for a nuclear criticality.

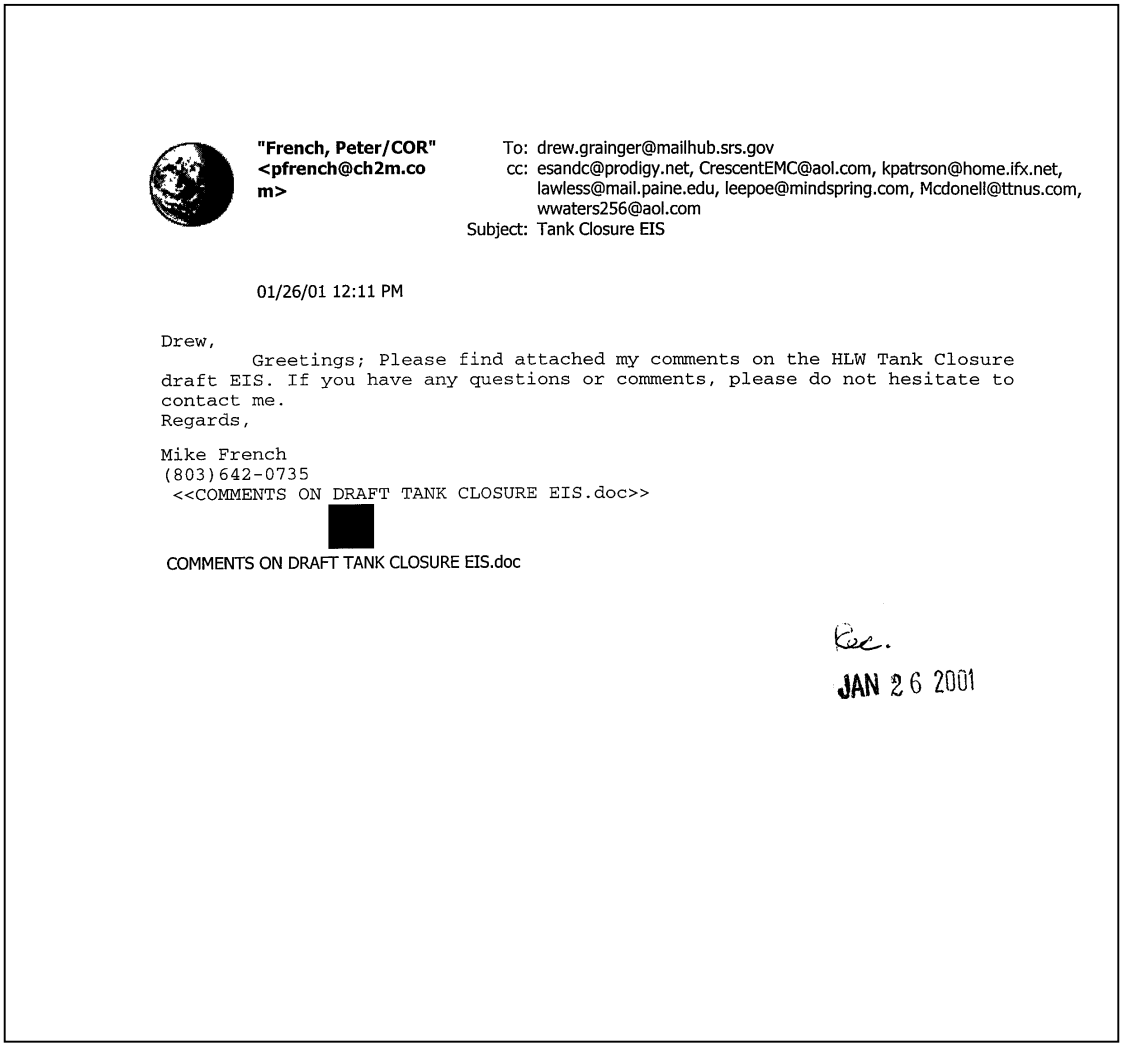
The potential for nuclear criticality is one significant technical constraint on the practicality of chemical cleaning (such as with oxalic acid). Concern about potential criticality would not preclude using chemical cleaning. However, a thorough, tank-specific evaluation for criticality would need to be done before using chemical cleaning in any tank and may result in the identification of additional tank-specific controls to ensure prevention of criticality.

Response to comment L-4-24: Section 4.1.3.2 describes the airborne emissions attributable to tank closure activities for each alternative. The phrase "after tank closure" has been added to the third paragraph of Section C.1.1 to clarify this point. A reference to Section 4.1.3.2 was also added to Section C.1.1.

Response to comment L-4-25: The exposure points for the worker and the resident receptors are different. The worker is assumed to be present at the seepline, where the soil is very damp, which would make resuspension and inhalation of soil very unlikely. The resident is assumed to reside on the opposite side of the stream, at a downstream location that ensures complete mixing of the seep water with the surface water. At this hypothetical resident location, the soil moisture characteristics cannot be accurately defined, therefore, it was conservatively assumed that resuspension and inhalation of soil could occur.

Response to comment L-4-26: As discussed in the first paragraph of Section C.2.2.2, sediment as an exposure medium for terrestrial wildlife was not quantitatively evaluated. This is because estimating sediment contamination from surface water inputs would be highly speculative. Seepage into sediment is not considered in the groundwater model; however, because exposure to chemicals in sediments is theoretically possible, the first paragraph of Section C.2.2.2, has been revised to clarify this point.

Response to comment L-4-27: The fish consumption rate used in the long-term dose assessment modeling was derived from SRS-specific studies. DOE would use all appropriate institutional control measures, including the possibility of using warning signs related to fish consumption. The specific details of these measures over the long term are speculative and cannot be accurately predicted at this time. The states of South Carolina and Georgia have programs in place to assess the quality of water in the Savannah River and other surface water bodies in their states and post fish consumption advisories which they deem necessary. There is no public fishing access to the on-site streams assessed in this EIS.



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Subject: Tank Closure EIS

01/26/01 12:11 PM

Drew,

Greetings; Please find attached my comments on the HLW Tank Closure draft EIS. If you have any questions or comments, please do not hesitate to contact me.

Regards,

Mike French
(803)642-0735
<<COMMENTS ON DRAFT TANK CLOSURE EIS.doc>>

COMMENTS ON DRAFT TANK CLOSURE EIS.doc

Rec.
JAN 26 2001

COMMENTS ON DRAFT TANK CLOSURE EIS.

1. Various CAB Committees have stated that they believe that Salt Processing and HLW Tank Closure to be the most important activity at SRS. Consequently, we believe that it is imperative get on with Tank Closure activities as expeditiously as possible, and under no circumstances allow this EIS – or any other item – to interfere with the closure schedule negotiated with the Site regulators. L-5-1
2. The statement "... Highly Corrosive Waste ..." is not correct. The word "corrosive should be deleted, as the waste is <u>not</u> corrosive to its containment system. Leaks into the annulus are as a result of stress corrosion cracking because the lower tank weld was not annealed prior to use. L-5-2
3. On P. S8 you state that waste that leaked into the annulus of Tank 16 has not been removed. However, on P.S11 it states that the annulus cleaning operation was "only 70% completed". These 2 statements are not consistent. Also on P. S11, we believe that you are seriously underestimating the annulus cleaning problem as indicated in several CAB committee meetings. Emphasizing this issue, the CAB is in process of submitting recommendations to DOE/SR that state that 1. "SRS develop, test and have a method for annuli cleaning for use no later than 2007" & 2. " SRS develop a HLW tank-annulus cleaning plan .... and submit it to Salt Team Focus Group before the end of 2001! L-5-3
4. I believe that the 4mrem/yr dose consequence regulatory limit at the seep is too low & unrealistic. You emphasize that the contaminants from all tanks should not exceed this limit! Once again, it should be emphasized that the 4mrem/yr is municipal water drinking standard, & as such is hardly applicable. Furthermore, if I interpret Table S-2 correctly, only the "clean & grout" option stands a chance of meeting this limit. Consequently, as this 4mrem/yr limit poses no health risk in this case, a higher, more realistic limit should be evaluated in this EIS & negotiated with the regulators as soon as possible. L-5-4
5. On Pages S10 & 11, you talk about the potential for a nuclear criticality when using oxalic acid cleaning. I would question that statement. As a minimum, I believe that a detailed explanation of these statements would be appropriate & useful. This also ties in with the CAB recommendation discussed in #3 above. L-5-5
6. On Page S12, the potential impact of new missions at SRS are discussed re additional HLW generation. In particular you refer to the 3 new Pu disposition facilities, & state that "these will not add to the current HLW waste inventory at SRS". I do not believe that this statement is true. Specifically, in the Pit Disassembly & Conversion Facility, DOE has approved the addition of a "Polishing Capability" to the front end of the unit, whose sole function is to remove Americium & other "nasty materials" from the Pu. Surely these impurities constitute HLW & should be treated as such just like the Pu residues from RFETS. As you indicate, treating the latter at SRS is expected to result in an additional 5 DWPF canisters. I believe this needs to be checked out. L-5-6
7. Per #6, how can you guarantee that additional new programs that might come to SRS will not be HLW generators? Don't let yourself get "boxed in" & allow for contingencies. L-5-7

Response to comment L-5-1: DOE agrees that HLW tank closure is important and that undertaking tank closure activities expeditiously is an important objective.

Response to comment L-5-2: The word "corrosive" has been deleted in Sections S.1 and 1.1.

Response to comment L-5-3: The last sentence of the third paragraph of Section S.2.3 has been revised as follows: "Waste removal from the Tank 16 primary vessel was completed in 1980. DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

The following new paragraph concerning DOE's response to the CAB recommendations has been added to Sections S.2.3 and 1.4.3: "The SRS CAB recommendation (January 23, 2001) regarding annulus cleaning stated the Board's concern that SRS appears to be placing a low priority on annulus cleaning. DOE responded to this recommendation (February 8, 2001) stating, 'the Savannah River Operations Office considers the issue of removal of waste from the tank annulus to be important to the long-term success of the HLW Tank Closure program.' The response further states, 'However, the development of methods for removal of waste from the tank annulus as part of the longer term effort to close Tank 14 reflects a balanced and responsive approach to solving this important challenge.' This conclusion is valid for closure of all tanks that have annuli."

Response to comment L-5-4: Chapter 7 of the EIS describes the process DOE used in reviewing requirements and guidance to identify environmental protection standards. Since application of the 4 mrem/year drinking water standard at the seepline was established by SCDHEC, DOE does not consider looking at a higher regulatory limit to be useful as this requirement is not likely to be relaxed. Sections 2.4.2 and 4.2.2.2 have been revised to state that the contaminant level at the seepline is specified in the General Closure Plan for the tanks as the regulatory compliance point for groundwater, and would be compared with the 4 mrem/year standard.

Additionally, your observation is correct relative to the options and this is one of the main reasons DOE prefers the Fill with Grout Option of the Stabilize Tanks Alternative.

Response to comment L-5-5: The detailed discussion requested exceeds the level of detail appropriate for an EIS summary. Criticality and other concerns associated with the use of oxalic acid are discussed in Sections 2.1, A.4.3, and B.3.1. Also, see the response to comment L-7-32.

Response to comment L-5-6: This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document.

The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

Response to comment L-5-7: The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 22, 2001

Rec.
JAN 24 2001

Andrew R. Grainger
NEPA Compliance Officer
Savannah River Site
Building 742-A, Room 185
Aiken, SC 29802

Dear Mr. Grainger:

NRC staff have reviewed the U.S. Department of Energy's (DOE) "Savannah River [SR] Site High-Level Waste [HLW] Tank Closure Draft Environmental Impact Statement [EIS]," and have prepared the following list of comments on the document.

1. **Comment:**

   None of the NRC recommendations from its review appear to have been incorporated.

   Basis:

   NRC staff performed a review of the DOE-SR methodology for determining that residual tank waste met the incidental waste criteria. The results of the review are summarized in the June 30, 2000 letter and associated technical evaluation report (TER) (letter from W. Kane/NRC to R. Schepens/ DOE-SR, June 30, 2000). Staff recognizes that the Draft EIS was in preparation at the same time as the NRC review was being performed. L-6-1

   Recommendation:

   NRC staff suggests incorporation of its recommendations in the Final EIS and supporting performance assessment(s).

2. **Comment:**

   There is no cost-benefit analysis provided for the alternatives.

   Basis:

   No cost-benefit analysis has been provided. Only order of magnitude estimates are provided on page 2-9. A cost-benefit analysis (including rad-worker exposure) for the various alternatives would be useful for comparison. It would prove particularly useful in comparing the "Fill with Grout" and "Fill with Saltstone" alternatives. If the "Fill with Saltstone" alternative were selected, normal saltstone activities at the Saltstone Manufacturing and Disposal Facility in Z-Area would be decreased. It is not apparent in the Draft EIS that the cost analysis (discussion on pages S-10, 2-5) for the "Fill with Saltstone" alternative takes into consideration the cost-savings from decreased usage of the Saltstone Manufacturing and Disposal Facility in Z-Area and construction of fewer disposal vaults, nor L-6-2 does it appear to balance worker exposure from filling tanks with saltstone against the worker exposures that would have occurred at the Z-Area facility.

Recommendation:

Provide a thorough cost-benefit analysis in the Final EIS to aid in comparison of alternatives. L-6-2

3. **Comment:**

There is no discussion of the waste form meeting Class C concentration limits as required by DOE G435.1, Section II.B, "Waste Incidental to Reprocessing." (See also comment 5.)

Basis:

The third criterion in DOE G435.1 for Waste Incidental to Reprocessing is 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 waste as set out in 10 CFR 61.55." Not only is this requirement never discussed, it is also conspicuously absent from direct quotations of DOE G435.1 (Text Box page S-9, page S-17, Text Box page 1-11, page 2-2, page 7-5 etc.). L-6-3

Recommendation:

Provide an analysis of the residual tank waste with respect to this criterion, or provide a rationale for alternative waste classification as discussed in DOE G435.1, Section II.B(2)(a)3.

4. **Comment:**

The Waste Incidental to Reprocessing analysis provided in the Draft EIS is inconclusive.

Basis:

There are three incidental waste criteria in DOE G435.1. The second requires "the waste meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61...." One of the performance objectives is protection of an inadvertent intruder. The Part 61 intruder is a resident farmer (with a well), which would place the farmer near the tank farms (i.e., the 1m or 100m wells). The dose limit for an inadvertent intruder is 500 mrem/year. It appears from the information provided in this Draft EIS, that a resident farmer on H-tank farm would receive ~ 100 rem/yr from 1m well (+20% for other sources (pages 4-47 and C-24)). Pages 2-28 and 4-34 state that the 1m and 100m well doses are extremely conservative due to modeling assumptions. In addition, there is a complete absence of any discussion in the Draft EIS of the third criterion, which requires that the waste be "incorporated in a solid physical form at a concentration that does not exceed the applicable L-6-4 concentration limits for Class C low-level waste as set out in 10 CFR 61.55." The Class C concentration limits were developed to protect an inadvertent intruder, which is particularly important because the intruder performance objective is the one that is not met.

When NRC staff reviewed the DOE-SR methodology for meeting the incidental waste criteria, the information we were provided indicated that a resident farmer intruder would be protected at F-tank farm. The methodology also indicated that Class C concentration limits could not be met for all tanks, however, a rationale similar to the provisions in 10 CFR 61.58 was provided. (10 CFR 61.58 states that, "[t]he Commission may... authorize other provisions for the classification... of waste on a specific basis, if, after evaluation, or 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.") Based on the information provided, NRC staff concluded that "the methodology for tank closure at SRS appears to reasonably analyse the relevant considerations for Criterion One and Criterion Three of the incidental waste criteria. DOE would undertake cleanup to the maximum extent that is technically and economically practical, and would demonstrate it can meet performance objectives consistent with those required for disposal of low-level waste. These commitments, if satisfied, should serve to provide adequate protection of public health and safety (June 30, 2000 letter)." In addition, staff recommended that DOE-SR develop site-specific concentration limits. L-6-4

The information currently provided in the Draft EIS does not conclusively support the Waste Incidental to Reprocessing determination, for two of the three criteria listed in DOE G435.1.

Recommendation:

(1) Perform an updated performance assessment which does not artificially skew the 1m and 100m well results (i.e., provides a more realistic analysis). However, if these results show a drinking water dose greater than 416 mrem/year (500 mrem/year ÷ 120%), the 10 CFR Part 61 resident farmer intruder may not be sufficiently protected.

OR

(2) Provide sufficient rationale for extended institutional controls, and explain how they would provide protection to an inadvertent intruder comparable to that provided by the performance objectives in 10 CFR Part 61.

5. **Editorial Comment:**

This document needs more technical editing.

Basis: L-6-5

There are many mistakes in the document, including spelling, grammar and misuse of terms, for example:

On page 3-5, it states that, "[t]he mineralogy of the sands and pebbles primarily consists of quarts and feldspars."

On page 1-10, the document abbreviates the National Research Council as "NRC;" however, the list of Abbreviations (and later sections of the document) use "NRC" to mean the U.S. Nuclear Regulatory Commission.

Recommendation:

The Final EIS should be more closely edited.

L-6-5

If you have any questions on this letter, please contact Jennifer Davis, of my staff, at (301) 415-5874, or bjd1@nrc.gov.

Sincerely,

Thomas H Essig

Thomas H. Essig, Chief
Environmental and Performance
Assessment Branch
Division of Waste Management
Office of Nuclear Materials Safety
and Safeguards

Response to comment L-6-1: DOE expects to make waste incidental to reprocessing determinations tank by tank, based on analyses that will be provided in future tank-specific Closure Modules. The NRC recommendations, which included such items as additional sensitivity analyses and calculations for the long-term performance evaluation, will be incorporated in these analyses. The level of detail requested is not appropriate for the EIS.

Response to comment L-6-2: The Draft EIS presented data on both the costs and impacts of each alternative. Further details regarding quantitative cost-benefit analysis are not required by NEPA regulations and would not be appropriate for the EIS. The Final EIS Summary (Section S.8.1) has been revised to more clearly present the cost information from Chapter 2 of the EIS.

Response to comment L-6-3: The text in the referenced text boxes was not intended to be a direct quotation from DOE Manual 435.1-1. The text included in Criterion 3 the fact that DOE will manage the waste in accordance with AEA and 435.1-1 requirements. 10 CFR 61.55 Class C requirements are addressed in 435.1-1. These text boxes were intended to address instances where the residual material would be managed as low-level waste or as transuranic waste, depending on the concentration of alpha-emitting radionuclides in the residual. The text in the referenced text boxes has been revised to include all of Criterion 3. As a result of several comments, the text in Section 2.1 of the Final EIS has been revised to provide a more comprehensive discussion of DOE's Waste Incidental to Reprocessing determination process, including the requirement to meet Class C limits (if the residual material was considered low-level waste).

Response to comment L-6-4: Identification of standards for the long-term performance of the SRS HLW tank closure process was the result of a series of interactions between DOE, SCDHEC, and EPA Region 4. The South Carolina regulations on closure of facilities permitted as industrial wastewater treatment systems (R.61-82, "Proper Closeout of Wastewater Treatment Facilities") require that 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. As a result of these interactions, it was determined that the point of compliance for SRS HLW tank closure impacts would be the point at which the groundwater potentially impacted by contaminants from closed HLW tanks enters the accessible environment (i.e., the seepline).

This location is also in accordance with DOE policy on the long-term performance of closed HLW tanks. DOE Manual 435.1-1, Section IV.P.(2)(b) states, "The point of compliance shall correspond to the point of highest projected dose or concentration beyond a 100-meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided." As discussed in DOE Guidance 435.1-1 (Page IV-193), this requirement provides flexibility in establishing the extent of the buffer zone considering site-specific issues. For example, in cases where the disposal facility is located far from the DOE site boundary, and the site's land-use planning does not envision relinquishing control of the site, a larger buffer zone could be considered. The justification for the selection of the point of compliance and size of the buffer zone is based on land use plans and commitments that have been negotiated during consent agreements or other regulatory actions. The justification could also be based on the proximity of already existing contaminated areas or nearby operational facilities that establish a boundary, or which would render the 100-meter point of compliance as unreasonable.

Therefore, the long-term fate and transport modeling for HLW tank closure is optimized to provide the most accurate (while still conservative) results at the seepline. In doing so, DOE's assumption that the tank farms are nearly a point source is reasonable for a seepline that is nearly one mile downgradient.

Calculated doses at both the 1-meter and 100-meter wells for the H-Area Tank Farm north of the groundwater divide (the highest location) are dominated by a single tank group, Tanks 9-12, because of its vertical location within the water table. Since the 1-meter and 100-meter well locations are determined from the downgradient edge of the tank farm, and are therefore more than 1 meter and 100 meters from the edge of the tank group, the dose resulting from summing the doses from all tank groups within H-Area Tank Farm north of the groundwater divide is a close approximation to the maximum dose from that tank group. The results reported in the EIS indicate that the 100-meter well drinking water dose would comply with the cited criterion under the Fill with Grout Option (the highest dose under this option is 300 mrem/year for the H-Area Tank Farm, north of the groundwater divide), but not under the other options of the Stabilize Tanks Alternative, nor under the No Action Alternative. Under the Fill with Grout Option, the dose at the seepline is within the 4 mrem/year performance objective for both F-and H-Area Tank Farms.

Meeting all three criteria under the waste incidental to reprocessing requirement is a condition for closure of the tanks. For closure of a specific tank, DOE must demonstrate that all three criteria are satisfied before the tank can be closed. For example, if the residual material remaining in the HLW tank did not conform to the definition of Class C Waste from 10 CFR 61.55, DOE could apply the methodology presented in the NRC's Branch Technical Position on Concentration Averaging to demonstrate that the configuration of the resulting closed tank conforms with this concentration criterion. DOE's determination of how a closed tank conforms to the waste incidental to reprocessing criteria will be included in Tank Specific Closure Modules.

Response to comment L-6-5: The Final EIS was subjected to a thorough technical edit prior to publication.

Drew Grainger
01/24/01 01:16 PM

To: L Ling/DOE/Srs@Srs, George Hannah@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Comments on Tank Closure EIS

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 01:18 PM -----

Lee Poe <leepoe@springmail.com>
Sent by: leepoe@springmail.com
01/24/01 01:09 PM
Please respond to leepoe

To: Drew Grainger <drew.grainger@mailhub.srs.gov>, NEPA Compliance <nepa@mailhub.srs.gov>
cc: Rick McLeod <CrescentEMC@aol.com>, Bill Lawless <lawlessw@mail.paine.edu>, Ernie Chaput <esandc@prodigy.net>, Mike French <pfrench@ch2m.com>, Karen Patterson <kpatrson@home.ifx.net>, Kelly Dean <kelly.dean@mailhub.srs.gov>, Donna Martin <donna.martin@mailhub.srs.gov>, Wade Waters <wwaters258@aol.com>, Larry Ling <l.ling@mailhub.srs.gov>
Subject: Comments on Tank Closure EIS

Attached are my comments on the Tank Closure EIS.

Please respond telling me you recieved them. I will mail you a copy if you desire a signed copy.

