

CHAPTER 4. ENVIRONMENTAL IMPACTS

Chapter 4 describes the impacts to the Savannah River Site (SRS) and the surrounding region of implementing each of the alternatives described in Chapter 2. As discussed in Chapter 2, in addition to the No Action alternative, the U.S. Department of Energy (DOE) has identified four *action* alternatives that would meet the purpose and need for action: *to identify and implement one or more technologies to prepare the SRS high-level waste (HLW) salt component for disposal*. The five alternatives are as follows:

- No Action
- Small Tank Precipitation
- Ion Exchange
- Solvent Extraction (DOE's preferred alternative)
- Direct Disposal in Grout

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Environmental impacts could include direct physical disturbance of resources, consumption of resources, or degradation of resources caused by effluents and emissions. Resources include air, water, soils, plants, animals, cultural artifacts, and people, including SRS workers and people in nearby communities. Impacts may be detrimental (e.g., increased airborne emissions of hazardous chemicals) or beneficial (e.g., improvements to the environmental baseline of the SRS HLW System).

Section 4.1 describes the short-term impacts associated with construction and operation of each alternative, including No Action. For purposes of the analyses in this Supplemental Environmental Impact Statement (SEIS), the short-term impacts span from the year 2001 until completion of salt processing operations (approximately 2023). As indicated in Chapter 2, the time of completion varies slightly with the selected tech-

nology. Section 4.2 describes for each action alternative the long-term impacts of the radioactive and non-radioactive constituents solidified in saltstone and disposed of in the saltstone disposal vaults. Long-term assessment of the action alternatives involves a performance evaluation beginning with a 100-year period of institutional control and continuing through an extended period, during which it is assumed that residential and/or agricultural uses could occur. For the No Action alternative, Section 4.2 describes the long-term impacts of the radioactive constituents if salt waste were left in the HLW tanks. The long-term assessment of the No Action alternative involves a 100-year period of institutional control after which the HLW tanks would fail, allowing salt solution to overflow to the ground and run off to surface streams that could serve as sources of drinking water.

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The assessments in this SEIS have generally been performed so that the estimated magnitude and intensity of impacts would not be exceeded by the actual facility. Predictions of the impacts of routine operations are based on monitoring of similar operations and are, therefore, considered realistic estimates. For accidents, there is more uncertainty because the impacts are based on events that have not occurred. In this SEIS, DOE selected hypothetical accidents that would produce impacts as severe or more severe than any reasonably foreseeable accidents, which ensures that DOE has bounded all potential accidents for each alternative.

To ensure that small potential impacts are not over-analyzed and large potential impacts are not under-analyzed, analysts have focused efforts on significant environmental issues and have discussed impacts in proportion to their significance. This methodology follows the recommendation for the use of a "sliding scale" approach to analysis described in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993).

4.1 Short-Term Impacts

This section describes the short-term impacts associated with construction and operation of each action alternative (i.e., Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout). Construction includes those actions necessary to prepare land and erect facilities for the alternatives evaluated in this SEIS. Routine operations would include normal use of those facilities. For the No Action alternative, this section describes the short-term impacts associated with continuing tank space management activities through approximately 2010. Because the specific activities that DOE would pursue after the initial period of tank space management have not been determined, only those No Action activities that would be expected to have an impact on a given resource are addressed in this section. For purposes of the analyses, the short-term impacts span from the year 2001 until completion of salt processing operations (approximately 2023). As indicated in Chapter 2, the time of completion varies slightly with the selected technology.

The structure of Section 4.1 closely parallels that of Chapter 3, Affected Environment, with the addition of sections on traffic and transportation, accidents, and a Pilot Plant. The sections discuss methodology and present the potential impacts of each alternative evaluated. More details on the methodology for accident analysis are provided in Appendix B.

4.1.1 GEOLOGIC RESOURCES

This section describes impacts to geologic resources from activities associated with construction and operation of each salt processing action alternative. For the No Action alternative, this section describes impacts to geological resources from ongoing tank space optimization activities, the construction of new HLW tanks, and reuse of existing HLW tanks.

The sites under consideration for the salt processing facilities are located in existing industrial areas (S and Z Areas), where landforms and surface soils have already been disturbed. The No Action alternative would also occur in previously disturbed areas near S and Z Areas. Geologic deposits of economic value are not known to exist in these areas.

Construction

As shown in Table 4-1, the footprints for proposed facilities under the four salt processing action alternatives are similar and would range from about 26,000 square feet for the Direct Disposal in Grout facility to 42,000 square feet for the Small Tank Precipitation facility. The footprints for the Ion Exchange and Solvent Extraction facilities would be approximately 38,000 square feet each. Between 23,000 cubic yards of soil (Direct Disposal in Grout) and 82,000 cubic yards of soil (Solvent Extraction) would be excavated during construction of the process facility. The total land area that would be cleared in S Area for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternative is about 23 acres or 0.12 percent of SRS land dedicated to industrial use. Approximately 15 acres or 0.078 percent of SRS land dedicated to industrial use would be cleared for the Direct Disposal in Grout facility in Z Area. The use of best management practices at existing industrial areas would minimize the impact to the area during construction. Soils excavated during construction would be used as backfill or transported to an appropriate site within 2,500 feet of the facility for disposal (WSRC 1999a). Best management practices would consist of the use of silt fences at the construction site and also at the excavated soil disposal areas. In addition, exposed soils would be stabilized by seeding with grasses or legumes to control erosion. By doing this, DOE would substantially limit the possibility of the soils being eroded and transported to nearby surface waters. Therefore, impacts to geologic resources during construction would be minimal.

Table 4-1. Impact to SRS land from each of the proposed action alternatives.^a

	Alternative			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Facility footprint ^b (square feet)	42,000	38,000	38,000	26,000
Material excavated (cubic yards)	77,000	78,000	82,000	23,000
Total land area cleared for process facility (acres) ^b	23	23	23	15
Land cleared as percent- age of SRS industrial area	0.12	0.12	0.12	0.078
Land cleared as percent- age of total SRS Area	0.012	0.012	0.012	0.0078
Number of new saltstone vaults ^c	16	13	15	13
Land set aside for vaults (Acres)	180	180	180	180
Land set aside as percent- age of SRS industrial area	0.94	0.94	0.94	0.94
Land set aside as percent- age of total SRS Area	0.094	0.094	0.094	0.094

Total SRS area = 300 square miles (192,000 acres) (DOE 1997b).

Total Industrial area = 30 square miles (19,200 acres) (DOE 1997b).

- a. As many as 18 tanks could be constructed under the No Action alternative. The footprint for each tank constructed under the No Action alternative would be about 5,000 square feet. Approximately 43,000 cubic yards of soil would be excavated for each tank built.
- b. (WSRC 1998a).
- c. (WSRC 1998b).

Saltstone disposal vaults would be constructed as needed throughout the period of salt processing. Construction of new saltstone disposal vaults in Z Area over the period from 2010 to 2023 (Small Tank Precipitation), 2011 to 2023 (Ion Exchange), 2010 to 2023 (Solvent Extraction), or 2010 to 2023 (Direct Disposal in Grout) would require minimal soil excavation. Thirteen to 16 vaults (see Table 4-1), each 300 feet long by 200 feet wide by 25 feet high, would be constructed at or slightly below grade. In accordance with best management practices, DOE would stabilize exposed soils by seeding with grasses or legumes to stabilize disturbed areas and control erosion.

Because of the phased nature – construction of process facilities for all action alternatives

followed by construction of vaults over a 13-year period as additional saltstone disposal capacity is required – some excavation of soils would continue for nearly 20 years.

Under the No Action alternative, DOE would use approved siting procedures to ensure that any new HLW storage tanks would be built in previously disturbed industrial areas. Each new tank would require excavation of approximately 43,000 cubic yards of soil. About 28,000 cubic yards would be used for backfill (DOE 1980). The remaining 15,000 cubic yards of soil would be transported to an appropriate site for disposal. Best management practices would be used to stabilize soils and control erosion. Up to 18 new tanks would be necessary to store the waste generated from sludge-only processing at DWPF.

Operation

Facility operations would not disturb landforms or surface soils under any action alternative. Therefore, regardless of the salt processing action alternative chosen, operation of the selected alternative would have no short-term impact on the geology of the identified sites.

Under the No Action alternative, continuation of tank space optimization activities through approximately 2010 would increase the surveillance necessary to ensure safe and environmentally satisfactory performance of these tanks. The reuse of existing HLW tanks (after 2010) would also increase the risk of tank leaks and spills, resulting in the release of HLW to soils. The operation of any new HLW storage tanks constructed under the No Action alternative would not disturb any landforms or surface soils and, therefore, would have no short-term impact on geological resources.

4.1.2 WATER RESOURCES

This section describes incremental impacts to surface water and groundwater quality from activities associated with each salt processing alternative. For the No Action alternative, this section addresses impacts from ongoing tank space optimization activities, reuse of existing HLW storage tanks, and construction and operation of new HLW storage tanks. Water use is discussed in Section 4.1.12.1.

4.1.2.1 Surface Water

McQueen Branch, a first-order tributary of Upper Three Runs, is the closest surface water body to the proposed construction sites in S and Z Areas (see Figure 3-7). McQueen Branch lies approximately 1,000 feet east of the identified process facility site in S Area (Site B) for the Small Tank Precipitation, Ion Exchange, and Solvent Extraction alternatives, and approximately one mile (5,000 feet) east of the process facility site in the center of Z Area for the Direct

Disposal in Grout alternative (see Figures 3-1 and 3-2). The identified locations for new saltstone vaults, in the eastern portion of Z Area, range from 1,500 to 5,000 feet from McQueen Branch.

Overland runoff from the process facility construction site in S Area (Site B) for the Small Tank Precipitation, Ion Exchange, and Solvent Extraction alternatives generally flows east in the direction of the stream (see Figure 3-1), but is interrupted by a drainage ditch along the eastern perimeter of the site (WSRC 1999b). Runoff moves from the drainage ditch to four culverts that channel water under a roadway and railroad embankment and, once through the culverts, overland by sheet flow to a ravine or ditch that was stabilized with netting and riprap in the past and appears to have received little or no flow in recent years. This lined channel was designed to convey storm water to McQueen Branch during construction of the DWPF, but has grown up in grasses and weeds.

Surface drainage is to the east and northeast from the construction sites for the saltstone disposal vaults and the Direct Disposal in Grout process facility in Z Area (see Figure 3-2). Drainage ditches in the area intercept stormwater flow and direct it to stormwater retention basins on the periphery of the area (WSRC 1999b). Discharge from these basins moves to McQueen Branch via an engineered ditch.

Construction

As discussed in Section 4.1.1 for the action alternatives, up to 23 acres of land would be cleared and 23,000 to 82,000 cubic yards of soil would be excavated for construction of the salt processing facility. A slight increase in suspended solids and particulates in stormwater runoff could occur as soils are disturbed during the four-year period when process and support facilities are being built, but would be expected only during periods of unusually high rainfall. Soil excavated for building foundations would be used as backfill or trucked to suitable disposal sites on SRS, greatly reducing the likelihood that loose or stockpiled soil would be transported to streams along with stormwater.

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In accordance with best management practices, DOE would stabilize exposed soils by seeding with grasses or legumes (e.g., clovers) in a water medium that includes mulch and fertilizer. Hydroseeding is often used at SRS to stabilize disturbed areas and control erosion.

As discussed in Section 2.3.4, DOE could build as many as 18 new HLW storage tanks under the No Action alternative; DOE would use approved siting procedures to ensure that any new tanks would be built in previously disturbed industrial areas with a water table well below ground surface. Each new tank would require excavation of approximately 43,000 cubic yards of soil. Excavated soil would be used as backfill or trucked to suitable disposal sites on SRS. Best management practices would be used to stabilize soils and prevent runoff, reducing the likelihood that loose or stockpiled soil would be transported to streams along with stormwater.

Construction at SRS must comply with the requirements of the South Carolina stormwater management and sediment control regulations, which became effective in 1992 as part of the Clean Water Act. The regulations and associated permits require DOE to prepare erosion and sedimentation control plans for all land-disturbing projects, regardless of the size of the area affected, to minimize potential discharges of silts, solids, and other contaminants to surface waters. Effective January 2, 1997, the South Carolina Department of Health and Environmental Control (SCDHEC) approved a General Permit for stormwater management and sediment reduction at SRS (SCDHEC 1996). Although the General Permit does not exempt any land-disturbing and construction activities from the requirement of state stormwater management and sediment control regulations, it does not require SCDHEC approval of individual erosion and sediment control plans for construction activities at SRS.

Before beginning construction, DOE would develop site-specific erosion and sediment control plans for the proposed facilities. After construction, and depending on the location of the site, it may be necessary to include applicable mitigation measures in the SRS *Storm Water Pollution Prevention Plan* (WSRC 1993), which is a requirement of the General Permit covering industrial activities (Permit No. SCR000000). If the facility to be constructed is in the drainage area of a stormwater collection system permitted as part of National Pollutant Discharge Elimination System (NPDES) Permit No. SC0000175, it would not be necessary to include mitigation measures in the Plan.

DOE anticipates that impacts to McQueen Branch water quality from processing facility construction activities in S Area or Z Area would be small and would cease once construction was completed. Depending on the alternative selected, as many as 16 saltstone vaults (see Table 4-1) would be constructed in Z Area. These vaults would be built as needed during the 13 years required to process the salt solutions. DOE anticipates that impacts to surface water from this construction would be small due to implementation of best management practices and an approved site-specific erosion and sediment control plan.

Under all alternatives, including No Action, construction activities would be confined to established facility areas with established stormwater controls. Discharges from construction sites would be in compliance with SRS's site-wide stormwater permit and mitigated by best construction management practices and engineering controls. Because erosion and sedimentation from land-disturbing activities in S and Z Areas are not expected to degrade water quality in McQueen Branch, downstream impacts to Upper Three Runs would be unlikely.

Operations

Sanitary wastewater from salt processing facilities would be treated in the Centralized Sanitary Wastewater Treatment Facility and discharged to Fourmile Branch via NPDES Outfall G-10.

Process wastewater from salt processing facilities would be treated at the F/H Effluent Treatment Facility (ETF) and discharged to Upper Three Runs via NPDES Outfall H-16. As can be seen in Table 4-2, the volume of sanitary and process wastewater generated by each of the action alternatives is similar and low. The Solvent Extraction alternative would generate the highest volume of both wastewater streams, but would only constitute 2.2 percent of the SRS sanitary wastewater treatment capacity and 0.57 percent of the ETF capacity. In both instances, current treatment capacity would be more than adequate to handle the additional demand from salt processing facilities. Current NPDES discharge limitations would remain in effect, meaning that no degradation of water quality in Fourmile Branch, Upper Three Runs, or the Savannah River would be expected. Under the No Action alternative, sanitary and process wastewater generation rates would continue at current levels.

4.1.2.2 Groundwater Resources

Construction

Elements of the processing facility would be constructed below grade. The depth below grade for the Small Tank Precipitation and Ion Exchange process buildings would be about 45 feet, while the process building for Solvent Extraction would be about 40 feet below grade (WSRC 1998a). Because the surficial water table (Upper Three Runs Aquifer) is about 45 feet below ground surface (see Section 3.2.2.1) at the preferred site in S Area (see Figure 3-9), excavation for the deeper elements of the processing buildings and associated structures would approach groundwater. Therefore, dewatering could be necessary during construction. The dewatering would be performed for a short period of time and impact to the surficial aquifer would be minimal.

The process building in Z Area for Direct Disposal in Grout would be about 25 feet below grade (WSRC 1998a). The saltstone disposal vaults for all action alternatives would be at or slightly below grade. Depth to groundwater in Z Area is about 60 to 70 feet (see Figure 3-10, Section 3.2.2.1). Dewatering at this site would not be required. The potential at Z Area for impacts to groundwater during excavation and construction would be minimal because best management practices would be used, in compliance with Federal and state regulations.

DOE would use the approved siting process to ensure that any new HLW storage tanks built under the No Action alternative would be constructed in a previously disturbed area and not within the groundwater table. Therefore, groundwater impacts from construction of new tanks would be minimal.

Operations

Facility operations would not discharge to groundwater under any action alternative. Therefore, regardless of the salt processing alternative chosen, operation of the selected alternative would create no short-term impact to the groundwater. Groundwater use is discussed in Section 4.1.12, Utilities and Energy.

Under the No Action alternative, continuation of tank space optimization activities through approximately 2010 would increase the potential for tank failure and the resulting release of HLW to groundwater. The reuse of existing HLW tanks (after 2010) would also increase the risk of tank leaks and spills resulting in the release of HLW to groundwater. DOE would increase maintenance, monitoring and surveillances to minimize the potential for leaks and spills. The operation of any new HLW storage tanks constructed under the No Action alternative would not involve discharges to groundwater. Therefore, operation of any new HLW storage tanks would have no short-term impact to the groundwater.

Table 4-2. Total annual wastewater generation and as a percentage of available treatment capacity for all salt processing action alternatives.

	Baseline ^a	Small Tank Precipitation		Ion Exchange		Solvent Extraction		Direct Disposal in Grout	
	Percent utilization	Total (million gallons)	Percentage of treatment capacity	Total (million gallons)	Percentage of treatment capacity	Total (million gallons)	Percentage of treatment capacity	Total (million gallons)	Percentage of treatment capacity
Sanitary Wastewater	18 ^b	6.9 ^c	1.8 ^b	6.6 ^c	1.7 ^b	8.4 ^c	2.2 ^b	5.2 ^c	1.4 ^b
Process Wastewater	2.67 ^{d,e}	0.30 ^f	0.19 ^e	0.25 ^f	0.16 ^e	0.90 ^f	0.57 ^e	0.15 ^f	0.09 ^e

- a. For all scenarios under the No Action alternative, volume of wastewater generated would be similar to the wastewater generation at the existing HLW Tank Farms. Therefore, wastewater generation under No Action would be included in the SRS baseline.
- b. SRS Centralized Sanitary Waste Treatment Facility capacity = 1.05 million gallons per day (Schafner 2001).
- c. Adapted from WSRC (1999e). Sanitary wastewater based on estimated potable water use.
- d. F/H ETF design capacity = 433,000 gallons per day (DOE 1995).
- e. ETF percent utilization based on 1994 data (DOE 1995).
- f. Total process wastewater (radioactive liquid waste) annually (WSRC 1999b, 2000b).

4.1.3 AIR RESOURCES

To determine impacts on air quality, DOE estimated the nonradiological and radiological emission rates associated with processes and equipment used in each action alternative. This included identifying potential emission sources and any methods by which air would be filtered before being released to the environment. These emissions were entered into air dispersion models to determine potential maximum concentrations at onsite and offsite locations. Air emissions under the No Action alternative would be similar to those from the existing HLW Tank Farm operations for all scenarios. Therefore, the No Action alternative is represented by slight increases above the baseline. The estimated emissions and air concentrations of nonradiological and radiological pollutants are discussed and compared to the pertinent SCDHEC and Federal regulatory limits in the following two sections. Impacts resulting from incremental increases of air pollutant concentrations are measured in terms of human health effects and are discussed in Section 4.1.4, Worker and Public Health.

4.1.3.1 Nonradiological Emissions

Construction

Construction (excluding vaults) would occur over approximately four years for each action alternative. As discussed in Section 4.1.1, 13 to 16 saltstone vaults would be constructed over the 13-year period between 2010 and 2023. Building new tanks under the No Action alternative would require four or more years of construction, depending on the number of tanks needed. Construction activities would involve the use of heavy equipment such as bulldozers, cranes, dump trucks, and backhoes to clear the land, construct buildings, and develop the infrastructure to support the facilities (e.g., paved roads, sewer/potable water and feed lines). Table 4-3 lists the expected construction-related air emission sources for all alternatives, including No Action. Table 4-4 shows the annual air emission rates from all con-

struction-related sources (Hunter 2000). The type and rate of construction emissions for all alternatives would be the same.

During construction, the excavation and transfer of soils and the disturbance of surface dust by heavy equipment all result in particulate matter emissions. These emissions of particulate matter caused by wind or man's activities, or both, are known as fugitive dust. In accordance with good dust control practices required by South Carolina regulations, measures would be implemented to control fugitive particulate matter. Best management practices would be used during land clearing, road grading, and construction to minimize airborne dust. Dust control measures could include seeding, wind speed reduction (e.g., wind barriers), wet or chemical suppression, or early paving. The U.S. Environmental Protection Agency's (EPA's) Fugitive Dust Model (FDM) (EPA 1992) computer program was used to model all fugitive emissions from construction activities.

Heavy-duty construction equipment (i.e., trucks, bulldozers, and other diesel-powered support equipment) would be used for excavation and grading, hauling soil and debris for disposal, and other routine construction activities. Exhaust emissions from these diesel engines would result in releases of sulfur dioxide (SO₂), oxides of nitrogen (NO_x), particulate matter (PM₁₀), carbon monoxide (CO), and total suspended particulate (TSP) matter. A detailed listing of the construction equipment that would be used is documented in WSRC (1999b).

Facility construction (including new tanks under the No Action alternative) would necessitate a concrete batch plant at the building site. Particulate matter, consisting primarily of cement dust, would be the only regulated pollutant emitted in the concrete mixing process. Emissions would occur at the point of transfer of cement to the silo. However, DOE would use filter bags, which have control efficiencies as high as 99 percent, or a similar technology to remove particulate emissions. Particulate emission limits for the operation of a concrete batch plant would be established in a construction permit

Table 4-3. Expected sources of air emissions from construction activities for all alternatives.

Alternative	Source of air emissions
All alternatives, including No Action	Excavation/soil transfers Dust from vehicle traffic on unpaved surfaces Vehicle exhaust Concrete batch plant emissions

Table 4-4. Estimated nonradiological air emissions (tons per year) from construction activities associated with all alternatives.

Air pollutant	Vehicle exhaust (tons per year)	Fugitive Dust (tons per year) ^a	Concrete Batch Plant (tons per year)
SO ₂	13	–	–
TSP	16	100	14
PM ₁₀	NA ^b	25	NA
CO	60	–	–
NO _x	150	–	–

Source: Hunter (2000).

a. Includes fugitive dust caused from excavation/soil transfers and dust disturbed by moving vehicles used for site preparation and facility construction.

b. NA = Not available. No method for estimating PM₁₀ emissions from this type of emission source is available.

SO₂ = sulfur dioxide, TSP = total suspended particles, PM₁₀ = particulate matter with an aerodynamic diameter ≤ 10 micrometers, CO = carbon monoxide, NO_x = oxides of nitrogen.

granted by SCDHEC. Any fugitive dust emissions from sand and aggregate piles around the batch plant would be controlled by water suppression, chemical dust suppressants, or other approved methods. Using the emission rates from construction vehicles and the concrete batch plant (Table 4-4), maximum concentrations of regulated pollutants were determined, using Release 3 of the Industrial Source Complex – Short Term (ISC3) air dispersion model (EPA 1995).

Meteorological data input into the models (ISC3 and FDM) included sequential hourly averages of wind speed, wind direction, turbulence intensity (stability), and temperature (from SRS meteorological tower network), and twice-daily mixing height (rural) data (for Atlanta, Georgia). A one-year data set (1996) was used.

Using ISC3 and FDM, the maximum concentrations at the SRS boundary were esti-

mated because that is the closest location where members of the public potentially would be exposed. At the Site boundary, concentrations are estimated at ground level because, at this distance from the emission point(s), the vertical distribution of the contaminants would be relatively uniform. The resulting incremental increases to background concentrations (in micrograms per cubic meter) at the SRS boundary are listed in Table 4-5. Particulate matter (TSP and PM₁₀) concentrations would be slightly increased (1 percent and 2 percent, respectively), with fugitive dust emissions accounting for most of the particulate matter emissions. All other regulated pollutant concentrations estimated at the Site boundary increase less than 1 percent of the standard. Because the increases in concentration listed in Table 4-5 would be associated only with construction, they would be temporary, lasting only until construction ended. Also, all the construction emission sources would not be in operation at the same time or throughout the entire construction period.

Table 4-5. Estimated maximum incremental increases of air concentrations (micrograms per cubic meter) of SCDHEC-regulated nonradiological air pollutants at the SRS boundary from construction activities associated with all salt processing alternatives.

Air pollutant	Averaging time	SCDHEC standard ($\mu\text{g}/\text{m}^3$) ^a	SRS baseline concentration ($\mu\text{g}/\text{m}^3$) ^b	SRS baseline concentration (% of standard)	Maximum concentration ($\mu\text{g}/\text{m}^3$) ^c	SRS baseline + concentration (% of standard)
SO ₂	3-hr	1,300	1,240	96	5.0	96
	24-hr	365	350	96	0.7	96
	Annual	80	34	42	0.009	42
TSP	Annual	75	67	89	0.04	90
	geometric mean					
PM ₁₀ ^d	24-hr	150	130	88	2	90
	Annual	50	25	51	0.03	51
CO	1-hr	40,000	10,350	26	70	26
	8-hr	10,000	6,870	69	10	69
NO ₂	Annual	100	26	26	01	26

Source: Hunter (2000).

a. SCDHEC Regulation 61-62.5, Standard 2, "Ambient Air Quality Standards".

b. Sum of (1) an estimated maximum Site boundary concentration from modeling all SRS sources of the indicated pollutant not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory data base) and (2) observed concentrations from nearby ambient air monitoring stations (Hunter 2000).

c. Maximum concentrations would be the same for all alternatives including construction of new tanks under No Action.

d. New standards for particulate matter will come into effect during the construction of this project.

SO₂ = sulfur dioxide, TSP = total suspended particles, PM₁₀ = particulate matter with an aerodynamic diameter ≤ 10 μm , CO = carbon monoxide, NO₂ = nitrogen dioxide.

Operations

Salt processing activities would result in the release of regulated nonradiological pollutants to the surrounding air. Table 4-6 lists, by alternative, the expected air emission sources during the operation of each action alternative. For all scenarios under the No Action alternative, the only air emission source would be the ventilation exhaust from each utilized tank. As presented in the following tables, the baseline is representative of the No Action alternative. The estimated emission rates (tons per year) for non-radiological pollutants emitted under each action alternative are presented in Table 4-7 (Hunter 2000). These emission rates can be compared against emission rates defined in SCDHEC Standard 7, "Prevention of Significant Deterioration (PSD)," to determine if the emission would exceed this standard or cause a significant pollutant emission increase.

As part of its evaluation of the impact of air emissions, DOE consulted the Guidance on Clean Air Act General Conformity requirements (DOE 2000a). DOE determined that the General Conformity rule does not apply because the area where the DOE action would take place is an attainment area for all criteria pollutants. Therefore, although each alternative would emit criteria pollutants, a conformity review is not necessary.

As can be seen in Table 4-7, sulfur dioxide (SO₂), TSP, PM₁₀, CO, NO_x, lead, beryllium, and mercury emissions are similar for all action alternatives and would be well below their corresponding PSD limits.¹ The estimated emission rates for these air pollutants range from 53 percent of the PSD limit (for NO_x under the Small Tank Precipitation, Ion Exchange, and Solvent

¹ PSD limit refers to the threshold emissions rates that trigger the need for a PSD review.

Table 4-6. Expected sources of air emissions during salt processing for the four action alternatives^a.

Alternative	Source of air emissions
All action alternatives	Minimal new emission sources (S Area)
Small Tank Precipitation, Ion Exchange, Solvent Extraction	Exhaust stack for the Process Facility (S Area) Ventilation exhaust from the Cold Chemical Feed Area (S Area) Exhaust stack for existing saltstone facility (Z Area) Exhaust from two emergency diesel generators (S Area) Exhaust from one emergency diesel generator (Z Area)
Direct Disposal in Grout	Exhaust stack for the Direct Disposal in Grout Process Facility (Z Area) Ventilation exhaust from the Cold Chemical Feed Area (Z Area) Ventilation exhaust from the Vaults (Z Area) ^b Exhaust from two emergency diesel generators (Z Area)

a. For all scenarios under the No Action alternative, the expected source of emissions would be the ventilation exhaust from each tank.

b. Vaults for the other three action alternatives would have minimal emissions because the saltstone produced by these action alternatives would have a lower activity level and the vaults would not be ventilated.

Extraction alternatives) to less than 1 percent of the limit for SO₂, lead, and mercury.

The estimated volatile organic compounds (VOC) emissions rate of 70 tons per year for the Small Tank Precipitation alternative would exceed the threshold value established by SCDHEC for PSD permit review, whereas estimated emissions from the other alternatives are either estimated below the PSD limit or covered by existing air permit levels. Implementation of the Small Tank Precipitation alternative would result in small increases in offsite concentrations of benzene and ozone, with minimal impacts to public health. The other alternatives would have lower impacts.

VOC emissions are subject to a PSD limit because they contribute to the formation of ozone. Ozone is a photochemical oxidant and the major component of smog. Ozone is not emitted directly into the air, but is formed through complex chemical reactions between emissions of VOCs and NO_x in the presence of sunlight. Both VOCs and NO_x are emitted by industrial and transportation sources.