Thanks Lee

Comments on Tk Closure EIS.doc

January 23, 2001
807 E. Rollingwood Rd
Aiken, SC 29801

Mr. Andrew R. Grainger
NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742-A, Room 183
Aiken, SC 29801

Comments on Tank Closure EIS
DOE/EIS-0303D, November 2000

I would like to provide the following comments on DOE/EIS-0303D.

General Comments:

1. **Get on with the closure of HLW Tanks.** Do not allow this EIS or anything else interfere with the closure schedule that has been negotiated with SRS regulators. Tank 19F closure schedule is 2003 but the plan for closure is 2002. Meet the planned schedule. Closure of the remaining tank in the four-pack is scheduled for 2004. Meet these and all other HLW Tank closure schedules. L-7-1

2. **Select the "Clean and Stabilize Tanks Alternative" with the "Fill with Grout" option.** It is the only long-term alternative/option that provides sufficient long term environmental protection. The option "Fill with Sand" allows water to freely flow through the sand (after tank failure) hastening release of radionuclides. The "Fill with Saltstone" requires three saltstone manufacture plants at unnecessary expense. The "Clean and Remove the Tank" does not provide the environmental impacts of long-term storage of the steel and concrete rubble. Of course the "No Action" is an incomplete cleanup of the SRS. L-7-2

3. I suggest the site look at and include a higher regulatory limit than the 4 mrem/yr dose consequence at the seep. Based on my knowledge of the HLW System, I doubt that the inventories of radionuclides postulated to be left in the tank system can be met, in reality. To achieve the projected inventories may be impossible or very difficult and require much more water washing and tank cleaning. **A higher regulatory limit should be considered in the EIS.** The 4 mrem/yr limit poses no health consequence and a higher limit should be evaluated in this EIS and appropriate administrative controls (but not another EIS) should be specified now in this EIS to allow its use if needed. L-7-3

4. **The 20% additional inventory, allowed for piping, equipment, etc, should be given a more prominent position in the EIS.** I was able to find it only in Appendix C. L-7-4

5. **Information should be included in the EIS on how waste and waste residues, left in the HLW Tanks, will be measured and how well the residual quantities will be known.** This issue is a paramount issue in establishing cleanliness before closure can be initiated. At this time, it is not dealt with in this EIS. L-7-5

6. **The environmental impacts of all alternatives should be included in this EIS.** If those impacts have been previously determined in other EIS's, the impacts should be included here also. Only in this manner can the decision-maker compare and evaluate the various alternatives. L-7-6

7. **Include a section on Institutional Controls (IC) planned to ensure both near-term and long-term safety of the public.** For example, if IC do not prevent intrusion to the water table and use of the groundwater, adoption of the seep line limit makes no sense. L-7-7

8. **The summary should be included in the large EIS book.** Or at the very least, the big book should say this is only a partial EIS. L-7-8

Specific Comments:

Summary:

1. The Summary is well written and includes much of the pertinent findings of the EIS. L-7-9

2. In the second paragraph of S-1, delete the word corrosive when describing the waste. The waste is not corrosive to the system it is contained in. This also makes this section consistent with other sections in the EIS that describe the waste as highly radioactive. L-7-10

3. Add to section S.2.3 a short paragraph on the basis for HLW Tank cracking and its present status. L-7-11

4. On Page S-8, in the second paragraph, add a short sentence stating why Tanks 17 and 20 cracks are thought to be groundwater corrosion. Does this infer that the tanks components exposed to groundwater are severely corroded? L-7-12

5. In the last paragraph in Section S.2.3 (page S-8), add a sentence or two on why the primary of Type III tanks have not leaked. L-7-13

6. The second paragraph of Section S.2.4 states DOE has reviewed several EIS for waste removal. The section should summarize what DOE found in this review. L-7-14

7. The Performance Objective paragraph, on Page S-9, should be expanded to provide the CAB the opportunity to review of the tank specific Closure Modules at the same time as the regulator's review. L-7-15

8. The cumulative curies removed in Table S-1 are shown to be 10^{-6}. The minus sign is a typographical error. L-7-16

9. I consider the last sentence is Section S.2.4, on Page S-11, to be wrong. SRS documentation of the waste in the annulus of Tank 16 show it contains 30,000 curies of Cs-137. That amount of waste exceeds the entire inventory in F- or H-Areas used in calculating the dose rates in Table S-3. Other examples can also be given to show the inventory is large compared to the values given in Table C.3.1-1. L-7-17

10. The middle paragraph in Page S-12 says that in response to comments DOE has included total volumes of waste remaining in the tanks as residual waste. I have been unable to locate this. It is obviously used in the analysis that went into the EIS. L-7-18

11. If I assume the 4 mrem/yr seepline limit, Table S-3 (page S-22) shows that two of the alternatives examined will exceed the limit and the third will be essentially at the limit. Only "Clean and Fill with Grout" is acceptable. See General Comment number 3 above that proposes a higher limit than the 4 mrem/yr. L-7-19

12. Please check the "No Action" seepline dose rate to Upper Three Runs Creek. Table S-3 shows it to be 2,500 mrem/yr. That value seems high when compared with other values given and is probably a typographical error. L-7-20

13. Figure S-7 shows a plot of predicted drinking water dose over the 10,000-year analysis period. Add information to the text to show why the curves appear as they do and what are the principal radionuclides reaching the creeks. It is my understanding that the dose rate is primarily due to Tc^{99}. L-7-21

Chapter 1:

1. In the second paragraph, delete the word corrosive when describing the waste. The waste is not corrosive to the system it is contained in. This also makes this section consistent with other sections in the EIS that describe the waste as highly radioactive. L-7-22

2. On page 1-7, in the Section on Tanks, and in the third paragraph; change the wording of the fourth sentence. As written it infers all of the waste has been contained in the concrete encasement; it has not as mentioned for Tank 16. Suggest the sentence read "Most of the waste was contained in the concrete encasement……" L-7-23

3. On page 1-7, in the Section on Tanks, and in the fourth paragraph; add a statement on Type III HLW Tank leakage or lack of it. This keeps section parallel to other sections. L-7-24

4. On page 1-7, in the Section on Evaporator Systems; aren't there three evaporators operating? Use care when you say words like "at present" because your reader thinks it is a statement of the condition at the time the EIS was published or when he is reading it and it is probably neither. L-7-25

5. On page 1-11, in the Section on Decisions to be based on this EIS, and in the first paragraph; the third sentence is not technically correct. Some of the environmental impacts are not included in the EIS but referenced to other NEPA documents. L-7-26

6. On page 1-12, in the second paragraph; the EIS states a tank-specific Closure Module is required. This specific Module should contain the measured inventory of residual waste after water washing and estimated inventory before tank stabilization with grout. (This EIS should specify what the type of information that will be contained in these tank-specific Closure Modules. L-7-27

7. The last full paragraph on page 1-12 should be expanded to describe the process in reference DOE-1996. This paragraph should describe the coordination and interactions between HLW and ER. L-7-28

8. The top paragraph on Page 1-13 say the ER activities will be governed by CERCLA/RCRA. Will the 4 mrem/yr at the seepline be rescinded and the DWS imposed at the HLW fence post as is currently being required for other CERCLA/RCRA sites? This last paragraph should be more informative. L-7-29

9. Include CAB/WM Committee/Salt FG interactions with SRS and the regulators in Section 1.4.3. L-7-30

Chapter 2:

1. On page 2-1, in the Section on HLW Tank Cleaning; the volume of waste left after spray washing was given for Tank 16 & 17, add similar information for Tank 20. Also add for the three tanks the amount of waste (probably expressed in curies) to the paragraph. L-7-31

2. The second paragraph on Page 2-2 states that a nuclear criticality evaluation is required before oxalic acid will be allowed. The EIS, by discussing it, gives the impression it is not a criticality contributor. If the EIS discussed oxalic acid washing as a possible mode of cleaning the tanks, it should be known to be acceptable. After reading this information, I am left with a significant question on its use. Please clarify. L-7-32

3. Table 2-1 on page 2-3 and associated text, SRS needs to include information to show the amount of waste left in the tank after oxalic acid cleaning. Otherwise the % removed and the cumulative columns are incomplete and do not tell the appropriate story. | L-7-33

4. On page 2-3, in the second paragraph, add discussion on dissolution of salts from the annulus. | L-7-34

5. Page 2-5 says that the saltstone alternative has "a large quantity of nitrates". This statement should be quantified to identify what the concern or point is. | L-7-35

6. Section 2.1.4.2 should discuss the environmental impacts of delayed closure of the tanks. | L-7-36

7. In Section 2.3 on page 2-9, in the middle paragraph; in addition to new technologies add demonstration of old technologies to the section. | L-7-37

8. In Section 2.3 on page 2-9, the statement is made that "for the period of delay, the impact of this approach would be the same as the No-Action Alternative". Without additional information, I do not understand why it is true. If fact, I doubt that it is correct. | L-7-38

9. Environmental Impacts of Clean and Remove Alternative are stated not to be included in the EIS because they are included in another EIS. This EIS should summarize the impacts, not leave them out. | L-7-39

10. Section 2 should include discussion of accidents during the long-term. If the EIS doesn't determine them, a clear rational must be given. | L-7-40

11. Section 2.4.2 on page 2-27 states "the principal source of potential impacts to the public health is leaching and groundwater transport of contaminants". With the analysis presented, I conclude that falling into an unfilled HLW tank with a high probability of death is a much larger public health consequence and risk. Contaminant transport will not kill members of the public. | L-7-41

12. I consider the discussion on page 2-27 in the last paragraph comparing lifetime dose commitment and the single year limit to be weak. | L-7-42

Chapter 3:

No comments are provided on this section. It contains lots of information in its 58 pages that is required by NEPA but does not impact the conclusions of this EIS. A better way of implementing the NEPA requirements should be developed for the many SRS EISs that essentially have the same type of information. | L-7-43

Page 5

Chapter 4:

1. Page 4-10 in Section 4.1.3.2, the EIS makes the assumption for Clean and Remove Tanks Alternative that HEPA Filtered enclosures are used during removal of metal from the tank enclosures. I question this assumption. It is not clear to me that the safety improvement justifies this requirement after the tank has been decontaminated and while the steel is being removed. L-7-44

2. Table 4.1.8-1 et al includes partial environmental impacts. The long-term impacts of disposal of the steel should be included. L-7-45

3. On page 4-25, the No Action Alternative environmental impacts are shown as zeros. That alternative will have impacts. L-7-46

4. Table 4.1.12-1 on page 4-29 does not include accident consequences for the No Action Alternative. It seems to me that the time duration of these type activities is 10,000 years not 30 as assumed for other alternatives resulting in probabilities of one for the various accidents. L-7-47

5. The long-term impacts for the Clean and Remove Tank alternative should be given in Section 4.2 (page 2-30). If the impacts are given in other EISs, they should be summarized here, as I stated under the General Comments. L-7-48

6. Table 4.2.2-6 (page 4-37) doesn't seem to include iron from the steel of the tanks. What are the impacts of this iron? L-7-49

7. Text associated with Figure 4.2.2-1, should describe when the plutonium is expected to arrive at the seep line and what impact it may have on dose rate. I expect it is beyond the 10,000 year analysis period but still should be given in the EIS. L-7-50

8. The Public Health (Section 4.2.5 on page 4-44) seems to be long-term effects. The title of the section should provide this information since there are other public impacts as well. L-7-51

Chapter 5:

1. Modify the section title on page 5-3 (Spacial and Temporal Boundaries), it is unclear. What is being covered here? L-7-52

2. Delete reference to a specific company (Bridgestone Tire) or use other company names. This usage is on page 5-3.) L-7-53

3. Table 5-2 (page 5-8) should include the impacts of the Composite Analysis for the 200-Areas (it includes the long-term impacts of other discharges to the SRS streams impacted by this EIS). L-7-54

Chapter 6:

No comments.

Chapter 7:

1. The example given on page 7-3 in Section 7.1.2, doesn't seem to be the most stringent requirement. Expand to ensure your reader understands the point you are making. L-7-55

Appendix A:

1. Add the basis for that statement made on Page A-5 "there is no evidence that he waste has leaked from the secondary containment". L-7-56
2. Section A.3 on page A-5, add a reference for Tank 16 "the 10s of gallons leakage that migrated to the surrounding soil" L-7-57
3. Page A-5 also contains the statement about Type IV tanks "small amounts of groundwater have leaked into these tanks". Also add a reference for the statement. L-7-58
4. Section A.3 needs a paragraph that describes when the cracks occurred and what is projected for the future. It is my understanding they occurred early in the Tank Farm life and cracking has decreased materially or stopped. Describe why. Tank 15 cracking may be the exception. Reader needs to feel the cracking is under control or has been eliminated. L-7-59
5. Last line on page A-5 has a spelling error. L-7-60
6. Change the work "complete" in Table A-1 on page A-7 as used in Tank 16 current usage. The work says the annulus cleaning is complete. I doubt that it is complete with 30,000 Ci of Cs-137 still in the annulus. It may have meant to state cleaning was stopped in the past. L-7-61
7. The first full paragraph on page A-9 describes 17 RCRA/CERCLA contaminations. Add a Table with this information showing the location and quantity of waste that leaked and what is still there. L-7-62

8. Add the basis for the last statement in that first full paragraph on Page A-9. The one that states these leak sources probably will not contribute to the tank closure performance. L-7-63

9. Reference the source of the information in the second full paragraph on page A-9. In particular the leakage stated to be a few gallons but the date (and presumably other pertinent information on the leak) is unknown. This certainly raises questions on validity of what is being stated. L-7-64

10. Reference the Tank 16 leak statement in the top paragraph on page A-9. L-7-65

11. Expand the first sentence of the second paragraph in the right hand column of Page A-9. Why is it unlikely that waste has not leaked from other tanks? L-7-66

12. What is the basis for the last statement in the second paragraph in the right hand column of Page A-9? L-7-67

13. In Section A.3.2 on page A-9, the same comment as given earlier. Use care in using "recently" in an EIS. It won't be read the same way by all readers. I thought that there were three operating evaporators. L-7-68

14. Add a paragraph to Section A.3.2 describing how HLW evaporators are contained and shielded. L-7-69

15. At the top of page A-12, evaporator rated capacity is expressed as volume. The normal way to describe capacity of an evaporator is throughput rate (volume per unit time). L-7-70

16. Suggest rewording the last sentence of Section A.3.2. In the sentence supernate probably means evaporator feed. The volume is reduced to 25% of its original volume and it freezes as crystallized salt (perhaps that is the immobilize term used). Perhaps a better way to say this is that the concentrated waste crystallizes into a solid salt cake reducing its mobility. L-7-71

17. Add a paragraph describing the expected inventory of radionuclides after flushing and prior to closure. Is the inventory significant? Why is that judgment made? L-7-72

18. Section A.3.5 starts off saying that the HLW produced in the canyons contains insoluble and highly radioactive metal hydroxides. When initially produced, these hydroxides are in a meta-stable solution and require weeks for form the insoluble metal hydroxides. Thus the insoluble form occurs in the waste tanks not in the canyons. L-7-73

19. Section A.4.1 references earlier EISs. It is OK to reference them but also the key conclusions applicable to this EIS should be summarized here. I consider the waste L-7-74

removal heel to be one of the principal issues of uncertainty for success of this Tank Closure activity. | L-7-74

20. In Section A.4, add several paragraphs on waste removal from tank annulus and from between the primary tank bottom and the annulus tank bottom. | L-7-75

21. On page A-14, in Section A.4.3; the fourth paragraph states that only salt is in the annulus and it should be easily removed with water. Provide referencable support for the first point and basis for the second. It is my understanding there is very little information on dissolvability of salts in the annulus. We know Tank 16 salt did not dissolve and I understand the only other sample available also shows that the salt is difficult to dissolve. | L-7-76

22. On page A-15, the last paragraph of Section A.4.3; it would be beneficial to the EIS to have descriptive information on what is known about how clean the primary Tank is based on the inspections made. | L-7-77

23. Page A-19 &20, add more conceptual description on how the Clean and Remove Alternative would be accomplished. Will the removal and packaging be done remotely or hands on, etc.? | L-7-78

24. The soil cover described in the last sentence on Page A-20 should also include prevention of deep-rooted plants so they will not add a new dispersion pathway. | L-7-79

Appendix B:

1. As I read Section B.2 and looked at Table B-1; I concluded that 10,000 year analytical period made all of the accident frequencies greater than one. I later found that the accident analysis was performed for 30 years. It is very important to set the stage for this analysis. I do not understand why accident (particularly naturally occurring events) should not be looked at for the full 10,000 years. At the very least tell your reader that you are only examining 30 year tank closure period and not the decay and release time period. | L-7-80

2. Section B.2.2 writes off surface runoff and underground releases by saying mitigative actions would be taken, again applies to the period of active institutional control. Why is this appropriate? | L-7-81

3. Section B.3.1.1 on page B-5, needs to also consider in-tank-generated hydrogen. The analysis seems only to look at flammable chemicals that are accidentally introduced into the tanks. | L-7-82

4. Section B.3 (Pages B.4 – B.7) should be expanded to consider loss of containment. The CAB is concerned about this with the numerous changes of equipment that | L-7-83

require opening and closing containment during sludge and salt removal and the same issues exist during tank cleaning. L-7-83

5. Section B.3.1.3 on Page B-6; add a paragraph to show why underground releases are not considered for seismic events. The only seismic event considered is one that releases the content of the above ground waste being pumped. I also do not consider mitigation appropriate for a severe seismic event of sufficient strength to breach HLW piping or tankage since off-site damage to essential infrastructure will also be sever and require immediate correction. This will dilute the priority that will be placed on SRS damage. L-7-84

6. Section B.3.1.7 (Page B-7) doesn't seem to include liquid release. Why not? L-7-85

7. Section B.3.2.1 states that flooding after 200 years is not considered. It is stated to be a long-term impacts and is not considered in Appendix B. Where is it included? In a 10,000 year analysis, this logic seems questionable. L-7-86

Appendix C:

1. The assumption in the third paragraph that DOE intends that the area immediately surrounding the tank farms would remain in commercial/industrial use for the entire 10,000 year period of analysis seems unlikely. There may be deed restrictions on these areas but the area will probably not look like commercial/industrial use that we currently recognize. L-7-87

2. The intruder on page C-1 is defined as a teenager. Why and did all of the parameters associated with dose commitment use teenager parameters? L-7-88

3. Section C.1.1 on Page C-3, in the bottom paragraph in the left column, the logic given for atmospheric releases seem unlikely but the conclusion seems reasonable. L-7-89

4. Does the nearby resident and the child resident, decribed on Pages C-6 & C-7 drink contaminated water? I am not able to tell if they do or do not from the write up given. L-7-90

5. Discussion on page C-9 says that the inventory is increased by 20% to account for tank-specific systems outside of the Waste Tanks. This is the only place I saw this and could find no calculated results from this assumption. One questions the validity of this assumption. Environmental impacts for the outside systems need to be given. L-7-91

6. Table C.3.1-1 provides the entire inventory for F-Area Tank Farm that results in 1.9 mrem/yr seepline dose rate for F-Area. The 4,300 Ci of Cs^{137} is the equivalent of 860 gallons of HLW left in the entire tank farm or on the average 39 gallons/tank. (This conversion of curies to gallons assumes HLW contains 1 to 20 curies of Cs^{137}/gallon HLW. I used 5 Ci/gallon for this conversion.) This small volume of waste raises the issue discussed in General Comment # 3. Similar calculation for H-Area Tank Farm L-7-92

Page 10

give similar small volumes. It should be noted that the principal dose in the seeps are from Tc^{99} left in the tanks. Tc^{99} is more mobile than cesium. L-7-92

Appendix D:

Reading the comment and DOE Response then reading the EIS to ensure that the response was truly implemented, I found several that are inconsistent. DOE should reconsider the responses to the comments and the body of the EIS to be sure they are consistent. A couple of examples are listed below where the response did not seem to be carried through into the EIS.

- The response to the top comment-response given on Page D-3 in the right hand columns seems inconsistent with the text of the EIS. L-7-93
- The response (listed at the top of the left columns on Page D-4) says that lessons learned from closing tanks 17 and 20 will be used for closing other tanks. In general this was done, in that the experience from those tanks is the total experience to date on tank closure. I found no section that explicitly listed those lessons learned that were considered to be important.

I hope these comments are useful in reaching a decision that allows tank closure to continue on schedule. The process should recognize the potential that waste removal will be more difficult than planned and provide a preplanned process that accepts larger quantities of waste while not impacting safety of future generations downstream from SRS.

If I can answer questions or shed additional light on these issues, please call me.

Sincerely

W. Lee Poe, Jr.

Response to comment L-7-1: Comment noted.

Response to comment L-7-2: Comment noted.

Response to comment L-7-3: See response to comment L-5-4, first paragraph.

Response to comment L-7-4: As stated in Section 4.2.2.2, Appendix C presents the major assumptions and inputs used in the long-term fate and transport modeling, including the assumption regarding the contaminant inventory in piping and ancillary equipment. Section 1.4.1 describes the overall HLW tank closure process. Section 4.2.2.2 has been revised to more clearly state the assumptions regarding residual material in piping and ancillary equipment.

Response to comment L-7-5: DOE agrees that accurately measuring the residual is an important task. However, the EIS is a decision-making tool to determine the preferred closure alternative, which is independent of the method used to determine tank residuals. Only a summary description of residual characterization is possible now, until a closure method is chosen and tank-specific procedures are established. Two paragraphs were added to Section 4.2.2.2 and are included below.

"The source term for the modeling described in this EIS was based on knowledge of the processes that generated the waste. DOE assumed that the residuals left behind after waste removal would have approximately the same composition as the waste currently in the tanks. The total amount of radionuclides in the tank farms is well known, so this approach should yield a reasonable estimate of tank-farm-wide doses, because overestimates in one tank should be balanced by underestimates in another tank. This modeling also considered residual material remaining in piping and ancillary equipment associated with the closed HLW tanks. This piping and ancillary equipment is assumed to contribute an additional 20 percent of the inventory in the closed tanks.

Before each tank is closed, DOE will determine the actual residual in that tank and, through modeling, ensure that closure of the tank would be within requirements. In Tanks 17 and 20 (the two tanks that have been closed), this was done by separately estimating the volume and composition of the waste, and then combining these two pieces of information to develop tank inventories of each radionuclide of interest. A similar procedure will be followed in the future for residual waste in each tank. In Tanks 17 and 20, the depth of the solids was estimated at various points in the tank by comparing the sludge level to objects of known height in the tank, and this information was integrated over the area of the tank to yield a total tank volume of residual. The composition of the waste was estimated 1) by knowledge of the processes that sent waste to the tank and 2) by samples. If there was a discrepancy between the two methods, the method yielding the higher concentration was used for modeling. In the future, new techniques may need to be developed to accurately assess the residuals. For example, in tanks with high radionuclide concentration, the depth of solids remaining after aggressive cleaning may be too small to accurately measure visually, so some other technique may need to be employed."

Response to comment L-7-6: Section 2.1.2, has been revised to present a more detailed summary of impacts from the 1995 Waste Management EIS (DOE 1995) in indicating that impacts from low-level waste disposal of tank components in the vaults would be well below impacts expected from tank closure.

Response to comment L-7-7: See response to comment L-8-3. The specific details of the implementation of DOE's Institutional Controls would be developed as part of the Environmental Restoration Program.

Response to comment L-7-8: The Foreword and the Table of Contents in the EIS indicate that the Summary is published as a separate volume. DOE publishes the Summary separately as a service to the reader, many of whom only read the Summary. Publication of an EIS in several volumes is a common practice consistent with the Council on Environmental Quality NEPA regulations on the content of an EIS.

Response to comment L-7-9: Comment noted.

Response to comment L-7-10: The word "corrosive" has been deleted in Section S.1.

Response to comment L-7-11: Section S.2.3 is a summary section, so the level of detail suggested in the comment is not appropriate. However, the following additional technical information on tank cracking mechanisms and current tank status was added to Section 1.1.3: "The cracks in the Types I and II tanks were due to nitrate-induced stress corrosion cracking. The cracks generally occurred in the heat-affected zones adjacent to tank welds. These zones have high tensile stresses and are susceptible to the corrosive effects of the high concentrations of nitrates that occur in SRS wastes. Nitrate-induced stress corrosion cracking is inhibited by sodium hydroxide and sodium nitrite, but the initial wastes added to these tanks did not have sufficient inhibitors to prevent cracking. Since the time of the initial cracks, considerable research has been done to determine inhibitor levels that will prevent stress corrosion cracking and other types of corrosion that could affect the SRS tanks. (There are other types of corrosion, such as pitting that have not caused leaks, but are a potential threat.) SRS tanks are routinely sampled to determine inhibitor levels, and additional inhibitors are added if concentrations are not sufficient to prevent corrosion. In addition, the newest tanks (the Type III tanks) were stress relieved (heat-treated to remove residual stresses in the metal introduced during the manufacturing process) to eliminate the high stresses that promote cracking."

Response to comment L-7-12: There is no evidence to support a generalization that tank components in groundwater experience severe corrosion. Sections S.2.3 and 1.1.3 have been changed to read, "Interior photographic inspections have indicated that small amounts of groundwater have leaked into…"

Response to comment L-7-13: The following sentence has been added to the last paragraph in Section S.2.3: "During construction, the Type III tanks were stress relieved (heat treated to remove residual stresses in the metal introduced during the manufacturing process) to eliminate the high stresses that promote stress corrosion cracking."

Response to comment L-7-14: The intent of this paragraph was to illustrate that the environmental impacts of bulk waste removal have been previously analyzed in several EISs. In preparing this HLW Tank Closure EISs, DOE did not "review" these previous EISs, other than to confirm that they addressed the activities associated with bulk waste removal. Therefore, the first sentence of the second paragraph of Section S.2.4 has been revised to state: "DOE has analyzed the environmental impacts of bulk waste removal from the HLW tanks…."

Response to comment L-7-15: The CAB will be provided with the opportunity to review Closure Modules as a matter of regular interaction between DOE and the CAB. Also, see the response to comment L-2-1.

Response to comment L-7-16: The values for curies remaining in the tanks in the "Cumulative Curies Removed" column have been changed to "10^6" in Table S-1 and Table 2-1.

Response to comment L-7-17: The values for curies remaining in the tanks in Table C.3.1-1 represent the values after all waste removal has been completed. The SRS High-Level Waste Tank Closure program is designed such that DOE must remove enough waste from the HLW tank systems so the performance objectives would be met. This is true whether the residual waste is in the tank, the annulus, or piping and ancillary equipment. Therefore, DOE would be obligated to clean the tank annuli to a level at which the performance objectives for a tank would be met. In the case of Tank 16, DOE would remove Cs-137 from the annulus until modeling demonstrated that the performance objectives could be met. For other tanks that have annuli, as part of the tank closure process, DOE would be required to fully characterize any residual material remaining in the annulus. The last sentence of Sections S.2.4 and 2.1 have been revised to clarify this point.

Response to comment L-7-18: Appendix C has been revised to present Table C.3.1-2, which lists the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned.

Response to comment L-7-19: True. This is one of the main reasons DOE prefers the Fill with Grout Option of the Stabilize Tanks Alternative.

Response to comment L-7-20: The value of 2,500 mrem/year is correct for the No Action seepline dose rate at Upper Three Runs Creek. The No Action Alternative assumes that the tank contents are removed but residual waste is available for transport after the tank containment fails. This residual waste results in the high dose observed for this alternative.

Response to comment L-7-21: Further information describing Figure S-7 has been added to Section S.8.2.

Response to comment L-7-22: The word "corrosive" has been deleted in Section 1.1.

Response to comment L-7-23: Section 1.1.3 has been revised as suggested in the comment.

Response to comment L-7-24: The fifth paragraph of the section labeled "tanks" (which discusses the Type III tanks) contains the sentence "None of them has known leak sites." Therefore, no change to the EIS in required.

Response to comment L-7-25: True. The wording in the "Evaporator Systems" sections of Chapter 1, Appendix A and Appendix E were changed to reflect two evaporators in F-Area and three evaporators in H-Area, and indicate that three evaporators are operational.

Response to comment L-7-26: This EIS provides the decision maker with an assessment of the environmental impacts that would provide a discrimination between alternatives. Details of certain impacts are provided by summarizing information from other EISs and providing reference to these other documents. This approach is allowed, in fact recommended in the CEQ regulations at 40 CFR 1502.21.

Response to comment L-7-27: The second paragraph of Section 1.3 has been revised to state that the module will also contain the measured inventory of residual material in the tank at the time of closure and an estimate of the volume of this material.

Response to comment L-7-28: Section 7.1.4 of the EIS presents a discussion of the Environmental Restoration Program and its interactions with the HLW tank closure program.

Response to comment L-7-29: The performance objectives for the HLW tank closure program were developed through an evaluation of all applicable or relevant and appropriate requirements, which is the same process required under CERCLA and RCRA. Therefore, it is unlikely that the performance objectives would be revised during the performance of Environmental Restoration activities.

Response to comment L-7-30: See response to comment L-2-1.

Response to comment L-7-31: The assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned is presented in Table C.3.1-2 of Appendix C. The volume of waste in Tank 20 after spray washing was about 1,000 gallons (P. D. d'Entremont and J. R. Hester, "Characterization of Tank 20 Residual Waste," WSRC-TR-96-0267, March 17, 1997) which also presents the measured radiological and non-radiological composition of the residual material. In each tank, an inventory has been estimated for over 30 radionuclides and many non-radioactive constituents (also in Tables C.3.1-1 and C.3.1-3 of Appendix C). These estimates were compared to the results of analysis of the samples of the residual material and the results showed that the estimates were in good agreement with the sampling results. Section 2.1 of the EIS has been revised to include this reference. Table C.3.1 has been revised to present the average concentration for each listed radionuclide (curies/gallon).

Response to comment L-7-32: Concerns about potential criticality would not preclude using oxalic acid for tank cleaning. However, any use of oxalic acid must be thoroughly evaluated for criticality concerns. This evaluation must be done on a tank-by-tank basis to account for variations in waste characteristics, tank internal geometry, and waste removal technology. The evaluation may result in the identification of additional tank specific controls and/or compensatory measures to ensure prevention of criticality. DOE expects that it would be possible to use oxalic acid safely if it is determined to be necessary, but it is premature to do the detailed analysis necessary to define measures needed to allow its use for specific tanks. A bounding evaluation covering all tanks would not be meaningful and is not necessary to ensure safety. In summary, it is not inconsistent to state that the use of oxalic acid is restricted, yet to assume that it could be used to further clean the tanks.

Response to comment L-7-33: See response to comments L-2-8 and L-14-4 regarding DOE's estimates of the volume and characteristics of the residual material remaining in the closed HLW tanks. As noted in that response, DOE has added Table C.3.1-2, which lists the assumed volume of residual waste in each closed HLW tank if the tanks are cleaned (actual measured volume for Tanks 16, 17, and 20) to Appendix C of the EIS. This new table provides the information requested in the comment and is a more appropriate location for this information than Table 2-1 as suggested in the comment.

Response to comment L-7-34: A new paragraph was inserted at the end of Section 2.1 starting with the sentence "Cleaning of the secondary containment…" It states that: "Most likely, the waste would be removed from the annulus using water and/or steam sprays, perhaps combined with a chemical cleaning agent, such as oxalic acid."

Response to comment L-7-35: The sentence that follows the one referred to by the commenter explains that, "Because nitrates are very mobile in the environment, these large quantities of nitrate would adversely impact the groundwater near the tank farms in the long term," indicating the environmental concern.

Response to comment L-7-36: The environmental impacts of delayed tank closure would be the same as the No Action Alternative impacts in the short term for the duration of the delay. These impacts are described in Section 2.1.4.2. See also response to comment L-7-38.

Response to comment L-7-37: DOE does not intend to conduct demonstrations of known technologies at this time.

Response to comment L-7-38: In the short term, No Action would be equivalent to delayed closure because in both cases the tanks would be managed to protect human health and safety for a period of institutional control, at least during the active operations of other missions at the SRS. The impacts of structural failure of the tanks at 100 years and consequent release of residual waste to the groundwater are described in Section 2.4.2 of this EIS.

Response to comment L-7-39: See response to comment L-7-6. Also, note that these impacts (from the low-activity waste vaults) would occur at the E-Area Vaults Facility, not the tank farm areas.

Response to comment L-7-40: Accidents are described in Section 2.4.1. Additional details are provided in Section 4.1.12 and Appendix B. Those accidents involving natural phenomena, such as a design basis seismic event during cleaning, are assumed to occur during the period of tank closure activities (i.e., at times of active handling of contaminated material). These short-term seismic or other natural phenomena events would not result in higher releases if modeled as part of the long-term impacts. In addition, no credit is given for the structural integrity of the tanks after 100 years (Scenarios 1 and 3) or 1,000 years (Scenario 2 and 4). A seismic event that would be severe enough to fail the tank top, grout and basemat before the postulated failure after 1,000 years would have a very small probability of occurrence (and would be even lower for the 100-year period). Therefore, the risk associated with this accident would be very small compared to the risk from a release that is assumed to occur (probability of 1) after either 100 or 1,000 years.

Response to comment L-7-41: For clarity, the phrase, "with the exception of the safety hazard of collapsed tanks under the No Action Alternative," has been added to the sentence after the word "therefore" in Section 2.4.2.

Response to comment L-7-42: The cited paragraph in Section 2.4.2 has been revised to present the average annual dose that is equivalent to the calculated maximum lifetime dose. This annual dose is then compared to regulatory standards and natural background radiation dose.

Response to comment L-7-43: Comment noted.

Response to comment L-7-44: The existing HEPA-filtered ventilation system would be utilized to the extent practicable during closure activities. This practice would provide an extra margin of safety at minimal extra cost, regardless of the level of internal contamination detected.

Response to comment L-7-45: Long term impacts of the alternatives are described in Section 4.2 of the EIS; in Section 4.1, Short-Term Impacts, only impacts in the short term are discussed. In Section 4.2, impacts of the Clean and Remove alternative in regard to disposal of the tank systems as low-level waste are given by reference to the SRS Waste Management EIS. They are summarized in the third paragraph of Section 4.2 of the EIS.

Response to comment L-7-46: Tables 4.1.10-1 and 10-2 estimate waste generated in the short term by implementation of each of the alternatives. No wastes would be generated because no cleaning would take place under the no action alternative in the short term.

Response to comment L-7-47: Consequences of accidents involving the No Action Alternative have been postulated over the 30-year period covered by short term impacts. Under the No Action Alternative, after bulk removal of waste has occurred (a process that is common to all alternatives and outside the scope of the EIS) the tanks would not be actively managed and an accident involving a natural phenomenon, such as a seismic event, could possibly result in failure of the tank, with concurrent release of contaminants to soil below the tank. Also see the response to comments L-7-40 and L-7-80.

The long-term impacts analysis for No Action assumes that the tanks fail after the 100-year institutional control period, a failure which is not assumed to require an accident initiator. To affect the estimated risk from No Action, any accident that would accelerate such failure would have to be assumed to occur before 100 years. Such an early failure would not contribute significantly to long term risks due to the long transport times in groundwater relative to the assumed 100-year pre-failure period.

Response to comment L-7-48: See the response to comment L-7-45.

Response to comment L-7-49: DOE analyzed the long-term impacts of transport of iron from the HLW tanks in Appendix C of the EIS (see Table C.4.1-19). Tables 4.2.2-6, 4.2.2-7, and 4.2.2-8 present a summary of the detailed analyses in Appendix C.

Response to comment L-7-50: The commenter is correct in that plutonium (and other radionuclides) may not reach the seepline within the 10,000-year period of analysis. As indicated in the response to comment L-3-16 regarding the basis for the 10,000-year period of analysis, this period was chosen to conform to regulatory guidance, and because the value of projecting beyond it is low.

Response to comment L-7-51: Section 4.2.5, "Public Health" is contained within the larger Section 4.2, which is entitled "Long-Term Impacts." Therefore, no change to the title of Section 4.2.5 is necessary.

Response to comment L-7-52: The following new introductory text regarding the scope and purpose of this section has been added: "The purpose of this section is to identify the boundaries (both in space and time) of DOE's cumulative impacts analysis."

Response to comment L-7-53: The reference to the specific company in the Section "Spatial and Temporal Boundaries" of Chapter 5 has been deleted.

Response to comment L-7-54: Table 5-2 presents the offsite impacts of atmospheric emissions. The Composite Analysis presents long-term impacts from releases to groundwater and surface water and is presented in Section 5.7 of the EIS.

Response to comment L-7-55: As described in Section 7.1.1, DOE undertook a comprehensive review of requirements and guidance to identify environmental protection standards. That review is documented in Appendix B of the General Closure Plan (DOE 1996), which was updated in 2000 (DOE 2000). DOE will define tank-specific performance objectives that are consistent with these environmental protection standards. DOE expects the groundwater protection standards to be the most limiting performance objectives for HLW tank system closures. The example cited in Section 7.1.2 (the 4 mrem/year dose limit for beta-gamma radioactivity) is one of these groundwater protection standards (see Table 7-3 of the EIS for other examples). Section 7.1.2 uses the groundwater protection standards to illustrate how the environmental protection standards are used to establish tank-specific performance objectives. Table 7-4 illustrates how the performance objectives would be allocated to individual tanks to ensure that the impacts from all sources affecting a particular media (e.g., groundwater) would comply with the relevant standards. Section 7.1.2 has been revised to present compliance with drinking water standards at the seepline as the example.

Response to comment L-7-56: The second sentence of the second paragraph under Sections A.3.1 and E.2 have been revised to read "The leaked waste is kept dry by air circulation, and, based upon groundwater monitoring results, there is no evidence…."

Response to comment L-7-57: The reference was added to Sections A.3.1 and E.2, and to the list of references for these appendices. See response to comment L-7-65.

Response to comment L-7-58: A reference to the Annual Radioactive Waste Tank Inspection Program has been added.

Response to comment L-7-59: In response to comment L-7-11, a new paragraph describing tank cracking has been added to Section 1.1.3.

Response to comment L-7-60: The word "thee" has been changed to "these."

Response to comment L-7-61: Sections A.3.1 and E.2 have been revised to read, "DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

Response to comment L-7-62: Rather than add a table to the EIS, a reference to the Federal Facility Agreement for the Savannah River Site (EPA 1993) has been added.

Response to comment L-7-63: DOE believes that these sources external to the tanks would not contribute significantly to the dose reported in this EIS for tank closure for the following reasons:

(1) The sizes of these spills are small, compared to the residual tank contents.

(2) The contamination is outside the tanks and would thus transport through the soil and groundwater much more rapidly than those contaminants bound inside the tanks. This would cause their impacts to be noncoincident in time with those from tank closure.

(3) Contamination outside the tanks would be addressed in the CERCLA closure of the tank farm areas. Tank closure and CERCLA closure are being coordinated so that cumulative impacts

are within limits established with SRS regulators through the risk-based closure process. Therefore, if any spill appears to produce a large contribution, it would be remediated until it produces a small contribution.

DOE has revised Sections A.3.1 and E.2 to incorporate this text.

Response to comment L-7-64: As noted in the EIS, the source of information for the first leak was Odum 1976. The source of information for the second is P. D. d'Entremont, "Written Report on Contingency Plan Activation," WSRC-RP-89-259, May 17, 1989. Based on a radiation survey of the soil surrounding the leak site, the leaked mass was estimated to be about 50 pounds, or about 5 gallons. The survey was conducted on April 27, 1989. A reference to this latter study has been added to this paragraph.

Response to comment L-7-65: The reference is W. L. Poe, "Leakage from Waste Tank 16: Amount, Fate, and Impact," DP-1358, 11/74, and was inserted after the sentence ending" . . . Tens of gallons of waste leaked into the soil."

Response to comment L-7-66: The intent of the sentence was not to indicate leaks were unlikely but to indicate that it was unlikely that leaks would be undetected. The paragraph has been expanded as follows: "Because all tanks at SRS have leak detection, it is unlikely that any large leaks have occurred that have not been detected. In eight tanks other than Tank 16, observable amounts of waste have leaked from primary containment into secondary containment. These tanks are managed to ensure that the leaked waste remains dry and immobile. The waste in the annuli of these tanks has been observed carefully over a period of years and minimal movement of the waste has been observed. Other than Tank 16, there is no evidence that waste has leaked from a tank into the soil."

Response to comment L-7-67: See response to L-7-66.

Response to comment L-7-68: True. See response to comment L-7-25.

Response to comment L-7-69: Sections A.3.2, 1.1.3, and E.3 now state "Because of the radioactivity emitted from the waste, the evaporator systems are either shielded (i.e., lead, steel, or concrete vaults) or placed underground."

Response to comment L-7-70: Production capacity can be expressed in overheads production per unit time, feed rate, throughput rate, etc. The EIS was merely giving a sense of the size of the evaporator and thus the volume of the evaporator vessel was used. Section A.3.2 has been extensively revised to provide an updated description of the SRS HLW evaporator systems and no longer presents a specific evaporator capacity.

Response to comment L-7-71: The last sentence of Sections A.3.2 and E.3 have been revised as follows: "…volume by successive evaporation of liquid supernate. This concentrated waste crystallizes into a solid salt cake, which reduces its mobility."

Response to comment L-7-72: The expected inventory of radionuclides after waste removal is shown in Tables C.3.1-1 (total radioactivity) and C.3.1-2 (volume). Table C.3.1-2 was added to the Final EIS to help address concerns such as those expressed in this comment.

Response to comment L-7-73: The first sentence of Sections A.3.5 and E.6 have been revised to state: "The waste streams generated by the F- and H-Area Canyons form insoluble and highly radioactive metal hydroxides (manganese, iron, and aluminum) that settle to the bottom of the waste tanks to form a sludge layer."

Response to comment L-7-74: Section A.4.1 references other EISs that have addressed waste removal from the HLW tanks, the subject of this section. Section A.4.1 then goes on to describe waste removal priorities and techniques. The other EISs do not address heel removal.

Response to comment L-7-75: See response to comment L-5-3.

Response to comment L-7-76: In the third paragraph of A.4.3, reference is made to the Annual Radioactive Waste Tank Inspection Program - 1999 (to support the presence of salt deposits). Past demonstrations have shown that these salts are relatively easily dissolved with water.

As noted in Section A.4.3 of the EIS, the Tank 16 annulus waste contains sand and compounds that formed when the sand mixed with the salt. This mixture makes the waste more difficult to dissolve than if it were purely salt.

Response to comment L-7-77: The following two sentences have been added after the second sentence: "More than 99.9 percent of the original volume of sludge was removed during cleaning (approximately 10 kilograms of solid material was left). Based upon sample results, approximately 830 curies of strontium-90 (the predominant radionuclide) remained."

Response to comment L-7-78: The conceptual design for the Clean and Remove Tanks Alternative is not developed and a definitive description cannot be provided. Because of the high radiation levels, any removal and packaging activities would have to be accomplished remotely. What is provided are advantages and disadvantages inherent to the scope of work that would be required to carry out this alternative so that impacts can be understood.

Response to comment L-7-79: Comment noted. Detailed discussions of specific environmental restoration activities are beyond the scope of this EIS.

Response to comment L-7-80: The different treatment of short-term and long-term impacts of accidents is clarified in the Final EIS in Section 4.1.12 and Section C.1.5 in Appendix C.

The following text was added to Section 4.1.12: "Accidents are explicitly analyzed as part of short-term impacts, and are postulated to occur during the storage, cleaning, transfer, or processing operations conducted prior to final tank closure. While accidents are not considered explicitly as part of the long-term impacts, any accident leading to post-closure tank failure would result in the same long-term impacts described in Section 4.2 and Appendix C."

Also, the following explanation was added to Appendix C as Section C.1.5: "Because the tanks are assumed to fail after either 100 (Scenarios 1 and 3) or 1,000 years (Scenarios 2 and 4), the probability of a release from the tanks is one (i.e., it is assumed that the tank will fail). If an accident severe enough to cause tank failure were to occur before the 100- to 1,000-year post-closure periods, the impacts would not be significantly different than the calculated long-term impacts for the following reasons. First, the probability of such an accident occurring in the first 100 or 1,000 years post-closure would be much smaller than one. Therefore, any impacts from accidents that cause tank failures to occur prior to 100 or 1,000 years would have to be multiplied by this small probability of premature failure. Second, due to the long transport times of the contaminants in groundwater, the difference between the impacts from an early release would be insignificant compared to the calculated impacts based on releases occurring at 100 or 1,000 years."

Response to comment L-7-81: The statements in Section B.2.2 apply to both surface runoff and underground releases only in that accidental releases during operation (30 years) and the subsequent period of active institutional control (100 years) would not result in radiological impacts offsite. Section B.2.2 explains why this is the case. Mitigation actions would prevent offsite human exposures from releases to the surface, and any materials released to subsurface waters during the period of active institutional control would take a long period to reach the potential human receptors. As stated in the last sentence of the first paragraph in this section, the potential long-term consequences of subsurface releases are considered in the EIS assessment of long-term impacts (i.e., in Appendix C). The response to comment L-1-9 discusses the potential long-term impacts of releases to the surface environment under the No Action Alternative. For the action alternatives, surface releases over the long term are not a potential source of impacts because the tanks would be isolated from the surface environment following their closure.

Response to comment L-7-82: Under the No Action Alternative, during the short term, DOE would continue to manage the tank farms, but not close any tanks. This means that normal operations would be conducted in accordance with approved safety analyses. During this period of time, the tanks would not be abandoned, but actively managed to ensure worker and public health and safety. In-tank generation of hydrogen may be an issue in the highly concentrated radioactive waste contained in the tanks prior to bulk waste removal; however, that condition would not exist for the actions in the scope of this EIS. The impacts from each alternative are evaluated assuming bulk removal has already been done. Under these conditions, the amount of hydrogen that could be generated internally would be insufficient to support combustion.

Response to comment L-7-83: For short-term impacts analysis, the impacts of accidents involving temporary losses of containment can be classified as either leaks or spills. The impacts of loss of containment would be bounded by the transfer error scenario (Section B.3.1.2), which would result in a large release of liquid to the environment with subsequent airborne release by evaporation. The last sentence in the first paragraph of Section B.3.1.2 has been revised to state "This scenario would bound all leak/spill events, including loss of containment."