Prevention of Significant Deterioration Review

Facilities, such as SRS, that are located in attainment areas for air quality and are classified as major facilities may trigger a PSD review under the new source review requirements of the Clean Air Act when they construct a major stationary source or make a major modification to a major source. (A major source is defined as a source with the potential to emit any air pollutant regulated under the Clean Air Act in amounts equal to or exceeding specified thresholds). The SCDHEC uses a two-step process to determine whether a new source results in a significant emissions increase of a regulated pollutant. First, the potential emissions from the new source are compared to their corresponding PSD significant emission limits. If the emission increase is by itself (without considering any contemporaneous decreases) less than the PSD limit, no further analysis is required. If, however, the emission increase is equal to or greater than the PSD limit, then all contemporaneous emissions increases and decreases must be summed and the net increase is compared to the PSD limit. A PSD permit review is required if that modification or addition to the major facility results in a net increase of any regulated pollutant over the level established in the current permit that is greater than the corresponding PSD limit.

Table 4-7. Estimated nonradiological air emissions (tons per year) from routine operations for salt processing alternatives.^a

Air pollutant	SRS Permit Allowance	PSD New Source Emission Limit	Small Tank Precipitation		Ion Exchange		Solvent Extraction		Direct Disposal in Grout	
	(tons/yr) ^b	(tons/yr) ^c	(tons/yr)	(% of PSD limit)	(tons/yr)	(% of PSD limit)	(tons/yr)	(% of PSD limit)	(tons/yr)	(% of PSD limit)
SO ₂	3.32	40	0.33	0.81	0.33	0.81	0.33	0.81	0.30	0.75
TSP	5.51	25	0.95	3.8	0.95	3.8	0.95	3.8	0.80	3.2
PM ₁₀	2.4	15	0.4	2.7	0.4	2.7	0.4	2.7	0.30	2.0
CO	86.9	100	5.4	5.4	5.4	5.4	5.4	5.4	4.9	4.9
VOCs ^d	70.23 ^e	40	70	175	1.6	4.1	40	100	1.5	3.6
NO _x	232.8	40	21	53	21	53	21	53	19	48
Lead	NA ^f	0.6	4.0×10 ⁻⁴	0.067	4.0×10 ⁻⁴	0.067	4.0×10 ⁻⁴	0.067	3.5×10 ⁻⁴	0.058
Beryllium	NA ^f	4.0×10 ⁻⁴	1.0×10 ⁻⁴	25	1.0×10 ⁻⁴	25	1.0×10 ⁻⁴	25	5.0×10 ⁻⁵	13
Mercury	0.88	0.1	0.0026	2.6	0.0026	2.6	0.0026	2.6	0.0025	2.5
Formic Acid ^g	1.6	NA ^h	1.6	-	None	-	None	-	None	-
Benzene	50.48	NA ^h	53	-	0.0085	-	0.0085	-	0.0080	-
Biphenyl ⁱ	NA ^j	NA ^h	1.1	-	None	-	None	-	None	-
Methanol ^k	NA ^j	NA ^h	0.42	-	0.42	-	0.42	-	0.42	-
n-Propanol ^l	NA ^j	NA ^h	0.42	-	0.42	-	0.42	-	0.42	-
Isopar [®] L ^m	NA ^j	NA ^h	0.0	-	0.0	-	38	-	0.0	-

Source: Hunter (2000).

- For all scenarios under the No Action alternative, air emissions would be similar to those from the existing HLW Tank Farm operations. Therefore, No Action is represented by slight increases above the SRS baseline.
- SCDHEC Bureau of Air Quality Control Operating Permits for HLW management facilities.
- SCDHEC Regulation 61-62.5, Standard 7, "Prevention of Significant Deterioration".
- VOCs are subject to a PSD limit because they are a precursor to ozone. VOCs that may be emitted as a result of the proposed action include benzene, biphenyl, methanol, n-Propanol, and Isopar[®]L. NO_x also contributes to ozone formation.
- Value includes 50.48 tons per year of benzene and 19.75 tons per year of other VOCs.
- SRS lead and beryllium emissions originate from permit-exempted units, so no allowance has been established.
- Formic acid emissions would shift from DWPf to the Small Tank Precipitation facility, resulting in no net change in emissions.
- No PSD limit is defined for this pollutant.
- Also known as diphenyl.
- This pollutant is a VOC and the SRS air permits do not have a specific permit allowance for this pollutant.
- Also known as methyl alcohol.
- Also known as n-Propyl alcohol; OSHA-regulated pollutant.
- Isopar[®]L is a proprietary chemical; regulated as a VOC only.

NA = not applicable, SO₂ = sulfur dioxide, TSP = total suspended particulates, PM₁₀ = particulate matter with an aerodynamic diameter ≤ 10 μm, CO = carbon monoxide, NO_x = oxides of nitrogen, PSD = prevention of significant deterioration, VOC = volatile organic compound.

According to EPA AIRS databases (EPA 2001), Aiken and Barnwell Counties combined produced a total of more than 10,000 tons per year of NO_x in 1998 and anthropogenic VOC emissions were over 10,000 tons per year. According to the EPA TRENDS reports (EPA 2000), the biogenic VOC contribution for the Aiken-Barnwell region is around 9,000 tons per year. Estimated emissions from the alternative with the highest VOC emissions (i.e., Small Tank Precipitation) are 21 tons per year NO_x and 70 tons per year VOCs. Therefore, regional emissions of ozone precursors would be expected to increase by less than one percent for this alternative. From modeling results such as those presented in Carter (1994), percentage increases in ozone precursors are generally greater than the resulting changes in ozone. Therefore, ozone concentrations would be expected to increase by no more than one percent. The background level of ozone is 216 micrograms per cubic meter, and the ambient air quality standard for ozone is 235 micrograms per cubic meter. Therefore, a one percent increase in ozone, to about 218 micrograms per cubic meter, at the point of maximum impact would not exceed the ambient air quality standard.

As shown in Table 4-6, nonradionuclide emissions from routine salt processing operations would come from several sources. Using the emission rates from Table 4-7 for the listed sources, maximum concentrations of released regulated pollutants were determined using the ISC3 air dispersion model. Because the proposed sites for salt processing facilities in S and Z Areas are located in close proximity to DWPF and would be subject to the same meteorological conditions as DWPF, the stack for each process facility was assumed to be the same height as the DWPF stack (i.e., 46 meters). Emissions from the cold chemical feed area (see Section 2.7.4, Support Facilities) and from the emergency generators were assumed to occur at ground level. The process facilities and the cold chemical feed areas were assumed to emit pollutants continuously. The emergency generators were assumed to

operate 250 hours per year, primarily for testing.

The ICS3 short-term modeling results provided estimated maximum concentrations at the SRS boundary, where members of the public potentially would be exposed, and at the location of a hypothetical noninvolved site worker. For the location of the noninvolved worker, the analysis used a generic location 640 meters from the release point in the direction of the greatest concentration. This location is the distance for assessing consequences from facility accidents and, for consistency, is used here for normal operations. Concentrations at the noninvolved worker location were calculated at an elevation of 1.8 meters above ground to simulate the breathing height of a typical adult.

The maximum air concentrations (micrograms per cubic meter) at the SRS boundary that would be associated with the release of regulated nonradiological pollutants are presented in Table 4-8. For the action alternatives, the incremental increase in concentrations of SO₂, TSP, PM₁₀, CO, nitrogen dioxide (NO₂), and lead (SCDHEC Ambient Air Quality Standards [Standard 2] regulated pollutants) would be less than 1 percent of the baseline (i.e., No Action alternative). Incremental concentration increases of air toxic pollutants (NO₂, lead, beryllium, mercury, benzene, biphenyl, methanol, and formic acid) would be small under all alternatives; for most pollutants, there would be an incremental increase of less than 1 percent of the baseline (i.e., No Action alternative). The greatest increase (7.5 percent) would occur for biphenyl under the Small Tank Precipitation alternative, but ambient concentrations would remain far below the SCDHEC Toxic Air Pollutants (Standard 8) limit. Therefore, no salt processing alternative would exceed SCDHEC standards at the SRS boundary.

The air quality impacts at the location of a hypothetical noninvolved worker in the vicinity of the processing facilities are presented in

Table 4-8. Estimated maximum increases in air concentrations (micrograms per cubic meter) and percent of standard of SCDHEC-regulated non-radiological air pollutants at the SRS boundary from salt processing alternatives.

Air pollutant	Averaging time	Maximum concentration											
		SCDHEC standard		SRS baseline concentration		Small Tank Precipitation		Ion Exchange		Solvent Extraction		Direct Disposal in Grout	
		($\mu\text{g}/\text{m}^3$) ^a	($\mu\text{g}/\text{m}^3$) ^b	(% of standard)	Concentration ($\mu\text{g}/\text{m}^3$)	Concentration (% of standard)	Concentration ($\mu\text{g}/\text{m}^3$)	Concentration (% of standard)	Concentration ($\mu\text{g}/\text{m}^3$)	Concentration (% of standard)	Concentration ($\mu\text{g}/\text{m}^3$)	Concentration (% of standard)	
<i>Ambient air pollutants</i>													
SO ₂	3-hr	1,300	1,240	96	0.30	96	0.30	96	0.30	96	0.40	96	
	24-hr	365	350	96	0.040	96	0.040	96	0.040	96	0.050	96	
	Annual	80	34	42	4.0×10^{-4}	42	4.0×10^{-4}	42	4.0×10^{-4}	42	5.0×10^{-4}	42	
TSP	Annual geometric mean	75	67	89	0.0010	89	0.0010	89	0.0010	89	0.0010	89	
PM ₁₀ ^c	24-hr	150	130	88	0.070	89	0.070	89	0.070	89	0.070	89	
	Annual	50	25	51	0.0010	51	0.0010	51	0.0010	51	0.0010	51	
CO	1-hr	40,000	10,350	26	15	26	15	26	15	26	18	26	
	8-hr	10,000	6,870	69	1.9	69	1.9	69	1.9	69	2.3	69	
Ozone ^e	1-hr	235	216	92	ND	ND	ND	ND	ND	ND	ND	ND	
NO ₂	Annual	100	26	26	0.030	26	0.030	26	0.030	26	0.030	26	
Lead	Max. calendar quarter	1.5	0.03	2.0	4.0×10^{-7}	2.0	4.0×10^{-7}	2.0	4.0×10^{-7}	2.0	4.0×10^{-7}	2.0	
<i>Air toxic pollutants^f</i>													
Benzene	24-hr	150	5	3.1	4.0	5.7	0.0010	26	0.0010	26	0.0010	26	
Mercury	24-hr	0.25	0.03	12	3.0×10^{-5}	12	3.0×10^{-5}	12	3.0×10^{-5}	12	3.0×10^{-5}	12	
Biphenyl ^g	24-hr	6	0.02	0.33	0.45	7.8	None	0.33	None	0.33	None	0.33	
Methanol ^g	24-hr	1,310	0.9	0.069	0.32	0.093	0.32	0.090	0.32	0.090	0.53	0.11	
Beryllium	24-hr	0.01	0.0090	90	1.0×10^{-5}	90	1.0×10^{-5}	90	1.0×10^{-5}	90	1.0×10^{-5}	90	
Formic Acid ^h	24-hr	225	0.15	0.067	0.01	0.067	None	0.067	None	0.067	None	0.067	

Source: Hunter (2000). Concentrations are based on maximum potential emissions.

- SCDHEC Air Pollution Regulation 61-62 5, Standard 2, "Ambient Air Quality Standards", and Standard 8, "Toxic Air Pollutants".
- Sum of (1) estimated maximum site boundary concentration from modeling all SRS sources of the indicated pollutant not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory data base) and (2) observed concentrations from nearby ambient air monitoring stations (Hunter 2000). For all scenarios under the No Action alternative, emissions would be similar to those from existing HLW Tank Farm operations and would be represented by slight increases over the SRS baseline.
- New standards for this pollutant may come into effect during the lifetime of this project.
- Source: SCDHEC (1998). Observed concentration of ozone at SCDHEC ambient monitoring station for Aiken County.
- n-Propanol is not included on this table because it is an OSHA-regulated pollutant, not an SCDHEC-regulated pollutant.
- Also known as diphenyl.
- Also known as methyl alcohol.
- Formic acid emissions would shift from DWPF to the Small Tank Precipitation Facility, resulting in no net change in emissions.

ND = Not determined, SO₂ = sulfur dioxide, TSP = total suspended particulates, PM₁₀ = particulate matter with an aerodynamic diameter $\leq 10 \mu\text{m}$, CO = carbon monoxide, NO₂ = nitrogen dioxide.

the Worker and Public Health section (Section 4.1.4.1 – Nonradiological Health Effects). For all processing alternatives, ambient concentrations of NO₂ would reach 78 percent of the Occupational Safety and Health Administration (OSHA) ceiling limit of 9 milligrams per cubic meter (mg/m³). These NO₂ emissions would result from the periodic operation of the emergency generators. Since the estimated emissions are based on maximum potential emissions and all the emergency generators likely would not operate at the same time, the estimated emissions and resulting concentrations are conservative. All concentrations of OSHA-regulated pollutants would be below the established limits.

4.1.3.2 Radiological Emissions

Construction

No known radiological contamination exists at the proposed construction sites in S and Z Areas. DOE would use the approved siting process to ensure that any new HLW tanks constructed under the No Action alternative would be constructed in an area where no radiological contamination is known to exist. Therefore, regardless of the alternative chosen, no radiological air emissions are expected as a result of construction activities.

Operations

DOE estimated routine radionuclide air emissions for each salt alternative. Under each processing alternative, radionuclides would be emitted to the air via a stack. As discussed in Section 4.1.3.1, the stack for each process facility was assumed to be 46 meters high, the same height as the DWPF stack. For all the salt processing alternatives, the ventilation exhaust would be filtered through high-efficiency particulate air filters. The Direct Disposal in Grout alternative would have an additional emission point at each vault in operation because radioactive cesium would not be removed before grouting, requiring the vaults to have a

forced air ventilation system for temperature control while the saltstone cures. Because the other three action alternatives would remove more radionuclides (including radioactive cesium) from the low-activity salt fraction, the grout would have much lower activity levels and the vaults would not need to be ventilated. Therefore, the Small Tank Precipitation, Ion Exchange, and Solvent Extraction alternatives would have no measurable emissions from the associated saltstone vaults. Emissions from the vaults for Direct Disposal in Grout alternative were assumed to be at ground level. The estimated total radiological air emissions for each action alternative are shown in Table 4-9 (Pike 2000). Because there are no equivalent facilities at SRS, DOE's method for estimating emission rates from the alternative salt processing facilities is conservative and ensures that total emissions are not underestimated. All action alternatives are all treated with the same conservative basis. The Small Tank Precipitation, Ion Exchange, and Solvent Extraction processes all produce highly concentrated cesium-bearing process streams. The engineered systems designed for each facility would ensure that the cesium emissions are as low as reasonably achievable.

Air emissions under the No Action alternative would be similar to those from existing HLW Tank Farms operations for ongoing tank space management activities and all subsequent scenarios. Therefore, the No Action alternative is represented by slight increases above the baseline.

After determining routine emission rates for the action alternatives, DOE used the MAXIGASP and POPGASP computer codes to estimate radiological doses to the maximally exposed (off-site) individual (MEI), the hypothetical noninvolved worker, and the offsite population surrounding SRS. Both codes utilize the GASP (Eckerman et al. 1980) and XOQDOQ (Sagendorf et al. 1976, 1982) modules; GASP and XOQDOQ are based on U.S. Nuclear Regulatory Commission (NRC) Regulatory Guides 1.111 and 1.109 (NRC1977), respectively. Both GASP and XOQDOQ have

Table 4-9. Annual radionuclide emissions (curies/year) resulting from operations.^a

	Annual emission rate			
	Small Tank Precipitation (Ci/yr)	Ion Exchange (Ci/yr)	Solvent Extraction (Ci/yr)	Direct Disposal in Grout ^b (Ci/yr)
Tritium	4.3	18	24	9.2
Strontium-90	8.3×10^{-4}	4.9×10^{-5}	0.0019	0.0036
Technetium-99	1.6×10^{-5}	1.6×10^{-6}	8.4×10^{-5}	3.4×10^{-5}
Ruthenium-106	5.2×10^{-6}	4.9×10^{-7}	2.6×10^{-5}	1.0×10^{-5}
Antimony-125	1.5×10^{-6}	1.6×10^{-7}	9.0×10^{-6}	3.5×10^{-6}
Iodine-129	1.5×10^{-8}	1.7×10^{-9}	6.9×10^{-7}	3.7×10^{-8}
Cesium-134	0.0035	0.0024	0.014	8.5×10^{-4}
Cesium-137	0.98	0.24	1.4	0.085
Total Alpha ^c	0.0010	1.5×10^{-4}	0.0060	0.011
Total	5.3	18.2	25.4	9.3

Source: Pike (2000).

- Air emissions under the No Action alternative would be similar to those from existing HLW Tank Farm operations for continuing tank space management activities and all subsequent scenarios. Therefore, the No Action alternative is represented by slight increases over the SRS baseline. SRS baseline emissions are shown in Table 3-12.
- Includes emissions from vaults. Vaults for the other three action alternatives would have no measurable emissions because the saltstone produced by these action alternatives would have a much lower activity level and the vaults would not be ventilated.
- Assumed to be plutonium-239.

been adapted and verified for use at SRS (Hamby 1992 and Bauer 1991, respectively). MAXIGASP and POPGASP are both Site-specific computer programs that have SRS-specific meteorological parameters (e.g., wind speeds and directions) and population distribution parameters (e.g., number of people in sectors around the Site). The 1990 census population database was used to represent the population living within a 50-mile radius of the center of SRS.

Table 4-10 presents the calculated maximum radiological doses (as 50-year committed effective dose equivalents) associated with salt processing activities for all the analyzed alternatives. Based on the dispersion modeling for stack emissions from processing facilities for each alternative, the MEI (public) was identified as being located north-northeast at the SRS boundary. For ground-level releases (vault emission under the Direct Disposal in Grout alternative), the MEI would be located at the north SRS boundary (Simpkins 1999, 2000a,b). The maximum committed effective dose equivalent for the MEI would be 0.31 millirem per year for the Solvent Extraction alternative, which is

higher than the other alternatives, due to higher estimated radioactive cesium emissions. Ninety percent of the dose to the MEI is associated with the radioactive cesium emissions and 9.5 percent of the dose would result from the total alpha emissions. The Small Tank Precipitation alternative has a maximum committed effective dose equivalent of 0.20 millirem per year, while the Ion Exchange and Direct Disposal alternatives have a lower maximum committed effective dose equivalent for the MEI of 0.049 and 0.086, respectively. The annual MEI dose under all the alternatives would still be well below the established annual dose limit of 10 millirem for SRS atmospheric releases (40 CFR 61.92).

The maximum estimated dose to the offsite population residing within a 50-mile (80-kilometer) radius (approximately 620,000 people) would be 18.1 person-rem per year, also as a result of the Solvent Extraction alternative. As with the MEI dose, offsite concentrations of radioactive cesium would compose most (93 percent) of the total population dose. The Small Tank Precipitation alternative has an offsite population dose of 12.0 person-rem per year. The Ion Exchange and Direct Disposal in Grout

Table 4-10. Annual doses from radiological air emissions from salt processing activities presented as 50-year committed effective dose equivalents.

	Maximum dose ^a			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout ^b
Maximally exposed offsite individual dose (millirem/year)	0.20	0.049	0.31	0.086
Offsite population dose (person-rem/year)	12.0	2.9	18.1	4.0
Noninvolved worker dose (millirem/year)	3.3	0.8	4.8	1.7
Involved worker dose (millirem/year)	15.7	3.9	22.8	10.1
Onsite population dose (person-rem/year)	4.3	1.1	6.5	2.3

Source: Based on emission values listed in Table 4-7 and Simpkins (1999 and 2000a,b).

a. For all scenarios under the No Action alternative, radiological air emissions would be similar to those from existing HLW Tank Farm operations, and would be represented by slight increases above the baseline. Therefore, under the No Action alternative, doses to all receptors would be minimal.

b. Includes building stack and ground-level vault doses.

alternatives have values that are similar to each other, but lower than the previous alternatives (2.9 and 4.0 person-rem per year, respectively). For all scenarios, the total offsite population dose is low.

Table 4-10 also reports doses to the noninvolved (onsite) worker, the involved worker, and the collective onsite population from the estimated annual radiological emissions. For each case, the highest estimated dose would occur under the Solvent Extraction alternative, with the Small Tank Precipitation alternative having similar results and the Ion Exchange and the Direct Disposal in Grout alternatives having lower doses. The maximum dose to the noninvolved and involved worker would be 4.8 millirem per year and 22.8 millirem per year, respectively, with radioactive cesium emissions contributing about 98 percent of the total dose. The maximum estimated dose to the onsite population would be 6.5 person-rem per year, with 94 percent of this total dose due to radioactive cesium emissions. In all cases these doses are low.

For ongoing tank space management activities and all subsequent scenarios under the

No Action alternative, radiological air emissions would be similar to those from existing HLW Tank Farm operations, and would be represented by slight increases above the baseline. Therefore, under the No Action alternative, doses to all receptors would be minimal.

4.1.4 WORKER AND PUBLIC HEALTH

This section discusses potential radiological and nonradiological health effects to SRS workers and the surrounding public from construction and routine operation of the salt processing alternatives; it does not include impacts of potential accidents, which are discussed in Section 4.1.13. DOE based its calculations of health effects from radiological releases to air as doses with the corresponding impacts expressed as latent cancer fatalities (LCFs) to (1) the MEI; (2) the collective population within a 50-mile (80-kilometer) radius around SRS (approximately 620,000 people); (3) the maximally exposed noninvolved worker (i.e., an SRS employee who may work in the vicinity of the salt processing facilities, but is not directly involved with the work); (4) the involved worker; (5) the onsite population of involved workers (i.e., the workers directly involved in salt processing activities); and (6) the population of SRS workers

(includes both involved and noninvolved workers). All radiation doses in this SEIS are committed effective dose equivalents. This section presents total impacts for the entire length of time necessary to implement each technology. The annual impacts attributable to each phase were multiplied by the duration of that phase. The impacts from all phases were summed to calculate the total impact for the technology. This discussion characterizes health effects to populations as additional lifetime LCFs likely to occur in the general population around SRS, the population of onsite workers, and the population of workers who would be associated with implementing the alternatives. Health effects to the MEI and the noninvolved and involved worker are characterized by the additional probability of an LCF to the exposed individual.

Nonradiological health effects discussed in this section include effects from nonradiological emissions to air of toxic and criteria pollutants. In addition to radiological and nonradiological health effects, common occupational health impacts are presented in terms of estimated work-related illness and injury events associated with each of the salt processing alternatives. There are no radiological or nonradiological releases to water from any of the action alternatives.

4.1.4.1 Nonradiological Health Effects

The Occupational Health and Industrial Hygiene programs at SRS deal with all aspects of worker health and the workers' relationships with their work environment. The objective of an effective Occupational Health program is to enable employees to work safely and to recognize unsafe work practices or conditions before an accident occurs.

The objective of an Industrial Hygiene program is to evaluate toxic or hazardous chemicals in the work environment and use established procedures and routine monitoring to prevent or minimize employee exposures to these chemicals. Exposure limit

values are the basis of most occupational health codes and standards and are used to regulate worker exposure to hazardous chemicals.

OSHA permissible exposure limits (PELs) (29 CFR 1910.1000) are established limits that ensure the safety of the worker population. PELs are time-weighted average concentrations that a facility cannot exceed in any 8-hour work shift of a 40-hour work week. OSHA ceiling limits are concentrations of substances that cannot be exceeded during any part of the workday. Both of these exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could be exposed day after day without adverse health effects. However, because of the wide variation in individual susceptibility, a small percentage of workers could experience discomfort from some substances at concentrations at or below the permissible limits. The OSHA PEL standards for identified pollutants of concern during salt processing activities are listed in Table 3-18.

DOE evaluated the range of chemicals in facility air emissions to which the public and workers would be exposed due to salt processing activities and expects minimal health impacts from nonradiological exposures. Section 4.1.3 discusses onsite and offsite chemical concentrations from air emissions. DOE estimated noninvolved worker impacts and Site boundary concentrations to which a maximally exposed member of the public could be exposed. Site boundary concentrations were compared to the SCDHEC standards for ambient concentrations and DOE concluded that all air emission concentrations would be below the applicable standard. See Section 4.1.3 for comparison of estimated concentrations at the Site boundary with SCDHEC standards.

The noninvolved worker concentrations were compared to OSHA PELs or ceiling limits for protecting worker health, and the comparisons indicated that all criteria pollutant concentrations would be negligible compared to the OSHA standards.

Beryllium is a pollutant of concern for salt processing activities. A naturally occurring metal,

beryllium is used primarily in electronic components and cellular network communication systems. It is also used in aerospace and defense applications. Most of the beryllium emissions in the United States are a result of beryllium-copper alloy production and burning of fossil fuels (e.g., coal and oil) to produce electricity. Beryllium is also a constituent of cigarette smoke (ATSDR 1988). The beryllium that would be emitted by the salt processing alternatives is primarily a constituent of the exhaust from the emergency generators (Hunter 2000), which were assumed to operate 250 hours per year for testing. Health concerns from beryllium exposure include excess lifetime cancer risk and chronic beryllium disease (CBD), which can be seriously debilitating and lead to premature death. The maximum excess lifetime cancer risks to the noninvolved worker and to the MEI from exposure to beryllium emissions were estimated to be 7.2×10^{-5} and 2.4×10^{-8} , respectively, based on the EPA's Integrated Risk Information System (IRIS) database (EPA 1998) unit risk factor for beryllium of 2.4×10^{-3} excess cancer risk per microgram per cubic meter. This excess cancer risk from beryllium emissions is the same for all given alternatives.

Exposure to respirable beryllium fumes, dusts, or powder can also cause CBD in individuals who are sensitized (allergic) to beryllium. One to six percent of workers engaged in operations producing or using beryllium and its compounds develop CBD over their lifetimes (National Jewish Medical and Research Center 2001). While some cases of CBD have been reported in individuals with no occupational exposure to beryllium, only one case has been reported since 1973. No cases of CBD have been associated with low atmospheric concentrations of beryllium, such as those observed in the vicinity of SRS (NIOSH 1986). Therefore, DOE believes that the excess CBD risk to workers and the public as a result of salt

processing operations would be minimal for all salt processing alternatives.

Benzene is the pollutant of most concern for salt processing activities. The maximum excess lifetime cancer risks to the noninvolved worker and MEI from exposure to benzene emissions were estimated to be 6.6×10^{-3} and 1.7×10^{-5} , respectively, based on the EPA's IRIS database (EPA 1998) unit risk factor for benzene of 8.3×10^{-6} excess cancer risk per microgram per cubic meter. This excess cancer risk from benzene emissions is associated with the Small Tank Precipitation alternative. Because benzene emissions (primarily from the emergency generators) from the other salt processing alternatives are similar and would be much lower than the emissions from the Small Tank Precipitation alternative, they are expected to have considerably lower excess lifetime cancer risks. See Table 4-11 for additional nonradiological pollutant concentrations. Under the No Action alternative, air emissions from ongoing tank space management activities and all subsequent scenarios would be similar to air emissions from the HLW operations included in the SRS baseline. Therefore, incremental health effects would be minimal.

Engineered systems designed for the process facilities and tanks under the No Action alternative would ensure that there would be little possibility of involved workers in the proposed facilities being exposed to anything other than very small concentrations of airborne nonradiological materials that would be similar among all alternatives. Therefore, health effects from exposure to nonradiological material inside the facilities would be minimal for all alternatives.

4.1.4.2 Radiological Health Effects

Radiation can cause a variety of health effects in people. The major effect of environmental and occupational radiation exposures is a delayed cancer fatality, which is called an LCF, because the cancer can take many years to develop and cause death.

Table 4-11. Estimated maximum concentration in milligrams per cubic meter (mg/m³) of air pollutants to the noninvolved worker from facility air emissions.^{a,b}

	Averaging time ^c	OSHA Standard ^c	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Sulfur dioxide	8-hr TWA ^d	13	0.01	0.01	0.01	0.01
Total particulates	8-hr TWA	15	0.02	0.02	0.02	0.01
Particulates <10 microns	8-hr TWA	5	0.02	0.02	0.02	0.01
Carbon monoxide	8-hr TWA	55	0.2	0.2	0.2	0.2
Nitrogen dioxide	Ceiling ^e	9	7.0	7.0	7.0	7.0
Lead	8-hr TWA	0.5	1.0×10 ⁻⁵	1.0×10 ⁻⁵	1.0×10 ⁻⁵	1.0×10 ⁻⁵
Beryllium	8-hr Ceiling	0.002 0.005	3.0×10 ⁻⁶ 3.0×10 ⁻⁵	3.0×10 ⁻⁶ 3.0×10 ⁻⁵	3.0×10 ⁻⁶ 3.0×10 ⁻⁵	3.0×10 ⁻⁶ 3.0×10 ⁻⁵
Methyl alcohol	8-hr TWA	260	0.08	0.08	0.08	0.08
n-Propyl alcohol	8-hr TWA	500	0.08	0.08	0.08	0.08
Mercury	Ceiling	0.1	3.0×10 ⁻⁵	3.0×10 ⁻⁵	3.0×10 ⁻⁵	3.0×10 ⁻⁵
Benzene	8-hr Ceiling	3.1 15.5	0.1 0.8	3.0×10 ⁻⁴ 0.004	3.0×10 ⁻⁴ 0.004	3.0×10 ⁻⁴ 0.004
Formic Acid ^f	8-hr	9	2.2×10 ⁻⁴	None	None	None

Source: Hunter (2000).