Response to comment L-7-84: Section B.3.1.3 actually addresses vehicle impact. The comment would more appropriately apply to Section B.3.1.5, Seismic Event. Underground releases resulting from seismic events are not separately analyzed because their impacts would be similar to the long-term impacts from tank failures that are considered in Appendix C. Short-term impacts from seismic events are limited to those that cause releases of material to the surface. The fact that it may be unlikely that immediate action would be taken to mitigate the release following a seismic event due to competing priorities is also taken into consideration in the analysis. The last sentence in Section B.3.1.5 starts by stating, "If mitigation measures are not taken..." Also, see the response to comment L-7-80.

Response to comment L-7-85: The failure of the salt solution hold tank would be in fact a liquid release. However, the only pathway for short-term off-site exposure would be through the evaporation of this liquid, as postulated in the scenario. Any portions of the liquid spill that are not cleaned up would contribute to the long-term impacts addressed in Appendix C. There could be some exposure of SRS workers to this spilled salt solution. However, DOE anticipates that the human health consequences would be minimal because of the application of standard radiological control practices, such as posting, monitoring, and access control.

Response to comment L-7-86: Section B.3.2.1 addresses flooding as a potential contributing factor to long-term impacts and directs the reader to the analysis of long-term impacts (contained in Appendix C). While flooding is not explicitly mentioned in Appendix C, it is one of several potential mechanisms that may cause the tanks to fail after 100 years. The tanks are assumed to fail after 100 years (No Action Alternative) or 1,000 years (Stabilize Tanks Alternative) regardless of the initiating event (whether it be seismic, flooding, corrosion, or other mechanism). The analysis of long-term impacts following a tank failure will bound the impacts from tank failures caused by flooding.

Response to comment L-7-87: This paragraph (the third paragraph in Appendix C) has been deleted.

While DOE does not envision relinquishing control of the area in or near the Tank Farms, it recognizes that there is uncertainty in projecting future land use and effectiveness of institutional controls considered in this EIS. For purposes of analysis, DOE assumes direct physical control in the General Separations Area only for the next 100 years. In accordance with agreements with the State of South Carolina and as reflected in the *Industrial Wastewater Closure Plan for F-*

and H-Area High-Level Waste Tank Systems, DOE has calculated human health impacts based on doses that would be received over time at a point of compliance that is at the seepline, about a mile from the tank farms. However, recognizing the potential for exposure to groundwater and the fact that DOE's land use assumptions may be incorrect, DOE has also provided estimates of human health implications of doses that would be received directly adjacent to the boundary of the tank farm. This location is much closer to the tank farm than the point of compliance and the projected doses and consequent health effects are greater. Section 4.2.4 of the EIS describes the long-term land use impacts of the residual radioactive and non-radioactive material in the closed HLW tanks.

Response to comment L-7-88: The intruder was assumed to be a teenager for consistency with EPA Region 4 assessment guidance. All parameter values used in the long-term dose assessment modeling presented in Appendix C are consistent with this assumption.

Response to comment L-7-89: DOE believes that its rationale for not performing analysis for the atmospheric release pathway is valid and appropriate.

Response to comment L-7-90: As described in Section C.2.1.2, the Nearby Adult Resident/Nearby Child Resident are assumed to ingest surface water. To clarify this point, the word "incidental" has been deleted from the sixth bullet in the discussion of receptors.

Response to comment L-7-91: Based on engineering judgement, DOE believes that the assumption of 20% of the inventory in ancillary equipment is conservative. The impacts presented in the EIS include the 20 percent inventory as part of the analysis. Presenting the impacts of the ancillary equipment separately is not appropriate because the tank closure process would close the tank with its ancillary equipment. Section 4.2.2.2 has been revised to more clearly state the assumptions regarding residual material in piping and ancillary equipment.

Response to comment L-7-92: The doses were calculated based on 1,000 gallons of sludge in second-cycle tanks and 100 gallons of sludge in first-cycle tanks. The residual left behind after waste removal is primarily sludge. For example, Tank 20 was a salt receiver that never received sludge, but the residual after waste removal was about 1,000 gallons of a sludge-like material. The 5 curies/gallon number quoted by the Commenter is characteristic of Cs-137 in supernate. Sludge levels of Cs-137 are lower.

Response to comment L-7-93: The Draft EIS Appendix D, Public Scoping summary, has been replaced in the Final EIS with Appendix D, Response to Public Comments (on the Draft EIS). However, as indicated in the Comment Response referred to by the commenter, the EIS discusses potential impacts to a hypothetical resident who consumes fish exposed to contaminants from the tanks in Section 4.1.8 of the EIS. The assumptions regarding the calculations are described in Appendix C.

As the comment response indicated, and the commenter acknowledged, DOE used available information from the closure of Tanks 17 and 20 in preparing the EIS. The information is relevant to several sections of the EIS. Therefore DOE did not consolidate the information in a single section of the EIS. Lessons learned included grout emplacement methods, tank system isolation, and occupational radiation protection.

Drew Grainger

01/23/01 09:53 AM

To: L Ling/DOE/Srs@Srs, John Knox/DOE/Srs@Srs, Howard Gnann/DOE/Srs@Srs
cc: Jeffrey Allison/DOE/Srs@srs
Subject: Comments on DOE/EIS-0303

fyi
----- Forwarded by Drew Grainger/DOE/Srs on 01/23/01 09:54 AM -----

Jim Hardeman
<Jim_Hardeman@mail.dnr.state.ga.us>

01/23/01 09:23 AM

To: nepa@mailhub.srs.gov
cc: andrew.grainger@mailhub.srs.gov
Subject: Comments on DOE/EIS-0303

Rec.
JAN 23 2001
jmk

Thank you for the opportunity to comment on "The Savannah River Site (SRS) High-Level Waste Tank Closure Draft Environmental Impact Statement (EIS), Aiken, South Carolina (DOE/EIS-0303)". Mr. Cliff Blackman of this office has already submitted comments; these comments are supplemental to Mr. Blackman's.

The referenced document, in its current form, is inadequate to determine the acceptability of DOE's proposed action or any of the alternatives. The document does not contain information sufficient to confirm DOE's estimate of residual activity (i.e. "source term"), and independent estimates by this Department indicate that DOE's estimate of residual radioactivity may be low by a factor of 20 or more. For example, a residual of 3,000 gallons of sludge in each tank which currently has a sludge inventory (consistent with tank washing results from Tanks 16 and 17) would result in residual radioactivity some 20 times greater than the estimate presented in the DEIS in Table C.3.1-1 (the only estimate of residual activity presented in the DEIS). This increased source term would result in increased dose to members of the general public, and would call DOE's ability to meet tank closure performance standards into question. L-8-1

The use of oxalic acid to clean waste tanks is treated in an inconsistent manner in the DEIS. On one hand, DOE states that "oxalic acid cleaning of any waste tank is prohibited." (p. 2-2). On the other hand, the DEIS states that "DOE expects that oxalic acid cleaning would be required on tanks that contain first-cycle wastes, the most highly radioactive waste in the tanks". The DEIS should present on a tank-by-tank basis, DOE's estimate of residual radioactivity after bulk removal, bulk removal plus spray water wash, and after oxalic acid spray wash, and long-term dose modeling should be performed for each case. DOE should also include in this analysis significant radionuclides not included in Table C.3.1-1, such as Pu-240, Am-241 and Cm-244, which may increase doses to the general public even further, perhaps by a factor of 100 or more, as indicated in Mr. Blackman's comments. L-8-2

In addition to questioning the source term presented in the DEIS, we question DOE's long term modeling analyses themselves, particularly the assumption that the point of compliance for radionuclides in groundwater is the seepline (i.e. where groundwater seeps out of the ground and into surface streams). By measuring compliance at this point, DOE would de facto preclude the direct use of groundwater for drinking water purposes. The graphic presented in Figure C.1, by not presenting the direct ingestion of contaminated groundwater as a "potential exposure pathway for human receptors" tends to confirm this conclusion. It is unreasonable to conclude that DOE can and will maintain institutional control of the site for the 10,000 year duration of the modeling analysis, and likewise it is unreasonable to exclude direct use of groundwater as an exposure pathway during the 10,000 year modeling timeframe. DOE's proposal for tank closure appears, by using groundwater as a "buffer", to be simply a larger, longer-term version of the use of seepage basins for low-level radioactive waste disposal. That practice is now universally viewed as unacceptable. L-8-3

We welcome the opportunity to review a revised draft EIS which addresses the issues itemized above.

Jim Hardeman, Manager
Environmental Radiation Program
Environmental Protection Division
Georgia Department of Natural Resources
4244 International Parkway, Suite 114
Atlanta, GA 30354
(404) 362-2675 fax: (404) 362-2653
Jim_Hardeman@mail.dnr.state.ga.us

Response to comment L-8-1: DOE believes that the assumed source term values are appropriate for use in this EIS. As discussed in the response to comment L-7-18, Appendix C has been revised to present a table listing the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned. These assumed volume estimates are based on previous experience with closure of Tanks 17 and 20 and on judgments of the effectiveness of the waste removal method. For example, in Tanks 17 and 20, the depth of the solids was estimated at various points in the tank by comparing the sludge level to objects of known height.

The characteristics of this residual sludge were based on knowledge of the processes that generated the waste. It was assumed that the residuals left behind after waste removal would have approximately the same composition as the sludge currently in the tanks. Before each tank is closed, the residual in that tank will be estimated and modeled to ensure that the closure is within requirements. In Tanks 17 and 20, the two tanks that were closed, this was done by separately estimating the volume and composition of the waste, and then combining these two pieces of information to develop tank inventories of each species of interest. A similar procedure will be followed in the future for waste residual in each tank.

Response to comment L-8-2: For use of oxalic acid, see response to comment L-4-23. For residual radioactivity, see response to comment L-8-1.

The radionuclides listed in the comment were included in DOE's long-term fate and transport modeling and are factored in the calculated alpha concentration and total dose values. However, those radionuclides are not listed in Table C.3.1-1 because this table was intended to present those radionuclides that constitute the majority of the calculated radiation dose.

Response to comment L-8-3: While DOE does not envision relinquishing control of the area in or near the Tank Farms, it recognizes that there is uncertainty in projecting future land use and effectiveness of institutional controls considered in this EIS. For purposes of analysis, DOE assumes direct physical control in the General Separations Area only for the next 100 years from the date of tank closure. In accordance with agreements with the State of South Carolina and as reflected in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems*, DOE has calculated human health impacts based on doses that would be received over time at a point of compliance that is at the seepline, about a mile from the tank farms. However, recognizing the potential for exposure to groundwater and the fact that DOE's land use assumptions may be incorrect, DOE has also provided estimates of human health implications of doses that would be received directly adjacent to the boundary of the tank farm. This location is much closer to the tank farm than the point of compliance and the projected doses and consequent health effects are greater. Section 4.2.4 of the EIS describes the long-term land use impacts of the residual radioactive and non-radioactive material in the closed HLW tanks.

The EIS presents results in groundwater downgradient from the tank farms at the 1-meter well, the 100-meter well, and the seepline. The point of compliance at the seepline is based on two factors: (1) the General Separations Area where the tank farms are located precludes residential use as described by the Savannah River Site Land Use Plan and in Section 4.2.4 of the EIS and (2) this point of compliance is agreed upon with the SCDHEC.

Drew Grainger

12/06/00 12:30 PM

To: L Ling/DOE/Srs@Srs, youngp@ttnus.com, John Knox/DOE/Srs@Srs
cc: Donna Martin/WSRC/Srs@Srs
Subject: Tank EIS Comment

Mr. Frank Watters called the toll-free line and wanted to submit comments on the tank EIS. I called him back and discussed the EIS with him.

Mr. Watters said he was one of the "original 17" duPont employees assigned to the Savannah River project in Wilmington in 1951, and was author of the design data report for the tank farms. He worked at SRP from 1953 to 1981, when he retired.

He had one comment:

Add to the list of acronyms HDB and FDB - H Diversion Box and F Diversion Box. They are in the legend for the tank farm drawings but he felt they should be in the acronym list, too. | L-9-1

He had one question, which we should treat as a comment:

There are two parallel waste headers (a redundancy) from the canyons. They are in concrete casements. How will these (and other waste transfer lines) be closed? Would some lines be grouted into the tanks and disposed of that way? | L-9-2

He also observed that he would have picked the preferred alternative as the closure method. | L-9-3

Response to comment L-9-1: The figure has been extensively revised and no longer contains the referenced terms.

Response to comment L-9-2: Closure of these and similar components will be addressed case by case in a specific closure module for each tank. One option would be to flush these transfer lines and grout them in place.

Response to comment L-9-3: Comment noted.

Drew Grainger

01/24/01 01:03 PM

To: L Ling/DOE/Srs@Srs, George Hannah@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Comments - Draft Tank Closure EIS

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 01:05 PM -----

NEPA

01/24/01 12:59 PM

To: Drew Grainger/DOE/Srs
cc:
Subject: Comments - Draft Tank Closure EIS

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: "Ernest S. Chaput" <ESandC@prodigy.net> AT SRS
Date: 01/24/2001 11:49 AM
To: "Andrew R. Grainger" <nepa@mailhub.srs.gov> AT SRS
Subject: Comments - Draft Tank Closure EIS

Forward Header
Subject: Comments - Draft Tank Closure EIS
Author: "Ernest S. Chaput" <ESandC@prodigy.net> at SRS
Date: 1/24/01 11:49 AM

Dear Mr. Grainger:

I have two comments on the Draft Environmental Impact Statement High-Level Waste Tank Closure (DOE/EIS-0303D):

Comment No. 1:

There appears to be an inconsistency in the evaluation of the alternatives. In the preferred "Clean and Stabilize" alternative, it is stated that oxalic acid cleaning could be required on as many as three-quarters of the tanks to meet performance objectives.

For the "Clean and Remove" alternative the document states that cleaning techniques such as oxalic acid might be required to reduce worker exposure during tank removal operations. The draft EIS then states that DOE considers these additional actions are "not technically and economically feasible within the meaning of DOE Order 435.1" because of criticality safety and possible interference with downstream processing activities. L-10-1

It appears that DOE is stating that oxalic acid is acceptable for the preferred grout option but, without explanation, is unacceptable for the removal option. This apparent inconsistency and source of confusion should be corrected. L-10-1

Comment No. 2:

All closure options are predicated upon removing sufficient waste from each tank so that the safety and environmental "performance objectives" will be met. However, the draft EIS does not describe the process by which the amount of waste remaining in each tank (the source term) will be determined - either in volume or curies. It is unclear whether the "source term" will be determined/ estimated by measurement or by analysis without measurement. The EIS should describe the process that will assure that the source term (and follow-on safety and environmental impacts) reflect the actual conditions in each tank prior to closure. L-10-2

Thank you for the opportunity to comment on this draft EIS.

Ernest S. Chaput
108 Cherry Hills Drive
Aiken, SC 29803

803-648-5402

Response to comment L-10-1: See response to comment L-4-23.

Response to comment L-10-2: See response to comment L-7-5.

DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30341-3724

December 18, 2000

Rec.
DEC 22 2000

Andrew R. Grainger, NEPA Compliance Officer
U.S. DOE, Savannah River Operations Office
Building 742A, Room 183
Aiken, South, Carolina 29802

Dear Mr. Grainger:

We have completed our review of the Draft Environmental Impact Statement (DEIS) for the Savannah River Site, High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D), Aiken, SC. We are responding on behalf of the U.S. Public Health Service, Department of Health and Human Services. Technical assistance for this review was provided by Dr. Robert C. Whitcomb, Radiation Studies Branch, National Center for Environmental Health, Centers for Disease Control & Prevention.

This DEIS provides an evaluation of three alternatives regarding the HLW tanks at the SRS. The document appears to be well documented, organized, and referenced. However, there are some inconsistencies in projected doses and risks as reported in tables throughout the document. The recommendations are attached in a memo to me from Dr. Whitcomb. Please consider the attached comments as you prepare the Final EIS. If you should have any questions regarding these technical comments, you may contact Dr. Whitcomb directly at (404) 639-2517.

Thank you for the opportunity to review and comment on this DEIS. Please send us a copy of the Final EIS, and any future environmental impact statements which may indicate potential public health impact and are developed under the National Environmental Policy Act (NEPA).

Sincerely,

Kenneth W. Holt

Kenneth W. Holt, MSEH
National Center for Environmental Health (F16)

attachment

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Centers for Disease Control

Memorandum

Date December 8, 2000

From Robert C. Whitcomb, Jr., Physical Scientist, National Center for Environmental Health, Division of Environmental Hazards and Health Effects, Radiation Studies Branch

Subject Review of the "Savannah River Site, High-Level Waste Tank Closure Draft Environmental Impact Statement" (DOE/EIS-0303D, November 2000)

To Ken Holt, Environmental Health Scientist, Emergency and Environmental Health Services, National Center for Environmental Health

This memorandum provides a review that focuses on the public health consequences associated with several proposed alternatives for closure of 49 high-level waste (HLW) tanks at the Savannah River Site (SRS). This Environmental Impact Statement (EIS) evaluates three alternatives regarding the HLW tanks at the SRS. The three alternatives are to clean and stabilize tanks, clean and remove tanks, or no action. Three options are considered for tank stabilization: Fill with Grout (Preferred Alternative); Fill with Sand; or Fill with Saltstone. Overall, this EIS is well documented, organized, and referenced. However, there are some inconsistencies in projected doses and risks as reported in tables throughout the document. Recommended changes to these inconsistencies would improve the document as follows.

Specific Comments

1. Page 2-12, Table 2-2 Summary comparison of short-term impacts by tank closure alternative.

   The table value for the noninvolved worker dose from the fill with saltstone alternative is 2.6×10^{-3} mrem/yr. L-11-1

   This value should be 2.7×10^{-3} mrem/yr, which is consistent with higher dose estimates from this alternative as listed in Table 4.1.8-1, page 4-17.

2. Page 2-13, Table 2-2 Summary comparison of short-term impacts by tank closure alternative.

   a. The table value for the maximally exposed offsite individual dose from the fill with saltstone alternative is 5.0×10^{-5} mrem/yr. L-11-2

      This value should be 5.2×10^{-5} mrem/yr, which is consistent with summing the dose estimates for both the H-area and F-area tank farms (e.g., 2.6×10^{-5} mrem/yr + 2.6×10^{-5} mrem/yr = 5.2×10^{-5} mrem/yr).

Page 2 – Mr. Ken Holt

b. The table value for the noninvolved worker estimated latent cancer fatality risk from all alternatives is 5.1 x 10^{-5}.

   This value should be 5.3 x 10^{-8} (*a thousand-fold difference*) for the fill with saltstone alternative and 5.1 x 10^{-8} for the other alternatives. This is consistent with summing the dose estimates for both the H-area and F-area tank farms (e.g., 2.6 x 10^{-3} mrem/yr + 2.6 x 10^{-3} mrem/yr = 5.2 x 10^{-3} mrem/yr), multiplying by the number of years to complete the work (24.5) on 49 total tanks at the rate of two tanks per year (e.g., 5.2 x 10^{-3} mrem/yr x 24.5 years = 1.3 x 10^{-1} mrem), converting mrem to rem (e.g., 1.3 x 10^{-1} mrem x 0.001 rem/mrem = 1.3 x 10^{-4} rem), and multiplying by the worker risk coefficient (e.g., 1.3 x 10^{-4} rem x 4.0 x 10^{-4} risk/rem = 5.1 x 10^{-8}). L-11-3

3. Page 2-18, Table 2-3 Estimated accident consequences by alternative.

   The table values for the latent cancer fatalities for the maximally exposed offsite individual are 4.8 x 10^{-5}, 9.6 x 10^{-5}, 1.7 x 10^{-7}, 4.8 x 10^{-5}, and 9.6 x 10^{-5} respectively.

   These values should be 6.0 x 10^{-5}, 1.2 x 10^{-4}, 2.1 x 10^{-7}, 6.0 x 10^{-5}, and 1.2 x 10^{-4}. Apparently, the authors incorrectly used the worker risk coefficient (4 x 10^{-4} risk/rem) for the maximally exposed offsite individual instead of the population risk coefficient (5 x 10^{-4} risk/rem). L-11-4

4. Page 2-23, Table 2-4 Summary comparison of long-term impacts by tank closure alternative.

   The table value for the adult resident latent cancer fatality risk for the fill with grout alternative is 2.0 x 10^{-6}.

   This value differs from the 3.9 x 10^{-7} value listed in Table 4.2.5-2 page 4-49 and Table S-3, page S-23 of the Summary document. Calculating the risk based on a 0.7 mrem dose estimate produces a risk number of 3.5 x 10^{-7} (e.g., 0.7 mrem x 0.001 rem/mrem x 5 x 10^{-4} risk/rem = 3.5 x 10^{-7}). L-11-5

5. Page 2-24, Table 2-4 Summary comparison of long- term impacts by tank closure alternative

   The table value for the adult resident lifetime dose for the fill with grout alternative is 4 mrem.

   This value differs from the 0.7 mrem value listed in Table 4.2.5-2 page 4-49 and Table S-3, page S-23 of the Summary document. L-11-6

6. Page 4-11, Table 4.1.3-5 Annual radionuclide emissions (curies/year) resulting from tank closure activities.

   Annual emission rates (curies/year) are listed for F-Area, H-Area, and the Saltstone Facility for all alternatives.

   Why are only the Saltstone Facility emission rates found in Table S-2, page S-19 in the Summary document? Shouldn't the F-Area, H-Area, and Total emission rates be listed in Table S-2 also? L-11-7

7. Page 4-11, Table 4.1.3-6 Annual doses from radiological air emissions from tank closure activities.

   The table value for the noninvolved worker dose from the fill with saltstone alternative is 2.6 x 10^{-3} mrem/yr.

   This value should be 2.7 x 10^{-3} mrem/yr, which is consistent with higher dose estimates from this alternative as listed in Table 4.1.8-1, page 4-17. L-11-8

8. Page 4-17, Table 4.1.8-1 Estimated radiological dose and health impacts to the public and noninvolved worker from SRS airborne emissions.

   The table values for the latent cancer fatality risk for the maximally exposed offsite individual have exponential values of 10^{-10} for the first two columns and 10^{10} for the remaining columns.

   These exponential values should all be 10^{-10}. L-11-9

9. Page 4-29, Table 4.1.12-1 Estimated accident consequences by alternative.

   The table dose value for the maximally exposed offsite individual from the potential failure of salt solution hold tank (saltstone option only) is 2.1 rem.

   This value probably should be 4.2 x 10^{-4} rem to be consistent with the values listed in Table 2-3, page 2-18 and Table B-3, page B-9. L-11-10

10. Page 4-49, Table 4.2.5-2 Radiological results from contaminant transport from H-Area Tank Farm.

    The table value for the adult resident latent cancer fatality risk for the fill with grout alternative is 3.9 x 10^{-7}.

    This value should be 3.5 x 10^{-7} (e.g., 0.7 mrem x 0.001 rem/mrem x 5 x 10^{-4} risk/rem = 3.5 x 10^{-7}). L-11-11

Response to comment L-11-1: The value in Table 2-2 is correct. The values in Table 4.1.8-1 have been corrected.

Response to comment L-11-2: The value in Table 2-2 is correct. The values in Table 4.1.8-1 have been corrected.

Response to comment L-11-3: The values in Table 2-2 have been updated due to a correction in Table 4.1.8-1.

Response to comment L-11-4: The incorrect risk coefficient was used in the calculation. The correct risk coefficient has now been used and the values have been revised in Table 2-3.

Response to comment L-11-5: The value in Table 2-4 has been corrected.

Response to comment L-11-6: The value in Table 2-4 has been corrected.

Response to comment L-11-7: The original intent was to present the values that discriminate among the alternatives, not to list all of them. However, the total emission rate is more appropriate for this intent and has replaced the values for the saltstone facility in Table S.2.

Response to comment L-11-8: The value in Table 4.1.3-6 is correct. The value in Table 4.1.8-1 has been corrected.

Response to comment L-11-9: The values have been changed to the appropriate order of magnitude in Table 4.1.8-1.

Response to comment L-11-10: The value should be 4.2×10^{-4} rem and has been corrected in Table 4.1.12-1.

Response to comment L-11-11: The value has been corrected in Table 4.2.5-2.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702
(727) 570-5317, FAX 570-5300

January 8, 2001 F/SER4:DR:am

Rec.
JAN 16 2001

Mr. Andrew R. Grainger, NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183 Attn: Tank Closure EIS
Aiken, South Carolina 29802

Dear Mr. Grainger:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Impact Statement (DEIS) for the Savannah River Site High-Level Waste Tank Closure, Aiken, South Carolina (DOE/EIS-0303D). Based on our review, we find that the document sufficiently addresses potential impacts to resources for which we have stewardship responsibilities. Although we are concerned over the possibility of unintentional releases of highly toxic chemicals, it appears that great effort has been devoted to ensuring containment of radioactive and other toxic substances. We further note that the planned action is not expected to cause adverse impacts to wetlands or significant diminution in the quality of surrounding aquatic systems, and it is deemed to be the most environmentally sound and least hazardous means for tank closure. L-12-1

Several agencies, including the NMFS, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and the States of Georgia and South Carolina are jointly and individually examining aquatic resource protection and restoration needs in the Savannah River. These efforts have been initiated as a result of increasing concern over the river's environmental quality and growing recognition of its enormous fishery, natural aesthetic, recreational, power production, and other public interest features. Of particular interest to the NMFS is the river's function as a spawning and nursery site for anadromous fishes including American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), striped bass *(Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), and shortnose sturgeon (*Acipenser brevirostrum*). Because of their migratory nature, these species utilize significant portions of the river, including sections that would be affected by discharges (if any) from the Savannah River Site. Accordingly, any modification in the selected alternative and associated action that could potentially affect these resources should be disclosed. This includes possible release of toxic materials into tributary waters of the Savannah River. L-12-2

Finally, in accordance with the Endangered Species Act of 1973, as amended, it is the responsibility of the appropriate federal regulatory agency to review its activities and programs and to identify any activity or programs that may affect endangered or threatened species or their habitat. If it is determined that these activities may adversely affect any species listed as endangered or threatened, formal consultation with our Protected Species Management Branch must be initiated. The appropriate contact person for matters pertaining to protected species is the Assistant Regional Administrator for Protected Resources who may be contacted at the letterhead address. L-12-3

We appreciate the opportunity to review the subject DEIS and to provide comments. Related questions or comments should be directed to the attention of Mr. David Rackley at our Charleston Area Office. He may be reached at 219 Fort Johnson Road, Charleston, South Carolina 29412-9110, or at (843) 762-8574.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

Response to comment L-12-1: Comment noted.

Response to comment L-12-2: Any potential changes in the HLW tank closure program would be disclosed.

Response to comment L-12-3: Comment noted. As noted in Section 3.4.1, no threatened or endangered species or critical habitat occurs in one near the F- and H-Area Tank Farms.

Drew Grainger
To: L Ling/DOE/Srs@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Additional Comments on DOE/EIS-0303D

01/31/01 09:34 AM

Cc.

----- Forwarded by Drew Grainger/DOE/Srs on 01/31/01 09:37 AM -----

NEPA
To: Drew Grainger/DOE/Srs
cc:
Subject: Additional Comments on DOE/EIS-0303D

01/31/01 09:34 AM

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date: 01/26/2001 08:30 AM
To: nepa@mailhub.srs.gov AT SRS
Cc: Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject: Additional Comments on DOE/EIS-0303D

Forward Header
Subject: Additional Comments on DOE/EIS-0303D
Author: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date: 1/26/01 8:30 AM

Please accept the attached additional EIS comments for review. I apologize for being a couple of days late, but I didn't receive the EIS for review until the end of December.

These comments relate mainly to Kd assumptions used in the MEPAS model. High aluminum values measured in groundwater from E, F, and H Areas suggest a much lower Kd value than used in the model. In addition, the projected groundwater flow from F and H Tank farms to Four Mile Creek will traverse the seepage basins where very low pH values have been reported. This factor, along with the high results for aluminum, suggests that much lower Kd values for soil may apply for groundwater flow south of the water table divide. The implication is that some radionuclides will reach Four Mile Creek sooner, and that higher doses may result, since the radionuclides will not have as much decay time. L-13-1

Other comments relate to possible exponent problems with projected risk calculations (risk > 1E+10) and with possible concentration unit problems for reported concentrations of tritium in groundwater (H-3 = 0.296 mCi/ml in E Area). L-13-2

Thank you for your consideration.

Cliff Blackman (Ga-DNR)

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/25/2001 ... Additional Comments

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

1) Maximally Exposed Offsite Individual Latent Cancer Risk Exponent Problem:

Table 4.1.8-1 reports this risk as $3.1x10^{10}$ for the H-Tank area options. Presumably this is a typo, as this level of risk would probably require an individual to jump into the waste tank! L-13-3

2) Maximum Groundwater Contaminant Concentration Units Problem:

Tables 3.2-3, 3.2-4, and 3.2-5 report the maximum groundwater contaminant concentrations for parameters in excess of the regulatory limit for E-Area, F-Area, and H-Area, respectively. Likewise, Figure 3.2-5 provides a map of these areas with some of the same results listed. However, there may be a typo or else some confusion over units for tritium. The tables provide tritium concentrations in uCi/ml (micro), whereas the map reports tritium concentrations in mCi/ml (milli). For example, Table 3.2-3 indicates that the maximum tritium concentration in E-Area was $2.96x10^{-1}$ uCi/ml, whereas Figure 3.2-5 indicates that the maximum concentration was 0.296 mCi/ml, which would actually be $2.96x10^{+2}$ uCi/ml or 1000 times higher than reported in the table. Presumably the intent was to report in uCi/ml. L-13-4

3) Projected vs Measured Concentrations of Aluminum in Groundwater and Possible Kd Implications:

Table C.4.1-14 provides the MEPA modeled concentration of aluminum in groundwater for all options under consideration. This table suggests that the aluminum concentration will be less than $1x10^{-6}$ mg/L, which is the same as $1x10^{-3}$ ug/L. However, actual groundwater measurements provided in Tables 3.2-3, 3.2-4, and 3.2-5 indicate that the maximum concentrations measured in E, F, and H Areas are currently $3.67x10^{+3}$, $3.7x10^{+4}$, and $1.3x10^{+4}$ ug/L, respectively. Since the modeled results are over 1,000,000 times lower than currently measured values, doesn't that suggest that the soil Kd values for aluminum (and possibly other nuclides) in groundwater in this area must be much lower than the Kd values used in MEPAS as provided in Table C.3.2-1 (35,300)? L-13-5

4) Groundwater Flow Past Seepage Basins with Low pH and Possible Kd Implications:

Figures 3.2-2 and 3.2-3 indicate that groundwater flow from the F and H Tank Farms on the south side of the divide will intercept closed seepage basins en-route to Four Mile Creek. Groundwater testing in these areas indicated very low pH in some monitoring wells (WSRC-TR97-00322 and WSRC-TR98-00312, Groundwater Data Section). Low pH has been linked with lower Kd values for some radionuclides (<10 for Cs and <1 for Sr as provided in DOE/EIS-0082, p. F-12) and, consequently, more mobility and higher concentrations than would otherwise be predicted, down-gradient. How does the MEPAS model account for this phenomenon? L-13-6

Response to comment L-13-1: See response to comment L-13-5.

Response to comment L-13-2: See response to comment L-13-3.

Response to comment L-13-3: The values have been changed to the appropriate order of magnitude in Table 4.1.8-1.

Response to comment L-13-4: The units shown on Figure 3.2-5 for tritium were incorrect and have been revised (all constituents, in addition to tritium, have been checked and revised as needed).

Response to comment L-13-5: The aluminum concentrations detected in groundwater monitoring wells reported in Tables 3.2-3 through - 5 may represent location-specific conditions (e.g., source terms, release mechanisms, soil chemistry, and groundwater sample characteristics [turbidity]) different from general assumptions used in the MEPAS modeling for the HLW tank farms. For instance, the maximum aluminum concentration of 37,100 micrograms/liter reported in Table 3.2-3 for the F-Area occurred in well FSB77 during the 3rd quarter of 1998 sampling. This well is located adjacent to the F-Area seepage basin and a groundwater pH of 3.4 was reported. This low pH is due to the presence of the seepage basin and is not indicative of natural conditions. This very site-specific condition that may locally affect parameters such as K_d should not overshadow the soil and groundwater chemistry along the entire 6,000 foot groundwater flowpath between the F tank farm and the seepline along Four Mile Creek. Therefore, the values reported in the tables for aluminum (and other constituents) measured during groundwater monitoring conducting in 1997 and 1998 do not suggest that the selected K_d value for aluminum (and other constituents) used in the MEPAS modeling are inappropriate.

The K_d value selected to represent aluminum in the aquifer was taken from data for soils with <10% clay and a pH range of 5 to 9. A review of published reports for the General Separations Area containing descriptions of the site geology, the aquifer formations, soil and groundwater chemistry, and previous modeling efforts was the basis for selecting physical and chemical parameter values that DOE believed were representative of the predominant aquifer conditions across the groundwater flow paths at each of the tank farms. The descriptions of numerous soil core samples from borings in the Upper Three Runs aquifer in the General Separations Area, including the F and H Areas, suggests that the average clay content of the aquifer might be higher than 10%. Because K_d values often increase with an increase in clay content, it is possible that an even higher K_d value than the one used in the modeling could be justified. However, because most groundwater flow and contaminant transport will occur in the most transmissive zone of an aquifer, we have used a K_d for aluminum based on a conservatively low clay content of 10% for the aquifer matrix (generally, in porous aquifers, higher transmissivity is associated with lower clay content).

Response to comment L-13-6: The MEPAS model cannot directly account for a change in K_d over the flow path of the groundwater plume. DOE has allowed for such variations by selecting appropriate K_d values for each radionuclide (and nonradionuclide) migrating through the saturated zone (i.e., through which the plume would migrate beneath the seepage basins enroute to Four Mile Creek) that represents the majority of the aquifer material through which the flow occurs. We recognize that some portion of the flowpath may contain altered chemistry (e.g., low pH at the seepage basins), but on the other hand, a portion of the flowpath may contain offsetting chemistry (e.g., higher than average soil pH). K_d values can also be strongly affected by the clay and organic content of the aquifer matrix.

It should also be noted that most groundwater flow and contaminant transport will occur in the most transmissive zone of an aquifer. At the same time, the most transmissive zone allows for the most flushing of the aquifer with upgradient groundwater that has not been impacted by the low pH conditions locally beneath the seepage basins. This suggests that the most transmissive aquifer zone is less affected by any low pH leachate from the seepage basins and that changes to the K_d of the aquifer would be minimized. Wells demonstrating low pH in the vicinity of the seepage basins may not be screened in the most transmissive section of the aquifer.

Please also note that although a combination of site-specific and literature-based sources for the K_d values were used in the MEPAS modeling, the MEPAS data base indicates that the Kd values for the primary contributors to the radiological dose (i.e., Se-79, Tc-99, C-14, and I-129) do not vary with pH, so no adjustment to the K_d values for these constituents would be necessary to model flow beneath the seepage basins. In addition, the major contributor to the radiological dose, Tc-99, has a relatively low Kd value of 0.36 ml/g. Decreasing this already low K_d value by an order of magnitude (i.e., K_d = 0.036 ml/g) would have no effect on the maximum plume concentration (and doses); only the time of the maximum concentration would change from 750 to 737 years.

Finally, because the low pH conditions occur some distance downgradient of the tank farms, there is no potential to increase the release of constituents from the source zone in the bottom of the tanks, and no potential effects on the 1-and 100-meter well concentration predictions.

Drew Grainger
To: John Knox/DOE/Srs@Srs, L Ling/DOE/Srs@Srs
cc:
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

01/24/01 09:49 AM

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 09:51 AM -----

NEPA
To: Drew Grainger/DOE/Srs
cc:
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

01/24/01 09:43 AM

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date: 01/22/2001 10:48 AM
To: nepa@mailhub.srs.gov AT SRS
Cc: Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

____________________ Forward Header ____________________
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D
Author: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date: 1/22/01 10:48 AM

Please accept the attached comments and questions regarding the Draft EIS 0303D ... High-Level Waste Tank Closure. The main concern that I have is that the residual source term appears to be significantly underestimated. This may result in future doses that will be at least 2 orders of magnitude higher than presented in the EIS. L-14-1

The impact of such an underestimate will likely carry over from ground water to the Savannah River, as well. In such a case, drinking water and fish consumption from the Savannah River could be significantly impacted for thousands of years. Georgia and South Carolina cannot afford to ignore such potential impacts. Therefore, additional review is highly recommended prior to finalizing your EIS and closure methodology. L-14-2

It is recognized that the proposed grout-fill option probably represents the most cost-effective and safe method for closure of the tanks, at this time. If lower residual source terms cannot be guaranteed, however, additional barriers may be needed. L-14-3

Thank you for the opportunity to review this document.

Cliff Blackman,
Georgia Department of Natural Resources
404/894-2418 or 404/362-2675

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/22/2001

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

Residual Source-Term Concerns and Potential Consequences:

The long-term dose model appears to be based on an unrealistically low residual source term, as presented in Table C.3.1-1. Thus, the long-term dose estimates presented in the EIS may be at least two orders of magnitude too low. This source term, which was used in modeling the long-term consequences, represents only a fraction of the DOE figure-of-merit, achievable goal (1 – 2 % residual) spelled out in DOE/EIS-0303D (p 2-3). The residual term listed in Table C.3.1-1 is equivalent to 0.04% of the Sr-90 tank inventory, 0.2% of the Tc-99, 0.01% of the Cs-137, and 0.1% of the Pu-238 tank inventory, as derived from Table 3.3 of DOE/EIS-0082, WSRC-RP-92-250 (p 3-13), WSRC-RP-92-984 (p 3-23), and WSRC-RP-92-879-Rev 1 (p 3-19). In addition, source terms were not provided for several other significant, long-lived radionuclides that were reported to be in the waste tanks, including Pu-240, Am-241, and Cm-244. L-14-4

The use of the low EIS source term appears to be dependent on the use of oxalic acid for final wash and rinse. It should be noted that, based on the Bradley and Hill (1977) study of chemical dissolution of high level waste tank sludge, the highest dissolution achieved was 70% with well-mixed sludge. Assuming that this represents the best-case recovery, then the residual in Tank 16, after oxalic acid wash, may be higher than reported in Table 2-1. Since 6.0E+04 Ci was reportedly removed at this stage, a 70% recovery would suggest that as much as 2.6E+04 Ci or 0.9% of the initial 2.82E+06 Ci bulk in the tank may remain. This represents a much higher residual percentage than Table C.3.1-1, consistent with the DOE figure of merit (1-2 % residual). Therefore, lower residual fractions should not be assumed, unless adequate in-situ (in-tank) assays can demonstrate otherwise. L-14-5

Even if a lower residual can be demonstrated, oxalic acid is currently not approved without further criticality studies. Therefore, it's use should not be considered in the current EIS, especially since a criticality accident scenario was not included in the Accident Analysis (Appendix B) portion of the EIS. If later studies approve it's use, then an amended EIS can be generated, assuming that the interior of the tank is still accessible. The current EIS indicates that DOE considers bulk removal with spray washing (98% to 99% curie removal) as the limit of what is economically and technically practicable (P 2-3). Based on this statement and on Tank 16 experience, a 2 % residual should, therefore, be assumed. Using a 2% residual, the EIS residual inventory should be amended as follows: L-14-6

Radionuclide	EIS Source Term (Ci)	Proposed Amended Source Term (Ci)	Basis
Tc-99	4.9E+01	4.0E+02	DOE/EIS-0082 Table 3-3
Sr-90 (F+H)	1.6E+05	8.4E+06	WSRC-RP-92-984 p 3-23
Cs-137 (F+H)	9.9E+03	3.9E+06	WSRC-RP-92-250 p 3-13
Pu-238 (H)	1.7E+03	3.2E+04	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-239 (F+H)	1.5E+02	4.4E+02	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-240	Not Listed	2.2E+02	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-241	Not Listed	1.7E+04	WSRC-RP-92-879-Rev 1 Table 3-7
Am-241	Not Listed	2.2E+03	WSRC-RP-92-879-Rev 1 Table 3-7 ... estimated in-growth from Pu-241, prior to 20-year decay
Cm-244	Not Listed	1.2E+03	DOE/EIS-0082 Table 3-3
Other Nuclides	---	No Change	

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure ... cont.

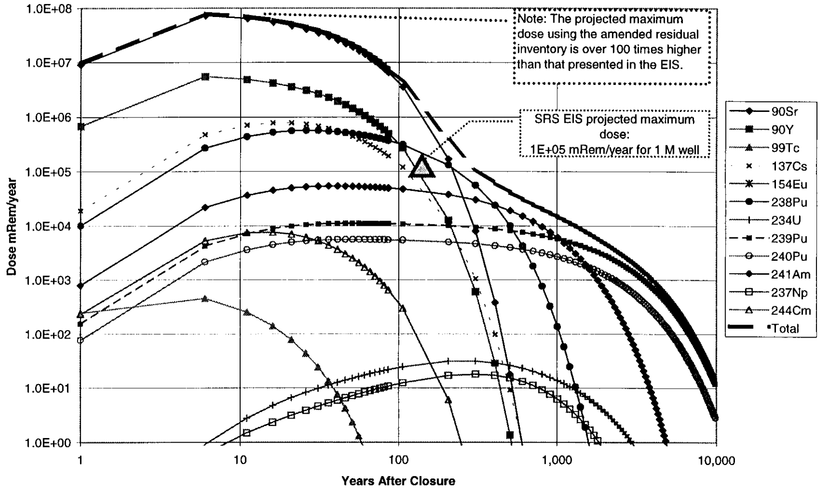
1/22/2001

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

Of course, the Cs-137 residual inventory cannot be very well defined, at this stage, since the in-tank precipitate process has not worked. This leaves the fate of this material and residual inventory in question, at this time. A supplemental EIS for this process is currently under review, accordingly (p 1-14, 1-15 of DOE/EIS-0303D). It would appear that the lack of a good source term for Cs-137 could pose a significant problem, especially if high residuals (> 10%) are left. L-14-7

Using the above-proposed amended source term, the projected long-term doses and consequences should be re-evaluated. An initial dose projection using the D&D code (NRC) suggests that long-term dose may be underestimated by at least a factor of 100, as illustrated below for the 1-meter well scenario. Similar underestimates would apply for the 100-meter well, seepline, and surface water scenarios. If this is the case, then more thought should be given to improved closure options, and additional modeling would be in order. Of the options presented in the EIS, the tank closure with grout option still appears to be the most effective choice. Unless the residual can be improved, however, additional costs may be justified, in order to mitigate future consequences to groundwater and the Savannah River. L-14-8

Projected 1-M Well Drinking Water Doses for Tank Farm Closure With Amended Residual Inventory and Grout Option



Note: The projected maximum dose using the amended residual inventory is over 100 times higher than that presented in the EIS.

SRS EIS projected maximum dose: 1E+05 mRem/year for 1 M well

2

Response to comment L-14-1: See response to L-14-4.

Response to comment L-14-2: See response to L-14-8.

Response to comment L-14-3: See response to L-14-8.

Response to comment L-14-4: DOE believes that the assumed source term values are appropriate for use in this EIS. As discussed in the response to comment L-2-8, Appendix C has been revised to present Table C.3.1-2, which lists the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned. Table C.3.1-1 has been revised to present the average concentration for each listed radionuclide (curies/gallon). These assumed volume estimates are based on previous experience with closure of Tanks 17 and 20 and on judgments of the effectiveness of the waste removal method. For example, in Tanks 17 and 20, the depth of the solids was estimated at various points in the tank by comparing the sludge level to objects of known height. These volume estimates (which typically are 100 or 1,000 gallons of sludge remaining in the closed tank) are not derived from applying the "figure-of-merit" referred to in the comment.

The characteristics of this residual sludge were based on knowledge of the processes that generated the waste. It was assumed that the residuals left behind after waste removal would have approximately the same composition as the sludge currently in the tanks. Before each tank is closed, the residual in that tank will be estimated and modeled to ensure that the closure is within requirements. In Tanks 17 and 20, the two tanks that were closed, this was done by separately estimating the volume and composition of the waste, and then combining these two pieces of information to develop tank inventories of each species of interest. A similar procedure will be followed in the future for residual waste in each tank.

Response to comment L-14-5: While it is true that oxalic acid cannot completely dissolve sludge, dissolving the sludge is not required to remove it. The hydraulic slurry techniques used to remove wastes from SRS waste tanks were designed to slurry and hydraulically convey solids out of the tank. The residuals remaining at the end of waste removal would be either (1) large, fast-settling particles that were not pumped out of the tank or (2) particles in difficult-to-reach locations where the liquid velocity was too low to suspend them. Oxalic acid loosens the particles and causes them to crumble, so that the larger particles can be removed, and particles can be dislodged from most difficult-to-reach locations. Admittedly, experience with oxalic acid cleaning is limited to one tank at SRS, Tank 16. See response to comment L-14-4 regarding DOE's assumed residual material volumes.

Response to comment L-14-6: See response to comment L-4-23.

Response to comment L-14-7: The residual material remaining in the closed HLW tanks would be composed of sludge. The quantity and characteristics of residual sludge depends on the completeness of bulk waste removal and cleaning, if necessary. It would be unaffected by decisions made regarding processing of the salt and supernate components of the waste.

Response to comment L-14-8: As discussed in the response to comment L-14-4, DOE believes that the assumed source term values are appropriate for use in this EIS. Therefore, additional long-term dose and consequence analysis is not necessary.

Drew Grainger

01/24/01 10:36 AM

To: John Knox/DOE/Srs@Srs, L Ling/DOE/Srs@Srs, George Hannah@Srs
cc:
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 10:37 AM -----

NEPA

01/24/01 10:13 AM

To: Drew Grainger/DOE/Srs
cc:
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date: 01/24/2001 09:59 AM
To: nepa@mailhub.srs.gov AT SRS
Cc: Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)

Additional comments from GDNR I just received.

______________________________ Forward Header ______________________________
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)
Author: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date: 1/24/01 9:59 AM

Please accept for review the additional EIS comments contained in the attachment. These comments relate to enhanced groundwater contaminant transport in the water table on the south side of the H-Area, and a possible relationship between a previously unknown fault (H-Fault) and highly permeable channels that reportedly transport a majority of this water to Four Mile Creek.