- For a noninvolved onsite worker at a distance of 640 meters from the process building stack and a 1.8-meter breathing height.
- Under the No Action alternative, air emissions from all scenarios would be similar to air emissions from the HLW operations included in the SRS baseline. Therefore, incremental health effects would be minimal.
- From 29 CFR 1910.1000.
- TWA – Time-weighted average.
- Ceiling limits are permissible exposure limits that a facility cannot exceed at any time.
- Formic acid emissions would be shifted from DWPF to the Small Tank Precipitation facility, resulting in no net change.

To relate a dose to its effect, DOE has adopted a dose-to-risk conversion factor of 0.0004 LCFs per person-rem for workers and 0.0005 LCFs per person-rem for the general population (NCRP 1993) to estimate the number of LCFs that could result from the calculated exposure. The factor for the general population is slightly higher because infants and children are more sensitive to radiation than the adult worker population.

These dose-to-risk factors are consistent with the factors used by the NRC in its rulemaking *Standards for Protection Against Radiation* (10 CFR 20). The factors apply if the dose to an individual is less than 20 rem and the dose rate is less than 10 rem per hour. At doses greater than 20 rem, the factors used to relate radiation doses to LCFs are doubled. At much higher dose

rates, prompt effects, rather than LCFs, would be the primary concern.

DOE expects minimal worker and public health impacts from the radiological consequences of salt processing activities under any of the technology alternatives. All alternatives are expected to result in similar radiological release levels. Public radiation doses would occur from airborne releases only (Section 4.1.3). Table 4-12 lists estimated radiation doses and corresponding incremental LCFs for the noninvolved worker (a worker not directly involved with implementing the alternative, but located 2,100 feet [640 meters] from the salt processing facility), the involved worker (a worker located 328 feet [100 meters] from the salt processing facility), the collective population of involved workers, the collective onsite (SRS) population, and the public (MEI and the collective offsite population) for each technology alternative.

Table 4-12. Estimated public and occupational radiological doses and health impacts from atmospheric emissions during operations.^{a,b,c}

Receptor ^{d,e}	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout ^f
MEI dose (millirem/year)	0.20	0.049	0.31	0.086
Probability of an LCF from MEI dose ^g	1.3×10^{-6}	3.2×10^{-7}	2.0×10^{-6}	5.6×10^{-7}
Dose to population within 50 miles of SRS (person-rem/year)	12.0	2.9	18.1	4.0
Estimated number of project-phase LCFs in the population within 50 miles of SRS ^g	0.078	0.019	0.12	0.026
Noninvolved worker dose (millirem/year)	3.3	0.8	4.8	1.7
Probability of an LCF from noninvolved worker dose ^g	1.7×10^{-5}	4.2×10^{-6}	2.5×10^{-5}	8.6×10^{-6}
Annual number of radiological workers ^h	140	100	160	110
Involved worker dose (millirem/year)	16	3.9	23	10
Probability of an LCF from involved worker dose ^g	8.2×10^{-5}	2.0×10^{-5}	1.2×10^{-4}	5.3×10^{-5}
Annual dose to the population of involved workers (person-rem per year)	2.2	0.39	3.6	1.1
Project-phase dose to involved workers (person-rem)	29	5.0	47	14
Estimated number of project-phase LCFs to involved workers ^g	0.012	0.0020	0.019	0.0056
Annual dose to the population of SRS workers (person rem/year)	4.3	1.1	6.5	2.3
Estimated number of project-phase LCFs in the worker population at SRS ^g	0.022	0.0055	0.034	0.012

- a. Source term is based on data from Pike (2000).
- b. Doses represent increment above baseline values from existing SRS activities.
- c. Under the No Action alternative, air emissions from all scenarios would be similar to emissions from the HLW operations included in the SRS baseline. Therefore, incremental health effects would be minimal.
- d. The MEI is 11,800 meters from the facility stack(s). The noninvolved worker is located 640 meters from the facility stack(s). The involved worker is located 100 meters from the facility stack(s).
- e. Doses presented here are based on emissions from a 46-meter stack elevation.
- f. Includes dose from operations and vaults.
- g. LCFs are calculated for the project duration only. (When facility operations cease, residual contaminant levels would be negligible.) Each of the four action alternatives would operate for 13 years.
- h. Assumes 75 percent of operations staff are radiological workers (WSRC 1999c).

As shown in Table 4-12, the highest radiological impacts to both involved and noninvolved workers and to the public would be associated with the Solvent Extraction alternative. The Small Tank Precipitation alternative would have impacts similar to Solvent Extraction, and the Ion Exchange and Direct Disposal in Grout alternatives would result in slightly lower impacts. The radiological doses from the Solvent Extraction alternative airborne emissions are higher

than those for the other alternatives, and would result in an estimated additional 0.12 LCF for the general population surrounding SRS (50-mile radius) over the period of operation. Emissions from the Solvent Extraction alternative would also result in the highest impact to workers at SRS, an estimated 0.034 LCF for the collective SRS worker population (includes both involved and noninvolved workers) over the 13-year life of the project.

As expected, the collective involved worker doses and total project-phase doses shown in Table 4-12 are similar for all four action alternatives. The Solvent Extraction project-phase collective worker dose is the highest of the alternatives at 47 person-rem over the life of the project, and would result in 0.019 LCF. All doses are well within the administrative control limits for SRS workers (500 millirem per year).

The estimated number of LCFs in the public (Table 4-12) due to airborne emissions from each action alternative can be compared to the projected number of fatal cancers (approximately 140,000) in the public around the SRS from all causes (as discussed in Section 3.8.1). Similarly, the estimated number of fatal cancers in the involved worker population can be compared to the percent of the general population that succumbs from cancer regardless of cause (approximately 23.3 percent; see Section 3.8.1). In all cases, the incremental impacts from the alternatives would be minimal.

4.1.4.3 Occupational Health and Safety

The established method of determining a company or facility's safety record is by using its historic number of total recordable cases (TRCs) and lost workday cases (LWCs). Table 4-13 provides estimates of the number of TRCs and LWCs that would occur during a year and during the facility life cycle for the estimated number of involved workers for each alternative. The projected injury rates are based on historic SRS injury rates over a four-year period (1995 through 1999) multiplied by the employment levels and years for each alternative and the appropriate TRC and LWC rates.

The TRC rate includes work-related deaths, illnesses, or injuries that resulted in loss of consciousness, restriction from work or motion, transfer to another job, or required medical treatment beyond first aid. The LWC rate represents the number of work-days, beyond the day of injury or onset of

illness, the employee was away from work or limited to restricted work activity because of an occupational injury or illness.

The results in Table 4-13 indicate that each action alternative has similar TRCs and LWCs, but the Solvent Extraction alternative would have the highest TRCs and LWCs. The higher number of injuries for this alternative is due to the larger number of workers needed to operate the facility. The number of TRCs and LWCs would remain at current levels during continuation of tank space management activities under the No Action alternative. Up to 65 new workers would be employed for operation of any new tanks built under No Action. This small increase in employment levels would result in 11 TRCs and 5 LWCs over the 13-year operations phase of the new tanks.

Tables 3-19 and 3-20 demonstrate that the SRS health and safety program has resulted in lower incidences of injury and illness than those in the general industry and manufacturing workforces.

These lower injury and illness rates for a proposed workforce ranged between 135 and 220 workers annually and for a period of 14.3 years are represented in Table 4-13. Considering the improvements the SRS safety program has made and continues to make in lowering the TRC and LWC rates, the numbers presented in Table 4-13 are conservative and future safety rates are expected to be much lower than the rates currently presented.

4.1.5 ENVIRONMENTAL JUSTICE

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs each Federal agency to "make...achieving environmental justice part of its mission" and to identify and address "...disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." The Presidential Memorandum that accompanied Executive Order 12898 emphasized the importance of using existing laws, including the

Table 4-13. Estimated total recordable cases and lost workdays annually and for the life cycle of each alternative.^a

Incident rate	No Action ^b	Small Tank Precipitation ^c	Ion Exchange ^c	Solvent Extraction ^c	Direct Disposal in Grout ^c
Total recordable cases (annual)	0.8	2.2	1.7	2.7	1.8
Total lost workday cases (annual)	0.35	1.0	0.72	1.2	0.77
Total recordable cases (facility life cycle)	11	32	24	39	25
Total lost workday cases (facility life cycle)	5	14	10	17	11

Source: WSRC (1998b, 1999d), DOE (2000b).

a. Based on working 8 hours per day, 250 days per year.

b. Based on 65 new workers for a period of 13 years to operate any new tanks built under the No Action alternative.

c. Facility life cycle includes 1.3 years for startup and 13 years of full operations.

National Environmental Policy Act (NEPA), to identify and address environmental justice concerns, “including human health, economic, and social effects, of Federal actions.”

The Council on Environmental Quality (CEQ), which oversees the Federal government’s compliance with Executive Order 12898 and NEPA, subsequently developed guidelines to assist Federal agencies in incorporating the goals of Executive Order 12898 in the NEPA process. This guidance, published in 1997, was intended to “...assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed.”

As part of this process, DOE identified (in Section 3.6.2) minority and low-income populations within a 50-mile radius of the SRS (plus areas downstream of the Site that withdraw drinking water from the Savannah River), which was defined as the region of influence for the environmental justice analysis. The following section discusses whether implementing the alternatives described in Chapter 2 would result in disproportionately high and adverse impacts to minority or low-income populations.

DOE referred to the Draft Guidance on Environmental Justice and NEPA (DOE 2000c) in preparing this section.

4.1.5.1 Background

The CEQ issued guidance on assessing potential environmental justice impacts. No standard formula has been issued on how environmental justice issues should be identified or addressed. However, the following six principles provide general guidance (CEQ 1997):

- The composition of the area should be considered to determine whether minority populations, low-income populations, or Indian tribes are present in the area affected by the proposed action and, if so, whether there may be disproportionately high and adverse human health or environmental effects on those populations.
- Relevant public health data and industry data concerning the potential for multiple or cumulative exposures to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards should be considered.

Environmental Impacts

- The interrelated cultural, social, occupational, historical, and economic factors that may amplify the natural and physical environmental effects of the proposed action should be recognized.
- Effective public participation strategies should be developed.
- Meaningful community representation in the process should be ensured.
- Tribal representation in the process should be sought in a manner that is consistent with the government-to-government relationship between the United States and tribal governments.

Environmental justice guidance developed by CEQ defines "minority" as individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic (CEQ 1997). The Council identifies these groups as minority populations when either (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage in the affected area is meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis.

Low-income populations are identified using statistical poverty thresholds from the Bureau of Census Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effects.

Environmental justice impacts can result if the proposed activities cause disproportionately high and adverse human health or environmental effects to minority or low-

income populations. DOE assesses three factors to the extent practicable to identify disproportionately high and adverse human health effects:

- Whether the health effects are significant (as used by NEPA) or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of exposure by a minority or low-income population to an environmental hazard is significant (within the meaning of NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

4.1.5.2 Methodology

First, DOE assessed the impacts of the proposed action and alternatives to the general population which, near the SRS, includes minority and low-income populations. No special considerations, such as unique exposure pathways or cultural practices, contribute to any discernible disproportionate impacts. The only identified cultural practice (or unusual pathway) potentially associated with minority and low-income populations is use of the Savannah River for subsistence fishing. For the Final *Accelerator Production of Tritium for the Savannah River Site Environmental Impact Statement* (EIS) (issued in 1999), DOE reviewed the limited body of literature available on subsistence activities in the region.

DOE concluded that, because the identified minority or low-income communities are widely distributed, and the potential impact to the general population is not discernible, there would be no potential for disproportionate impacts among minority or low-income populations. Second, having concluded that the potential offsite consequences to the general public of the proposed action and the alternatives would be small, DOE concluded that there would be no disproportion-

ately high and adverse impacts to minority or low-income populations.

These conclusions are based on the comparison of salt processing actions to past actions for which environmental justice issues were evaluated in detail. In 1995, DOE conducted an analysis of economic and racial characteristics of the population potentially affected by SRS operations within a 50-mile radius of the Site (DOE 1995). In addition, DOE examined the population downstream of the Site that withdraws drinking water from the Savannah River. The economic and racial characterization was based on 1990 census tract data from the U.S. Census Bureau. More recent census tract data are not available. The nearest minority and low-income populations to SRS are south of Augusta, Georgia, northwest of the Site.

This environmental justice analysis was based on the assessment of potential impacts associated with the various HLW salt processing alternatives to determine if there would be high and adverse human health or environmental impacts. In this assessment, DOE reviewed potential impacts arising under the major disciplines and resource areas, including: socioeconomics; cultural, air, water, and ecological resources; and public and worker health over the short term (approximately the years 2001 to 2023) and long term (approximately 10,000 years after saltstone was placed in vaults). Regarding health effects, both normal facility operations and postulated accident conditions were analyzed, with accident scenarios evaluated in terms of risk to workers and the public.

Although no high and adverse impacts were predicted for the activities analyzed in this SEIS, DOE nevertheless considered whether there were any means for minority or low-income populations to experience disproportionately high and adverse impacts. The basis for making this determination would be a comparison of areas predicted to experience human health or environmental impacts with areas in the region of influence

known to contain high percentages of minority or low-income populations.

The environmental justice analysis for the HLW salt processing alternatives was assessed for a 50-mile area surrounding SRS (plus downstream areas), as discussed in Section 3.6.2.

Short-Term Impacts

For environmental justice concerns to be initiated, high and adverse human health or environmental impacts must disproportionately affect minority or low-income populations.

None of the proposed alternatives would produce appreciable short-term impacts to surface water (see Section 4.1.2.1) or groundwater (see Section 4.1.2.2). With the exception of VOCs, emissions of nonradiological and radiological air pollutants from HLW salt processing activities would be below regulatory limits (see Section 4.1.3) and would result in minimal impacts to workers and the public (see Section 4.1.4.2). The estimated radiological doses and health impacts to the noninvolved worker and the public are small (highest dose is 4.8 millirem per year to the noninvolved worker, under the Solvent Extraction alternative).

Because all salt processing activities would take place in an area that has been dedicated to industrial use for more than 40 years, no short-term impacts to ecological resources (see Section 4.1.6), existing land uses (see Section 4.1.7), or cultural resources (see Section 4.1.9) are expected.

Relatively small numbers of workers would be required to carry out salt processing activities, regardless of the alternative selected (see Section 4.1.8); as a result, none of the alternatives would affect socioeconomic trends (i.e., unemployment, wages, housing) in the region of influence.

As noted in Section 4.2, no long-term environmental justice impacts are anticipated.

Because short-term impacts would not substantially affect the surrounding population, and no

means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations under any of the alternatives.

Subsistence Consumption of Fish, Wildlife, and Game

Section 4-4 of Executive Order 12898 directs Federal agencies "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that Federal governments communicate to the public the risks of these consumption patterns." There is no evidence to suggest that minority or low-income populations in the SRS region of influence are dependent on subsistence fishing, hunting, or gathering. DOE nevertheless considered whether there were any means for minority or low-income populations to be disproportionately affected by examining levels for contaminants in vegetables, fruit, livestock, and game animals collected from the SRS or adjacent lands. In addition, DOE assessed concentrations of contaminants in fish collected from SRS waterbodies and from the Savannah River up- and downstream of the Site.

Based on recent monitoring results, concentrations of radiological and nonradiological contaminants in vegetables, fruit, livestock, game animals, and fish from the SRS and surrounding areas are generally low, in virtually all instances below applicable DOE standards (Arnett and Mamatey 1998a,b). Consequently, no disproportionately high and adverse human health impacts would be expected in minority or low-income populations in the region that rely on subsistence consumption of fish, wildlife, or native plants.

It should be noted that mercury, which is present in relatively high concentrations in fish collected from SRS and the middle reaches of the Savannah River, could pose a

potential threat to individuals and populations that rely on subsistence fishing. This mercury in fish has been attributed to upstream (non-DOE) industrial sources and natural sources (DOE 1997a). The salt processing alternatives under consideration would not affect mercury concentrations in SRS waterbodies or the Savannah River.

4.1.6 ECOLOGICAL RESOURCES

Construction

Depending on the salt processing alternative selected by DOE, construction of several new facilities would be required in either S or Z Area. Process buildings for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternatives would be built in S Area, while the process building for the Direct Disposal in Grout alternative would be built in Z Area. Regardless of the salt processing alternative (thus, process facility configuration) chosen, support facilities, including a service building, office building, and an electrical substation would be constructed in close proximity to the main process building (see Chapter 2 and Appendix A for details). New salt disposal vaults would be built in Z Area under all of the salt processing action alternatives.

As shown in Table 4-1, construction of process facilities for the Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout alternatives would require the excavation of approximately 77,000, 78,000, 82,000 and 23,000 cubic yards of soil, respectively. The total land area that would be cleared in S area (see Figure 3-1) for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternative is 23 acres or 0.12 percent of SRS land dedicated to industrial use. Approximately 15 acres or 0.078 percent of SRS land dedicated to industrial use would be cleared for the Direct Disposal in Grout facility in Z Area (see Figure 3-2). Land in Z Area would also be required for construction of new saltstone vaults. All land-disturbing activity would be within the fenced boundaries of S and Z Areas, areas currently devoted to industrial use (waste management facilities).

As noted in Section 3.4.1, the preferred site (Site B) for salt processing facilities in S Area is approximately one-quarter mile south of DWPF (an active industrial facility) and, as a result, is within an area with relatively high levels of noise and activity. Because the Saltstone Manufacturing and Disposal Facility has not operated since 1998, the preferred site in Z Area has lower levels than S Area of noise and activity, limited for the most part to security patrols and an occasional tour.

There is the potential to disturb wildlife in both S and Z Areas and in adjacent woodlands during the construction phase of the project (approximately four years for site preparation and facility construction). Construction would involve the movement of workers and construction equipment and would be associated with relatively loud noises from earth-moving equipment (including backhoes, bulldozers, and graders), portable generators, and air compressors. Although noise levels in construction areas could be as high as 110 decibels (dBA), these high local noise levels would not extend far beyond the boundaries of the proposed project sites.

Table 4-14 shows the attenuation of construction noise over relatively short distances. At 400 feet from the construction sites, construction noises would range from approximately 55 to 85 dBA. Golden et al. (1980) suggest that noise levels higher than 80 to 85 dBA are sufficient to startle or frighten birds and small mammals. Thus, there would be little potential for disturbing birds and small mammals outside a 400-foot radius of the construction sites.

Although noise levels would be relatively low outside the immediate construction areas, the combination of construction noise and human activity probably would displace small numbers of animals (e.g., songbirds and small mammals) that forage, feed, nest, rest, or den in the woodlands to the east of S Area and to the south and east of Z Area. An access road and a railroad spur (Z Line)

separate Site B in S Area from woodlands to the east (see Figure 3-1), reducing the value of Site B and adjacent woodlands as wildlife habitat. The identified site in Z Area (see Figure 3-2) is farther removed from roads and the railroad spur (and heavy industrial facilities in H and S Areas) and is presumed to have marginally higher value as wildlife habitat. Construction-related disturbances in both areas are likely to create impacts to wildlife that would be small, intermittent, and localized. Some animals could be driven from the area permanently, while others could become accustomed to the increased noise and activity and return to the area. Species likely to be affected (e.g., gray squirrel, opossum, white-tailed deer) are common to ubiquitous on SRS.

Under the No Action alternative, DOE would use approved siting procedures to ensure that any new tanks would be built in a previously disturbed industrial area. Studies and continued monitoring would also be performed to determine the presence of any threatened or endangered species and ensure that critical habitats would not be affected.

Operations

Operation of salt processing facilities would be less disruptive to wildlife than construction activities, but would entail movement of workers and equipment and noise from public address systems (e.g., testing of radiation and fire alarms), air compressors, pumps, and HVAC-related equipment. These activities would be similar under all alternatives, including No Action. With the possible exception of the public address systems, noise levels generated by these kinds of sources are not expected to disturb wildlife outside of facility boundaries.

As noted in Section 3.4, no threatened or endangered species or critical habitats occur in or near S or Z Areas, which are industrial sites surrounded by roads, parking lots, construction shops, and construction lay-down areas that are continually exposed to high levels of human disturbance. Proposed salt processing activities (and Tank Farm operations under No Action) would not disturb any threatened or endangered

Table 4-14. Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.

Source	Noise level (peak)	Distance from source			
		50 feet	100 feet	200 feet	400 feet
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

Source: Golden et al. (1980).

species, would not degrade any critical or sensitive habitat, and would not affect any wetlands. DOE would continue to monitor the areas around S and Z Areas for the presence of threatened or endangered species. If a listed species were found, DOE would determine if salt processing activities would affect that species. If DOE were to determine that adverse impacts could occur, DOE would initiate consultation with the U.S. Fish and Wildlife Service, as required by Section 7 of the Endangered Species Act.

4.1.7 LAND USE

The *Savannah River Site Future Use Plan* (DOE 1998) provides an Integral Site Model that lays out intended future land use policies. DOE determined that this model most realistically accommodates development during the next 50 years. The model divides the SRS into three zones: industrial, industrial support, and restricted public use. The future use plan does not contemplate DOE relinquishing ownership of or institutional control over any portion of the SRS. The industrial zone surrounds facilities that: process or store radioactive liquid or solid waste, fissionable materials, or tritium; con-

duct separations operations; or conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations. The new salt processing facility would be constructed in areas (S or Z) designated as industrial. As shown in Table 4-1, approximately 23 acres (0.12 percent of SRS land dedicated to industrial use) would be cleared and graded for salt processing facilities at the selected site in S Area (see Figure 3-1), should the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternative be selected. Approximately 15 acres (0.078 percent of SRS land dedicated to industrial use) would be cleared and graded for salt processing facilities in Z Area (see Figure 3-2), should the Direct Disposal in Grout alternative be selected. All land-disturbing activity would be within the fenced boundaries of S and Z Areas, areas currently devoted to industrial use (waste management facilities).

DOE would use the approved siting process to ensure that any new tanks under the No Action alternative would be constructed in a previously disturbed industrial area with a deep groundwater table. Due to the speculative nature of the No Action alternative, DOE has not determined how much land would be cleared for construction of any new HLW storage tanks. However, a

Type III HLW tank and associated equipment would occupy about one acre. Construction and operation of the proposed salt processing facility, including ongoing tank space management activities and building new tanks under the No Action alternative, would be consistent with the current SRS land use plans (DOE 1998).

4.1.8 SOCIOECONOMICS

Socioeconomic impact assessments are performed to determine the effects changes in local economic variables (e.g., number of jobs in a particular industry, wage rates, or increases in capital investment) may have on other economic measures (total regional employment, population, and total personal income).

New economic information was not developed for this SEIS. However, in 1999, DOE issued its *Accelerator Production of Tritium for the Savannah River Site Final Environmental Impact Statement* (DOE 1999). This EIS proposed a large accelerator for the SRS, and a full array of socioeconomic impact assessments was performed for the EIS. Based on these assessments, DOE concluded that the potential impacts attributed to construction and operation of the accelerator were relatively small in comparison with historical economic trends in the region and were not expected to stress existing regional infrastructures or result in an economic "boom."

Construction

During the construction phase of this project, based on preliminary design information, each salt processing alternative would employ approximately 500 construction workers annually, or about 50 percent fewer than the accelerator in its peak year of construction. Additionally, the estimated construction phase for the salt processing alternatives would be about 4 years, rather than 11 years for the accelerator, so potential construction impacts would be shorter in duration than those for the accelerator would have been.

Table 4-15 presents the estimated employment levels for each salt processing action alternative. The construction workforce is assumed to be constant over the life of the construction phase. The construction phase, expected to last approximately 4 years for each action alternative, would require less than 3.6 percent of the existing SRS workforce.

Under the No Action alternative, up to 500 construction workers may be employed to construct new HLW tanks. Tank construction would be expected to last 4 or more years (DOE 1980).

Operations

The Small Tank Precipitation alternative would require approximately 180 operations employees. The Ion Exchange alternative would require approximately 135 operations employees.

Table 4-15. Estimated salt processing employment by alternative.

Project phase	No Action	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Construction	500 ^a	500	500	500	500
Operations	65 ^b	180	135	220	145

Source: (WSRC 1998a, 2000a)

- a. Up to 500 construction workers could be employed if new HLW tanks were built under the No Action alternative.
- b. Up to 65 operations workers could be employed if new HLW tanks were built under the No Action alternative. However, a workforce reduction could occur if operations at the DWPF were suspended under No Action.

The Solvent Extraction alternative would require approximately 220 operations employees, and the Direct Disposal in Grout alternative would require approximately 145 operations employees, (WSRC 1998a, 2000a). During the operations phase, the Solvent Extraction alternative would require the most workers, but would still require less than 1.5 percent of the existing SRS workforce.

DOE believes staffing requirements for construction and operations of any salt processing action alternative could be filled with existing SRS employees. Given the size of the local economy, any supplemental workforce requirements could be met without measurable impacts or the influx of large workforces. Therefore, DOE does not expect any salt processing action alternative to have measurable socioeconomic impacts.

Under the No Action alternative, DOE would continue tank space management activities for a period of approximately 10 years and employment would remain at the current level. Subsequent activities under No Action could impact employment levels. DOE could suspend operations at DWPF. Suspension of operations at these facilities could result in a workforce reduction, which would have a negative impact on the communities surrounding SRS. Alternatively, up to 65 new employees would be needed for the operation of any new HLW tanks constructed under No Action (DOE 1980).

4.1.9 CULTURAL RESOURCES

Depending on the salt processing alternative selected by DOE, construction of new facilities would be required in either S (Site B) or Z Area. Process buildings for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternatives would be built in S Area, while the process building for the Direct Disposal in Grout alternative would be built in Z Area. Regardless of the salt processing alternative (thus, facility configuration) chosen, support facilities including a service building, office building, and an

electrical substation would also be constructed in close proximity to the main process building (see Chapter 2 and Appendix A for details). New salt disposal vaults would be built in Z Area under any of the salt processing alternatives.

Because no important archaeological resources were discovered during the S Area surveys conducted in support of the *Final Environmental Impact Statement Defense Waste Processing Facility Savannah River Plant* (DOE 1982), DOE believes additional construction within this area would not adversely impact cultural resources. Most of Z Area also has been surveyed in the past, and no important cultural resources were discovered (DOE 1994). Both areas have been disturbed repeatedly by construction activity over the last 15 to 20 years, and the likelihood of undiscovered cultural or historic resources is small.

DOE would use the approved siting process to ensure that any new tanks for the No Action alternative would be constructed in a previously disturbed industrial area. DOE would ensure that any tank construction would not impact cultural or historic resources.

If any archaeological or cultural resources were discovered in the course of developing the previously described facilities in S and Z Areas or new tanks for the No Action alternative, DOE would contact the Savannah River Archaeological Research Program and the State Historic Preservation Officer in compliance with Section 106 of the National Historic Preservation Act for guidance on mitigating potential impacts to these resources.

4.1.10 TRAFFIC AND TRANSPORTATION

SRS is served by more than 199 miles of primary roads and more than 995 miles of unpaved secondary roads. The primary highways used by SRS commuters are State Routes 19, 64, and 125; 40, 10, and 50 percent of the workers, respectively, use these routes. Traffic congestion can occur during peak periods onsite on SRS Road 1-A, State Routes 19 and 125, and U.S. Route 278 at SRS access points. Vehicles asso-

ciated with this project would use these same routes and access points. None of the routes would require additional traffic controls or highway modifications, as explained below.

Construction

As shown in Table 4-16, concrete premix would be required during construction of the facilities under all action alternatives. Assuming that these materials are supplied by vendor facilities in Jackson and New Ellenton (for a round-trip distance of 18 miles), implementation of the alternatives would result in 55,000 to 61,000 freight miles traveled. Using Federal Highway Administration roadway composite statistics for South Carolina for the 1994 to 1996 period of record (Saricks and Tompkins 1999), these shipments would result in a maximum occurrence of 0.05 accidents, no fatalities, and 0.03 injuries as a result of material transport activities during construction. These projections are similar for all action alternatives. Therefore, it is highly unlikely that material transport activities during construction would lead to any accidents, fatalities, or injuries, regardless of the alternative selected.

As shown in Table 4-17, approximately 500 workers would travel to the Site 5 days a week (250 round trips per year for each worker) for 45 to 50 months during the construction phase of the project. Assuming no ride sharing and a round-trip commute distance of 50 miles, up to 26 million commuter miles would be traveled during the construction phase. Using 1998 national transportation statistics (BTS 1998), as many as 98 vehicle accidents could occur with this mileage, resulting in a maximum of 0.4 fatalities and 43 injuries. These projections are similar for all action alternatives.

Building new HLW tanks under the No Action alternative would require a similar number of material shipments as that required for construction of the action alternatives. DOE anticipates that the construction

workforce under the No Action alternative would also be similar to the number of workers employed for construction of the action alternatives.

Operations

As shown in Table 4-16, saltstone premix and process reagents would be required during operation of the facilities under all action alternatives. Assuming that these materials are supplied by vendor facilities in Jackson and New Ellenton (for a round-trip distance of 18 miles), implementation of the alternatives would result in 340,000 to 470,000 miles traveled. Using Federal Highway Administration roadway composite statistics for South Carolina for the 1994 to 1996 period of record (Saricks and Tompkins 1999), these shipments would result in a maximum occurrence of 0.4 accidents, 0.02 fatalities, and 0.3 injuries as a result of material transport activities during construction. These projections are similar for all action alternatives. Therefore, it is very unlikely that material transport activities during construction would lead to any accidents, fatalities, or injuries, regardless of the alternative selected.

As shown in Table 4-17, between approximately 135 and 220 workers, depending on the alternative selected, would travel to the Site 5 days a week (250 round trips per year for each worker) for the 14.3-year startup and operation phase of the project. Assuming no ride sharing and a round-trip commute distance of 50 miles, up to 39 million commuter miles would be traveled during the operations phase. Using 1998 national transportation statistics (BTS 1998), as many as 148 vehicle accidents could occur with this mileage, resulting in a maximum of 0.6 fatalities and 65 injuries. The projections are similar for all action alternatives.

For the No Action alternative, up to 65 new employees would be needed for the 13-year operation phase (2010-2023) for any tanks constructed (DOE 1980). Therefore, approximately 39 vehicle accidents could occur under the No Action alternative, resulting in a maximum occurrence of 0.2 fatalities and 17 injuries.

Table 4-16. Material shipments (totals for the construction and operation phases) and transportation impacts associated with the salt processing alternatives.

Material use impact categories		Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>Construction</i>					
Structural concrete premix shipments ^{a,b}		3,000	3,000	3,000	3,400
Total round-trip shipment distance (miles)		55,000	55,000	55,000	61,000
Number of	Accidents	0.04	0.04	0.04	0.05
	Fatalities	0	0	0	0
	Injuries	0.03	0.03	0.03	0.03
<i>Operations^c</i>					
Saltstone premix ^d		25,500	21,100	23,800	19,000
Sodium hydroxide ^d		6	56	416	4
Oxalic acid ^d		1	1	1	1
Tetraphenylborate ^d		710	NA	NA	NA
Monosodium titanate ^d		1	1	1	1
Crystalline Silicotitanate ^d		NA	11	NA	NA
90% Formic acid ^{d,e}		66	NA	NA	NA
15% Cupric nitrate ^{d,e}		45	NA	NA	NA
Nitric Acid ^d		NA	NA	9	NA
Isopar [®] L ^d		NA	NA	40	NA
Trioctylamine ^d		NA	NA	1	NA
Calixarene ^d		NA	NA	1	NA
Cs-7SBT ^d		NA	NA	1	NA
Total number of shipments		26,000	21,000	24,000	19,000
Total round-trip shipment distance (miles)		470,000	380,000	440,000	340,000
Number of	Accidents	0.4	0.3	0.3	0.3
	Fatalities	0.02	0.02	0.02	0.01
	Injuries	0.3	0.2	0.2	0.2

a. Data for structural concrete use adapted from Attachments 9.2, 9.3, 9.4, and 9.5 of the life cycle cost estimate report (WSRC 1998a) using an assumed blended concrete premix density of 3,934 lb/yd³ and a truck load capacity of 50,000 pounds.

b. Concrete requirements for construction of any new tanks under the No Action alternative would be similar to those required for the action alternatives.

c. For operations under the No Action alternative, material shipments would remain at current levels.

d. Number of shipments.

e. Corresponding decrease at DWPF.

NA = not applicable. The chemical would not be used in that particular alternative.

Table 4-17. Worker transportation impacts associated with the salt processing alternatives.

Worker travel impact categories		No Action	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>Construction worker travel</i>						
Number of workers		500 ^a	500	500	500	500
Total number of Site trips		500,000 ^a	500,000	520,000	500,000	480,000
Total round-trip distance (million miles)		25 ^a	25	26	25	24
Number of	Accidents	95 ^a	95	98	95	91
	Fatalities	0.4 ^a	0.4	0.4	0.4	0.4
	Injuries	42 ^a	42	43	42	40
<i>Operations worker travel</i>						
Number of workers		65 ^b	180	135	220	145
Total number of Site trips		210,000 ^b	640,000	480,000	780,000	510,000
Total round-trip distance (million miles)		11 ^b	32	24	39	26
Number of	Accidents	39 ^b	122	91	148	97
	Fatalities	0.2 ^b	0.5	0.4	0.6	0.4
	Injuries	17 ^b	53	40	65	42

- a. Based on 500 construction workers over a 4-year construction period. The construction period could be longer, depending on the number of tanks built.
- b. Up to 65 workers would be required for operation of any new tanks built under No Action.

The surrounding area already has a certain volume of truck and car traffic associated with SRS logging, agriculture, and industrial activity. The amount of traffic associated with any of the alternatives (including No Action) is not expected to substantially increase traffic volume.

4.1.11 WASTE GENERATION

4.1.11.1 Wastes From Salt Processing

Each of the action alternatives would produce a low-activity salt waste stream that would be grouted for disposal in vaults in Z Area. The characteristics and volumes of grout produced from the low-activity salt solutions would vary among the alternatives. In addition, the high-activity materials separated from the salt solution would be transferred to DWPF for processing to borosilicate glass. Details of the wastes from salt processing under each of the action alternatives are discussed below.

Under the Small Tank Precipitation alternative, the low-activity salt solution would be transferred to the existing Saltstone Manufacturing and Disposal Facility in Z Area for disposal as grout. New cement silos would be built to accommodate saltstone production. Sixteen new vaults would be needed to accommodate the expected grout volume (188 million gallons). The grout would be equivalent to Class A LLW, as defined in 10 CFR 61.55 (see Appendix A for Class A limits). Approximately 2.9 million gallons of slurry, containing monosodium titanate (MST) solids and precipitate hydrolysis aqueous (PHA) product, would be transferred to DWPF. Treatment of this material by adding it to the HLW sludge to be vitrified in DWPF would produce HLW canisters that would be included in the total of approximately 5,700 HLW canisters destined for a geologic repository. Processing the precipitate in the Small Tank Precipitation Facility would create a benzene waste stream that is unique to this salt processing alternative. The management of this benzene waste is described in Section 4.1.11.2.

Under the Ion Exchange alternative, the low-activity salt solution would be transferred to the existing Saltstone Manufacturing and Disposal Facility in Z Area for disposal as grout. No modifications to the existing grouting process would be required. Thirteen new vaults would be needed to accommodate the expected grout volume (156 million gallons). The grout would be equivalent to Class A LLW, as defined in 10 CFR 61.55. Approximately 2 million gallons of slurry containing MST solids and 600,000 gallons of cesium-loaded crystalline silicotitanate (CST) resin would be transferred to DWPF. Treatment of this material by adding it to the HLW sludge to be vitrified in DWPF would produce HLW canisters that would be included in the total of approximately 5,700 HLW canisters destined for a geologic repository.

Under the Solvent Extraction alternative, the low-activity salt solution would be transferred to the existing Saltstone Manufacturing and Disposal Facility in Z Area for disposal as grout. No modifications to the existing grouting process would be required. Fifteen new vaults would be needed to accommodate the expected grout volume (175 million gallons). The grout would be equivalent to Class A LLW, as defined in 10 CFR 61.55. Approximately 2 million gallons of slurry containing MST solids and 6.8 million gallons of cesium-loaded strip solution would be transferred to DWPF. Treatment of this material by adding it to the HLW sludge to be vitrified in DWPF would produce HLW canisters that would be included in the total of approximately 5,700 HLW canisters destined for a geologic repository. The Solvent Extraction process would also generate a liquid organic solvent. Management of this solvent waste is described in Section 4.1.11.2.

Under the Direct Disposal in Grout alternative, radioactive cesium would not be separated from salt solutions. Because of the shielding requirements for handling the cesium-containing salt solution, this material could not be processed in the existing Z

Area Saltstone Manufacturing and Disposal Facility. After treatment with MST and filtration to remove strontium, uranium, plutonium, and entrained sludge, the clarified salt solution would be transferred to a new grouting facility located in Z Area. Thirteen new vaults would be needed to accommodate the expected grout disposal volume (141 million gallons). Because of its cesium content, the grout would be equivalent to Class C LLW, as defined in 10 CFR 61.55 (see Appendix A for Class C limits). Approximately 2 million gallons of slurry containing MST solids would be transferred to DWPF. Treatment of this material by adding it to the HLW sludge to be vitrified in DWPF would produce HLW canisters that would be included in the total of approximately 5,700 HLW canisters destined for a geologic repository.

Under the No Action alternative, DOE would continue current HLW management activities, including tank space management and tank closure, without a process for separating the high-activity and low-activity salt fractions. DWPF would vitrify only sludge from the HLW tanks. HLW salt would be stored in existing tanks and monitoring activities would continue. Current tank space management projections indicate that, after 2010, additional tank space would be needed to support continued operations (WSRC 1999d). The course of action that DOE would follow cannot be predicted at this time but, regardless of which option DOE would pursue, waste generation rates under No Action would not be expected to increase from current levels.

4.1.11.2 Secondary Waste

This section presents the secondary waste generation estimates for each salt processing alternative that DOE considers in this SEIS. Unlike wastes from salt processing that are the direct result of processing the salt solutions, secondary wastes are those wastes generated as a result of construction, operation, and maintenance of the salt processing facilities under the action alternatives. Impacts are assessed in terms of the amount of secondary waste projected for each of the alternatives, relative to the quantity of waste that would otherwise be managed at SRS during the period of analysis. Table 4-18 provides es-

timates of the maximum annual waste generation. Table 4-19 provides the total waste volumes that would be generated over the life cycle of each of the salt processing alternatives.

Waste generation under the No Action alternative would be similar to waste generation rates at the existing HLW Tank Farms and would therefore constitute a slight increase over the baseline. Baseline forecasts are provided in Table 5-4.

Liquid Waste

The radioactive wastewater that would be generated as a result of salt processing activities is produced during the DWPF vitrification process. The incremental increase in DWPF radioactive liquid waste would be associated with processing the high-activity waste (e.g., MST slurry, PHA product, loaded CST resin, cesium strip solution) from the various salt processing action alternatives, and would vary from about 150,000 gallons per year for the Direct Disposal in Grout alternative to 900,000 gallons per year for the Solvent Extraction alternative. The Small Tank Precipitation and the Ion Exchange alternatives would generate 300,000 and 250,000 gallons per year, respectively. The DWPF radioactive wastewater would be returned to the Tank Farm to be processed in the waste evaporators. Evaporator overheads would be treated in the ETF and discharged to Upper Three Runs via NPDES outfall H-16. DOE currently is examining options to ensure sufficient capacity in the Tank Farms to accommodate the DWPF radioactive liquid waste stream and other projected influents to the SRS HLW management system (WSRC 1999d).

Transuranic waste

DOE would not expect to generate transuranic wastes as a result of the proposed salt processing activities.

LLW

Under each of the action alternatives, DOE would expect to generate approximately 71 cubic meters per year of LLW. The projected volume represents about 0.5 percent of the forecasted SRS LLW generation through 2029 (Halverson 1999). Compactible LLW would be segregated from non-compactible LLW and processed in a volume reduction facility before disposal. Currently all LLW is disposed of onsite, but DOE is investigating the possibility of sending some LLW offsite for commercial treatment and disposal (DOE 2000d).

Hazardous waste

Under each of the action alternatives, DOE would expect to generate approximately 23 cubic meters per year of hazardous waste as a result of startup activities. This waste would consist of nonradioactive chemicals used to test the new facilities prior to actual waste processing. An additional 1 cubic meter per year of hazardous waste is expected during operations. The projected volume represents about 0.7 percent of the forecasted SRS hazardous waste generation through 2029 (Halverson 1999). This waste would be shipped offsite to commercial facilities for treatment and disposal (DOE 2000d).

Mixed LLW

Under each of the action alternatives, DOE would expect to generate small amounts (about 1 cubic meter per year) of mixed waste. These projected volumes represent about 0.4 percent of the forecasted SRS mixed LLW generation through 2029 (Halverson 1999). This waste would be treated onsite or at other DOE sites. Disposal would be at offsite facilities (DOE 2000d).

Table 4-18. Maximum annual waste generation for the salt processing action alternatives^a.

	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Radioactive liquid waste (gallons)	300,000	250,000	900,000	150,000
Nonradioactive liquid waste (gallons)	Negligible ^b	34,000 ^{b,c}	Negligible ^b	Negligible ^b
Transuranic waste (m ³)	negligible	negligible	negligible	negligible
LLW (m ³)	71	71	71	71
Hazardous waste (m ³)	Startup – 23 ^d Operations – 1			
Mixed LLW (m ³)	1	1	1	1
Mixed low-level liquid waste (gallons)	60,000	None	1,000	None
Industrial waste (metric tons)	Startup – 30 ^d Operations – 20			
Sanitary waste (metric tons)	Startup – 62 ^d Operations – 41			

Source: WSRC (1999b, 2000b).

- Under the No Action alternative, waste generation rates would be similar to those at the existing HLW Tank Farms. Therefore, waste generation rates would not be expected to increase from current levels.
- Assumes continuous operation.
- CST resin pretreatment generates a spent 1 M NaOH solution and CST fines slurry.
- Assumes a 1.3-year duration for startup activities under each action alternative.

Table 4-19. Total estimated waste generation for the salt processing action alternatives^a.

	Small Tank Pre- cipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Radioactive liquid waste (million gallons)	3.9	3.3	12	2.0
Nonradioactive liquid waste (million gallons)	negligible	0.49	negligible	negligible
Transuranic waste (m ³)	negligible	negligible	negligible	negligible
LLW (m ³)	920	920	920	920
Hazardous waste (m ³)	Startup – 30 ^b Operations – 13			
Mixed LLW (m ³)	13	13	13	13
Mixed low-level liquid waste (gallons)	780,000	None	13,000	None
Industrial waste (metric tons)	Startup – 39 Operations – 260			
Sanitary waste (metric tons)	Startup – 81 Operations – 530			

- Under the No Action alternative, waste generation rates would be similar to those at the existing HLW Tank Farms. Therefore, waste generation rates would not be expected to increase from current levels.
- Assumes a 1.3-year duration for startup activities and 13 years of operation for each of the action alternatives.

Under the Small Tank Precipitation alternative, additional mixed LLW would be produced as a result of processing the precipitate. In a section of the Small Tank Precipitation facility, the precipitate slurry would undergo acid hydrolysis to separate it into a low-radioactivity organic portion (benzene) and a high-radioactivity aqueous portion. The organic portion would then be separated from the aqueous portion, washed to reduce the level of cesium, and transferred to the Organic Waste Storage Tank in S Area, which has a storage capacity of 150,000 gallons. A maximum of 60,000 gallons per year of benzene waste could be produced. DOE is investigating treatment and disposal options for this waste stream. This waste would be treated by incineration in the Consolidated Incineration Facility, in a portable vendor-operated incinerator or in a suitable offsite incineration facility, followed by disposal in a permitted facility. DOE analyzed the impacts of incineration in the Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility (DOE 1994).

L1-11

Under the Solvent Extraction alternative, additional mixed LLW would be produced as a result of solvent replacement. The total solvent inventory for the process, consisting primarily of the diluent Isopar[®]L, is a projected 1,000 gallons. Using the conservative assumption that the solvent inventory is replaced once per year, a total of 13,000 gallons of organic solvent could be accumulated over the 13-year operating life. DOE is investigating treatment and disposal options for this waste stream similar to those discussed in the previous paragraph for benzene.

L1-11

Industrial waste

Under each of the action alternatives, DOE would expect to generate approximately 30 metric tons per year of industrial (nonhazardous, nonradioactive) waste as a result of startup activities and an additional 20 metric tons per year during operations. The projected volume represents less than 1 percent

of the forecasted SRS industrial waste generation through 2029 (Halverson 1999). This waste would be recovered for recycling or disposed of onsite at the Three Rivers Landfill (DOE 2000d).

Sanitary waste

Sanitary wastewater from the salt processing facilities would be treated in the Centralized Sanitary Wastewater Treatment Facility and discharged to Fourmile Branch via NPDES outfall G-10. These discharges would be expected to comply with current NPDES permit limitations.

Under each of the action alternatives, DOE would expect to generate approximately 62 metric tons per year of solid sanitary wastes as a result of startup activities and an additional 41 metric tons per year during operations. The projected volume represents about 5 percent of the forecasted SRS sanitary waste generation through 2029 (Halverson 1999). This waste would be disposed of onsite at the Three Rivers landfill (DOE 2000d).

4.1.12 UTILITIES AND ENERGY

This section discusses potential utility and energy impacts from construction and operation under each of the salt processing alternatives. The scope of the analysis includes electric power, fuel (diesel and gasoline) consumption, process water consumption, and steam use. DOE used applicable past SRS operations or engineering to estimate the energy and utility requirements of the alternatives. Estimates of water use include: process additions, cooling, and flushing; product washes; and grout production. Steam is used primarily to operate the ventilation systems and to heat waste solutions during processing. Fuel consumption is based on use of diesel-powered equipment during construction activities and diesel emergency power generators. The analysis compared the use of electricity, water, and steam to the available capacities discussed in Section 3.10.

DOE would obtain utilities and energy from existing sources and suppliers. Water would come from existing site wells; and electricity and fuel

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would come from existing on- and offsite suppliers. Steam would be produced onsite.

Table 4-20 lists electric energy, fuel, steam, and water use during the construction and

operation phases of each action alternative. Overall, DOE does not expect substantial increases in water use or energy consumption with implementation of any of the alternatives, including No Action.

Table 4-20. Estimated project total energy and utilities use for the salt processing alternatives.

Phase ^a	SRS Baseline ^b	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>Potable water use (million gallons)</i>					
Construction	NA	19	20	19	18
Operation	NA	99	95	120	75
Project subtotal use	NA	118	115	139	93
<i>Process water use (million gallons)</i>					
Construction	NA	16	17	16	15
Operation	23,000 ^c	301	271	225	181
Project subtotal use	NA	317	288	241	196
Project total water use (million gal- lons)	NA	435	403	380	289
<i>Peak electrical power demand (megawatts)</i>					
Construction	NA	1.66	1.66	1.66	1.66
Operation	130 ^c	24	24	32	18
<i>Electricity use (gigawatt-hours)</i>					
Construction	NA	76	79	76	73
Operation	410 ^c	243	286	315	172
Project total use	NA	319	365	391	245
<i>Steam use (million pounds)</i>					
Construction	NA	0	0	0	0
Operation	NA	2,548	2,300	1,915	1,536
Project total use	NA	2,548	2,300	1,915	1,536
<i>Fuel use (million gallons)</i>					
Construction	NA	8.4	9	8.4	8
Operation	8.75 ^d	0.3	0.3	0.3	0.2
Project total use	NA	8.7	9.3	8.7	8.2

Adapted from WSRC (1999e).

- From Table 2-1, the construction and operation duration of each alternative are as follows: Small Tank Precipitation – 48 months and 13 years; Ion Exchange – 50 months and 13 years; Solvent Extraction – 48 months and 13 years; and Direct Disposal in Grout – 46 months and 13 years. The total project duration includes a startup duration of 1.3 years for each alternative (Sessions 1999).
 - Construction of any new tanks would require approximately 660,000 gallons of water and 45,000 gallons of fuel per tank. Utility and energy use under the No Action alternative would be similar to use at the existing HLW Tank Farms, and is included in the baseline.
 - Halverson (1999).
 - DOE (1995).
- NA = Not Available.

4.1.12.1 Water Use

During the approximately 4-year construction phase, the estimated demand for water would range from 33 to 37 million gallons, depending on the processing alternative selected. On a daily average basis, the highest use would represent about 2.3 percent of water used in H-, S-, and Z-Area facilities in 1998 (SCDHEC 1999a) and 0.2 percent of the lowest estimated production capacity of the aquifer (16 million gallons per day) (WSRC 1998b).

Under the No Action alternative, construction of any new tanks would require approximately 660,000 gallons of water per tank (DOE 1980), which is less than 0.1 percent of the aquifer production capacity.

During the 13-year operational phase, total water use for the action alternatives would be similar and would vary between 256 and 400 million gallons, depending on the processing alternative selected. On a daily average use basis, the highest use would be about 22.6 percent of the volume used in H-, S-, and Z-Area facilities during 1998 (SCDHEC 1999a), and 1.5 percent of the lowest estimated production capacity of the aquifer (WSRC 1998b).

Water use for the entire duration of the project would be similar for all action alternatives and would be between 289 and 435 million gallons, for the Direct Disposal in Grout and Small Tank Precipitation alternatives, respectively.

For the No Action alternative, water use during operation under any scenario would be slightly higher than the existing HLW Tank Farms and would therefore constitute a slight increase over the baseline.

4.1.12.2 Electricity Use

During construction, the estimated peak electrical power demand would be 1.7 megawatts for each alternative, with use varying between about 73 and 79 gigawatt-

hours, depending on the processing alternative selected. The peak power demand would be a small fraction of the H-Area power distribution network's capacity (64 megawatts) (WSRC 1996). Power for S and Z Areas would be supplied through the H-Area network.

Electric power demand during construction of any tanks under the No Action alternative would be similar to that of the action alternatives.

During operations, the peak electric power demand would be very similar for each action alternative and would vary between 18 and 32 megawatts, depending on the processing alternative selected. In combination with the 22-megawatt demand for power from H-Area facilities, a total demand of 54 megawatts is possible, which represents 84 percent of the H-Area power distribution network's capacity (WSRC 1996). The highest peak power demands and electricity use would occur under the Solvent Extraction alternative. Electricity use during operations would be similar for each action alternative and would vary between 172 and 315 gigawatt-hours, depending on the alternative selected.

Electricity use for the entire duration of the project would be between 245 and 391 gigawatt-hours, for the Direct Disposal in Grout and Solvent Extraction alternatives, respectively.

For the No Action alternative, electric power demand during operation of any scenario would be slightly higher than the existing HLW Tank Farms and would therefore constitute a slight increase over the baseline.

4.1.12.3 Steam Use

No steam would be used during the construction phase for any of the alternatives, including No Action. The main uses for steam during the operation phase would be operation of building ventilation systems and waste solution heating. Operation of the ventilation systems would account for most of the steam used. Total steam use during the operations phase would be similar under each alternative and would range from 1.5 to 2.5 billion pounds for the Direct Disposal in

Grout and Small Tank Precipitation alternatives, respectively. On a daily average use basis, the highest use would be about 18.3 percent of the steam used in H-, S-, and Z-Area facilities, and 1.5 percent of the steam production capacity for H-, S-, and Z-Area facilities (WSRC 1996).

Steam use under the No Action alternative would be slightly higher than current use rates at the existing HLW Tank Farms. Therefore, the No Action alternative would constitute a slight increase over the baseline.

4.1.12.4 Fuel Use

Diesel and gasoline fuels would be used during the construction and operation phases of the project, primarily for the operation of mobile heavy equipment and stationary support equipment. Fuel consumption would be similar under all the action alternatives. The highest consumption of liquid fuels, about 9 million gallons, would be during the construction phase of the Ion Exchange alternative (2.1 million gallons per year). Liquid fuel use during the operations phase of any alternative is low, at less than 300,000 gallons total. As a comparison, operations at SRS used approximately 8.75 million gallons of liquid fuels in 1994 (DOE 1995).

Under the No Action alternative, a total of approximately 45,000 gallons of diesel fuel and gasoline would be required per tank during construction (DOE 1980). Liquid fuel use during the operation phase would be similar to the existing Tank Farm and is included in the baseline.

4.1.13 ACCIDENT ANALYSIS

This section summarizes risks to the public and workers from potential accidents associated with the various salt processing action alternatives at SRS.

Detailed descriptions of each accident, including the scenario description, probability of occurring, radiological source terms, non-radiological hazardous chemical release

rates, and consequences are provided in Appendix B.

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as human error, equipment failure, or earthquake, 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:

- *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 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.

Because current operations are the basis from which each of the proposed alternatives begins, the hazards associated with each of the action alternatives are in addition to those of current operations. However, after the period of opera-

tion, the hazards associated with salt processing are eliminated and those associated with the storage of salt solutions would be substantially reduced. Because the No Action alternative includes primarily current operations that have been evaluated under the NEPA process and in approved safety analysis reports, accidents associated with current tank space management operations are not evaluated here. Failure of a Salt Solution Hold Tank is addressed in the High-Level Waste Tank Closure Draft EIS (DOE 2000e). The radiological and nonradiological hazards associated with the four action alternatives were evaluated in this section and Appendix B.

Nonradiological

The long-term health consequences of human exposure to nonradiological hazardous materials are not as well understood as those related to radiation exposure. 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.

Table 4-21 summarizes the impacts of accidents involving the release of nonradiological hazardous materials to the MEI and noninvolved workers. In general, impacts to these receptors resulting from accidents involving nonradiological hazardous materials are minimal. However, noninvolved workers exposed to atmospheric releases of benzene from two of the accidents evaluated under the Small Tank Precipitation alternative could develop serious or life-threatening health effects. Workers exposed to airborne benzene concentrations (950 mg/m^3) resulting from an Organic Waste Storage Tank (OWST) loss of confinement accident could experience serious health effects that may impair their ability to take protective action (e.g., dizziness, confusion, impaired vision). Workers exposed to airborne benzene concentrations ($8,840 \text{ mg/m}^3$) resulting from an explosion in the OWST, could experience life-threatening health effects (e.g., loss of

consciousness, cardiac dysrhythmia, respiratory failure). Both of these accidents would occur less than once in 100,000 years and are in the extremely unlikely category.

Radiological

Tables 4-22 through 4-25 summarize for each salt processing alternative the estimated impacts to onsite workers and the public from potential accidents involving the release of radiological materials. These tables list potential accident consequences for all receptors as LCFs per accident and LCFs per year. The LCF per accident values are an estimate of the consequences without accounting for the probability of the accident occurring. The LCF per year values do take the accident's probability into consideration and provide a common basis for comparison of accident consequences.

DOE estimated impacts to five receptors: (1) the MEI at the SRS boundary; (2) the offsite population in an area within 50 miles (80 kilometers); (3) an involved worker 328 feet (100 meters) from the accident; (4) a noninvolved worker 2,100 feet (640 meters) from the accident location, as discussed in DOE (1994); and (5) the onsite population (includes both involved and noninvolved workers).

For all of the accidents, there is a potential for injury or death to involved workers in the vicinity of the accident. In some cases, the impacts to the involved worker would be greater than to the noninvolved worker. DOE estimated the increased probability of an LCF to an involved and a noninvolved worker from radiation exposure during each of the accident scenarios.

However, prediction of latent potential health effects becomes increasingly difficult to quantify with any certainty as the distance between the accident location and the receptor decreases, because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The involved worker may be acutely injured or killed by physical effects of the accident itself. DOE identified potential accidents in Cappucci et al.

Table 4-21. Estimated consequences of accidents involving nonradioactive hazardous materials.

	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Accidents Involving Sodium Hydroxide Releases				
Caustic Feed Tank Loss of Confinement – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	5.9×10 ⁻⁴	5.9×10 ⁻⁴	5.9×10 ⁻⁴	5.9×10 ⁻⁴
Noninvolved Worker (640 m) Dose (mg/m ³)	0.18	0.18	0.18	0.18
Caustic Dilution Tank Loss of Confinement – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	NA	NA	NA	0.0031
Noninvolved Worker (640 m) Dose (mg/m ³)	NA	NA	NA	0.93 ^a
Accidents Involving Nitric Acid Releases				
Nitric Acid Feed Tank Loss of Confinement – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	NA	NA	8.8×10 ⁻⁵	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	NA	NA	0.026	NA
Accidents Involving Benzene Releases				
PHA Surge Tank Loss of Confinement – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	7.4×10 ⁻¹⁰	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	2.2×10 ⁻⁸	NA	NA	NA
TPB Tank Spill – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	0.060	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	18.7	NA	NA	NA
Organic Evaporator Loss of Confinement – Frequency:	Once in 30 years			
MEI Dose (mg/m ³)	0.45	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	130	NA	NA	NA
Beyond Design Basis Earthquake – Frequency:	Less than once in 2,000 years			
MEI Dose (mg/m ³)	0.0026	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	0.78	NA	NA	NA
OWST Loss of Confinement – Frequency:	Once in 140,000 years			
MEI Dose (mg/m ³)	3.2	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	950 ^b	NA	NA	NA
Loss of Cooling – Frequency:	Once in 170,000 years			
MEI Dose (mg/m ³)	0.0015	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	0.44	NA	NA	NA
Benzene Explosion in the OWST – Frequency:	Once in 770,000 years			
MEI Dose (mg/m ³)	30	NA	NA	NA
Noninvolved Worker (640 m) Dose (mg/m ³)	8,840 ^c	NA	NA	NA

- Individuals exposed to sodium hydroxide concentrations above 0.5 mg/m³ could experience mild transient health effects (e.g., rash, headache, nausea) or perception of a clearly defined objectionable odor.
- Individuals exposed to benzene concentrations above 480 mg/m³ could experience or develop irreversible or other serious health effects (e.g., dizziness, confusion, impaired vision).
- Individuals exposed to benzene concentrations above 3,190 mg/m³ could experience or develop life-threatening health effects (e.g., loss of consciousness, cardiac dysrhythmia, respiratory failure).