Thank you for the opportunity to review this EIS.

Cliff Blackman
Georgia Dept. of Natural Resources, Env. Radiation Program
cliff.blackman@oip.gatech.edu
404/894-2418 or -3776 (voice)
404/894-3828 (fax)

(See attached file: Tank_Rev2.doc)
- Tank_R~1.doc

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/24/2001 ... Additional Comments

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

H-Area (H-Fault and Channels) Hydro-Geologic Concerns:

Section 3.1.3 (Seismicity) and Figure 3.1.1 (map of seismic fault lines) of EIS-0303D indicate the presence of a previously unknown fault (H-Fault ... for lack of another name) that passes through the southeastern corner of H-Area (Wike et al. 1996, WSRC-TR-96-0279 Rev. 1, p4-14). Previous hydrogeological studies of Sr-90 transport (Carlton et al., WSRC-RP-92-984) in this same area of SRS (Four-Mile Creek side of the water table divide) report that "much of the groundwater flow in this area of the plant appears to occur in narrow, high permeability channels in the sediments." It was suggested that the majority of the flow of underground contaminants entering the water table in this portion of H-Area follow these channels to outcrop into Four-Mile Creek. A similar study of Cs-137 transport (Carlton et al., WSRC-RP-92-250, p4-11) suggests "facilitated transport is taking place in this locality." L-15-1

The overlapping presence of H-Fault and the narrow, highly permeable channels are likely interconnected, and thus provide a mechanism to facilitate future movement of contaminants from H-Area Tanks to Four-Mile Creek. Since several H-Area tanks (including 9 through 12) are reported to be in the water table (p.1-7 of EIS-0303D), contaminants from these tanks are likely to move rapidly through these channels to Four Mile Creek, once the bottom of these tanks corrode. This is likely to occur within 100 years, in which case the Sr-90 could pose a significant problem for consumption of surface water and fish from Four-Mile Creek and from the Savannah River. Current problems with Sr-90 in Four-Mile Creek would be insignificant compared to what could reach this creek in the future. Given the enhanced transport mechanism identified, provisions need to be made to insure that Sr-90 does not reach the water table in this area, at least until after 200 years. Possible facilitated transport of longer-lived contaminants (Pu-238, Pu-239, Am-241, etc.) in this area should also be reviewed in the MEPAS model presented in the EIS. L-15-2

Response to comment L-15-1: The offsets and displacements of the "H-Fault" are at a far greater depth than the solution channels around the seepage basins that can produce "facilitated transport."

Response to comment L-15-2: The channels causing "facilitated transport" occur in the vicinity of the F and H Area seepage basins, where very acidic water released into the sediments dissolved some of the soil constituents. Such dissolution channels do not occur in the area around the F- and H-Area Tank Farms. Transport from the tank farm areas would be through intact sediments for the greatest part of the flow paths.

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

January 11, 2001

Rec.
JAN 16 2001

ER-00/840

Andrew R. Grainger, NEPA Coordinator
U.S. Department of Energy, Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

ATTN: Tank Closure EIS

Dear Mr. Grainger:

The Department of the Interior has reviewed the draft Environmental Impact Statement for the High Level Waste Tank Closure at the Savannah River Site, Aiken, SC as requested. We have no comments to offer at this time. L-16-1

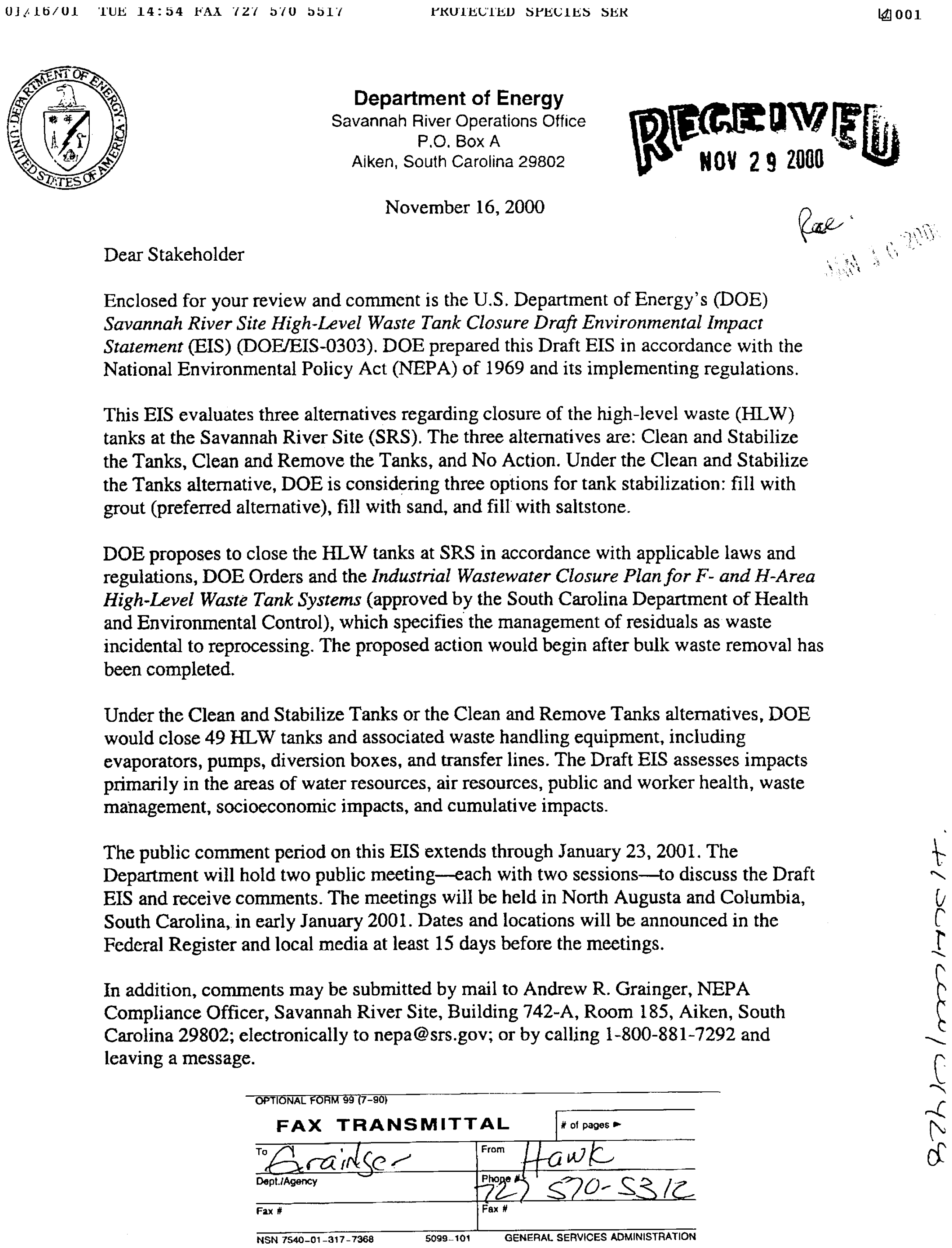
Thank you for the opportunity to review and comment on this draft EIS.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

Response to comment L-16-1: Comment noted.



01/16/01 TUE 14:54 FAX 727 570 5517 PROTECTED SPECIES SER ☑001

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

RECEIVED
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November 16, 2000

Rec'd

Dear Stakeholder

Enclosed for your review and comment is the U.S. Department of Energy's (DOE) *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement* (EIS) (DOE/EIS-0303). DOE prepared this Draft EIS in accordance with the National Environmental Policy Act (NEPA) of 1969 and its implementing regulations.

This EIS evaluates three alternatives regarding closure of the high-level waste (HLW) tanks at the Savannah River Site (SRS). The three alternatives are: Clean and Stabilize the Tanks, Clean and Remove the Tanks, and No Action. Under the Clean and Stabilize the Tanks alternative, DOE is considering three options for tank stabilization: fill with grout (preferred alternative), fill with sand, and fill with saltstone.

DOE proposes to close the HLW tanks at SRS in accordance with applicable laws and regulations, DOE Orders and the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (approved by the South Carolina Department of Health and Environmental Control), which specifies the management of residuals as waste incidental to reprocessing. The proposed action would begin after bulk waste removal has been completed.

Under the Clean and Stabilize Tanks or the Clean and Remove Tanks alternatives, DOE would close 49 HLW tanks and associated waste handling equipment, including evaporators, pumps, diversion boxes, and transfer lines. The Draft EIS assesses impacts primarily in the areas of water resources, air resources, public and worker health, waste management, socioeconomic impacts, and cumulative impacts.

The public comment period on this EIS extends through January 23, 2001. The Department will hold two public meeting—each with two sessions—to discuss the Draft EIS and receive comments. The meetings will be held in North Augusta and Columbia, South Carolina, in early January 2001. Dates and locations will be announced in the Federal Register and local media at least 15 days before the meetings.

In addition, comments may be submitted by mail to Andrew R. Grainger, NEPA Compliance Officer, Savannah River Site, Building 742-A, Room 185, Aiken, South Carolina 29802; electronically to nepa@srs.gov; or by calling 1-800-881-7292 and leaving a message.

4/SCH/0000/01428

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ►

To Grainger	From Hawk
Dept./Agency	Phone # 727 570-5312
Fax #	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

In preparing the Final EIS, DOE will consider all comments transmitted or postmarked by January 23, 2001. Comments submitted after this date will be considered to the extent practicable. DOE expects to issue the Final EIS in early 2001 and to issue a Record of Decision on SRS tank closure no sooner than 30 days after the Final EIS is issued. Thank you for your interest in the Department's activities.

Sincerely,

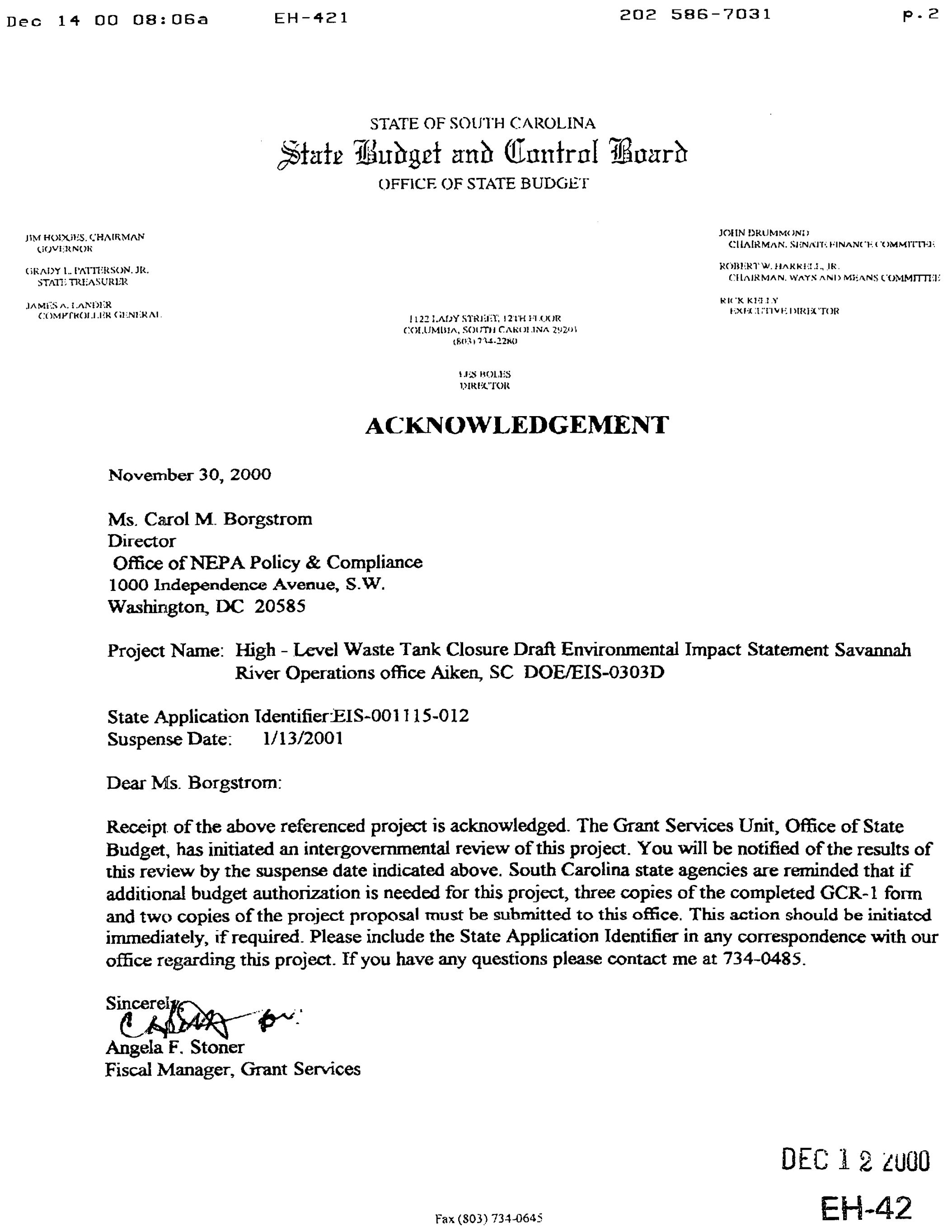
Andrew Grainger
NEPA Compliance Officer

Enclosure:
Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement

THE PROPOSED ACTION IS NOT LIKELY TO ADVERSELY AFFECT LISTED ENDANGERED OR THREATENED SPECIES OR DESIGNATED CRITICAL HABITAT PROTECTED BY THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED. L-17-1

SECTION 7 COORDINATOR
NATIONAL MARINE FISHERIES SERVICE
SOUTHEAST REGIONAL OFFICE
ST. PETERSBURG, FLORIDA
DATE: Dec-22, 2000

Response to comment L-17-1: Comment noted.



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LES BOLES
DIRECTOR

ACKNOWLEDGEMENT

November 30, 2000

Ms. Carol M. Borgstrom
Director
Office of NEPA Policy & Compliance
1000 Independence Avenue, S.W.
Washington, DC 20585

Project Name: High - Level Waste Tank Closure Draft Environmental Impact Statement Savannah River Operations office Aiken, SC DOE/EIS-0303D

State Application Identifier:EIS-001115-012
Suspense Date: 1/13/2001

Dear Ms. Borgstrom:

Receipt of the above referenced project is acknowledged. The Grant Services Unit, Office of State Budget, has initiated an intergovernmental review of this project. You will be notified of the results of this review by the suspense date indicated above. South Carolina state agencies are reminded that if additional budget authorization is needed for this project, three copies of the completed GCR-1 form and two copies of the project proposal must be submitted to this office. This action should be initiated immediately, if required. Please include the State Application Identifier in any correspondence with our office regarding this project. If you have any questions please contact me at 734-0485. L-18-1

Sincerely,

Angela F. Stoner
Fiscal Manager, Grant Services

DEC 12 2000
EH-42

Fax (803) 734-0645

Response to comment L-18-1: Comment noted.

D.3 Public Meeting Comments and DOE Responses

The public meetings consisted of brief presentations by DOE on the Draft EIS, followed by a question and answer and comment period. Court reporters documented comments and statements made during these public meeting sessions. In the sessions, eight individuals had questions, provided comments, or made public statements.

In this section, each public speaker's statement is placed in context and paraphrased because some statements are dependent on previous statements and interspersed with other discussion. The transcripts from the meetings can be reviewed at the DOE Public Reading Rooms: DOE Freedom of Information Reading Room, Forrestal Building, Room 1E-190, 1000 Independence Avenue, S.W., Washington, D.C., 20585, Phone: 202-586-6020 and DOE Public Document Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, 171 University Parkway, Aiken, SC 29801, Phone: 803-648-6815.

Paraphrased comments from the meetings and DOE's responses are as follows:

M-01: The commenter asked if the EIS evaluated the potential re-use of the Tank Farm area as a brownfield site, which might be available for other future uses.

Response: As noted in the *Savannah River Site Future Use Plan*, DOE plans to continue active institutional control over the land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) as long as necessary to protect the public and the environment. Future industrial uses of this area would not be precluded as a result of tank closure actions, but DOE does not expect to consider nonindustrial uses. [The EIS does evaluate the potential long-term impacts of other future uses of the tank farm areas, by calculating radiation doses to persons obtaining drinking water from wells located 1 meter and 100 meters downgradient from the tank farm boundaries.]

M-02: The commenter asked if there were there any disposal ramifications connected with oxalic acid. The commenter further asked if there was a product other than oxalic acid that could be used to remove the residual material in the tanks.

Response: Extensive use of oxalic acid cleaning may result in conditions that, if not addressed by checks within the Defense Waste Processing Facility (DWPF) feed preparation process, could allow carryover of sodium oxalate to the vitrification process. The presence of oxalates in the waste feed to DWPF that would result from oxalic acid cleaning would adversely affect the quality of the HLW glass produced at DWPF. To prevent that from occurring, special batches of the salt treatment process would be scheduled, in which the sodium oxalate concentrations would be controlled to not exceed their solubility limit in the low-radioactivity fraction.

Section 2.1 of the EIS cites an earlier DOE study that led to the selection of oxalic acid as the preferred chemical cleaning agent. The study examined cleaning agents that would not aggressively attack carbon steel and were compatible with HLW processes. The studies included tests with waste simulants and also tests with actual Tank 16 sludge. The agents tested were disodium salt EDTA, glycolic acid, formic acid, sulfamic acid, citric acid, dilute sulfuric acid, alkaline permanganate, and oxalic acid. None of these agents completely dissolved the sludge, but oxalic acid was shown to dissolve about 70 percent of the sludge in a well-mixed sample at 25° C, which was the highest of any of the cleaning agents tested.

M-03: The commenter asked if the Clean and Remove Tanks Alternative would result in making the Tank Farm area more favorable for potential future uses.

Response: Under the Clean and Remove Tanks Alternative, the tanks would be cleaned to the extent of allowing the steel tank components to be cut up, removed, and transported to SRS radioactive waste disposal facilities. DOE would then backfill the excavations left after tank removal. As noted in the response to comment M-01, future industrial uses of this area would not be precluded as a result of tank closure actions, but DOE does not expect to consider non-industrial uses. [As discussed in Section S.8.2, the Clean and Remove Tanks Alternative would have somewhat less impact on future land use because the tank systems would be removed.]

M-04: The commenter asked if the long-term impact analysis was based on standard EPA drinking water assumptions (i.e., two liters per day). Also, for the 1-meter and 100-meter wells, do the impacts assume a direct use of groundwater?

Response: The long-term impact analysis assumed a water ingestion rate of two liters per day. The impacts presented in the EIS for the 1-meter and 100-meter wells were based on direct consumption of the groundwater from hypothetical wells at these locations. Other assumptions are described in Appendix C.

M-05: The commenter asked where does Fourmile Branch eventually flow to.

Response: The water in Fourmile Branch flows directly to the Savannah River.

M-06: The commenter asked, for the Clean and Remove Tanks Alternative, if the removed tank components would be disposed in the SRS E-Area vaults.

Response: The removed tank components would be transported to SRS radioactive waste disposal facilities (assumed to be the E-Area Vaults) for disposal.

M-07: The commenter asked if the stabilizing material (i.e., grout, sand, or saltstone) would also be emplaced in the tank annulus.

Response: For those tank types that have annuli, in addition to cleaning the tanks, DOE would also clean and backfill the annulus with a stabilizing material (uncontaminated grout in the Fill with Saltstone Option). [Section 2.1.1. has been revised to clarify this point.]

M-08: The commenter asked if, after tank closure has been completed, the Tank Farm area would be considered a brownfield site that is available for other uses, or would it be left in an unusable state. The commenter further asked what DOE envisions the area will look like when tank closure activities have been completed (i.e., would the area be flat, would it be covered with a clay cap, would it be asphalted).

Response: As noted in the *Savannah River Site Future Use Plan*, land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) as long as necessary to protect the public and the environment. Future industrial uses of this area would not be precluded as a result of tank closure actions. [The EIS does evaluate the potential long-term impacts of other future uses of the tank farm areas, by calculating radiation doses to persons obtaining drinking water from wells located 1-meter and 100-meters downgradient from the tank farm boundary]. The area may be capped or an in situ groundwater treatment system may be installed. The necessity for a low-permeability cap, such as a clay cap, over a tank group to reduce rainwater infiltration would be established in accordance with the environmental restoration program described in the Federal Facility Agreement. 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.

M-09: The commenter asked what is the regulatory scheme once a tank has been closed. The commenter asked if it would be regulated as a low-level waste under South Carolina law. The commenter further asked what implications the regulatory scheme would have on the proposed administrative control over the Tank Farm area. Does the EIS assume that the federal government maintains administrative control over the site for the entire 10,000-year period of analysis?

Response: The residual material would be managed as low-level waste consistent with the requirements of DOE Order 435.1, "Radioactive

Waste Management." As noted in the *Savannah River Site Future Use Plan*, the land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) will be considered in the industrial use category. Consequently, DOE plans to continue active institutional control for those areas as long as necessary to protect the public and the environment. [The future land use of the tank farm area would not be affected by regulations governing the tank closure program or by the choice of a tank closure alternative. In addition, over the 10,000-year period of analysis in the EIS, DOE does not envision relinquishing control of this area. However, DOE recognizes that there is uncertainty in projecting future land use and effectiveness of institutional controls considered in this EIS. For purposes of analysis, DOE assumes direct physical control in the General Separations Area only for the next 100 years.]

M-10: The commenter asked if, for all of the tanks, DOE's preference is to leave them in the ground and fill them with grout.

Response: DOE's preferred alternative is the Fill with Grout Option under the Stabilize Tanks Alternative. Before each individual tank is closed, DOE will prepare a tank-specific closure module for that tank.

M-11: The commenter asked what DOE would do if, in the course of performing waste removal on the single-shell tanks, a leakage of waste is found that has moved beneath the tank. The commenter expressed the desire that DOE then consider removal of that tank.

Response: If, during the closure process, DOE were to discover a leaking tank, DOE would identify the location of the leak and take immediate action to stop the leak (e.g., remove the waste to below the level of the leak). DOE would then re-evaluate the closure plans for that tank. Depending on the ability of cleaning to meet the performance requirements for a given tank, the decision maker may elect to remove a tank if it is not possible to meet the performance requirements by another method. Only one tank (Tank 16) has leaked waste to the environment. In Tank 16, the waste overflowed the annulus pan (secondary containment) and a few tens of gallons of waste migrated into the surrounding soil, presumably through a construction joint in the concrete encasement. Waste removal from the Tank 16 primary vessel was completed in 1980.

M-12: The commenter stated that, over a period of time, these tanks rust away anyway. The commenter noted that, if these tanks were to rust away, this would get rid of them.

Response: The situation described by the commenter is equivalent to the No Action Alternative evaluated in the EIS. In the assessment of that alternative, DOE assumes that, at some point in the future, the tank top, grout, and basemat would fail, with a corresponding increase in their respective hydraulic conductivities. The long-term impacts of No Action are reviewed in the EIS. In accordance with the Federal Facility Agreement, DOE intends to remove the tanks from service as their missions are completed. For 24 tanks that do not meet the EPA's secondary containment standards, DOE is obligated to remove the tanks from service by 2022.

M-13: The commenter asked if a Record of Decision were to be issued that says that DOE will stabilize the tanks with grout, is there then nothing that would preclude, on a case-by-case basis, removing a given tank.

Response: In the Draft EIS, DOE examined the impacts of both tank removal and grouting in-place. Depending on the ability of cleaning to meet the performance requirements for a given tank, the decision maker may elect to remove a tank if it is not possible to meet the performance requirements by another method. This EIS captures the environmental and health and safety impacts of both options.

M-14: The commenter asked why the long-term dose at the 1-meter well for H Area is substantially higher than for F Area.

Response: In the H-Area Tank Farm north of the groundwater divide, most of the calculated radiation dose at the 1-meter well is attributable to Tanks 9 through 12. Those four tanks are submerged in the water table aquifer; thus, the transport of contaminants is driven by horizontal infiltration of groundwater rather than vertical infiltration of rainwater, causing the rapid transport of contaminants (i.e., before they can decay) to nearby locations such as the 1-meter well.

M-15: The commenter noted that, for the Fill with Saltstone Option, the EIS presents a radiation dose value of 1,800 person-rem. The commenter asked what time period that exposure represented (i.e., is it over 10,000 years or one lifetime). The commenter further asked about the radiation dose to the downstream consumers of water from the Savannah River.

Response: The short-term impacts were evaluated over a 30-year time frame. The value cited by the commenter represents the collective radiation dose to the workers doing the tank closure activity (i.e., over that period of time that it takes to close all 49 tanks). The downstream drinking water numbers for people consuming Savannah River water over the long term are also presented in the EIS (Table 4.2.5-3).

M-16: The commenter stated that there are many sources other than the Tank Farms in the General Separations Area that could impact the same groundwater and surface water. These include the canyons, the old radioactive waste burial ground, and the Mixed Waste Management Facility. The commenter asked if these sources are all covered under the same 4 millirem/year performance objective.

Response: In the HLW tank closure process, DOE considers all other non-tank sources within the Groundwater Transport Segment (GTS) applicable to the Tank Farm tanks. The combined impacts of all sources in the GTS must be below the performance objective. [Section 5.7 of the EIS discusses the long-term impacts of non-tank sources.]

M-17: The commenter asked if there was a schedule for the Final EIS. The commenter asked if this Final EIS schedule would impact the schedule for closure of Tank 19.

Response: DOE intends to issue a Final EIS in October 2001 and a ROD by November 2001. This will not impact the Tank 19 closure schedule, which is required by the Federal Facility Agreement to be closed by Fiscal Year 2003. [This schedule was DOE's stated intention as of January 2001.]

M-18: The commenter asked for further description of saltstone. The commenter further asked if SRS has previously produced or disposed of any saltstone.

Response: Saltstone is a low-activity waste that is produced at SRS. It is an evaporated low-radioactivity waste, which is mixed with cement, slag, and fly ash to produce a grout. The grout, which contains large concentrations of nitrates, is then poured into concrete vaults. In this EIS, this material is being considered as a potential tank stabilization material. The SRS Saltstone Manufacturing and Disposal Facility began operations in 1990 and operated until 1998 (when it was shut down for lack of feed material). During this period, saltstone was emplaced into two saltstone disposal vaults. The current plan is for this facility to resume operations in 2002.

M-19: The commenter expressed a concern regarding the potential impacts that new SRS missions might have on the amount of HLW generated and stored in the Tank Farms. The commenter was concerned about how this additional waste could affect the HLW tank closure process. The commenter also asked about what tank closure activities have occurred since 1996.

Response: The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the Tank Farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document. This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document. [Section 4.1.10.1 of this EIS does consider the potential impacts of tank closure alternatives on HLW volumes.]

The process of preparing to close tanks began in 1995. DOE prepared the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* that describes the general protocol for closing the tanks. This document (referred to as the General Closure Plan) was developed with extensive interaction with the State of South Carolina and EPA. Concurrent with the General Closure Plan, DOE prepared the *Environmental Assessment for the Closure of the High* Level *Waste Tanks in F- and H-Areas at the Savannah River Site*. In a Finding of No Significant Impact published on July 31, 1996, DOE concluded that closure of the HLW tanks in accordance with the General Closure Plan would not result in significant environmental impacts.

Accordingly, DOE began to close Tank 20, from which the bulk waste had already been removed. In accordance with the General Closure Plan, DOE prepared a tank-specific closure plan that outlined the specific steps for Tank 20 closure and presented the long-term environmental impacts of the closure. The State of South Carolina approved the Closure Module, and Tank 20 closure was completed on July 31, 1997. Later in 1997, following preparation and approval of a tank-specific Closure Module, Tank 17 was closed.

DOE decided to prepare this EIS before any additional HLW tanks are closed at SRS. This decision is based on several factors, including the desire to further explore the environmental impacts from closure and to open a new round of information sharing and dialogue with stakeholders. SRS is committed in the Federal Facility Agreement to close another HLW tank by Fiscal Year 2003.

The National Research Council released a study (National Research Council 1999) examining the technical options for HLW treatment and tank closure at the Idaho National Engineering and Environmental Laboratory (INEEL). The Council concluded that clean closure is impractical; some residual radioactivity will remain but, with rational judgement and prudent management, it is reasonable to expect all options will result in very low risks. Recommendations made by the Council included: 1- establish closure criteria, 2-develop an innovative sampling plan based on risks, and 3- conduct testing to anticipate possible process failure. The SRS General Closure Plan had anticipated and includes points similar to those raised by the Council.

M-20: The commenter made a statement that it is important to close the HLW tanks and the commenter is happy that DOE is making progress toward this goal.

<u>Response</u>: Comment noted.

M-21: The commenter stated that he recalled difficulty in removing waste from the tanks, particularly the saltcake material. The commenter inquired if the use of oxalic acid would be necessary to remove this material from the tanks.

<u>Response</u>: The salt portion of the waste is soluble and thus readily removed by water. The use of oxalic acid would only be required when removing insoluble materials (i.e., sludge) from the tanks. DOE anticipates that oxalic acid would be needed to clean tanks that contain the more radioactive first-cycle wastes (about three-fourths of the tanks).

M-22: The commenter stated that a factor affecting the tank closure process is operation of the DWPF. The commenter asked if DWPF was currently operating or if it was shut down.

<u>Response</u>: The DWPF is operating to process and vitrify the sludge component of the HLW. As of December 2000, DWPF had produced approximately 1,000 canisters of vitrified waste.

References

DOE (U.S. Department of Energy), 1995. *Final Environmental Impact Statement Waste Management,* DOE/EIS-0217, Savannah River Site, 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, Aiken, South Carolina, July 10.

DOE (U.S. Department of Energy), 1997. *Regulatory Basis for Incidental Waste Classification at the Savannah River Site High-Level Waste Tank Farms,* Rev. 1, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina, April 30.

National Research Council, 1999. *Alternative High-Level Waste Treatments at the Idaho National Engineering and Environmental Laboratory,* National Academy Press, Washington, D.C.

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Mr. Joseph A. Martillotti
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ATL

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GLOSSARY

Terms in this glossary are defined based on the context in which they are to be used in this EIS.

accident

An unplanned sequence of events that results in undesirable consequences.

alpha-emitter

A radioactive substance that decays by releasing an alpha particle.

alpha particle

A positively charged particle consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

alpha waste

Waste containing alpha-emitting transuranic radionuclides with activities between 10 and 100 nanocuries per gram.

alternative

A major choice or strategy to address the EIS "Purpose and Need" statement, as opposed to the engineering options available to achieve the goal of an alternative.

annulus

The space between the two walls of a double-wall tank.

applicable or relevant and appropriate requirements (ARARs)

Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and State law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

aquifer

A body of permeable rock, rock fragments, or soil through which groundwater moves.

as low as reasonably achievable (ALARA)

A process by which a graded approach is applied to maintaining dose levels to workers and the public, and releases of radioactive materials to the environment at a rate that is as far below applicable limits as reasonably achievable.

atomic number

The number of positively charged protons in the nucleus of an atom and the number of electrons on an electrically neutral atom.

background radiation

Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

backfill

Material such as soil or sand used in refilling an excavation.

basemat

The concrete and steel portion of the tank below the residual material and above the vadose zone.

beta-emitter

A radioactive substance that decays by releasing a beta particle.

beta particle

A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

beyond design basis accident (BDBA)

An accident with an annual frequency of occurring between 1 in 1,000,000 and 1 in 10,000,000 ($1.0\times^{-6}$ and 1.0×10^{-7}).

biodiversity

Pertains to the variety of life (e.g., plants, animals and other organisms) that inhabits a particular area or region.

blackwater stream

Water in coastal plains, creeks, swamp, and/or rivers that has been imparted a dark or black coloration due to dissolution of naturally occurring organic matter from soils and decaying vegetation.

borosilicate

A form of glass with silica sand, boric oxide, and soda ash.

borrow material

Material such as soil or sand that is removed from one location and used as fill material in another location.

bounding accident

A postulated accident that is defines to encompass the range of anticipated accidents and used to evaluate the consequences of accidents at facilities. The most conservative parameters (e.g., source terms, and meteorology) applied to a conservative accident resulting in a bounding accident analysis.

cancer

The name given to a group of diseases characterized by uncontrolled cellular growth.

canister

A container (generally stainless steel) into which immobilized radioactive waste is placed and sealed.

capable fault

In part, a capable fault is one that may have had movement at or near the ground surface at least once within the past 35,000 years, or has had recurring movement within the past 500,000 years. Further definition can be found in 10 CFR 100, Appendix A.

carcinogen

A radionuclide or nonradiological chemical that has been proven or suspected to be either a promoter or initiator of cancer in humans or animals.

characterization

The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

chronic exposure

The absorption of hazardous material (or intake of hazardous materials) over a long period of time (for example, over a lifetime).

Code of Federal Regulations (CFR)

A document containing the regulations of Federal executive departments and agencies.

collective effective dose equivalent

Sum of the effective dose equivalents for individuals composing a defined population. The units for this are person-rem or person-sievert.

committed dose equivalent

Total dose equivalent accumulated in an organ or tissue in the 50 years following a single intake of radioactive materials into the body.

committed effective dose equivalent

The sum of committed radiological dose equivalents to various tissues in the body, each multiplied by the appropriate weighing factor and expressed units of rem.

condensate

Liquid that results from condensing a gas by cooling below its saturation temperature.

confining (unit)

A rock layer (or stratum) having very low hydraulic conductivity (or permeability) that restricts the movement of groundwater either into or out of adjacent aquifers.

contaminant

Any gaseous, chemical or organic material that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

contamination

The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

critical

A condition where in uranium, plutonium or tritium is capable of sustaining a nuclear chain reaction.

criticality

State of being critical. Refers to a self-sustaining nuclear chain reaction in which there is an exact balance between the production of neutrons and the losses on neutrons in the absence of extraneous neutron sources.

curie (CI)

The basic unit used to describe the intensity of radioactivity in a sample of material. he curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

decay, radioactive

The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation (see half-life, radioactive).

decommissioning

The process of removing a facility from operation followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination

The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

design basis accident (DBA)

For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to maintain them in a safe shutdown condition indefinitely or to prevent or mitigate the consequences so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

design basis earthquake

The maximum intensity earthquake that might occur along the nearest fault to a structure. Structures are built to withstand a design basis earthquake.

DOE Orders

Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dosage

The concentration-time profile for exposure to toxicological hazards.

dose (or radiation dose)

A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose equivalent

Product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation on a common scale. The unit of dose equivalent is the rem. A millirem is one one-thousandth of a rem.

effective dose equivalent (EDE)

The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. It includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiation Protection defines this as the effective dose.

effluent

Liquid or gaseous waste streams released from a facility.

effluent monitoring

Sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants.

endemic

Native to a particular area or region.

environmental restoration

Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

environmental restoration program

A DOE subprogram 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, and decontamination and decommissioning are responsibilities of this program.

evaporator

A facility that mechanically reduces the water contents in tank waste to concentrate the waste and reduce storage space needs.

exposure pathways

The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air or water is also included.

external accident (or initiator)

An accident that is initiated by manmade energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility, and so forth.

facility basemat

For this purposes of this EIS, basemat is defined as the concrete pad beneath the HLW tank.

fissile material

Any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

floodplain

The level area adjoining a river or stream that is sometimes covered by flood water.

gamma-emitter

A radioactive substance that decays by releasing gamma radiation.

gamma ray (gamma radiation)

High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are similar to x-rays, but are usually more energetic.

geologic repository

A deep (on the order of 600 meter [1,928 feet] or more) underground mined array of tunnels used for permanent disposal of radioactive waste.

groundwater

Water occurring beneath the earth's surface in the intervals between soil grains, in fractures, and in porous formations.

grout

A fluid mixture of cement-like materials and liquid waste that sets up as a solid mass and is used for waste fixation, immobilization, and stabilization purposes.

habitat

The sum of environmental conditions in a specific place occupied by animals, plants, and other organisms.

half-life

The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

hazard index

The sum of several hazard quotients for multiple chemicals and/or multiple exposure pathways. A hazard index of greater than 1.0 is indicative of potential adverse health effects. Health effect could be minor temporary effects or fatal, depending on the chemical and amount of exposure.

hazard quotient

The ratio of an exposure level to a substance to a toxicity reference value selected for risk assessment purposes.

hazardous chemical

A term defined under the Occupational Safety and Health Act and the Emergency Planning and Community Right-to-Know Act as any chemical that is a physical hazard or a health hazard.

hazardous material

A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance

Any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

hazardous waste

Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

heavy metals

Metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

high-efficiency particulate air (HEPA) Filter

A filter with an efficiency of at least 99.95 percent used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

high-level waste

As defined by the Nuclear Waste Policy Act [42 U.S. C. 10101], High Level Waste means (a) the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid that contains [a combination of transuranic and] fission products [nuclides] in sufficient concentrations; and (b) other highly radioactive material that the [U.S. Nuclear Regulatory] Commission, consistent with existing law, determines by rule requires permanent isolation.

hydrology

The study of water, including groundwater, surface water, and rainfall.

immobilization

A process (e.g., grouting or vitrification) used to stabilized waste. Stabilizing the waste inhibits the release of waste to the environment.

inadvertent intrusion

The inadvertent disturbance of a disposal facility or its immediate environment by a potential future occupant that could result in loss of containment of the waste or exposure of personnel. Inadvertent intrusion is a significant consideration that shall be included either in the design requirements or waste acceptance criteria of a waste disposal facility.

incidental waste

Wastes that are not defined as high-level waste (i.e., originating from nuclear fuel processing).

inhibited water

Water to which sodium hydroxide has been added to inhibit corrosion.

in situ

A Latin term meaning "in place."

institutional control

The control of waste disposal sites or other contaminated sites by human institutions in order to prevent or limit exposures to hazardous materials. Institutional control may be accomplished by (1) active control measures, such as employing security guards and maintaining security fences to restrict site access, and (2) passive control measures, such as using physical markers, deed restrictions, government regulations, and public records and archives to preserve knowledge of the site and prevent inappropriate uses.

internal accidents

Accidents that are initiated by man-made energy sources associated with the operation of a given facility. Examples include process explosions, fires, spills, criticalities, and so forth.

involved worker

Workers that would be involved in a proposed action as opposed to workers that would be on the site of a proposed action but not involved in the action.

isotope

One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

latent cancer fatality

A fatality resulting from cancer caused by an exposure to a known or suspected radionuclide or carcinogenic chemical.

low-level waste (LLW)

Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section II e(2) of the Atomic Energy Act).

low-level mixed waste (LLMW)

Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic energy Act of 1954 2 USC 2011, *et seq.*).

macroinvertebrate

Small animal, such as a larval aquatic insect, that is visible to the naked eye and has no vertebral column.

maximally exposed individual (MEI)

A hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is located at the point on the DOE site boundary nearest to the facility in question.

millirad

One thousandth of a rad (see rad).

millirem

One thousandth of a rem (see rem).

mixed waste

Waste that contains both hazardous wastes under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

nanocurie

One billionth of a curie (see curie).

natural phenomena accidents

Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, and so forth.

noninvolved workers

Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located a specific distance (often 100 meters) from the reference facility area.

nuclear criticality

A self-sustaining nuclear chain reaction.

nuclide

A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.

offsite

Away from the SRS site.

offsite population

For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

oxalic acid

A water soluble organic acid, $H_2C_2O_4$, being considered as a cleaning agent to use in spray-washing tanks because it dissolves sludge and is only moderately aggressive against carbon steel, the material used in the construction of the waste tanks.

particulate

Pertains to minute, separate particles. An example of dry particulate is dust.

performance objectives

Parameters within which a facility must perform to be considered acceptable.

permanent disposal

For high level waste the term means emplacement in a repository for high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

permeability

The degree of ease with which water can pass through a rock or soil.

person-rem

A unit used to measure the radiation exposure to an entire group and to compare the effects of different amounts of radiation on groups of people. It is obtained by multiplying the average dose equivalent (measured in rems) to a given organ or tissue by the number of persons in the population of interest.

pH

A measure of the relative acidity or alkalinity of a solution. A neutral solution has a pH of 7, acids have a pH of less than 7, and bases have a pH of greater than 7.

picocurie

One trillionth of a curie (see curie).

pollutant migration

The movement of a contaminant away from its initial source.

population

For risk assessment purposes, population consists of the total potential members of the public or workforce who could be exposed to a possible radiation or chemical dose from an exposure to radionuclides or carcinogenic chemicals.

population dose

The overall dose to the offsite population.

rad

The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram.

radiation (ionizing radiation)

Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used here, does not include nonionizing radiation such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation worker

A worker who is occupationally exposed to ionizing radiation and receives specialized training and radiation monitoring devices to work in such circumstances.

radioactive waste

Waste that is managed for its radioactive content.

radioactivity

The property or characteristic of material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

radioisotope

An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. approximately 5,000 natural and artificial radioisotopes have been identified.

radionuclide

The radioisotopes that together comprise 95 percent of the total curie content of a waste package by volume and have a half-life of at least 1 week. Radionuclides that are important to a facility's radiological performance assessment and/or a safety analysis and are listed in the facility's waste acceptance criteria are considered major radionuclides.

Record of Decision (ROD)

A public document that records the final decision(s) concerning a proposed action.

reducing grout

A grout formulated to behave as a chemical reducing agent. A chemical reducing agent is a substance that reduces other substances (i.e., decreases their positive charge or valence) by supplying electrons. The purpose of a reducing grout in closure of the high-level waste tanks would be to provide long-term chemical durability against leaching of the residual waste by water. Reducing grout would be composed primarily of cement, blast furnace slag, masonry sand, and silica fume.

rem

A unit of radiation dose that reflects the ability of different types of radiation to damage human tissues and the susceptibility of different tissues to the damage. Rems are a measure of effective dose equivalent.

risk

Quantitative expression of possible loss that considers both the probability that a hazard causes harm and the consequences of that event.

Safety Analysis Report (SAR)

A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarize the hazards associated with the operation of a particular facility and defines minimum safety requirements.

saltcake

Salt compounds that have crystallized as a result of concentrating the liquid.

saltstone

Concrete-like substance formed when the low-activity fraction of high-level waste is mixed with cement, flyash, and slag.

seepline

An area where subsurface water or groundwater emerges from the earth and slowly flows overland.

segregation

The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment and storage or disposal.

seismicity

The phenomenon of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

sludge

Solid material that precipitates or settles to the bottom of a tank.

solvent

Substance (usually liquid) capable of dissolving one or more other substances.

source material

(a) Uranium, thorium, or any other material that is determined by the U.S. Nuclear Regulatory Commission pursuant to the provisions of the Atomic Energy Act of 1954, Section 61, to be source material; or (b) ores containing one or more of the foregoing materials, in such concentration as the U.S. Nuclear Regulatory Commission may by regulation determine from time-to-time [Atomic Energy Act 11(z)]. Source material is exempt from regulation under to Resource Conservation and Recovery Act.

source term (Q)

the quantity of radioactive material released by an accident or operation that causes exposure after transmission or deposition. Specifically, it is that fraction of respirable material at risk (MAR) that is released to the atmosphere from a specific location. The source term defines the initial condition for subsequent dispersion and consequence evaluations. Q = material at risk (MAR) damage ration (DR) x airborne release fraction (ARF) x respirable fraction (RF) x leak path factor (LPF). The units of Q are quantity at risk averaged over the specified time duration.

spent nuclear fuel

Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization

Treatment of waste to protect the environment from contamination. This includes rendering a waste immobile or safe for handling and disposal.

subsurface

The area below the land surface (including the vadose zone and aquifers).

tank farm

An installation of multiple adjacent tanks, usually interconnected for storage of liquid radioactive waste.

total effective dose equivalent

The sum of the external dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

transuranic waste

Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, except for (a) high-level radioactive waste; (b) waste that the U.S. Department of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

treatment

Any activity that alters the chemical or physical nature of a hazardous waste to reduce its toxicity, volume, mobility or to render it amenable for transport, storage or disposal.

vadose zone

The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

vitrification

A method of immobilizing waste (e.g., radioactive, hazardous, and mixed). This involves adding frit and waste to a joule-heated vessel and melting the mixture into a glass. The purpose of this process is to permanently immobilize the waste and to isolate it from the environment.

volatile organic compound (VOC)

Compounds that readily evaporate and vaporize at normal temperatures and pressures.

waste minimization

An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

waste stream

A waste or group of wastes with similar physical form, radiological properties, U. S. Environmental Protection Agency waste codes, or associated land disposal restriction treatment standards. It may be the result of one or more processes or operations.

wetlands

Area that are inundated or saturated by surface water or groundwater and that typically support vegetation adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas.

wind rose

A star-shaped diagram showing how often winds of various speeds blow from different directions. This is usually based on yearly average.

INDEX

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EIS RESPONSIBILITY: Reviewed Chapters 3 and 6.

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AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.S., Biology, 1995
B.S., Biology, 1991

TECHNICAL EXPERIENCE: Seven years in botany and plant community investigations.

EIS RESPONSIBILITY: Prepared Cultural Resources section of Chapter 3.

NAME: **JOHN KNOX**

AFFILIATION: U. S. Department of Energy

EDUCATION: M.S., Botany, 1974
B.S., Biology, 1972

TECHNICAL EXPERIENCE: Four years preparing or reviewing NEPA documents; 24 years in environmental analysis and environmental management.

EIS RESPONSIBILITY: Prepared Chapter 1; principal DOE reviewer of Draft EIS; contributed to Chapter 3.

NAME: **LARRY T. LING**

AFFILIATION: U. S. Department of Energy

EDUCATION: B.S., Chemical Engineering, 1982

TECHNICAL EXPERIENCE: Three years preparing or reviewing NEPA documents; over 17 years experience in nuclear facilities and systems.

EIS RESPONSIBILITY: Document Manager; DOE reviewer of Draft EIS; contributed to Chapters 1, 2, and 6, and Appendix A.

NAME: **LISA A. MATIS**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.S., Mechanical Engineering, 1989
B.S., Chemical Engineering, 1984

TECHNICAL EXPERIENCE: Fourteen years experience in chemical-environmental engineering.

EIS RESPONSIBILITY: Prepared Waste and Materials sections of Chapters 3 and 4; prepared Utilities and Energy section of Chapter 4; prepared Chapter 7.