NA = Not Applicable, MEI - maximally exposed (offsite) individual, PHA = precipitate hydrolysis aqueous, OWST = Organic Waste Storage Tank, TPB = tetrphenylborate.

Table 4-22. Estimated accident consequences for the Small Tank Precipitation process.

Frequency	Loss of Confinement - PHA surge tank ^a	Beyond Design-Basis Earthquake ^b	Fire in a Process Cell- PHA Surge tank ^a	Benzene explosion	Helicopter Impact - PHA Surge Tank ^a	Aircraft Impact ^b
	Once in 30 years	Less than once in 2,000 years	Once in 10,000 years	Once in 99,000 years	Once in 2,100,000 years	Once in 2,700,000 years
MEI dose (rem)	0.0016	0.31	0.014	0.70	3.3	5.4
MEI LCF per accident ^c	8.2×10^{-7}	1.5×10^{-4}	7.2×10^{-6}	3.5×10^{-4}	0.0016	0.0027
MEI LCF per year ^c	2.8×10^{-8}	7.6×10^{-8}	7.2×10^{-10}	3.5×10^{-9}	7.9×10^{-10}	1.0×10^{-9}
Offsite population dose (person-rem)	88	16,000	780	38,000	170,000	280,000
Offsite population LCF per accident	0.044	8.0	0.39	19	87	140
Offsite population LCF per year	0.0015	0.0040	3.9×10^{-5}	1.9×10^{-4}	4.2×10^{-5}	5.3×10^{-5}
Noninvolved worker Dose (rem)	0.024	9.6	0.21	10	100	170
Noninvolved worker LCF per accident ^c	9.5×10^{-6}	0.0038	8.5×10^{-5}	0.0041	0.041	0.067
Noninvolved worker LCF per year ^c	3.2×10^{-7}	1.9×10^{-6}	8.5×10^{-9}	4.1×10^{-8}	2.0×10^{-8}	2.5×10^{-8}
Involved worker dose (rem)	3.2×10^{-6}	310 ^d	2.8×10^{-5}	0.0014	3,300 ^d	5,400 ^d
Involved worker LCF per accident ^c	1.3×10^{-9}	0.12	1.1×10^{-8}	5.5×10^{-7}	1.3	2.1
Involved worker LCF per year ^c	4.3×10^{-11}	6.1×10^{-5}	1.1×10^{-12}	5.6×10^{-12}	6.3×10^{-7}	8.0×10^{-7}
Onsite population dose (person-rem)	39	9,000	340	17,000	97,000	160,000
Onsite population LCF per accident	0.016	3.6	0.14	6.7	39	63
Onsite population LCF per year	5.3×10^{-4}	0.0018	1.4×10^{-5}	6.8×10^{-5}	1.9×10^{-5}	2.3×10^{-5}

a. Tank/cell listed is bounding case (e.g., it results in the greatest impacts to offsite receptors and noninvolved workers).

b. Accident involves the entire facility.

c. Increased probability of an LCF to the exposed individual.

d. An acute dose to an individual over 300 rem would likely result in death.

PHA = precipitate hydrolysis aqueous; PHC = precipitate hydrolysis cell; MEI = maximally exposed offsite individual; LCF = latent cancer fatality.

Table 4-23. Estimated accident consequences for the Ion Exchange process.

Frequency	Loss of Con- finement - Alpha Filter Cell ^a	Beyond Design-Basis Earthquake ^b	Loss of Cooling- Loaded Resin Hold Tank ^a	Fire in a Pro- cess Cell - Alpha Filter Cell ^a	Helicopter Impact - Alpha Fil- ter Cell ^a	Aircraft impact ^b
	Once in 30 years	Less than once in 2,000 years	Once in 5,300 years	Once in 10,000 years	Once in 2,100,000 years	Once in 2,700,000 years
MEI Dose (rem)	8.3×10^{-4}	0.12	9.4×10^{-7}	0.0094	1.7	2.0
MEI LCF per acci- dent ^c	4.2×10^{-7}	5.9×10^{-5}	4.7×10^{-10}	4.7×10^{-6}	8.5×10^{-4}	0.0010
MEI LCF per year ^c	1.4×10^{-8}	2.9×10^{-8}	8.9×10^{-14}	4.7×10^{-10}	4.1×10^{-10}	3.7×10^{-10}
Offsite population Dose (person-rem)	45	6,200	0.052	500	89,000	110,000
Offsite population LCF per accident	0.022	3.1	2.6×10^{-5}	0.25	45	53
Offsite population LCF per year	7.6×10^{-4}	0.0016	5.0×10^{-9}	2.5×10^{-5}	2.1×10^{-5}	2.0×10^{-5}
Noninvolved Worker Dose (rem)	0.012	3.7	1.4×10^{-5}	0.14	53	63
Noninvolved Worker LCF per accident ^c	4.9×10^{-6}	0.0015	5.7×10^{-9}	5.5×10^{-5}	0.021	0.025
Noninvolved Worker LCF per year ^c	1.6×10^{-7}	7.4×10^{-7}	1.1×10^{-12}	5.5×10^{-9}	1.0×10^{-8}	9.4×10^{-9}
Involved Worker Dose (rem)	6.4×10^{-8}	120	8.8×10^{-8}	9.1×10^{-7}	1,700 ^d	2,000 ^d
Involved Worker LCF per accident ^c	2.6×10^{-11}	0.047	3.5×10^{-11}	3.6×10^{-10}	0.68	0.81
Involved Worker LCF per year ^c	8.7×10^{-13}	2.4×10^{-5}	6.7×10^{-15}	3.6×10^{-14}	3.2×10^{-7}	3.0×10^{-7}
Onsite population Dose (person-rem)	20	3,500	0.023	220	50,000	59,000
Onsite population LCF per accident	0.0080	1.4	9.0×10^{-6}	0.089	20	24
Onsite population LCF per year	2.7×10^{-4}	6.9×10^{-4}	1.7×10^{-9}	8.9×10^{-6}	9.5×10^{-6}	8.8×10^{-6}

a. Tank/cell listed is bounding case (e.g., it results in the greatest impacts to offsite receptors and noninvolved workers).

b. Accident involves the entire facility.

c. Increased probability of an LCF to the exposed individual.

d. An acute dose to an individual over 300 rem would likely result in death.

MEI = maximally exposed offsite individual; LCF = latent cancer fatality.

Table 4-24. Estimated accident consequences for the Solvent Extraction process.

Frequency	Loss of Confinement - SSRT ^a	Beyond Design-Basis Earthquake ^b	Fire in a Process Cell - Alpha Filter Cell ^a	Hydrogen Explosion-Extraction Cell ^a	Helicopter Impact - Alpha Filter Cell ^a	Aircraft impact ^b
	Once in 30 years	Less than once in 2,000 years	Once in 10,000 years	Once in 1,300,000 years	Once in 2,100,000 years	Once in 2,700,000 years
MEI Dose (rem)	8.3×10^{-4}	0.12	0.0094	0.0029	1.7	2.0
MEI LCF per accident ^c	4.2×10^{-7}	5.8×10^{-5}	4.7×10^{-6}	1.4×10^{-6}	8.5×10^{-4}	0.0010
MEI LCF per year ^c	1.4×10^{-8}	2.9×10^{-8}	4.7×10^{-10}	1.1×10^{-12}	4.1×10^{-10}	3.8×10^{-10}
Offsite population Dose (person-rem)	45	6,100	500	160	89,000	110,000
Offsite population LCF per accident	0.022	3.0	0.25	0.081	45	54
Offsite population LCF per year	7.6×10^{-4}	0.0015	2.5×10^{-5}	6.1×10^{-8}	2.1×10^{-5}	2.0×10^{-5}
Noninvolved Worker Dose (rem)	0.012	3.6	0.14	0.044	53	64
Noninvolved Worker LCF per accident ^c	4.9×10^{-6}	0.0015	5.5×10^{-5}	1.8×10^{-5}	0.021	0.026
Noninvolved Worker LCF per year ^c	1.6×10^{-7}	7.3×10^{-7}	5.5×10^{-9}	1.3×10^{-11}	1.0×10^{-8}	9.5×10^{-9}
Involved Worker Dose (rem)	6.4×10^{-8}	120	7.2×10^{-7}	2.7×10^{-4}	1,700 ^d	2,000 ^d
Involved Worker LCF per accident ^c	2.6×10^{-11}	0.046	2.9×10^{-10}	1.1×10^{-7}	0.68	0.81
Involved Worker LCF per year ^c	8.7×10^{-13}	2.3×10^{-5}	2.9×10^{-14}	8.1×10^{-14}	3.3×10^{-7}	3.0×10^{-7}
Onsite population Dose (person-rem)	20	3,400	220	70	50,000	60,000
Onsite population LCF per accident	0.0080	1.4	0.089	0.028	20	24
Onsite population LCF per year	2.7×10^{-4}	6.8×10^{-4}	8.9×10^{-6}	2.1×10^{-8}	9.6×10^{-6}	8.9×10^{-6}

- a. Tank/cell listed is bounding case (e.g., it results in the greatest impacts to offsite receptors and noninvolved workers).
b. Accident involves the entire facility.
c. Increased probability of an LCF to the exposed individual.
d. An acute dose to an individual over 300 rem would likely result in death.
SSRT = sludge solids receipt tank; MEI = maximally exposed offsite individual; LCF = latent cancer fatality.

Table 4-25. Estimated accident consequences for the Direct Disposal in Grout process.

Frequency	Loss of Confinement - SSRT ^a	Beyond Design-Basis Earthquake ^b	Fire in a Process Cell - SSRT ^a	Helicopter Impact - SSRT ^a	Aircraft impact ^b
	Once in 30 years	Less than once in 2,000 years	Once in 10,000 years	Once in 2,100,000 years	Once in 2,700,000 years
MEI Dose (rem)	2.4×10^{-4}	0.042	0.0027	0.53	0.74
MEI LCF per accident ^c	1.2×10^{-7}	2.1×10^{-5}	1.4×10^{-6}	2.7×10^{-4}	3.7×10^{-4}
MEI LCF per year ^c	4.1×10^{-9}	1.0×10^{-8}	1.4×10^{-10}	1.3×10^{-10}	1.4×10^{-10}
Offsite population Dose (person-rem)	14	2,300	160	29,000	40,000
Offsite population LCF per accident	0.0072	1.1	0.081	14	19
Offsite population LCF per year	2.4×10^{-4}	5.7×10^{-4}	8.1×10^{-6}	6.9×10^{-6}	7.4×10^{-6}
Noninvolved Worker Dose (rem)	0.0036	1.3	0.041	17	23
Noninvolved Worker LCF per accident ^c	1.5×10^{-6}	5.3×10^{-4}	1.6×10^{-5}	0.0067	0.0093
Noninvolved Worker LCF per year ^c	4.9×10^{-8}	2.6×10^{-7}	1.6×10^{-9}	3.2×10^{-9}	3.4×10^{-9}
Involved Worker Dose (rem)	7.3×10^{-8}	42	8.2×10^{-7}	53	740 ^d
Involved Worker LCF per accident ^c	2.9×10^{-11}	0.017	3.3×10^{-10}	0.21	0.30
Involved Worker LCF per year ^c	9.8×10^{-13}	8.4×10^{-6}	3.3×10^{-14}	1.0×10^{-7}	1.1×10^{-7}
Onsite population Dose (person-rem)	42	1,000	48	13,000	18,000
Onsite population LCF per accident	0.0017	0.41	0.19	5.3	7.3
Onsite population LCF per year	5.7×10^{-5}	2.1×10^{-4}	1.9×10^{-6}	2.5×10^{-6}	2.7×10^{-6}

a. Tank/cell listed is bounding case (e.g., results in the greatest impacts to offsite receptors and noninvolved workers).

b. Accident involves the entire facility.

c. Increased probability of an LCF to the exposed individual.

d. An acute dose to an individual over 300 rem would likely result in death.

SSRT = sludge solids receipt tank; MEI = maximally exposed offsite individual; LCF = latent cancer fatality.

(1999) and estimated impacts using the AXAIRQ computer model (Simpkins 1995a,b), as discussed in Appendix B.

4.1.14 PILOT PLANT

As discussed in Section 2.7.6, a Pilot Plant would be designed and constructed to dem-

onstrate the overall process objectives of the salt processing alternative that DOE will select. Details of the proposed demonstration objectives are provided in Appendix A. Detailed design and construction of the Pilot Plant would be initiated upon selection of the salt processing alternative and operation would extend through completion of final design and potentially

through startup of the full-scale facility. This section discusses potential impacts from construction and operation of the Pilot Plant for each salt processing action alternative.

For the purposes of this SEIS, DOE assumes that the Pilot Plant components would be sized to operate on a scale of approximately 1/100 to 1/10 that of the full-size facility, and would utilize a modular design to facilitate remote installation and modification of the process equipment. A Pilot Plant for the Direct Disposal in Grout alternative is not planned because this technology is better developed than the other action alternatives, and has been demonstrated at full scale in the Saltstone Manufacturing and Disposal Facility. Therefore, this SEIS does not include a demonstration of the Direct Disposal in Grout alternative.

DOE intends to construct and operate a Pilot Plant only for the selected alternative. Knowledge gained from the demonstration could lead to a decision to demonstrate more than one salt processing alternative technology. In the event that DOE decides to demonstrate more than one technology, the Pilot Plant units would be developed and operated in series. Therefore, impacts associated with more than one Pilot Plant would not occur at the same time, but would extend over a longer period.

The Pilot Plant would be designed to demonstrate the processing of real radioactive wastes. Principal process operations would be conducted inside shielded cells.

The Pilot Plant would be located in an existing process area well within the SRS boundary. Candidate sites include the Late Wash Facility in H Area (see Figure 2-3), which was designed and built to handle radiological operations and is located near DWPF, in S Area or in another area similar to the location of the proposed full-scale facility.

Services to support operations would be provided, including utilities, process chemicals, ventilation systems, and habitability services. An appropriate chemical storage area would be developed, with isolation of acids, caustics, oxidizing and reducing agents, and other incompatible reactants. Ventilation systems would be operated such that airflow is from regions of low contamination to areas of higher contamination.

The generation and dispersion of radioactive and hazardous materials would be minimized. Process waste would be managed at appropriate site locations, such as DWPF, Saltstone Manufacturing and Disposal Facility, HLW Tank Farms and the LLW vaults.

All Pilot Plants are at the pre-conceptual stage, therefore, the analysis in this section is qualitative.

4.1.14.1 Geologic Resources

The Pilot Plant would be constructed in an existing facility in a previously disturbed area. Therefore, no additional impact to geologic resources would occur.

4.1.14.2 Water Resources

The Pilot Plant would be constructed in an existing facility. No additional land would be disturbed therefore the water table would not be disturbed and no increase in suspended solids in stormwater runoff would be expected. Therefore, no impact to surface water or groundwater resources would occur during construction.

The Pilot Plant would generate less than 10 percent of the sanitary and process wastewater of the full size salt processing facility on an annual basis. DOE concluded in Section 4.1.2 that regardless of the alternative selected, impacts to surface water as a result of salt processing facility activities would be minimal and there would be no impact to groundwater quality. The quantity of sanitary and process wastewater generated by the Pilot Plant would be much smaller than the amount generated by the salt processing

facility, therefore surface water impacts from operation of the Pilot Plant would be minimal and there would be no impact to groundwater quality.

4.1.14.3 Air Resources

The Pilot Plant would use skid-mounted equipment and be constructed in an existing facility. No land would be disturbed during construction, therefore the use of heavy-duty construction equipment (i.e., trucks, bulldozers, and other diesel-powered support equipment) would be minimized. Therefore, impacts to air quality during construction would be minimal.

As shown in Table 4-7, with the exception of VOCs, the nonradiological air emissions from the full-scale salt processing facility for each alternative are similar and would be well below the SCDHEC PSD limit. The estimated VOC emissions for the full-scale Ion Exchange facility would not be greater than 5 percent of the PSD limit of 40 tons per year. The estimated VOC emissions for the full-scale Small Tank Precipitation facility would be 70 tons per year, while the emissions from the full-scale Solvent Extraction facility would be 40 tons per year. VOC emissions from both full-scale facilities would exceed the PSD limit of 40 tons per year. Because air emissions from the Pilot Plant would not be greater than 10 percent of the emissions from the full-size facility, all nonradiological emissions from the Pilot Plant would be much lower than their corresponding PSD limits. Similarly, incremental increases in air concentrations at the SRS boundary would also be much lower than those projected for the full-scale facility.

As shown in Table 4-8, all radiological air emissions from the full-scale facility for each alternative would be similar and low. Because air emissions from the Pilot Plant would not be greater than 10 percent of the emissions from the full-size facility, incremental impacts of radiological emissions from the Pilot Plant would be minimal.

4.1.14.4 Worker and Public Health

In Section 4.1.4 DOE concluded the overall occupational and health impacts (radiological, non-radiological, and occupational safety) would be minimal for the full-scale Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout facilities. Doses to the noninvolved worker would be well below Federal limits and SRS administrative guides and would not result in adverse impacts. Exposures to the MEI would result in an annual dose that is below the Federal exposure limits. The Pilot Plant would not be greater than 1/10 the size of the preferred salt processing alternative and would be operated in a manner that minimizes the generation and dispersion of radioactive and hazardous materials. Therefore, the overall occupational and health impacts (radiological, non-radiological, and occupational safety) would be similar and minimal.

4.1.14.5 Environmental Justice

In Section 4.1.5, DOE concluded that the potential offsite consequences to the general public of the proposed action and the alternatives would be small, and there would be no disproportionately high and adverse impacts to minority or low-income populations. The Pilot Plant would not be greater than 1/10 the size of the preferred salt processing alternative and would be operated in a manner that minimizes the generation and dispersion of radioactive and hazardous materials. Therefore, by similarity, the Pilot Plant would have no disproportionately high and adverse impacts to minority or low-income populations.

4.1.14.6 Ecological Resources

The Pilot Plant would be constructed in an existing facility located in a heavily industrialized area that has marginal value as wildlife habitat. Construction would involve the movement of workers and construction equipment, but no earth-moving equipment would be anticipated, so noise levels would be somewhat lower than the levels that would be experienced during construction of the full-scale facility. Construction-

related disturbances are likely to create impacts to wildlife that would be small, intermittent, and localized.

Operation of the Pilot Plant would entail movement of workers and equipment and noise from public address systems (e.g., testing of radiation and fire alarms), air compressors, pumps, and HVAC-related equipment. With the possible exception of the public address systems, noise levels generated by these kinds of sources are not expected to disturb wildlife outside of facility boundaries.

4.1.14.7 Land Use

The Pilot Plant would be constructed in an existing facility located in an area designated for industrial use. Therefore, no change in land use patterns would occur.

4.1.14.8 Socioeconomics

The Pilot Plant would be constructed in an existing facility. During construction of the Pilot Plant, the number of workers would be restricted by space constraints inside the proposed facility. In addition, the Pilot Plant would have a modular design that maximizes the use of skid-mounted equipment, which would facilitate remote installation and further limit the number of workers required for construction. Therefore, the number of workers involved in the construction of the Pilot Plant would be much lower than the number of workers required for construction of the salt processing facility.

The Small Tank Precipitation process facility would require approximately 180 operations employees. The Ion Exchange process facility would require approximately 135 operations employees. The Solvent Extraction process facility would require approximately 220 operations employees, (WSRC 1998a, 2000a). These same employees would be trained in and would operate the Pilot Plant.

4.1.14.9 Cultural Resources

The Pilot Plant would be constructed in an existing facility and would, therefore, not disturb any cultural or historic resources. Therefore, no impact to cultural resources would occur.

4.1.14.10 Traffic and Transportation

In Section 4.1.10, DOE estimated that material shipments required for implementation of the alternatives would result in 403,000 to 529,000 miles traveled over the 13 year life of the facility and no accidents involving injuries or fatalities would be expected during those material shipments. The Pilot Plant would operate potentially for a period of approximately 5.5 years and the number of material shipments would be substantially lower, so no accidents involving injuries or fatalities would be expected during material shipments to the Pilot Plant.

During the life of the Pilot Plant, workers would make between 184,250 and 292,000 Site trips. Under the Small Tank Precipitation Pilot Plant, workers would make approximately 240,000 Site trips; 45 accidents, 20 injuries and no fatalities would be expected. Under the Ion Exchange Pilot Plant, workers would make approximately 184,250 Site trips; 35 accidents, 15 injuries and no fatalities would be expected. Under the Solvent Extraction Pilot Plant, workers would make approximately 292,000 Site trips; 55 accidents, 24 injuries and no fatalities would be expected.

4.1.14.11 Waste Generation

The Pilot Plant would generate no greater than 10 percent of the waste of the full-size salt processing facility on an annual basis. Waste generation under the Solvent Extraction Pilot Plant would be slightly higher than the other Pilot Plant units, due to the inclusion of a 1/5-scale centrifugal contactor.

As with the full-scale salt processing facility, the Pilot Plant would generate minimal quantities of low-level, transuranic, hazardous, industrial, and sanitary waste under all scenarios. All opera-

tions would generate a small amount of radioactive liquid waste, but the quantity generated by the Solvent Extraction Pilot Plant would be somewhat higher than that generated by the other three Pilot Plants. The Ion Exchange Pilot Plant would generate a small amount of nonradioactive liquid waste, while the Pilot Plants for the other two action alternatives would generate minute quantities of nonradioactive liquid waste. All Pilot Plant operations would generate a small amount of mixed LLW, but the quantity generated by the Solvent Extraction Pilot Plant would be higher than that generated by the Small Tank Precipitation and Ion Exchange Pilot Plants. Because it produces a comparatively large amount of benzene, the Small Tank Precipitation Pilot Plant would generate considerably more mixed low-level liquid waste than the other two Pilot Plants.

4.1.14.12 Utilities and Energy

Utility and energy use during construction of the Pilot Plant would be minimal. No steam would be used, and the use of skid-mounted equipment and the fact that the Pilot Plant would be constructed in an existing facility would limit water, electricity, and fuel requirements.

Utility and energy use during operation of the Pilot Plant would not be greater than 10 percent of the amount used in the full-size salt processing facility on an annual basis. Utility and energy demand for the Solvent Extraction Pilot Plant would be slightly higher than the other Pilot Plants due to the inclusion of a 1/5-scale centrifugal contactor. The impact to SRS utility and energy supplies would be minimal during operation of the Pilot Plant.

4.2 Long-Term Impacts

This section presents estimates of long-term impacts of the four salt processing action alternatives and the No Action alternatives. For all the action alternatives, the major source of long-term impacts would be the saltstone that would result from each of the

four alternatives. As discussed in Chapter 2, the saltstone vaults would be located in Z Area, regardless of the selected alternative. Therefore, this SEIS analyzes impacts only from the placement of saltstone in Z Area. Short-term impacts of manufacturing the saltstone are included in Section 4.1.

For NEPA analysis of long-term impacts of the action alternatives, DOE assumed that institutional control would be maintained for 100 years post-closure, during which the land encompassing the saltstone vaults would be managed to prevent erosion or other conditions that would lead to early degradation of the vaults. DOE also assumed that the public would not have access to Z Area during this time to set up residence. DOE estimated long-term impacts by doing a performance evaluation that included fate and transport modeling to determine when certain impacts (e.g., radiation dose) could peak. DOE used the *Radiological Performance Assessment for the Z-Area Saltstone Disposal Facility* (WSRC 1992) (RPA) as the basis for the water resources and human health analyses. This performance assessment was done for the original saltstone that would have resulted from the In-Tank Precipitation process. For this SEIS, DOE modified the source terms for each of the action alternatives. See Appendix D for details of the analysis.

For NEPA analysis of long-term impacts of the No Action alternative, DOE assumes that the sludge in the HLW tanks would be processed to the extent practicable so that only salt waste would be left in the tanks, and the tanks would be nearly full. It is also assumed that DOE would take no further action to stabilize the waste remaining in the tanks or to stabilize the tank systems themselves, but would maintain institutional control and would maintain the tanks for 100 years. Following this 100-year period of institutional control, the HLW tanks would begin to fail. Failed tanks could create physical hazards to humans and wildlife in the area. Waste contaminants could be released from tanks into groundwater and the contaminants would eventually migrate to surface water. Precipitation could infiltrate into failed tanks, causing them to overflow and spill dissolved salt

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onto the ground surface. Salt solutions spilled onto the ground surface could contaminate the soil, vegetation, and groundwater, and could flow overland to surface streams (Upper Three Runs, Fourmile Branch, and the Savannah River). People who intruded into the site vicinity could receive radiation exposure by external exposure to contaminated soil or by consuming contaminated surface water, groundwater, or vegetation, or eating meat or dairy products from animals that had consumed such water or vegetation.

In the Draft SEIS, DOE did not model the eventual release of salt waste to the environment under the No Action alternative. Instead, DOE provided a comparison to the modeling results from the No Action alternative in the *High-Level Waste Tank Closure Draft Environmental Impact Statement* (DOE 2000). In the Tank Closure Draft EIS No Action scenario, most of the waste would be removed from the HLW tanks (i.e., approximately 10,000 gallons would remain as residual waste in a 1.3-million-gallon tank). After a period of several hundred years, the remaining waste, 200 curies of long half-life isotopes and 9,900 curies of cesium-137 (which has a relatively short half-life of 30 years), would be released to groundwater and eventually migrate to surface water. The Tank Closure Draft EIS modeling showed that an adult resident in the F-Area Tank Farm could receive a lifetime dose of 430 millirem (primarily from groundwater) and incur an incremental risk of 0.0022 of contracting a fatal cancer. For comparison, in the No Action alternative in the Salt Processing Alternatives Draft SEIS, DOE assumed that HLW would be left in the tanks and the tanks would be nearly full and that 160,000,000 curies (primarily cesium-137) in the salt component and 290,000,000 curies (primarily long half-life isotopes) in the sludge component of the HLW in the storage tanks would be released to groundwater and eventually enter surface water. This analysis did not take credit for any decay of the short half-life radionuclides, particularly cesium-137. Because the

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activity under this scenario (450,000,000 curies) would be much greater than the activity (10,000 curies) modeled in the Tank Closure Draft EIS, the Salt Processing Alternatives Draft SEIS stated that long-term impacts to human health resulting from the radiation dose under the No Action alternative would be catastrophic.

During the public comment period, DOE received several comments from the public (See Appendix C, Letters L3, L6, L7, and L8) questioning the description of the No Action alternative and its impacts. The commenters generally expressed the opinion that the long-term impacts of No Action would be more severe than portrayed qualitatively in the Salt Processing Alternatives Draft SEIS and requested that the No Action alternative be modified and the long-term impacts analyzed quantitatively. One commenter suggested that, to be consistent with the short-term No Action scenario described in Section 2.3, the long-term No Action scenario should contain the consequences of removing all the sludge and leaving the salt waste containing 160,000,000 curies of activity (primarily cesium-137) in the tanks. In addition, several commenters suggested that, by assuming all radionuclides would reach the public through groundwater, the Salt Processing Alternatives Draft SEIS missed the largest long-term risk to the public and that DOE should consider the release of HLW to surface run-off.

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In response to these comments, for this Final Salt Processing Alternatives SEIS, DOE modeled the potential impacts of a scenario in which precipitation leaks into the tanks, causing them to overflow and spill their contents onto the ground surface, from which contaminants migrate to surface streams.

DOE estimated that the salt waste in the HLW tanks now contains about 160,000,000 curies, approximately 500 curies of long half-life isotopes (e.g., technetium-99, iodine-129, and plutonium-239), and the balance short half-life isotopes, primarily cesium-137, which has a half-life of 30 years. Radioactive decay during the 100-year period of institutional control would reduce the activity level to around 16,000,000 curies.

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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. The modeling showed that an individual consuming 2 liters per day of water from Four-mile 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 a 2.2 percent increase in the probability of contracting a latent cancer fatality from a 70-year lifetime exposure. When a 2.2 percent increase is low, the probability of contracting a latent cancer fatality under the No Action alternative is 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 1.0 percent and 0.051 percent, respectively.

For the No Action alternative, 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 dose of about 2,320 rem in the first year following the event, which would result in a prompt fatality.

DOE expects that those two scenarios bound the potential impacts of the No Action alternative. This is consistent with results of a multipathway exposure analysis for the

Z-Area vaults, which showed that the external radiation dose an individual would receive from cesium-137 is considerably greater than doses an individual would receive from other exposure pathways (e.g., drinking water).

Because of the assumption that, in the long term, DOE would not be active at the Site, there would be no long-term impacts to socioeconomics, utilities and energy, worker health, traffic and transportation, or waste generation. Air and accident impacts would be very small and would not differ substantially among alternatives. Section 4.2 does not analyze or discuss long-term impacts to these resources. The following impact areas are analyzed: geologic resources, water resources (groundwater and surface water), ecological resources, land use, and public health.

4.2.1 GEOLOGIC RESOURCES

The Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout alternatives include disposal of radioactive waste in vaults in Z Area. Failure of the vaults at some time in the future would have the potential to contaminate the surrounding soils. If the integrity of a vault were breached, infiltration of water could result in contaminants leaching to groundwater. The water-borne contaminants would contaminate nearby soils, but would not alter their physical structure. No detrimental effect on surface soils, topography, or on the structural or load-bearing properties of geologic deposits would occur because of release of contaminants from the vaults.

Under the No Action alternative, DOE assumed that only salt waste would be left in the HLW tanks. Failure of the HLW tanks would allow precipitation to collect in the tanks and eventually salt solution could overflow and contaminate surface soils. No detrimental effect on topography or load-bearing properties of geologic deposits would result from release of contaminants from the HLW tanks.

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4.2.2 WATER RESOURCES

4.2.2.1 Surface Water

For the action alternatives surface water impacts would only occur by discharge of contaminated groundwater. Because the Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout alternatives would result in radioactive waste being disposed in the Z Area vaults, the potential exists for long-term impacts to groundwater (see Section 4.2.2.2). Contaminants in groundwater could then be transported through the Upper Three Runs Aquifer and the underlying Gordon Aquifer to the seepines along McQueen Branch and Upper Three Runs, respectively (see Section 4.2.2.2 for a more detailed discussion). The factors that govern the movement of contaminants through groundwater (i.e., the hydraulic conductivity, hydraulic gradient, effective porosity, and dispersion of aquifers in the area) and the processes resulting in attenuation of radiological and nonradiological contaminants (i.e., radioactive decay, ion exchange in the soil, and adsorption to soil particles) would be expected to reduce or mitigate impacts to surface water resources.

As described in Appendix D, DOE used an analysis based on the PORFLOW-3D computer code to model the fate and transport of contaminants in groundwater and subsequent flux (i.e., groundwater discharge at the seepine) to surface waters. The groundwater discharge at the seepine would naturally mix with the stream flow. Assuming that the upstream concentration of all contaminants in surface water is zero, and that no storm runoff is present, the resulting concentration of contaminants in surface water would be the result of the seepine groundwater mixing with uncontaminated surface water. The resulting concentrations in surface water would thus always be less than the groundwater seepine concentrations, due to dilution. The average flows in McQueen Branch and Upper Three Runs at the point of mixing with the groundwater

discharge along the seepines would be on the order of 2 to 3 cubic feet per second and 135 to 150 cubic feet per second, respectively (Parizek and Root 1986).

EPA periodically publishes water quality criteria as concentrations of substances that are known to affect "diversity, productivity, and stability" of aquatic communities including "plankton, fish, shellfish, and wildlife" (EPA 1986, 1999). These recommended criteria provide guidance for state regulatory agencies developing location-specific water quality standards to protect aquatic life (SCDHEC 1999b). Such standards are used in a number of environmental protection programs, including setting discharge limits in NPDES permits. Water quality criteria and standards are generally not legally enforceable; however, NPDES discharge limits based on these criteria and standards are legally binding and are enforced by SCDHEC.

The fate and transport modeling indicates that movement of radiological contaminants from failed vaults to nearby surface waters via groundwater discharge would be minimal. Based on the previous radiological performance assessment (RPA) contaminant screening (WSRC 1992), the radiological contaminants of concern would be carbon-14, selenium-79, technetium-99, tin-126, iodine-129, and cesium-135. Table 4-26 shows maximum radiation doses from all contaminants to humans and corresponding impacts expressed as LCFs from groundwater at the seepines of McQueen Branch and Upper Three Runs before dilution with surface water. Doses would be low under each action alternative and would be below the drinking water standard of 4 millirem per year (40 CFR 141.16) in all cases. As discussed above, the in-stream concentrations resulting from the mixing of groundwater discharge at the seepine with the upstream flow would result in lower downstream concentrations than shown in Table 4-26. These data represent that point in time.

The 4-millirem-per-year standard applies only to beta-emitting radionuclides but, because the total dose would be less than 4 millirem per year, the standard would be met.

Table 4-26. Maximum dose and health effects from concentrations of radionuclides in groundwater 1 meter and 100 meters downgradient of Z Area vaults and at the seepline.

Exposure point	Maximum dose							
	Upper Three Runs Aquifer				Gordon Aquifer			
	Small Tank Precipitation	Ion Exchange	Solvent Exchange	Direct Disposal in Grout	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>1 meter downgradient</i>								
Total dose (millirem/year)	0.080	0.095	0.074	0.096	0.49	0.58	0.45	0.57
Lifetime LCF ^a	2.8×10^{-6}	3.3×10^{-6}	2.6×10^{-6}	3.4×10^{-6}	1.7×10^{-8}	2.0×10^{-5}	1.6×10^{-5}	2.0×10^{-5}
<i>100 meters downgradient</i>								
Total dose (millirem/year)	0.0068	0.0073	0.0062	0.0079	0.042	0.044	0.038	0.048
Lifetime LCF ^a	2.4×10^{-7}	2.6×10^{-7}	2.2×10^{-7}	2.8×10^{-7}	1.5×10^{-6}	1.5×10^{-4}	1.3×10^{-6}	1.7×10^{-6}
<i>Seepline</i>								
McQueen Branch								
Maximum dose (millirem/year)	0.0019	0.0020	0.0017	0.0022	NA	NA	NA	NA
Lifetime LCF ^a	6.7×10^{-8}	7.0×10^{-8}	6.0×10^{-8}	7.7×10^{-8}	NA	NA	NA	NA
Upper Three Runs								
Maximum dose (millirem/year)	NA	NA	NA	NA	0.0029	0.0028	0.0025	0.0032
Lifetime LCF ^a	NA	NA	NA	NA	1.0×10^{-7}	6.3×10^{-8}	8.8×10^{-8}	1.1×10^{-7}
Regulatory limit (millirem /year)	4	4	4	4	4	4	4	4

- a. Increased probability of an LCF to the exposed individual over a 70-year period.
b. The discharge point for the Upper Three Runs aquifer is the McQueen Branch seepline, and the discharge point for the Gordon aquifer is the Upper Three Runs seepline.
c. Maximum impacts would not occur at the same time due to the different radionuclide transport times to the potential exposure locations.

LCF = latent cancer fatality.

The results of the fate and transport modeling of nonradiological contaminant migration from failed vaults to nearby surface water via groundwater discharge are presented in Table 4-27. Based on the previous RPA contaminant screening (WSRC 1992), the only nonradiological contaminant of concern would be nitrate. The recent modeling results indicate that there would be little difference between the alternatives and that none of the four action alternatives would result in an exceedance of the drink-

ing water criteria for nitrate in the groundwater discharge at the seeplines of McQueen Branch or Upper Three Runs. Concentrations of nitrate at the seeplines would be small (less than 3 milligrams per liter [mg/L]) in all cases. Taking into account the dilution effect of the groundwater discharge mixing with the in-stream flow (assumed to be contaminant-free), the predicted concentrations of nonradiological contaminants would be even lower than those in Table 4-27. Therefore, no health impacts are anticipated from nitrates discharged to surface waters.

Table 4-27. Maximum nonradiological contaminant concentrations (mg/L) in groundwater 1 meter and 100 meters downgradient and at the seepage line.

Exposure point/ contaminant	Maximum concentration							
	Upper Three Runs Aquifer ^a				Gordon Aquifer ^b			
	Small Tank Precipita- tion	Ion Ex- change	Solvent Exchange	Direct Disposal in Grout	Small Tank Precipita- tion	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>1 meter downgradient</i>								
Nitrate (mg/L)	56	66	51	66	338	395	307	394
<i>100 meters downgradient</i>								
Nitrate (mg/L)	4.8	5.1	4.4	5.6	29	31	26	33
<i>Seepage line</i>								
Nitrate (mg/L)	1.4	1.5	1.3	1.6	2.2	2.1	1.9	2.4
EPA MCL (mg/L)	44	44	44	44	44	44	44	44

- a. Surfaces at McQueen Branch seepage line.
b. Surfaces at Upper Three Runs seepage line.
c. Nitrate as total nitrogen.
MCL = maximum contaminant level.

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Under the No Action alternative, DOE assumed that only salt waste would be left in the HLW tanks. Failure of the HLW tanks would allow precipitation to collect in the tanks and eventually salt solution could overflow and run off to onsite streams (Upper Three Runs, Fourmile Branch and the Savannah River). The runoff would mix with the stream flow. Assuming that the upstream concentration of all contaminants would be zero and no groundwater infiltration occurred, the concentration of contaminants in Fourmile Branch would be 4.95×10^{-6} curies/liter resulting in a drinking water dose to an individual of 640 millirem per year. Similarly, Upper Three Runs concentrations would be 2.28×10^{-6} curies per liter and the Savannah River concentrations would be 1.12×10^{-7} curies per liter, respectively.

4.2.2.2 Groundwater

Each of the action alternatives proposed in Chapter 2 includes actions that could result in potential long-term impacts to groundwater beneath the Z-Area vaults. Because groundwater is in a state of constant flux, impacts that occur directly below the vaults

could propagate to areas hydraulically downgradient of Z Area.

The primary action that would result in long-term impacts to groundwater is failure of the vaults and the generation of contaminated leachate that would enter the vadose zone soils. The contamination has the potential to contaminate groundwater at some point in the future, due to leaching and water-borne transport of contaminants. As described in detail in Appendix D, shallow groundwater beneath the vaults flows to ward McQueen Branch, but also includes a vertical flow component toward deeper aquifers. In the analyzed alternatives, the mobile contaminants that leached from the vault would gradually migrate downward through unsaturated soil to the hydrogeologic units comprising the shallow aquifers underlying the vaults. As described in Section 4.1.2.1, because the vaults will be constructed above the typical elevation of the water table, contaminants released from the vaults would be released into the vadose zone and not directly into the shallow groundwater.

The shallowest hydrogeologic unit affected would be the upper zone of the Upper Three Runs Aquifer, formally known as the Water Ta-

ble Aquifer (Aadland, Gellici, and Thayer 1995). Hydrogeologic studies and modeling (Flach and Harris 1996) conducted for the area of SRS where S and Z Areas are located, suggest however that flow in the upper zone of the Upper Three Runs Aquifer that originates in the proposed vault disposal area does not outcrop to McQueen Branch. Rather, water in the upper zone would migrate downward into the lower zone of the Upper Three Runs Aquifer (formally known as the Barnwell-McBean Aquifer). Some contaminants would be transported subsequently to the northeast by groundwater flow through the lower zone of the Upper Three Runs Aquifer and discharge at the seepage line along McQueen Branch.

The previous modeling results for the General Separations Area (the location of S and Z Areas) (Flach and Harris 1996), also suggested that a portion of the contaminant mass released to the Upper Three Runs Aquifer would migrate downward and then laterally through the Gordon Aquifer to a point of discharge at the seepage line along Upper Three Runs. The groundwater flow direction in the Gordon Aquifer is toward the north-northwest.

Summary of Predicted Concentrations

The results of the groundwater fate and transport modeling for radiological and non-radiological contaminants entering the Upper Three Runs and Gordon Aquifers are presented in Tables 4-26 and 4-27. The modeling calculated impacts to each aquifer layer. The results are presented for each alternative for groundwater wells 1 meter and 100 meters downgradient of the vaults and for the seepings. The specific concentrations for each radiological and nonradiological contaminant for each aquifer layer and each exposure point are presented in Appendix D.

For radiological contaminants, the doses in millirem per year from all radionuclides are considered additive for any given aquifer layer at any exposure point. The concentra-

tions in groundwater from the various aquifers are, however, not additive. The maximum radiation dose (millirem per year), regardless of the aquifer layer is therefore presented in the tables for each exposure point. These data represent the increment in time when the sum of all beta-gamma emitters would be greatest, but not necessarily when all radionuclides are at their maximum concentrations. This method of data presentation shows the overall maximum dose or concentration that could occur at each exposure point. Based on the previous RPA contaminant screening (WSRC 1992), the radiological contaminants of concern in groundwater would be carbon-14, selenium-79, technetium-99, tin-126, iodine-129, and cesium-135.

Based on the previous RPA contaminant screening (WSRC 1992), the only non-radiological contaminant of concern would be nitrate; therefore, only nitrate was modeled. The maximum concentration of nitrate, regardless of time, was determined for each aquifer layer and for each exposure point.

Comparison of Alternatives

The groundwater radiological concentrations (Table 4-26) consistently show that the greatest long-term impacts for beta-gamma emitters at the 100-meter well would occur under the Direct Disposal in Grout or the Ion Exchange alternative, although the differences among alternatives are small. The results also indicate that none of the alternatives would result in an exceedance of the regulatory limit for dose to humans in drinking water (i.e., 4 millirem per year), either at the wells or at the seepings (i.e., groundwater discharge points). Public health effects are discussed in Section 4.2.5.

The nonradiological results presented in Table 4-27 identify a consistent trend for nitrate at all points of exposure; the highest concentration occurs under the Ion Exchange and Direct Disposal in Grout alternatives, but there are only small differences among alternatives. The data show that nitrate would exceed the maximum contaminant level (MCL) for drinking water 1 meter downgradient of the facility for all alternatives, but would not exceed the 100 meters

downgradient of the vaults for any alternatives. The MCL would not be exceeded at the seepline for either aquifer layer.

4.2.3 ECOLOGICAL RESOURCES

This section presents an evaluation of the potential long-term impacts of salt processing alternatives to ecological receptors. DOE assessed the potential risks to ecological receptors at the seeplines of McQueen Branch (a tributary of Upper Three Runs near Z Area) and Upper Three Runs.

Groundwater-to-surface water discharge of contaminants was the only long-term migration pathway evaluated because the disposal vaults will be several meters underground, precluding overland runoff of contaminants and associated terrestrial risks. The vaults would have concrete roofs and be capped with clay and gravel. This would provide an impervious layer for deep plant roots. As a result, only risks to aquatic or semi-aquatic biota were considered possible. The habitat in the vicinity of the seeplines is bottomland (riparian) hardwood forest along the channels of McQueen Branch and Upper Three Runs. Upslope of the floodplain, the forest is a mixture of pine and hardwood.

The Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout alternatives were assessed for their potential long-term ecological impacts. Modeling of groundwater-to-surface water migration of contaminants from the disposal vaults indicated that nitrate was the only nonradiological chemical that would reach McQueen Branch and Upper Three Runs, and that carbon-14, selenium-79, technetium-99, tin-126, iodine-129, and cesium-135 were the radionuclides that would reach the two streams. The model generated concentrations of these contaminants in the groundwater at the seeplines.

4.2.3.1 Radiological Contaminants

The Oak Ridge National Laboratory (ORNL) has developed screening guidelines

for the protection of aquatic organisms from radiological chemicals in surface water (Bechtel Jacobs Company 1998). These guidelines were developed by back-calculating the DOE Order 5400.5 dose rate limit for aquatic biota of 1.0 rad per day (rad/d) to obtain corresponding concentrations of radionuclides in surface water. These guidelines can then be compared to ambient concentrations to assess potential risks to aquatic biota. The guidelines are in picocuries per liter (pCi/L) and were developed separately for small fish and large fish. All guidelines include exposures from parent isotopes and all short-lived daughter products. They also include exposures from all major alpha, beta, and gamma emissions for each isotope. It should be noted that ORNL developed its guidelines for radionuclides of concern at the Oak Ridge Reservation. No similar values have been calculated for SRS. However, the ORNL values were derived using generic data and are based on types of fish that could occur on SRS. The groundwater chemical data for this SEIS were modeled for thousands of years after disposal and, therefore, the isotopes that comprise the data are not generally in agreement with ORNL's (i.e., in this analysis, credit was taken for radioactive decay). Only a guideline for technetium-99 was available.

The predicted radiological concentrations in groundwater at the McQueen Branch and Upper Three Runs seeplines are presented in Table 4-28 for each of the four action alternatives. The concentrations of technetium-99 were orders of magnitude lower than the ORNL guideline. Again, no ORNL guidelines were available for the other elements (their particular isotopes). However, a cesium-137 surrogate value of 6.19×10^3 pCi/L can be used to assess risks from the elements other than technetium-99. This value generates an acceptable dose of 1 rad/day. Cesium-137 has a higher energy emitted per day than the other radionuclides in the seepwater. Because the surrogate guideline concentration is orders of magnitude higher than all those of the detected radionuclides in the seepwater, it can be inferred that the risks from those elements would be much lower. Because the maximum radiological concentrations predicted for McQueen Branch and Upper Three Runs are all far below

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Table 4-28. Maximum concentrations of radiological contaminants in seepage groundwater compared to ORNL screening guidelines (pCi/L).

Contaminant	ORNL guideline Small/Large Fish ^a	Small Tank Precipitation		Ion Exchange		Solvent Extraction		Direct Disposal in Grout	
		McQueen Branch		McQueen Branch		McQueen Branch		McQueen Branch	
		Upper Three Runs Aquifer)	Upper Three Runs (Gordon Aquifer)	Upper Three Runs Aquifer)	Upper Three Runs (Gordon Aquifer)	Upper Three Runs Aquifer)	Upper Three Runs (Gordon Aquifer)	Upper Three Runs Aquifer)	Upper Three Runs (Gordon Aquifer)
Carbon-14	NA ^b	1.9×10 ⁻⁶	2.0×10 ⁻⁶	2.1×10 ⁻⁶	1.9×10 ⁻⁶	1.8×10 ⁻⁶	1.7×10 ⁻⁶	2.2×10 ⁻⁶	2.1×10 ⁻⁶
Selenium-79	NA ^b	0.16	0.23	0.17	0.23	0.15	0.20	0.19	0.25
Technetium-99	1.94×10 ⁶ / 1.94×10 ⁶	0.42	0.66	0.44	0.64	0.38	0.58	0.48	0.72
Tin-126	NA ^b	5.7×10 ⁻⁵	3.9×10 ⁻⁵	6.1×10 ⁻⁵	3.9×10 ⁻⁵	5.2×10 ⁻⁴	3.5×10 ⁻⁵	6.6×10 ⁻⁵	4.3×10 ⁻⁵
Iodine-129	NA ^b	0.0028	0.0045	0.0029	0.0044	0.0025	0.0039	0.0032	0.0049
Cesium-135	7,720/6,190	9.8×10 ⁻⁷	1.5×10 ⁻⁶	1.0×10 ⁻⁶	1.5×10 ⁻⁶	8.9×10 ⁻⁷	1.3×10 ⁻⁶	0.012	0.017

- a. Cesium-137 is used as a surrogate value for cesium-135. Cesium-137 has a higher decay energy than cesium-135. Therefore, this is a conservative estimate of the guideline for cesium-135.
- b. Specific guidelines for these radionuclides are not available. However, because cesium accumulates in biological tissues and because cesium-137 has a higher decay energy than any of the other radionuclides listed, guidelines for these radionuclides are unlikely to be smaller than the guideline for cesium-137.

this surrogate guideline, it can be concluded that potential risks to aquatic biota in McQueen Branch and Upper Three Runs from radionuclides in seepwater would be very low.

4.2.3.2 Nonradiological Contaminants

Nitrate is considered to be essentially non-toxic to fish and wildlife, and is important as a plant nutrient in aquatic systems (Wetzel 1983).

Nitrates are generally considered to be a potential human health hazard at high concentrations in drinking water because they are reduced to nitrites in the digestive system (EPA 1986). Nitrites are capable of oxidizing hemoglobin to produce methemoglobin, which is incapable of transporting oxygen (EPA 1986). However, in well-oxygenated aquatic systems, nitrite is typically oxidized to nitrate.

The relatively low ecotoxicity from nitrates is reflected in the lack of surface water screening levels and criteria. EPA (1986) points out that concentrations of nitrate or nitrite with toxic effects on fish could "rarely occur in nature" and, therefore, "restrictive criteria are not recommended". No Federal ambient water quality criteria based on protection of aquatic organisms are available for nitrates (or nitrites) (EPA 1999). Nevertheless, some guidelines for nitrate/nitrite toxicity are available. EPA (1986) concludes that (1) concentrations of nitrate at or below 90 mg/L will have no adverse effects on warmwater fishes, (2) nitrite at or below 5 mg/L would be protective of most warmwater fishes, and (3) nitrite at or below 0.06 mg/L should be protective of salmonid fishes (no salmonid fishes are present on SRS). The Canadian Council of Ministers of the Environment (CCME) presents a surface water guideline protective of aquatic organisms of 0.06 mg/L (Environment Canada 1998). In the past, DOE has used an MCL of 10 mg/L as a surrogate protective concentration for semi-aquatic wildlife, such as mink (DOE 1997b).

Generally speaking, the only effects of elevated nitrate concentrations in streams and reservoirs are the fertilization of algae and macrophytes and the hastening of eutrophication. This occurs mainly when significantly increased nitrate inputs and inputs of other nutrients, mainly phosphorous, continue over a long period of time (Wetzel 1983). The concentrations of nitrate in groundwater at the McQueen Branch and Upper Three Runs seep lines are presented in Table 4-29 for each of the four action alternatives. On the whole, the predicted concentrations in seepwater for all four action alternatives exceeded the EPA nitrite guideline for protection of coldwater fishes and the CCME nitrite guideline for protection of aquatic biota. The concentrations were comparable to the EPA nitrite guideline for protection of warmwater fishes and were an order of magnitude or more lower than the EPA nitrate no-adverse-effects guideline for warmwater fishes. They also were less than the human health nitrate MCL. It should be noted that guidelines for coldwater fishes are conservative because they are usually based on toxicity data for salmonids, which are generally more sensitive to contaminants than warmwater fishes (Mayer and Ellersieck 1986).

If the ratio of nitrates to nitrites introduced from the alternatives was lower, or the introduced nitrate was transformed to nitrite in appreciable quantities, substantive risks could potentially be present. However, EPA (1986) states that, in oxygenated natural water systems, nitrite is rapidly oxidized to nitrate. Upper Three Runs tends to be well oxygenated (Halverson et al. 1997).

More importantly, the assessment of risk to ecological receptors was performed on groundwater at the seep line and, hence, did not account for dilution by stream volumes. After dilution, the concentration of nitrate (and nitrite) would likely be much lower, probably by orders of magnitude.

Toxicity data for semi-aquatic receptors (e.g., mink) are scarce for nitrate, reflecting its relatively low ecotoxicity. Only one study of the effects of nitrate on mammals that applied to ecological risk considerations could be located.

Table 4-29. Maximum concentrations of nitrate in seepline groundwater compared to ecotoxicity guidelines (mg/L).

Aquifer	Alternative (mg/L)				Ecotoxicity guideline (mg/L)				
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout	No-adverse-effects on warmwater fishes (nitrate as nitrogen) ^a	Protection of warmwater fishes (nitrite as nitrogen) ^a	Protection of cold-water fishes (nitrite as nitrogen) ^a	CCME guideline for protection of aquatic biota (nitrite as nitrogen) ^b	MCL (nitrate as nitrogen) ^c
McQueen Branch (Upper Three Runs Aquifer)	1.4	1.5	1.3	1.6	90	5	0.06	0.06	10
Upper Three Runs (Gordon Aquifer)	2.2	2.1	1.9	2.4	90	5	0.06	0.06	10

a. EPA (1986).
b. Environment Canada (1998).
c. Maximum Contaminant Level (MCL) for drinking water (EPA 1999).

The study involved the effects of potassium nitrate on guinea pigs, using oral ingestion of water as the exposure medium (ORNL 1996). No adverse effects were observed at a dose of 507 milligrams per kilogram (mg/kg) of body weight per day (mg/kg/day). A reduction in the number of live births was observed at 1,130 mg/kg/day. ORNL (1996) extrapolated toxicity and dose concentration data from this study to determine potentially toxic concentrations in various media to wildlife species. Based on the ORNL study, nitrate concentrations of at least 6,341 and 4,932 mg/L in surface water would be necessary to produce toxic effects for the short-tailed shrew and mink, respectively. The concentrations are several orders of magnitude higher than the maximum modeled concentrations presented in Table 4-29. EPA (1986) does not indicate that nitrate bioaccumulates and, therefore, concentrations in the prey or forage of semi-aquatic wildlife would likely be low.

For these reasons, the potential risks to aquatic and semi-aquatic biota in McQueen Branch and Upper Three Runs from nitrate would be low for all alternatives.

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The No Action alternative would have severe adverse impacts on the ecological resources in one area of the tank farms.

4.2.4 LAND USE

Long-term impacts from saltstone disposal vaults would not affect proposed SRS future land use. However, the presence of 13 to 16 low-level radioactive vaults in Z Area (see Table 4-1) would limit any other use for as long as the vaults remained, a period of time modeled to 10,000 years in this analysis.

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The tank farm areas are already designated to remain an industrialized zone. In principle, industrial zones are ones in which the facilities pose either a potentially significant nuclear or non-nuclear hazard to employees or the general public. Because of the contamination under the No Action alternative, future land use at SRS tank farms would not support human or ecological habitats under this scenario.

4.2.5 PUBLIC HEALTH

This section presents the potential impacts on human health from contaminants in the saltstone at some point after the period of institutional control of Z Area. To determine the long-term impacts, DOE evaluated data for Z Area, including the following:

- Expected source inventory that would be present in the saltstone
- Existing technical information on geological and hydrogeological parameters in the vicinity of Z Area
- Arrangement of the saltstone vaults within the stratigraphy
- Actions to be completed under each of the alternatives.

In its evaluation, DOE reviewed the methodology and conclusions contained in the *Radiological Performance Assessment for the Z-Area Saltstone Facility* (WSRC 1992) to determine what changes in the RPA analysis, if any, would result from implementing any of the salt processing alternatives. (The RPA was done for saltstone that would have resulted from the In-Tank Precipitation process.) Based on its review, DOE believes the exposure pathway methodology in the RPA is technically valid. DOE has modified certain input parameters to represent the alternatives. Therefore, DOE believes this modeling is valid for evaluating long term impacts. See Appendix D for additional details.

The RPA considers multiple routes of exposure for humans in the future. Z Area is zoned as an industrial area, and DOE does not expect that any public access to Z Area would be allowed. However, for purposes of analysis, DOE assumed that people would have access to the land beginning 100 years after the last vault was closed. The RPA considered multiple routes of exposure for humans following a 100-year period of institutional control and determined that two scenarios, an agricultural

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scenario and a residential scenario, would have the greatest potential for exposing a hypothetical individual to saltstone contaminants. Impacts on trespassers were not considered for the action alternatives because the impacts on trespassers would be small due to much shorter exposure times relative to the agricultural scenario. The assumptions of the two scenarios are described below:

- An agricultural scenario, in which the individual unknowingly farms and constructs a home on the soil above the saltstone vaults. In this scenario, the individual is assumed to derive half of his vegetable consumption from a garden planted in contaminated soil located over the vaults. The time spent gardening is assumed to be short compared to the amount of time spent indoors or farming. Only potential impacts from external radiation, inhalation, incidental soil ingestion, and vegetable ingestion are calculated for indoor residence and outdoor gardening activities. Since the farming activities would occur over a widespread area that would include uncontaminated and undisturbed soil not subject to irrigation with contaminated water, the meat and milk pathways would not contribute significantly to the individual's dose. Because of DOE's expectation that the saltstone would remain relatively intact for an extended period of time, DOE does not believe this scenario could be reasonable until approximately 10,000 years post-closure because, at least until that time, the individual could identify that he was digging through a cementitious material. However, for conservatism, DOE has calculated the impacts of the agricultural scenario at 1,000 years post-closure. This scenario includes the 1,000-year residential scenario described below.
- A residential scenario, in which the individual constructs and lives in a permanent residence on the vaults. This scenario analyzes two options: construction at 100 years and at 1,000 years. Under the first option, a sufficient layer of soil would

cover the still-intact vaults so that the individual would not know that the residence was constructed on the vaults. Under the second option, the saltstone is assumed to have been exposed and weathered sufficiently so that a person could build a home directly on a degraded vault without being aware of the saltstone.

Radiological Contaminants

In addition to these scenarios and options, the RPA also determined the impacts from consuming water from a well drilled 100 meters from the saltstone vaults after the period of institutional control. The original analysis considered the two uppermost aquifers underneath the saltstone facility and determined the concentrations downgradient of the vaults.

Using this information from the RPA, DOE calculated new results for the groundwater concentrations and the exposure scenarios. First, DOE used the engineering data developed during the alternative development process to determine how the saltstone composition would differ for the alternatives analyzed in this SEIS, as compared to the composition of the saltstone analyzed in the original RPA. Second, DOE determined how the new saltstone compositions (including concentrations of contaminants) affected the results in the original RPA and used that information as the basis to determine results for the analyzed alternatives in this SEIS. For those issues that the RPA did not address (such as direct disposal of cesium in grout), DOE performed the necessary original calculations to account for the newer information. A detailed discussion of DOE's methodology is contained in Appendix D.