NAME: **PHILIP R. MOORE**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.S., Wildlife and Fisheries Biology, 1983
B.A., English, 1975

TECHNICAL EXPERIENCE: Seventeen years experience as fishery biologist and aquatic ecologist.

EIS RESPONSIBILITY: Prepared Surface Water and Ecological sections of Chapters 3 and 4.

NAME: **APARAJITA S. MORRISON**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: B.S., Health Physics, 1985

TECHNICAL EXPERIENCE: Eleven years experience in environmental and occupational radiological programs including management of an environmental monitoring laboratory, startup testing of nuclear instrumentation, training, and technical assessments of environmental and radiation protection programs.

EIS RESPONSIBILITY: Prepared Health and Safety sections of Chapters 3 and 4; prepared Chapter 5.

NAME: **JAMES L. OLIVER**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: B.S., Biology (Fisheries), 1971

TECHNICAL EXPERIENCE: Twenty-three years experience in research and impact assessment projects for the U.S. Department of Interior and DOE. Reviews environmental and natural resource management issues and performs strategic planning for National Environmental Policy Act documentation for DOE.

EIS RESPONSIBILITY: Prepared Chapter 6. Management Reviewer.

NAME: **JOSEPH W. RIVERS**

AFFILIATION: Jason Associates Corporation

EDUCATION: B.S., Mechanical Engineering, 1982

TECHNICAL EXPERIENCE: Three years experience in preparing NEPA documents; 16 years in commercial and DOE nuclear projects; design, systems engineering, safety and accident analysis, and regulatory compliance.

EIS RESPONSIBILITY: Prepared Accident Analysis section of Chapter 4; prepared Appendix B.

NAME: **DIANE S. SINKOWSKI**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.E., Nuclear Engineering, 1994
B.S., Nuclear Engineering Sciences, 1990

TECHNICAL EXPERIENCE: Six years in air permitting, fate and transport modeling, human health impacts, environmental compliance, and health physics.

EIS RESPONSIBILITY: Prepared Air Resources sections of Chapters 3 and 4; contributed to Appendix C.

NAME: **THOMAS TEMPLES**

AFFILIATION: U. S. Department of Energy

EDUCATION: Ph.D., Geology, 1996
M.S, Geology, 1978
B.S., Geology, 1976

TECHNICAL EXPERIENCE: Four years preparing NEPA documents; 18 years as a geophysicist.

EIS RESPONSIBILITY: Contributed to Chapter 3.

NAME: **ALAN L. TOBLIN**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.S., Chemical Engineering, 1970
B.E., Chemical Engineering, 1968

TECHNICAL EXPERIENCE: Twenty-three years experience in analyzing radiological and chemical contaminant transport in water resources.

EIS RESPONSIBILITY: Contributed to Appendix C.

NAME: **PHILIP L. YOUNG, CHP**

AFFILIATION: Tetra Tech NUS, Inc.

EDUCATION: M.S., Health Physics, 1989
B.S., Radiation Health (Health Physics), 1988

TECHNICAL EXPERIENCE: Fourteen years experience in environmental health physics and environmental impact assessment, with emphasis on radiological effluent monitoring, environmental surveillance, environmental dosimetry, radiological risk assessment, and radioactive waste management.

EIS RESPONSIBILITY: Project Manager; technical reviewer; contributed to Appendix C.

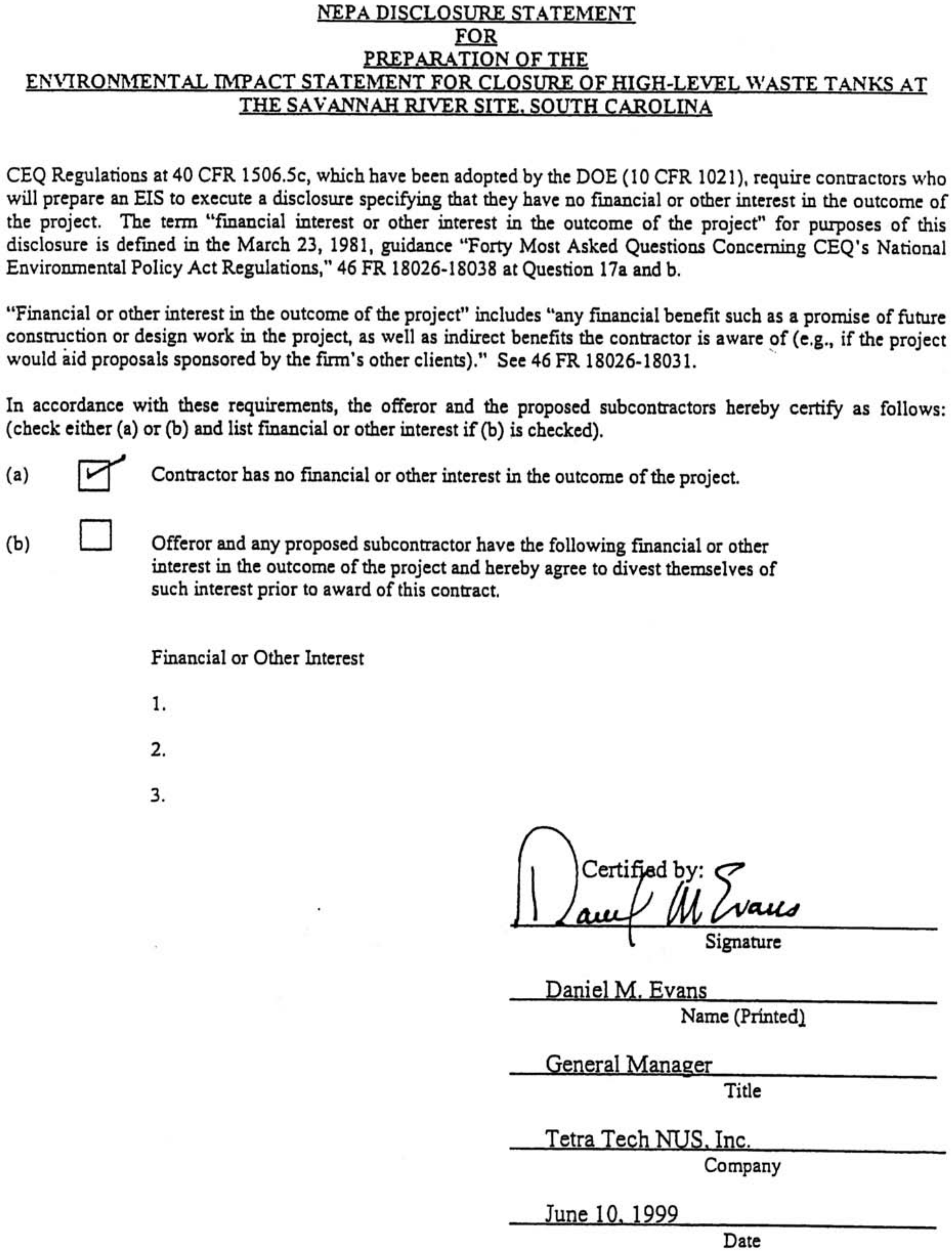
NAME: **JEFFREY L. ZIMMERLY**

AFFILIATION: Tetra Tech**,** NUS, Inc.

EDUCATION: B.S., Health Physics, 1996

TECHNICAL EXPERIENCE: Two years experience in radiation protection and environmental health physics.

EIS RESPONSIBILITY: Contributed to the Summary, Chapter 4, and Appendix D of the Final EIS.



NEPA DISCLOSURE STATEMENT
FOR
PREPARATION OF THE
ENVIRONMENTAL IMPACT STATEMENT FOR CLOSURE OF HIGH-LEVEL WASTE TANKS AT THE SAVANNAH RIVER SITE, SOUTH CAROLINA

CEQ Regulations at 40 CFR 1506.5c, which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." See 46 FR 18026-18031.

In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows: (check either (a) or (b) and list financial or other interest if (b) is checked).

(a) ☑ Contractor has no financial or other interest in the outcome of the project.

(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

1.

2.

3.

Certified by:

Daniel M Evans
Signature

Daniel M. Evans
Name (Printed)

General Manager
Title

Tetra Tech NUS, Inc.
Company

June 10, 1999
Date

DISTRIBUTION LIST

DOE provided copies of the *Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement* (EIS) to Federal, state, and local elected and appointed officials and agencies of government; Native American groups; Federal, state, and local environmental and public interest groups; and other organizations and individuals listed below. Copies will be provided to other interested parties upon request as identified in the cover sheet of this EIS.

CONTENT

A. UNITED STATES CONGRESS

A.1 SENATORS FROM AFFECTED AND ADJOINING STATES

The Honorable Max Cleland
United States Senate

The Honorable Zell Miller
United States Senate

The Honorable Ernest F. Hollings
United States Senate

The Honorable Strom Thurmond
United States Senate

A.2 UNITED STATES SENATE COMMITTEES

The Honorable Jack Reed
Chairman
Subcommittee on Strategic Forces
Committee on Armed Services

The Honorable Robert C. Byrd
Chairman
Committee on Appropriations

The Honorable Pete V. Domenici
Ranking Minority Member
Subcommittee on Energy and Water
Development
Committee on Appropriations

The Honorable Carl Levin
Chairman
Committee on Armed Services

The Honorable Harry Reid
Chairman
Subcommittee on Energy and Water
Development
Committee on Appropriations

The Honorable Wayne Allard
Ranking Minority Member
Subcommittee on Strategic Forces
Committee on Armed Services

The Honorable Ted Stevens
Ranking Minority Member
Committee on Appropriations

The Honorable John Warner
Ranking Minority Member
Committee on Armed Services

A.3 UNITED STATES HOUSE OF REPRESENTATIVES FROM AFFECTED AND ADJOINING STATES

The Honorable James E. Clyburn
U.S. House of Representatives

The Honorable Nathan Deal
U.S. House of Representatives

The Honorable Lindsey Graham
U.S. House of Representatives

The Honorable Jack Kingston
U.S. House of Representatives

The Honorable Cynthia McKinney
U.S. House of Representatives

The Honorable Charlie Norwood
U.S. House of Representatives

The Honorable Henry E. Brown
U.S. House of Representatives

The Honorable John M. Spratt, Jr.
U.S. House of Representatives

The Honorable Jim DeMint
U.S. House of Representatives

The Honorable Joe Wilson
U.S. House of Representatives

A.4 UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEES

The Honorable Peter Visclosky
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable Curt Welden
Chairman
Subcommittee on Military Procurement
Committee on Armed Services

The Honorable C. W. Bill Young
Chairman
Committee on Appropriations

The Honorable Sonny Callahan
Chairman
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable David Obey
Ranking Minority Member
Committee on Appropriations

The Honorable Gene Taylor
Ranking Minority Member
Subcommittee on Military Procurement
Committee on Armed Services

The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services

The Honorable Bob Stump
Chairman
Committee on Armed Services

B. FEDERAL AGENCIES

Mr. A. Forester Einarsen
NEPA Coordinator
Office of Environmental Policy
U.S. Army Corps of Engineers

Mr. Douglas H. Chapin
Richland Operations Office
U.S. Department of Energy

Commander, Savannah District
Attn: Planning Division
U.S. Army Corps of Engineers

Ms. Marjorie S. Davenport
District Chief
Water Resources Division
U.S. Geological Survey
U.S. Department of Interior

Mr. Paul F. X. Dunigan, Jr.
Richland Operations Office
U.S. Department of Energy

Mr. Robert Fairweather
Chief, Environment Branch
Office of Management and Budget

Mr. Joseph R. Franzmathes
Assistant Regional Administrator, Office of Policy and Management
U.S. Environmental Protection Agency,
Region IV

Mr. Dan Fontozzi
U.S. Department of State

Mr. Mark Frei (EM-40)
Office of the Deputy Assistant Secretary for Project Completion

Mr. Daniel Funk
U.S. DOE, NE-40

Mr. Kenneth W. Holt
Centers for Disease Control and Prevention
National Center for Environmental Health
U.S. Department of Health and Human Services

Mr. Dave Huizenga (EM-20)
Office of Deputy Assistant Secretary for Integration and Disposition
U.S. Department of Energy

Mr. Don L. Klima
Director, Office of Planning & Review
Advisory Council on Historic Preservation

Mr. Ron Koll
FDH-USDOE Hanford

Mr. Andreas Mager, Jr.
NOAA Habitat Conservation Division
National Marine Fisheries Service
U.S. Department of Commerce

Mr. James Melillo
Executive Director
Environmental Management Advisory Board
U.S. Department of Energy

Mr. Heinz Mueller
Office of Environmental Assessment
U.S. Environmental Protection Agency

Mr. Finn Neilsen
Acting Director, SO-22

Mr. Charles Oravetz
Chief
Protected Species Management Branch
Southeast Regional Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Ms. Cynthia Carpenter
Branch Chief, Generic Issues, Environmental, Financial and Rulemaking Branch
Office of Nuclear Reactor Regulations
U.S. Nuclear Regulatory Commission

Mr. Bob Peralta
Chief Council
Argonne National Laboratory
U.S. Department of Energy Laboratory

Mr. Jon Richards
Region IV
U.S. Environmental Protection Agency

Dr. Libby Stull
Argonne National Laboratory
U.S. Department of Energy Laboratory

Mr. Willie R. Taylor
Director
Office of Environmental Policy & Compliance
U.S. Department of Interior

Mr. Andrew Thibadeau
Director, Division of Information Technology and Security
Defense Nuclear Facility Safety Board

Mr. Barry Zalcman
Section Chief, Generic Issues, Environmental, Financial and Rulemaking Branch
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission

C. STATE OF SOUTH CAROLINA

C.1 STATEWIDE OFFICES AND LEGISLATURE

The Honorable Jim Hodges
Governor of South Carolina

The Honorable Bob Peeler
Lieutenant Governor of South Carolina

The Honorable Charles Condon
Attorney General

The Honorable William Clyburn
South Carolina House of Representatives

The Honorable Lonnie Hosey
South Carolina House of Representatives

The Honorable Robert S. Perry, Jr.
South Carolina House of Representatives

The Honorable Thomas N. Rhoad
South Carolina House of Representatives

The Honorable Charles R. Sharpe
South Carolina House of Representatives

The Honorable Donald C. Smith
South Carolina House of Representatives

The Honorable J. Roland Smith
South Carolina House of Representatives

The Honorable C. Bradley Hutto
South Carolina Senate

The Honorable Thomas L. Moore
South Carolina Senate

The Honorable Clementa C. Pickney
South Carolina Senate

The Honorable W. Greg Ryberg
South Carolina Senate

The Honorable Nikki G. Setzler
South Carolina Senate

The Honorable James E. Smith, Jr.
South Carolina House of Representatives

Ms. Omeagia Burgess
Grant Coordinator
Office of the State Budget

C.2 STATE AND LOCAL AGENCIES AND OFFICIALS

The Honorable Patrick D. Sullivan
Mayor of Jackson

The Honorable Fred Cavanaugh
Mayor of Aiken

The Honorable Edward Lemon
Mayor of Barnwell

EP Coordinator
Aiken County Emergency Services

Mr. Russell Berry
South Carolina Department of Health and Environmental Control

Mr. Keith Collinsworth, P.G.
Federal Facility Liaison
South Carolina Department of Health and Environmental Control

Mr. Donnie Cason
South Carolina Department of Highways and Public Transportation

Mr. G. Kendall Taylor
Division of Hydrogeology
Bureau of Land and Hazardous Waste Management
South Carolina Department of Health and Environmental Control

Mr. David Wilson
Division of Hydrogeology
Bureau of Land and Hazardous Waste
Management
South Carolina Department of Health and
Environmental Control

D. STATE OF GEORGIA

D.1 STATEWIDE OFFICES AND LEGISLATURE

The Honorable Roy Barnes
Governor of Georgia

The Honorable Mark Taylor
Lieutenant Governor of Georgia

The Honorable Charles W. Walker
Georgia Senate

The Honorable Thurbert Baker
Attorney General

The Honorable Ben L. Harbin
Georgia House of Representatives

D.2 STATE AND LOCAL AGENCIES AND OFFICIALS

The Honorable Bob Young
Mayor of Augusta

The Honorable Martin H. Dolin
Mayor of Waynesboro

E. NATURAL RESOURCE TRUSTEES, SAVANNAH RIVER SITE

Mr. Douglas E. Bryant
Commissioner, SCDHEC
Natural Resource Trustee

Mr. A. B. Gould
Director
DOE-SR Environmental Quality Management
Natural Resource Trustee

Mr. Robert Riggs
SRS Natural Resource Trustee
US Army Corps of Engineers
Charleston District
Department of the Army

Mr. David Holroyd
SRS Natural Resource Trustee
US Environmental Protection Agency Region IV

Mr. Ronald W. Kinney
SRS Natural Resource Trustee
SCDHEC Waste Assessment and Emergency Response

Dr. Thomas Dillion
SRS Natural Resource Trustee
National Oceanic and Atmospheric Administration
US EPA Waste Division

Mr. James H. Lee
Regional Environmental Officer
SRS Natural Resource Trustee
US Department of the Interior

Mr. Jim O. Stuckey, II
SRS Natural Resource Trustee
South Carolina Office of the Governor

Mr. James Setser
Chief, Program Coordinator Branch
SRS Natural Resource Trustee
Department of Natural Resources

Dr. Paul A. Sandifer
Director
SC Department of Natural Resources
SRS Natural Resource Trustee

F. NATIVE AMERICAN GROUPS

The Honorable Gilbert Blue
Chairman
Catawba Indian Nation

The Honorable R. Perry Beaver
Principal Chief
Muscogee (Creek) Nation

G. ENVIRONMENTAL AND PUBLIC INTEREST GROUPS

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The Sierra Club

Ms. Beatrice Brailsford
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Snake River Alliance

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Director, Nuclear Programs
Natural Resources Defense Council

Mr. Steven Dolley
Research Director
Nuclear Control Institute

Mr. David Beckman
Natural Resources Defense Council

Mr. Jim Bridgman
Program Associate Alliance for Nuclear
Accountability

Ms. Susan Gordon
Program Director
Alliance for Nuclear Accountability

Mr. Robert Holden
Director, Nuclear Waste Programs
National Congress of American Indians

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Ecology and Economics Research Department
The Wilderness Society

Dr. Mildred McClain
Executive Director
Harambee House, Inc.
Project: Citizens for Environmental Justice, Inc.

Mr. Alden Meyer
Director, Government Relations
Union of Concerned Scientists

Mr. Joel Yudken
Sectoral Economist
Department of Public Policy
AFL-CIO

Mr. Tom Zamora Collina
Global Security Program Director
Union of Concerned Scientists

Mr. Damon Moglen
Greenpeace
Washington, D.C.

Ms. Betsy Merritt
Associate General Counsel
Department of Law & Public Policy
National Trust for Historic Preservation

Mr. Kevin O'Neill
Deputy Director
Institute for Science and
International Security

Mr. Robert Musil, Ph.D., M.P.H.
Executive Director and CEO
Physicians for Social Responsibility

Mr. David Bradley
National Community Action Foundation

Mr. Paul Schwartz
National Campaign Director
Clean Water Action

Mr. Jim Lyon
Director of Legislative Affairs
National Wildlife Foundation

Mr. Gary E. Richardson
Executive Director
Snake River Alliance

Ms. Margaret MacDonald Stewart
Community Coordinator
Snake River Alliance

Mr. Harry Rogers
Carolina Peace Resource Center

H. OTHER GROUPS AND INDIVIDUALS

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SAIC

Mr. Tom Anderson
Battelle-Evergreen

Ms. Margaret Aoki
NINNHO IWAI American Corporation

Ms. Jila Banaee
Lockheed-Martin Idaho Technologies Company

Mr. Sy Baron
MUSC

Ms. Sonya Barnette

Ms. Lisa Baxter
Georgia Technical College

Mr. W. Alton Bell, Jr.

Mr. Edward P. Blanton, Jr.

Mr. Sam W. Booher

Mr. Colin Boardman
Business Development Manager
BNFL, Inc.

Dr. Edmund D. Boothe
Aiken Technical College

Mr. R. P. Borsody
S.P.A.C.E.-P.S.I.

Ms. Sara Jo Braid

Mr. Dannion Brinkley

Mr. Bill Brizes

Ms. Elizabeth R. Brown
Oak Haven of Charleston

Mr. James L. Buelt
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Mr. Ken Bulmahn

Mr. Earl Cagle, Jr.

Mr. Rich Campbell
Chem-Nuclear Systems

Mr. Ron Campbell

Mr. George R. Caskey

Mr. Donnie Cason
South Carolina Department of Highways and
Public Transportation

Dr. Kailash Chandra
Savannah State University

Mr. Douglas Chapin
U.S. DOE-Richland

Mr. Ernie Chaput

Mr. Vladimir Y. Chechik
Shaw, Pitman, Potts, & Trowbridge

Mr. Carl E. Cliche

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Edlow International Company

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Mr. Todd Crawford

Mr. Brian Costner

Mr. Salvatore Dimaria
Battelle Memorial Institute

Mr. John Dimarzio

Mr. Ross Dimmick

Mr. John F. Doherty, J.D.

Mr. George Dudich
Washington Group International, Inc.

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Dr. Linda B. Eldridge

Mr. Dave Ecklund

Ms. Lynne Fairobent

Ms. Rita Fellers
Department of Geography
University of North Carolina at Chapel Hill

Mr. Leverne P. Fernandez

Mr. Ken Fitch

Ms. Bonnie Fogdall
SAIC

Dr. Charles Forsberg
Oak Ridge National Laboratory

Mr. Mike French

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Institute for Policy and Research
Northwestern University

Mrs. Nadia Friloux
COGEMA Inc.

Mr. Ben Gannon

Mr. John Geddie

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Stone & Webster, Inc.

Ms. Stacy Gent-Howard
Federal Facility Coordinator
U. S. EPA Region IV

Colonel George A. Gibson

Mr. Anthony P. Gouge

Ms. Kathleen Gore
Exploration Resources

Dr. Randall Guensler
School of Civil & Environmental Engineering
Georgia Institute of Technology

Mr. Brandon Haddock
Augusta Chronicle

Mr. Frank J. Hahne

Mr. David Haines

Mr. C. Hardigree
Plumbers & Steamfitters Local Union #150

Mr. Larry Harrelson
District Chief, Water Resources Division, U. S,
Geological Survey

Mr. Thomas F. Hash
Bechtel National, Inc.

Ms. Kathryn Hauer

Mr. Dusty Hauser
Office of Senator Max Cleland

Ms. Shelley Hawkins
Jacobs Engineering Group, Inc.

Mr. Warren Hills
Laborers Local 1137
AFL-CIO

Mr. C. C. Holcomb

Mr. Perry Holcomb

Mr. Robert A. Hollingsworth

Mr. Charles E. Irvin

Mr. Cliff Jarman

Ms. Gail Jernigan

Mr. Keith Johnson

Ms. Allison Joiner

Mr. Norman Kaish

Mr. Larry Kripps

Mr. Joseph Krupa

Ms. Cynthia E. Lake

Mr. Jim Laplander
City of Savannah

Mr. Bill Lawless

Mr. David Lechel

Mr. Jimmy Mackey

Mr. Robert Maher

Mr. Steve Maheras

Ms. Karen Malone
West Valley Nuclear Services