Table 4-30 shows the calculated groundwater concentrations and radiation doses from the exposure scenarios. DOE compared groundwater results to the regulatory limits for drinking water specified in 40 CFR 141. The applicable drinking water standards for radionuclides are 4 millirem per year for beta/gamma-emitting radionuclides and

Table 4-30. Summary comparison of long-term human exposure scenarios and health effects.

Parameter	No Action	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Nitrate concentration at 100-meter well (mg/L) ^a	NA	29	31	26	33
Radiation dose (millirem per year) from 100-meter well	640 ^b	0.042	0.044	0.038	0.048
LCF from 100-meter well ^c	0.022 ^b	1.5×10 ⁻⁶	1.5×10 ⁻⁶	1.3×10 ⁻⁶	1.7×10 ⁻⁶
Radiation dose from Agricultural Scenario (millirem per year)	NA	110	130	110	140
LCF from Agricultural Scenario ^c	NA	3.9×10 ⁻³	4.6×10 ⁻³	3.9×10 ⁻³	4.9×10 ⁻³
Radiation dose from Residential Scenario at 100 years post-closure (millirem per year) ^e	2,320,000 ^d	0.11	0.13	0.1	1,200 ^e
LCF from Residential Scenario at 100 years post-closure ^e	1.16 ^f	3.9×10 ⁻⁶	4.6×10 ⁻⁶	3.5×10 ⁻⁶	4.2×10 ⁻²
Radiation dose from Residential Scenario at 1,000 years post-closure ^g (millirem per year) ^g	NA	69	80	65	85
LCF from Residential Scenario at 1,000 years post-closure ^e	NA	2.4×10 ⁻³	2.8×10 ⁻³	2.3×10 ⁻³	3.0×10 ⁻³

- a. Nitrate MCL is 10 mg/L (EPA 1999).
 - b. Based on consumption of contaminated surface water in Fourmile Branch.
 - c. Health effects are expressed as lifetime (70-year) individual probability of an LCF.
 - d. Based on external radiation in the area of the tank farm.
 - e. The external dose for direct disposal in grout alternative in the 100-year scenario is primarily due to cesium-137 (half-life 30 years). For all other action alternatives and scenarios, the external dose is primarily due to the isotopes with long half-lives.
 - f. Probability of an LCF provided for comparison. The external radiation dose from No Action would result in prompt fatalities.
 - g. External radiation doses at 1,000 years post-closure are higher than doses at 100 years post-closure because a layer of soil that provides shielding is assumed to be present in the 100 year scenario, but is assumed to be absent in the 1,000 year scenario.
- NA = not applicable.

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15 pCi/L for alpha-emitting radionuclides. The RPA analyses indicated that alpha-emitting radionuclides would not be transported from the saltstone vaults except in minute quantities, and DOE therefore excluded them from the impacts analysis. For nonradiological constituents (primarily nitrate), DOE compared the water concentrations directly to the concentrations listed as MCLs in 40 CFR 141.

The differences in calculated concentrations and doses among the action alternatives are primarily a function of the differences in composition of the saltstones. The Small Tank Precipitation alternative would pro-

duce a saltstone very similar to that analyzed in the RPA, and the results for this alternative (in Table 4-30) are therefore consistent with the results in the RPA. The Ion Exchange alternative would result in a salt solution with slightly higher contaminant concentrations, resulting in higher contaminant concentrations in saltstone and associated greater impacts. Similarly, the Solvent Extraction salt solution has slightly lower concentrations.

The Direct Disposal in Grout alternative would result in a salt solution with slightly higher concentrations for most constituents than the other alternatives, but with essentially all of the cesium. Cesium-137 has a relatively short half-life

(approximately 30 years), so the cesium-137 concentration at the end of 100 years would be decreased by a factor of about 10, with subsequent decreases as time elapses. Therefore, for most of the scenarios in Table 4-30, the impacts of Direct Disposal in Grout are comparable to those of the other alternatives. However, for the residential scenario that assumes construction at 100 years directly on top of the saltstone facility, radioactive cesium would still be present in quantities sufficient to produce a dose noticeably higher than the other alternatives. Because the second residential scenario assumes construction at 1,000 years, the radioactive cesium would have undergone approximately 30 half-lives, resulting in a greatly decreased dose contribution from that radionuclide (however, the longer-lived cesium-135 isotope would still be present).

The maximum doses from the drinking water, agricultural, and 100-year residential scenarios are not expected to occur concurrently, although the agricultural scenario values in the table include the 1,000-year residential scenario contribution, as discussed above. Therefore, it is not appropriate to add the doses from these scenarios.

As shown in Table 4-30, the 1,000-year residential scenario doses for all four action alternatives are similar and would be below the 100-millirem-per-year public dose limit. They range from as low as approximately 65 millirem per year to as high as 85 millirem per year. Doses for the agricultural scenario are similar, but exceed the 100-millirem-per-year public dose limit. Doses for the agricultural scenario would range from 110 to 140 millirem per year. For the 100-year residential scenario, the dose

would be highest for the Direct Disposal in Grout alternative (1,200 millirem per year) and would exceed the 100-millirem-per-year public dose limit. The 100-year residential scenario doses for the other three action alternatives would be much smaller and would not exceed 0.13 millirem per year.

As discussed in Section 4.1.4.1, DOE adopted a dose-to-risk conversion factor of 0.0005 LCFs per person-rem to estimate the probability of an individual developing a fatal cancer from the calculated radiation exposure. Because estimation of future populations is very speculative, DOE based the analysis of each scenario on an individual with a 70-year life span. As shown in Table 4-30, under the action alternatives, the probability of an LCF resulting from the long-term exposure scenarios is low. Therefore, DOE expects no adverse health impacts due to these radiation exposures.

As discussed above for the No Action alternative, 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 a 2.2 percent incremental increase in the probability of contracting a latent cancer fatality from a 70-year lifetime exposure. While a 2.2 percent increase is low, the probability of contracting an LCF under the No Action alternative is about 13,000 times greater than that of any of the action alternatives.

For the No Action alternative, an individual living in the tank farm area would receive an external dose of about 2,320,000 millirem in the first year following the event, which would result in a prompt fatality.

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CHAPTER 5. CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations that implement the procedural provisions of the National Environmental Policy Act (NEPA) define cumulative impacts as impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7).

Based on an examination of the environmental impacts resulting from salt processing, coupled with those from U.S. Department of Energy (DOE) and other agency actions and some private actions, it was determined that cumulative impacts for the following areas need to be presented: (1) air resources; (2) water resources; (3) public and worker health; (4) waste generation; and (5) utilities and energy consumption. Discussion of cumulative impacts for the following subject areas is omitted because impacts to these topics from the proposed salt processing alternatives would be so small that their potential contribution to cumulative impacts would be minimal: geologic resources, ecological resources, aesthetic and scenic resources, cultural resources, traffic, and socioeconomics.

The baseline represents current conditions at Savannah River Site (SRS), as detailed in Chapter 3. In this chapter, DOE considers the baseline to represent the No Action alternative because the No Action alternative would continue current high-level waste (HLW) management activities through 2010. Any incremental impacts under the No Action alternative would occur after that. DOE provides a mostly qualitative assessment of the No Action alternative in Chapter 4.

Impacts that vary among the salt processing alternatives

The cumulative impacts analysis presented in this section is based on the actions associated with the SRS salt processing alternative with

the greatest impact for each resource, other onsite activities, reasonably foreseeable future actions, and offsite activities with a potential for related environmental impacts. In certain cases, the magnitude of an impact to a particular resource varies among the salt processing alternatives. To be conservative, DOE based this analysis of cumulative impacts on the alternative with the highest impact for a particular resource category, but not on the same alternative for all resource areas (see data tables in this chapter).

As an overview, the resource categories that varied among the alternatives and the salt processing alternatives with the highest and lowest impacts are presented below:

Carbon monoxide and sulfur dioxide ground-level concentrations

- Highest – Direct Disposal in Grout
- Lowest – Small Tank Precipitation, Ion Exchange, and Solvent Extraction would be equal and have 83 percent of the Direct Disposal in Grout concentration for carbon monoxide, 75 percent of the highest 3-hour and annual sulfur dioxide concentrations, and 80 percent of the highest concentration for 24-hour sulfur dioxide.
- Conclusion – The addition to baseline concentrations is very small (less than 0.5 percent) for all action alternatives.

Ozone ground-level concentrations

- Highest – Small Tank Precipitation would not be expected to contribute more than 1 percent of observed background levels.
- Lowest – Concentration under Direct Disposal in Grout would be substantially lower than that for Small Tank Precipitation.

Cumulative Impacts

- Conclusion – The effect of any salt processing alternative is minimal on ozone concentration.

Project phase radiological dose and health effects

- Highest – Solvent Extraction would result in essentially no increased probability of latent cancer fatalities from exposure during the 13 years of operation (1.6×10^{-7}) for the maximally exposed offsite individual (MEI), and 0.009 and 0.12, respectively, for the offsite population and involved worker populations.
- Lowest – Ion Exchange would have 16 percent of Solvent Extraction's offsite population health impacts and 11 percent of the Solvent Extraction impacts to involved workers.
- Conclusion – Health effects from the salt processing alternatives are well below levels of concern.

Liquid High-Level Waste generation

- Highest – Solvent Extraction would be a major contributor (24 percent) to cumulative HLW generation.
- Lowest – Direct Disposal in Grout would contribute 16 percent of the Solvent Extraction contribution.
- Conclusion – If an HLW salt processing alternative is implemented, current and future liquid HLW generation would be managed effectively and safely.

Electric energy consumption

- Highest – Solvent Extraction would consume a minor portion (4 percent) of the cumulative energy consumption at SRS.
- Lowest – Direct Disposal in Grout would use 55 percent of the Solvent Extraction energy consumption rate.

- Conclusion – Existing electrical capacity is adequate to supply these very small increases in electrical energy consumption.

Water usage

- Highest – Small Tank Precipitation would consume a minute fraction of the production capacity of the aquifer.
- Lowest – Direct Disposal in Grout would use 67 percent of Small Tank Precipitation water requirements.
- Conclusion – The increment of water usage from salt processing is very small and would not be noticeable.

DOE has examined impacts of the construction and operation of SRS over its 50-year history. It has analyzed trends in the environmental characteristics of the Site and nearby resources to establish a baseline for measurement of the incremental impact of salt processing activities.

SRS History

In 1950, the U.S. Government selected a large rural area in southwestern South Carolina for construction and operation of facilities required to produce nuclear fuels (primarily defense-grade plutonium and tritium) for the Nation's defense. Then called the Savannah River Plant, the facility had full production capability, including fuel and target fabrication, irradiation of the fuel in five production reactors, product recovery in two chemical separations plants, and waste management facilities, including the HLW Tank Farms (DOE 1980). In 1988, DOE placed the active SRS reactors in standby, and the end of the Cold War in the early 1990s prompted their permanent shutdown.

Construction impacts included land clearing, excavation, air emissions from construction vehicles, relocation of about 6,000 persons, and the formation of mobile home communities to house workers and families during con-

struction. Peak construction employment totaled 38,500 in 1952 (DOE 1980).

Early impacts to surrounding communities stabilized quickly. The largest community on the Site, Ellenton, was relocated immediately north of the Site boundary and was renamed New Ellenton.

The SRS has had a beneficial effect on employment in the region. The operations workforce has varied from 7,500 (DOE 1980) to almost 26,000 (HNUS 1992), and presently numbers approximately 14,000 (DOE 2000a).

Currently, the SRS is approximately 90 percent natural areas, with 10 percent devoted to industrial facilities and infrastructure. The Savannah River Site Natural Resource Management and Research Institute (SRI), formerly the Savannah River Forest Station, manages natural resources at SRS. The SRI supports forest research projects, erosion control projects, and native plants and animals (through maintenance and improvements to their habitats). SRI sells timber, manages control-burns, plants seedlings, and maintains secondary roads and exterior boundaries (Arnett and Mamatey 1998a).

Normal SRS operations produced nonradioactive and radioactive emissions of pollutants to the surrounding air and discharges of pollutants to onsite streams. Impacts of these releases to the environment were minimal. In addition, large withdrawals of cooling water from the Savannah River caused minimal entrainment and impingement of aquatic biota from the river and severe thermal impacts to onsite streams, due to the discharge of high volumes of heated cooling water. The discharges stripped the vegetation along stream channels and adjacent banks and destroyed cypress-tupelo forests in the Savannah River Swamp. In 1991, DOE committed to reforest the Pen Branch delta in the Savannah River Swamp, using appropriate wetland species, and to manage it until successful reforestation had been achieved (56 FR 5584-5587; February 11, 1991). Groundwater contamination

occurred in areas of hazardous, radioactive, and mixed waste sites and seepage basins.

Because of the large buffer area between the center of operations and the Site boundary, offsite effects were minimal. Thermal effects from surface water discharges did not extend beyond the Site boundary. Groundwater contamination plumes did not move offsite, and onsite surface water contamination had minimal effects offsite because SRS streams discharge to the Savannah River and the large volume of river water, compared to the small volumes of onsite creek water, reduced the concentrations of pollutants to well below concentrations of concern.

Over the years of operation, mitigation measures have substantially reduced onsite environmental contamination. DOE installed a Liquid Effluent Treatment Facility that removes pollutants (except tritium) from wastewater to below regulatory limits before discharge through a National Pollutant Discharge Elimination System (NPDES) outfall to Upper Three Runs. Direct discharge of highly tritiated disassembly basin purge water to surface streams was replaced by discharge to seepage basins, allowing substantial decay of the tritium before the water from the seepage basins outcropped to onsite streams. In addition, DOE minimized the effects of thermal discharges with the construction of a cooling lake for L-Reactor and a cooling tower intended to support K-Reactor operation.

Savannah River water quality has improved over the years and the U.S. Army Corps of Engineers has regulated the flow. Five large reservoirs upriver of SRS were constructed from the 1950s through the early 1980s. These have reduced peak flows in the Savannah River, moderated flood cycles in the Savannah River Swamp and, with the exception of a severe drought from 1985 through 1988, maintained flows sufficient for water quality and managing fish and wildlife resources downstream (DOE 1990). In 1975, the City of Augusta installed a secondary sewage treatment plant to eliminate the discharge of untreated or inadequately treated domestic and

industrial waste into the Savannah River and its tributaries. Similar treatment facilities for Aiken County began operation in 1979 (DOE 1987). Industrial dischargers to the River complied with NPDES permits issued by the U.S. Environmental Protection Agency or the State (South Carolina and Georgia), which improved water quality.

Effects of operations decreased rapidly after production ceased. For example, one indicator of potential impacts to human health is the radiation dose to the MEI. The MEI is not an actual person, but is defined as a single person receiving the highest possible offsite dose. From dose, it is possible to estimate the probability of a latent cancer fatality. The estimate of latent cancers is, at best, an order of magnitude approximation. This means that with an estimate of 10^{-5} latent cancer fatalities, the actual probability of a latent cancer fatality is between 10^{-6} and 10^{-4} . By 1997, the dose to the MEI (and the associated probability of a latent cancer fatality) had decreased to about 1/7th of its 1988 value (Arnett and Mamatey 1998a). Further detail on the MEI is discussed later in Section 5.3 (Public and Worker Health) and shown in Table 5-3.

In general, the combination of mitigation measures and post-Cold War cleanup efforts are protecting and improving the quality of the SRS environment, and further minimizing any impacts to the offsite environment. Although groundwater modeling indicates that most contaminants in the groundwater have reached their peak concentrations, several slow-moving constituents will not reach maximum groundwater concentrations for thousands of years (DOE 1987). Long-term cumulative impacts are discussed further in Section 5.6.

CEQ Cumulative Effects Guidance

A handbook prepared by CEQ (1997) guided the preparation of this chapter. In accordance with the handbook, DOE identified the resource areas in which salt processing could add to the impacts of past, present, and reasonably foreseeable actions within the project impact zones, as defined by CEQ (1997).

Spatial and Temporal Boundaries

In accordance with the CEQ guidance, DOE defined the geographic (spatial) and time (temporal) boundaries to encompass cumulative impacts on the five identified areas of concern.

For determining the human health impact from airborne emissions of radionuclides, the population within the 50-mile radius surrounding SRS was selected as the project impact zone. Although the doses are almost undetectable at the 50-mile limit, this is the standard definition of the offsite public for air emissions.

For aqueous releases, the downstream population that uses the Savannah River as its source of drinking water was selected. This population is outside the 50-mile radius used for assessing air impacts. Analyses indicate that other potential incremental impacts from salt processing, including those to air quality (with the exception of ozone), waste management, and utilities and energy diminish within or very near the Site boundaries. Ozone is not emitted directly into the air, but is formed through complex chemical reactions between emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight. Both volatile organic compounds and nitrogen oxides are emitted by industrial sources. Ozone formation occurs fairly rapidly in warm climates and any ozone formation from salt processing emissions would most likely occur within the project impact zone described below. The effective project impact zone for each of these incremental impacts is identified in the discussions that follow.

Nuclear facilities in the vicinity of SRS include: Georgia Power's Plant Vogtle Electric Generating Plant across the Savannah River from SRS; Chem-Nuclear, Inc., a commercial low-level waste burial site just east of SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of SRS, which processes uranium-contaminated metals. Plant Vogtle, Chem-Nuclear, and Carolina Metals are approximately 11, 8, and 15 miles, respec-

tively, from S and Z Areas. Other nuclear facilities are too far away (more than 50 miles) to contribute to any cumulative effect. Therefore, the project impact zone for cumulative impacts on air quality from radioactive emissions includes four nuclear facilities, SRS and the three smaller ones discussed above. Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear power plant, are minimal; however, DOE has factored them into the analysis. The South Carolina Department of Health and Environmental Control (SCDHEC) *Annual Report* (SCDHEC 1995) indicates that operations of the Chem-Nuclear and Starmet CMI facilities do not noticeably impact radiation levels in air or liquid pathways in the vicinity of SRS. Therefore, they are not included in this assessment.

The counties surrounding SRS have numerous existing (e.g., Bridgestone Tire, textile mills, paper product mills, and manufacturing facilities) and planned industrial facilities with permitted air emissions and discharges to surface waters. Because of the distances between SRS and these private industrial facilities, there is little opportunity for interactions of plant emissions and no major cumulative impact on air or water quality. As indicated in results from the SRS Environmental Surveillance program report, ambient levels in air and water have remained below regulatory levels in and around the SRS region (Arnett and Mamatey 1998a).

An additional offsite facility with the potential to affect the nonradiological environment is South Carolina Electric and Gas Company's Urquhart Station. Urquhart Station is a three-unit, 250-megawatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, located about 20 river miles and about 18 aerial miles north of SRS. Because of the distance between SRS and the Urquhart Station and the regional wind direction frequencies, there is little opportunity for any interaction of plant emissions, and no detectable cumulative impact on air quality. The project impact zone for nonradiological atmospheric releases is less than 18 miles.

Finally, excess utility and energy capacity is available onsite and demand is too small to affect the offsite region. Similarly, onsite waste disposal capacity can easily satisfy the small quantities generated by salt processing. Thus, the extent of the project impact zone (from utilities, energy, and waste generation) is best described as the SRS.

Temporal limits were defined by examining the period of influence from both the proposed action and other Federal and non-Federal actions that have the potential for cumulative impacts. Actions for salt processing are expected to begin in 2001. The period of interest for the cumulative impacts analysis for this EIS includes 2001 to 2023.

Reasonably Foreseeable DOE Actions

DOE also evaluated possible impacts from its own reasonably foreseeable future actions by examining impacts to resources and the human environment identified in NEPA documents related to SRS (see Section 1.4). Impacts to the environment that are considered in this cumulative impacts section were identified in the following NEPA documents:

- *Final Environmental Impact Statement for the Interim Management of Nuclear Materials* (DOE/EIS-0220) (DOE 1995a). DOE has begun implementation of the preferred alternatives for the nuclear materials discussed in this Environmental Impact Statement (EIS). SRS baseline data in this chapter reflect projected impacts from implementation.
- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240) (DOE 1996). This cumulative impacts analysis incorporates an alternative at SRS that would blend highly enriched uranium to 4 percent low-enriched uranium as uranyl nitrate hexahydrate, as stated in the Record of Decision (61 FR 40619; August 5, 1996).

- *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy at the Rocky Flats Environmental Technology Site (DOE/EIS-0277)* (DOE 1998). As stated in the Records of Decision (64 FR 8068; February 18, 1999, and 66 FR 4803; January 18, 2001), DOE will process certain plutonium-bearing materials currently being stored at the Rocky Flats Environmental Technology Site. These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations formerly conducted by DOE at Rocky Flats. DOE has decided to ship certain residues from the Rocky Flats Environmental Technology Site to SRS for plutonium separation and stabilization. The separated plutonium will be stored at SRS, pending disposition decisions. Environmental impacts from using F-Canyon to chemically separate the plutonium from the remaining materials at SRS are included in this section.
 - *Final Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site (DOE/EIS-0271)* (DOE 1999a). As stated in the Record of Decision (64 FR 26369; May 14, 1999), DOE will construct and operate a Tritium Extraction Facility at SRS to provide the capability to extract tritium from commercial light-water reactor targets and targets of similar design. The purpose of the proposed action and alternatives evaluated in the EIS is to provide tritium extraction capability to support either accelerator or reactor tritium production. Environmental impacts from the maximum processing option in this EIS are included in this section.
 - *Surplus Plutonium Disposition Final Environmental Impact Statement (DOE/EIS-0283)* (DOE 1999b). This EIS analyzed the activities necessary to implement DOE's disposition strategy for surplus plutonium. As announced in the Record of Decision (65 FR 1608; January 11, 2000), SRS was selected for three disposition facilities, pit (a nuclear weapon component) disassembly and conversion, plutonium conversion and immobilization, and mixed oxide fuel fabrication. The DOE decision allows the immobilization of approximately 17 metric tons of surplus plutonium and the use of up to 33 metric tons of surplus plutonium as mixed oxide fuel. Both methods in this hybrid approach ensure that surplus plutonium originally produced for nuclear weapons is never again used for nuclear weapons. Impacts from this EIS are included in this section.
 - *Final Defense Waste Processing Facility Supplemental Environmental Impact Statement (DOE/EIS-0082-S)* (DOE 1994a). The selected alternative in the Record of Decision (60 FR 18589; April 12, 1995) was the completion and operation of the Defense Waste Processing Facility (DWPF) to immobilize HLW at SRS. The facility is currently processing sludge from SRS HLW tanks. However, SRS baseline data are not representative of full DWPF operational impacts, including the processing of salt solution from these tanks. Therefore, DWPF data are listed separately.
 - *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement (DOE/EIS-0279)* (DOE 2000a). The selected alternative in the Record of Decision (65 FR 48224; August 7, 2000) is to prepare for disposal about 97 percent by volume (about 60 percent by mass) of the aluminum-based fuel considered in the EIS (48 metric tons heavy metal), using a Melt and Dilute treatment process. The remaining 3 percent by volume (about 40 percent by mass) would be managed using conventional processing in existing SRS chemical separations facilities.
- As part of the preferred alternative, DOE will develop and demonstrate the Melt and Dilute technology. Following development and demonstration of the Melt and

Dilute technology, DOE will begin detailed design, construction, testing, and startup of a new treatment and storage facility to combine the Melt and Dilute function with a new dry storage facility. The spent nuclear fuel will remain in existing wet storage until treated and then be placed in dry storage.

- *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D)* (DOE 2000b). DOE evaluated three alternatives for tank closure. All of these alternatives would start after bulk waste removal occurs. The alternatives being considered include: (1) clean tanks with water and fill with grout (preferred option), sand, or saltstone; (2) clean and remove the tanks; and (3) no action. The cumulative impact analysis includes impacts from the preferred option to clean and fill with grout.
- *Savannah River Site Waste Management Final Environmental Impact Statement (DOE/EIS-0217)* (DOE 1995b). DOE issued the SRS Waste Management EIS to provide a basis for the selection of a Site-wide approach to managing present and future (through 2024) wastes generated at SRS. These wastes would come from ongoing operations and potential actions, new missions, environmental restoration, and decontamination and decommissioning programs. The SRS Waste Management EIS included the treatment of wastewater discharges in the Effluent Treatment Facility, F-and H-Area Tank Farm operations and waste removal, and construction and operation of a replacement HLW evaporator in the H-Area Tank Farm. In addition, it evaluated the Consolidated Incineration Facility for the treatment of mixed waste, including incineration of benzene waste from the then-planned In-Tank Precipitation (ITP) process. The first Record of Decision (60 FR 55249) on October 30, 1995, stated that DOE will configure its waste management system according to the moderate treatment alternative described in the EIS. The

second Record of Decision (62 FR 27241) was published on May 9, 1997. This ROD was deferred regarding treatment of mixed waste to ensure consistency with the *Approved Site Treatment Plan* (WSRC 2000). The Waste Management EIS is relevant to the assessment of cumulative impacts because it provides the baseline forecast of waste generation from operations, environmental restoration, and decontamination and decommissioning. This forecast was updated in 1999 (Halverson 1999).

- *Final F-Canyon Plutonium Solutions Environmental Impact Statement (DOE/EIS-0219)* (DOE 1994b). As stated in the Record of Decision (60 FR 9824; February 22, 1995), DOE will process plutonium solution to a metal form using F-Canyon and FB-Line facilities at SRS. SRS baseline data include wastes and emissions from this activity.

Other materials under consideration for processing at SRS chemical separation facilities include various components currently at other DOE sites, including Oak Ridge, Rocky Flats, Los Alamos, and Hanford. These materials, which were identified during a Processing Needs Assessment, consist of various plutonium and uranium components. If DOE were to propose processing these materials in the SRS chemical separations facilities, additional NEPA reviews would need to be performed. In this chapter, estimates of the impacts of processing these materials have been included in the cumulative analysis. These estimates are qualitative, because DOE has not yet determined the impacts from processing these materials. When considering cumulative impacts, the reader should be aware of the very speculative nature of some of the estimated impacts.

In addition, the cumulative impacts analysis includes impacts from actions proposed in this SEIS. Risks to members of the public and Site workers from radiological and nonradiological releases are based on operational impacts from the salt processing alternatives described in

Chapter 4. Because these impacts vary among the alternatives, DOE has selected the alternative that produces the maximum impact for each characteristic (e.g., concentration of a specific pollutant). This ensures that the incremental impacts of the proposed action are not underestimated.

The cumulative impacts analysis also accounts for other SRS operations. Most of the SRS baseline data are based on 1997 environmental report information (Arnett and Mamatey 1998a).

5.1 Air Resources

Table 5-1 compares the cumulative concentrations of nonradiological air pollutant emissions from SRS to Federal and state regulatory standards. The listed values are the maximum modeled concentrations that could occur at ground level at the Site boundary. The data demonstrate that total estimated concentrations of nonradiological air pollutants from SRS would, in all cases, be below regulatory standards at the Site boundary. The highest percentages of the regulatory standards are for sulfur dioxide concentrations for the shorter time intervals (approximately 96 percent of the 3-hour averaging standard and 96 percent of the 24-hour averaging standard), for ozone (approximately 94 percent of the 1-hour averaging standard), for particulate matter less than 10 micrometers in diameter (approximately 91 percent of the 24-hour averaging standard), and total suspended particulates (approximately 90 percent of the standard). The remaining cumulative pollutant concentrations would range from 2 to 69 percent of the applicable standards.

The majority of the impact comes from estimated SRS baseline concentrations and not from salt processing and other foreseeable actions. It is unlikely that actual concentrations at any ambient monitoring stations at the SRS boundary would be as high as those listed in Table 5-1. The SRS baseline values are based on the maximum potential emissions from the 1997 air emissions inventory for all SRS sources, as well as on observed concentrations

from nearby ambient air monitoring stations. The maximum cumulative concentration is an artificial calculation, which assumes that the maximum concentration from each source would occur at the same point on the SRS boundary and at the same time, without considering facility locations, operation schedules, variable wind directions, and other factors. Therefore, it is impossible to actually achieve the maximum cumulative concentration. Thus, the SRS baseline in Table 5-1 is overestimated and this affects the percent of standard values. For example, nearly all of the cumulative concentration for sulfur dioxide comes from the SRS baseline and, therefore, assuming it is 96 percent of the standard is very conservative.

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to an MEI at the SRS boundary. DOE included the impacts of Plant Vogtle (NRC 1996) in this cumulative total. The radiological emissions from the operation of the Chem-Nuclear, Inc., low-level waste disposal facility and Starmet CMI, Inc., are very low (SCDHEC 1995) and are not included.

Table 5-2 lists the results of this analysis, using SRS baseline 1997 emissions (1992 for Plant Vogtle). The cumulative dose from airborne emissions to the MEI would be 4.1×10^{-4} rem (or 0.41 millirem [mrem]) per year, well below the regulatory standard of 10 mrem per year (40 CFR Part 61). Summing the doses to the MEI for the actions and baseline SRS operations listed in Table 5-2 is an extremely conservative approach because, in order to get the calculated dose from each facility, the MEI would have to occupy different physical locations at the same time, which is impossible.

Adding the population doses from current and projected activities at SRS, Plant Vogtle, and salt processing activities could yield a total annual cumulative dose of 24 person-rem from airborne sources. That total annual cumulative dose translates into 0.012 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of SRS. A majority of this cumulative impact to the public is

Table 5-1. Estimated maximum nonradiological cumulative ground-level concentrations of criteria and toxic pollutants (micrograms per cubic meter) at the SRS boundary.^a

Pollutant	Averaging time	Regulatory standard	Salt processing alternative	Other foreseeable ^a	SRS baseline ^b	Cumulative concentrations	Percent of standard
Carbon monoxide	1 hour	40,000	18.0 ^c	40.7	10,354	10,413	26
	8 hours	10,000	2.3 ^c	6.0	6,866	6,874	69
Nitrogen oxides	Annual	100	0.03 ^d	4.7	26.2	31	31
Sulfur dioxide	3 hours	1,300	0.4 ^c	9.4	1,244	1,254	96
	24 hours	365	0.05 ^c	2.6	349	352	96
	Annual	80	5.0×10 ^{-4c}	0.19	33.6	34	42
Ozone	1 hr	235	2 ^e	3.5	216	221	94
Lead	Max Qtr	1.5	4.0×10 ^{-7d}	5.1×10 ⁻⁶	0.03	0.03	2
Particulate matter less than 10 microns	24 hr	150	0.07 ^d	3.3	132.7	136	91
	Annual	50	1.0×10 ^{-3d}	0.17	25.3	25	51
Total suspended particulates	Annual	75	1.0×10 ^{-3d}	0.089	67.1	67	90

Sources: DOE (1994a; 1996; 1998; 1999a,b; 2000a,b).

- a. All SRS sources including spent nuclear fuel management, disposition of highly enriched uranium, tritium extraction facility, management of certain plutonium and scrub alloy from the Rocky Flats site, HLW tank closure activities, plutonium disposition, and management of weapons components from the DOE complex.
- b. Source: Arnett and Mamatey (1998b).
- c. Based on data for the Direct Disposal in Grout alternative.
- d. Estimated emissions from each of the four action alternatives are the same for this parameter.
- e. Although a specific value has not been determined, ozone formation based on volatile organic compounds and nitrogen oxide emissions from the Small Tank Precipitation alternative would not be expected to exceed 2 micrograms per cubic meter.

Table 5-2. Estimated average annual cumulative radiological doses and resulting health effects to offsite population from airborne emissions.

Activity	Offsite population			
	Maximally exposed individual		50-mile population	
	Dose (rem)	Fatal cancer risk ^a	Collective dose (person-rem)	Latent cancer fatalities
SRS baseline ^b	5.0×10^{-5}	2.5×10^{-8}	2.2	1.1×10^{-3}
Salt processing ^c	3.1×10^{-4}	1.6×10^{-7}	18.1	9.1×10^{-3}
Other SRS activities ^d	5.1×10^{-5}	2.5×10^{-8}	3.4	1.7×10^{-3}
Plant Vogtle ^e	5.4×10^{-7}	2.7×10^{-10}	0.045	2.3×10^{-5}
Total	4.1×10^{-4}	2.1×10^{-7}	24	0.012

a. Probability of fatal cancer.

b. Arnett and Mamatey (1998b).

c. Based on data for the Solvent Extraction alternative.

d. Consists of dose impacts associated with reasonably foreseeable future actions such as DWPF, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a; 1996; 1998; 1999a,b; 2000a,b).

e. NRC (1996).

directly attributable to salt processing activities from the Solvent Extraction alternative. Doses are elevated due to the larger airborne cesium-137 emissions associated with this alternative. Small Tank Precipitation, Ion Exchange, and Direct Disposal in Grout alternatives range from 16 to 66 percent of the Solvent Extraction alternative values. Doses from the No Action alternative are considerably less. For comparison, as shown in Section 3.8.1, approximately 144,000 deaths from cancer due to all causes would be likely in the same population over their lifetimes.

5.2 Water Resources

At present, a number of SRS facilities discharge treated wastewater to Upper Three Runs and its tributaries via NPDES-permitted outfalls. These include the F/H-Area Effluent Treatment Facility and the M-Area Liquid Effluent Treatment Facility. The cumulative impact of liquid releases is measured in terms of human health effects and is presented in Section 5.3. As stated in Section 4.1.2, salt processing activities are not expected to result in any radiological or nonradiological discharges to groundwater.

Discharges to surface water would be treated to remove contaminants prior to release into Upper Three Runs. Other potential sources of contaminants into Upper Three Runs during the time of salt processing activities include DWPF, the tritium extraction facility, environmental restoration, decontamination and decommissioning activities, and modifications to existing SRS facilities. Discharges associated with the tritium extraction facility activities would not add significant amounts of nonradiological contaminants to Upper Three Runs. The amount of discharge associated with environmental restoration and decontamination and decommissioning activities would vary according to the activity. All potential activities that could result in wastewater discharges would be required to comply with the NPDES permit limits that ensure protection of water quality. Studies of water quality and biota in Upper Three Runs suggest that discharges from facilities' outfalls have not degraded the stream (Halverson et al. 1997).

5.3 Public and Worker Health

Table 5-3 summarizes the cumulative radiological health effects of routine SRS operations, proposed DOE actions, and non-Federal nuclear

Table 5-3. Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers.

Activity	Maximally exposed individual				Offsite population ^a				Workers	
	Dose from airborne releases (rem)	Dose from liquid releases (rem)	Total dose (rem)	Probability of fatal cancer risk	Collective dose from airborne releases (person-rem)	Collective dose from liquid releases (person-rem)	Total collective dose (person-rem)	Excess latent cancer fatalities	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline ^b	5.0×10^{-5}	1.3×10^{-4}	1.8×10^{-4}	9.0×10^{-8}	2.2	2.4	4.6	2.3×10^{-3}	160	0.066
Salt Processing ^c	3.1×10^{-4}	(d)	3.1×10^{-4}	1.6×10^{-7}	18.1	(d)	18.1	9.1×10^{-3}	29	0.12
Other foreseeable SRS activities ^e	5.1×10^{-5}	5.7×10^{-5}	1.1×10^{-4}	5.4×10^{-8}	3.4	0.19	3.6	1.8×10^{-3}	730	0.29
Plant Vogtle ^f	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	2.7×10^{-8}	0.045	2.5×10^{-3}	0.048	2.4×10^{-5}	NA	NA
Total	4.1×10^{-4}	2.4×10^{-4}	6.5×10^{-4}	3.3×10^{-7}	24	2.6	26	0.013	920	0.37

N/A = not available

a. A collective dose to the 50-mile population for atmospheric releases and to the downstream users of the Savannah River for aqueous releases.

b. Arnett and Mamatey (1998b) for 1997 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).

c. Based on data from the Solvent Extraction alternative.

d. Radioactive liquid waste would be returned to the HLW tank farms and treated in the waste evaporators. No radioactive liquids would be released to the environment. L6-62

e. Includes spent nuclear fuel, highly enriched uranium, tritium extraction facility, management of certain plutonium residues and scrub alloy concentrations, DWPF, and disposition of surplus plutonium and components from throughout the DOE complex.

f. NRC (1996).

facility operations (Plant Vogtle Electric Generating Facility). Impacts resulting from proposed DOE actions are described in the EISs listed previously in this chapter. In addition to estimated radiological doses to the hypothetical MEI, the offsite population, and involved workers, Table 5-3 also lists the potential number of latent cancer fatalities for the public and workers due to exposure to radiation. The radiation dose to the MEI from air and liquid pathways would be 6.5×10^{-4} rem (0.65 mrem) per year, which is well below the applicable DOE regulatory limits (10 mrem per year from the air pathway, 4 mrem per year from the liquid pathway, and 100 mrem per year for all pathways). The total annual population dose from current and projected activities of 26 person-rem translates into 0.013 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS, or essentially no cumulative latent cancer fatalities. Most (75%) of this cumulative impact to the public is directly attributable to airborne releases from salt processing activities from the Solvent Extraction alternative (Table 5-2).

The annual radiation dose to the involved worker population in Solvent Extraction would be 920 person-rem, which could result in 0.37 latent cancer fatality. Doses to individual workers would be kept below the regulatory limit of 5,000 mrem per year (10 CFR 835). Furthermore, as low as reasonably achievable principles would be exercised to maintain individual worker doses below the SRS Administrative Control Level of 500 mrem per year. Salt processing activities would minimally increase the workers' and general public's health impacts due to radiation.

5.4 Waste Generation and Disposal Capacity

As stated in Section 4.1.11, low-level waste, hazardous/mixed waste, and sanitary/industrial waste would be generated from salt processing activities.

Table 5-4 lists cumulative volumes of high-level, low-level, transuranic, hazardous, and mixed wastes that SRS would generate. The table includes data from the SRS 30-year expected waste forecast generated by Halverson (1999), which incorporates changes in SRS activities that have occurred since the publication of the *Final SRS Waste Management Environmental Impact Statement* (DOE 1995b). The 30-year expected waste forecast is based on operations, environmental remediation, and decontamination and decommissioning waste forecasts from existing generators and the following assumptions:

- secondary waste from DWPF operations are addressed in the *Defense Waste Processing Facility EIS* (DOE 1994a); HLW volumes are based on the selected options for the *F-Canyon Plutonium Solutions EIS* (DOE 1994b) and the *Interim Management of Nuclear Materials at SRS EIS* (DOE 1995a); some investigation-derived wastes are handled as hazardous wastes per Resource Conservation and Recovery Act regulations; purge water from well samplings is handled as hazardous waste; and the continued receipt of small amounts of low-level waste from other DOE facilities and nuclear naval operations would occur.

In this forecast, the estimated quantity of radioactive/hazardous waste from operations during the next 30 years would be about 140,000 cubic meters. In addition, radioactive/hazardous waste associated with environmental restoration and decontamination and decommissioning activities would have a 30-year expected forecast of 68,000 cubic meters. Based on maximum values, waste generated from the Solvent Extraction alternative would produce 46,000 cubic meters. During this same time period, other reasonably foreseeable activities that were not included in the 30-year forecast would produce almost an additional 400,000 cubic meters. The major contributor to the other waste volumes would be weapons components from various DOE sites that could be processed in SRS canyons

Table 5-4. Estimated cumulative waste generation from SRS concurrent activities (cubic meters)^a.

Waste type	Salt processing ^b	SRS operations ^c	ER/D&D activities ^c	Other waste volumes ^d	Total
HLW	45,000 ^f	14,000	0	130,000	190,000
(gallons) ^e	(12,000,000)	(3,700,000)	(0)	(34,000,000)	(50,000,000)
Low-level waste	920	120,000	62,000	250,000	430,000
Hazardous/mixed waste	56	3,900	6,200	5,000	15,000
Transuranic waste	0	6,000	0	12,000	18,000
Total	46,000	140,000	68,000	400,000	653,000

- a. Values are rounded to two digits. The totals may not equal the sum of the four components, due to rounding.
 b. Based on maximum value (Solvent Extraction alternative).
 c. Halverson (1999).
 d. Includes life-cycle waste associated with reasonably foreseeable future actions such as DWPF operations, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, commercial light-water reactor waste, sodium-bonded spent nuclear fuel, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a,b; 1996; 1998; 1999a,b; 2000a,b).
 e. To convert from cubic meters to gallons, multiply by 264.2.
 f. HLW value for salt processing is from DWPF recycle; it is not produced directly by salt processing activities.
 ER/D&D = Environmental remediation/decontamination and decommissioning.

and spent nuclear fuel management activities. Therefore, the potential cumulative amount of waste generated from SRS activities during the period of interest would be 653,000 cubic meters. It is important to note that the quantities of waste generated are not equivalent to the amounts that would require disposal. For example, HLW is evaporated and concentrated to a smaller volume for final disposal.

The Three Rivers Solid Waste Authority Regional Waste Management Center at SRS accepts non-hazardous and non-radioactive solid wastes from SRS and eight surrounding South Carolina counties. This municipal solid waste landfill provides state-of-the-art Subtitle D (non-hazardous) facilities for landfilling solid wastes, while reducing the environmental consequences associated with construction and operation of multiple county-level facilities (DOE 1995c). It was designed to accommodate SRS and county solid waste disposal needs for at least 20 years, with a projected maximum operational life of 45 to 60 years (DOE 1995c). The landfill is designed to handle an average of 1,000 tons per day and a maximum of 2,000 tons per day of municipal solid

wastes. The SRS and eight cooperating counties had a combined generation rate of 900 tons per day in 1995. The Three Rivers Solid Waste Authority Regional Waste Management Center opened in mid-1998.

Radioactive, hazardous, or solid wastes generated from salt processing activities and other planned SRS activities would not exceed current and projected capacities of SRS waste storage and/or management facilities.

5.5 Utilities and Energy

Table 5-5 lists the cumulative total of electricity used and water consumed by activities at SRS. The values are based on average annual consumption estimates.

Overall SRS electricity consumption would not increase greatly with the addition of salt processing activities. Electricity usage for salt processing would be less than 5 percent of the current SRS baseline level. Cumulative impacts of SRS baseline electricity consumption, coupled with salt processing and other foreseeable future usage (approximately 580,000 megawatt-hours per year), would be less than previous SRS annual consumption rates (1993 usage was over

Table 5-5. Estimated average annual cumulative utility consumption.

Activity	Electricity (megawatt-hours)	Water usage (liters)
SRS baseline	4.1×10^{5a}	1.7×10^{10b}
Salt processing	2.4×10^{4c}	1.2×10^{7d}
Other SRS foreseeable activities ^e	1.5×10^5	8.3×10^8
Total	5.8×10^5	1.8×10^{10}

a. Halverson (1999).

b. Arnett and Mamatey (1996).

c. Based on maximum values from the Solvent Extraction alternative.

d. Based on maximum values from the Small Tank Precipitation alternative.

e. Consists of utility consumption associated with reasonably foreseeable future actions, such as DWPF operations, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a,b; 1996; 1998; 1999a,b; 2000a,b).

600,000 megawatt-hours per year) (DOE 1995a).

DOE has also evaluated the SRS water needs during salt processing. At present, the SRS rate of groundwater withdrawal is estimated to be a maximum of 1.7×10^{10} liters per year. The maximum estimated amount of water needed annually for salt processing and other reasonably foreseeable future actions is listed in Table 5-5. The annual cumulative level of water withdrawal of 1.8×10^{10} liters is not expected to exceed the production capacity of the aquifer of more than 3.6×10^{11} liters.

5.6 Long-Term Cumulative Impacts

Computer models predict that radiological and nonradiological contaminants leaching from the saltstone produced by any of the salt processing alternatives would always be below their respective regulatory limits in the groundwater 100 meters downgradient of the vaults and at the seepines of McQueen Branch or Upper Three Runs.

SRS has prepared a report, referred to as the Composite Analysis (WSRC 1997), that calculated for 1,000 years into the future the potential cumulative impact to a hypothetical member of the public from releases to the environment from all sources of residual radioactive material expected to remain in the SRS General Separations Area. The

General Separations Area contains all SRS waste disposal facilities, chemical separations facilities, HLW tank farms, and numerous other sources of radioactive material. The Composite Analysis considered 114 potential sources of radioactive material containing 115 radionuclides.

The Composite Analysis calculated maximum radiation doses to hypothetical members of the public at the mouth of Fourmile Branch, at the mouth of Upper Three Runs, and on the Savannah River at the Highway 301 bridge. The estimated peak all-pathway dose from all radionuclides was 14 mrem/year (mouth of Fourmile Branch), 1.8 mrem/year (mouth of Upper Three Runs), and 0.1 mrem/year (Savannah River).

The major contributors to dose were tritium, carbon-14, neptunium-237, and isotopes of uranium (WSRC 1997).

The analysis also calculated radiation doses from drinking water in Fourmile Branch and Upper Three Runs. The estimated peak drinking water doses from all radionuclides for these creeks were 23 mrem/year for Fourmile Branch and 3 mrem/year for Upper Three Runs (WSRC 1997).

As discussed in Section 4.2.2, DOE does not expect salt processing activities to add noticeable levels of radiological contaminants to the accessible environment. The dose effects of saltstone at Upper Three Runs are several orders of magnitude less than those calculated in the

Composite Analysis for the entire General Separations Area. Therefore, the peak all-pathway dose and the peak drinking water dose presented in the Composite Analysis

will not be affected by salt processing activities and the conclusions of the Composite Analysis will remain the same.

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CHAPTER 6. RESOURCE COMMITMENTS

This chapter describes unavoidable adverse impacts, short-term uses of environmental resources versus long-term productivity, and irreversible and irretrievable commitments of resources associated with the construction and operation of a salt processing technology at the Savannah River Site (SRS). This chapter also includes discussions about U.S. Department of Energy Savannah River Operations Office (DOE-SR) waste minimization, pollution prevention, and energy conservation programs in relation to implementation of the proposed action.

For purposes of this Supplemental Environmental Impact Statement (SEIS), the analysis presented in this chapter has been divided between short-term and long-term impacts, where applicable. Short-term impacts cover the period from construction and implementation through completion of salt processing (from 2001 to 2023). The long-term performance evaluation for the saltstone generated by the Direct Disposal in Grout alternative involves the period of time beginning at the end of 100 years of post-closure institutional control and continuing through an extended period, during which it is assumed that residential and/or agricultural uses could occur.

6.1 Unavoidable Adverse Impacts

6.1.1 OPERATING-LIFE IMPACTS

Implementing any of the alternatives (including No Action) considered in this SEIS for replacement of the ITP process for management of the high-level waste (HLW) salt solutions would result in unavoidable adverse impacts to the human environment. Implementation of the Small Tank Precipitation alternative, the Ion Exchange alternative, or the Solvent Extraction alternative, in association with the continued operation of the existing saltstone manufacturing and

disposal facility in Z Area, would result in minimal short-term adverse impacts. These impacts would be primarily to geologic and water resources, air quality, waste generation, worker and public health, traffic and transportation, and utility and energy consumption, as presented in Chapter 4. Likewise, the construction and operation of a Direct Disposal in Grout facility in Z Area would result in minimal adverse impacts to the same resources during the operating-life of the facility as discussed in Chapter 4.

All construction activities for any of the alternatives would occur in previously disturbed areas. S Area encompasses 270 total acres, and the implementation of Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternative within S Area would require approximately 23 of these acres. Z Area encompasses 180 total acres, and the implementation of the Direct Disposal in Grout alternative within Z Area would require approximately 15 acres. In addition, construction of any alternative in either S or Z Area would require the temporary use of approximately 20 acres to accommodate construction materials, equipment, and a concrete batch plant. Once construction was completed, these areas would be revegetated and available for other uses.

Because the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternative would be constructed in S Area partly below grade (to a maximum depth of 45 feet), extensive soil excavations (77,000 to 82,000 cubic meters) could result in potential adverse impacts to geologic, groundwater, and surface water resources. The base of the facility might be in the water table aquifer, potentially requiring dewatering during construction. Construction of the Direct Disposal in Grout alternative in Z Area would result in the removal of approximately 23,000 cubic yards of soil. The aquifer is at a depth of 60 feet or more below Z Area and would therefore not require dewatering. Final grading would be required for all alternatives, to prevent surface water runoff from collecting in surface depres-

sions and impacting facility operations or vaults. As part of the required sediment and erosion control plan, storm water management and sediment control measures would be required to mitigate runoff and any potential discharges of silts, solids, and other contaminants to surface water streams. Best management practices, such as the development of retention basins, would be utilized. Any storm water collected in the retention basins would be diverted to current drainage control systems and discharged to McQueen Branch. In addition, use of best management practices would mitigate any short-term adverse impacts to geologic resources.

Implementation of the No Action alternative options identified in Chapter 2 could result in adverse impacts to the geologic and water resources. This is especially true if the option of constructing new wastewater treatment tanks is implemented. Each new tank would require the excavation of approximately 43,000 cubic meters of soil, of which approximately 28,000 cubic meters would be used for backfill. Implementation of this option could potentially result in adverse impacts to the geologic and water resources. However, DOE would mitigate these adverse impacts by utilizing best management practices to stabilize the soil and control erosion. Additional adverse impacts could result from construction of additional new tanks.

Air resources could be adversely impacted by any of the alternatives. These impacts would occur both during the construction (4 years) and during operation of the facilities (13 years). Adverse impacts during construction would be associated with heavy equipment (primarily diesel-powered) emissions and the dust created by their operation. In addition, the operation of a temporary concrete batch plant would produce adverse air quality impacts. Potential adverse impacts from fugitive dust would be mitigated by implementing best management practices. In addition, particulate

emission limits for the operation of the concrete batch plant would be established in a construction permit from South Carolina Department of Health and Environmental Control (SCDHEC). Based on a review of expected sources of emissions and emission rates, the emissions would increase background levels by 1 to 2 percent. Therefore, these increases and any impacts associated with construction would be considered negligible and, in addition, would cease once construction was completed.

During operation of the facilities, regulated air pollutants would be released and could have adverse impacts to the surrounding environment. A review of the expected emissions, compared to the regulatory limits, indicated that all emission rates (with the exception of volatile organic compounds [VOCs]) would be below SCDHEC, Clean Air Act, or Occupational Safety and Health Administration (OSHA) limits and should not have any adverse impacts.

The estimated VOC emissions rate for the Small Tank Precipitation alternative would exceed the threshold value established by SCDHEC for additional permit review, whereas estimated emissions from the other alternatives are either covered by existing air permit levels or below the threshold value. Implementation of the Small Tank Precipitation alternative would result in small increases in offsite concentrations of benzene and ozone, with minimal impacts to public health. The other alternatives would have lower impacts.

Implementation of any of the alternatives would result in the generation of wastes as an unavoidable result of normal operations. Each of the alternatives, excluding the No Action alternative, would produce a salt waste stream as a primary waste that would be grouted for disposal in vaults in Z Area. A total of 13 to 16 vaults would be needed, depending on the alternative selected. Any of the alternatives would also produce a high-level radioactive waste stream that would be vitrified in the Defense Waste Processing Facility (DWPF).

The types of secondary waste generated include low-level, hazardous, mixed, industrial, and sanitary. Table 6-1 lists the total estimated waste generation by each action alternative. Although DOE has implemented a number of pollution prevention measures (see Section 6.4), generation of wastes would be unavoidable. DOE would comply with all regulatory requirements related to the proper disposal of these wastes.

During operation of any of the proposed alternatives, a minimal amount of radioactive material and activation products would be released to the environment and could result in unavoidable adverse impacts. As presented in Section 4.2.4.2, the highest radiation dose received by a noninvolved worker would be 4.8 millirem per year, well below the SRS administrative limit of 500 millirem per year for the maximum individual exposure goal. The greatest collective dose to the surrounding population would be 18.1 person-rem per year, resulting in an estimated 0.12 latent cancer fatality to the public within 50 miles of SRS. Doses would vary among the alternatives; the Sol-

vent Extraction alternative would produce the highest dose.

SRS workers routinely handle hazardous and toxic chemicals; exposure to these materials would be unavoidable. In order to reduce impacts, occupational health codes and standards would be used to regulate worker exposure to these materials. Analysis has shown that chemical pollutant emissions to offsite areas would be minimal and below the applicable standards, and would not pose a danger to the public. See Section 4.2.4.2 for more details.

Construction and operation of any of the alternatives would result in injuries to workers and lost workdays, which are unavoidable adverse impacts. As discussed in Section 4.2.4.3, 1.7 to 2.7 recordable cases (which include death, illness, or injury) could occur annually, resulting in 0.72 to 1.2 lost workdays each year. The incidences of injury and illness reported for SRS are lower than those that occur in the general industry and manufacturing workforces. DOE continues to work to reduce these levels and SRS has shown continuous improvement over the years; therefore, the numbers presented in this SEIS are considered conservatively high.

Table 6-1. Total estimated waste generation for the salt processing action alternatives.^a

	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Radioactive liquid waste (gallons)	3.9×10 ⁶	3.3×10 ⁶	1.2×10 ⁷	2.0×10 ⁶
Nonradioactive liquid waste (gallons)	negligible	4.9×10 ⁵	negligible	negligible
Transuranic waste (m ³)	negligible	negligible	negligible	negligible
Low-level waste (m ³)	920	920	920	920
Hazardous waste (m ³)	Startup – 30 ^b Operations – 13			
Mixed low-level waste (m ³)	13	13	13	13
Mixed low-level liquid waste (gallons)	780,000	None	13,000	None
Industrial waste (metric tons)	Startup – 39 Operations – 260			
Sanitary waste (metric tons)	Startup – 81 Operations – 530			

- a. Under the No Action alternative, waste generation rates would be similar to those at the existing HLW Tank Farms. Therefore, waste generation rates would not be expected to increase from current levels.
- b. Assumes a 1.3-year duration for startup activities and 13 years of operation for each of the action alternatives.

Implementation of any of the alternatives would require transportation of many different materials, and such transport could have unavoidable adverse consequences. Transporting materials along public highways could impose unavoidable adverse effects on the environment through vehicle emissions, spills, and accidents resulting in injuries or fatalities. As presented in Table 4-17, a total of just over 19,000 shipments (340,000 miles) to almost 26,400 shipments (470,000 miles) would be made during construction and operation, depending on the alternative selected. Using Federal Highway Administration statistics for South Carolina, these shipments and the associated miles driven would result in less than one accident, no fatalities, and less than 0.3 injuries. However, during construction, workers would commute approximately 26 million miles (see Table 4-18). U.S. Department of Transportation statistics predict that 98 accidents would occur, resulting in 0.4 fatalities and 43 injuries.

Adverse impacts to the ecological resources would be minimal and of short duration. Most activities would occur within previously disturbed areas. Although noise levels would be relatively low outside the immediate areas of construction, the combination of construction noise and human activity probably would displace small numbers of animals within a 400-foot radius of the construction site. No threatened or endangered species or critical habitats occur in or near S or Z Areas. In addition, no construction or operational activities would affect any wetlands in S or Z Areas. DOE has committed to monitoring the areas for threatened and endangered species and would initiate consultation with the U.S. Fish and Wildlife Service if DOE determined that the potential for adverse impact to the species or its habitat existed.

6.1.2 LONG-TERM IMPACTS

Long-term impacts are those that would continue or commence after the completion

of all salt processing (i.e., 2023). DOE believes that the major source of these long-term impacts would be from the saltstone that would result from each of the four action alternatives and from tanks filled with salt under No Action. The saltstone vaults would be located in Z Area, regardless of the action alternative selected.

For National Environmental Policy Act (NEPA) analysis of long-term impacts, DOE assumed that institutional control would be maintained for 100 years post-closure, during which time the land encompassing the saltstone vaults would be managed to prevent erosion or other conditions that would lead to early degradation of the vaults. DOE also assumed that the public would not have access to Z Area during this time to set up residence.

For the No Action alternative DOE assumes a 100-year period of institutional control of the salt-filled tanks, after which the tank tops fail, allowing precipitation to fill the tanks and eventually salt solution would overflow and run off to onsite streams.

L6-60

Unavoidable adverse long-term impacts to geologic resources would be minimal, based on a performance evaluation that included fate and transport modeling. Results indicate no detrimental effect on topography or to the structural or load-bearing properties of the geologic deposits. Because of the contamination under the No Action alternative, future land use at SRS under this scenario would not support human or ecological habitats.

L6-60

Construction and operation of grout disposal facilities for any of the four action alternatives in Z Area would result in unavoidable adverse impacts to future land use of the area. The 15 acres that would be committed to the vaults and grout production facility would not be available for other productive uses.

Unavoidable long-term adverse impacts to groundwater resources could result from any of the alternatives. The fate and transport modeling results indicate that, under the action alternatives, movement of radiological contaminants

from failed vaults to nearby surface waters via groundwater discharge would be minimal and below regulatory standards for drinking water (4 millirem per year). Therefore, there would be no unavoidable adverse impacts to groundwater resources. However, long-term impacts to groundwater could occur as the saltstone ages.

Based on modeling results, the long-term movement of nonradiological residual contaminants (primarily nitrate) from the Z-Area vaults to nearby streams would be extremely small and, in all cases, would be below applicable standards. However, modeling results indicate that there would be little difference in impacts among the alternatives. None of the four action alternatives would result in an exceedance of the drinking water criteria for nitrate (i.e., 44 milligrams per liter). There would be no exceedances or any other constituent in groundwater discharge at the seep lines of McQueen Branch or Upper Three Runs. Therefore, there would be no unavoidable adverse impacts to surface water resources.

As a result of radioactive material being released many years after vault closure and the long half-lives of some of the radionuclides, there could be unavoidable adverse impacts to human receptors. Therefore, DOE described and modeled several future-use scenarios to determine the potential impacts to humans (see Section 4.2.5). Results indicate that doses for all scenarios, except the 100-year residential scenario for Direct Disposal in Grout, would be below or very near the 100-millirem-per-year dose limit. The 1,000-year residential scenario doses for all four action alternatives are similar and would be below the 100-millirem-per-year public dose limit. They range from as low as approximately 10 millirem per year to as high as 85 millirem per year. Doses for the agricultural scenario are similar, but could exceed the 100-millirem-per-year public dose limit. Doses for the agricultural scenario would range from 49 to 140 millirem per year. For the 100-year residential

scenario, the dose would be highest for the Direct Disposal in Grout alternative (150 to 1,200 millirem per year) and would exceed the 100-millirem-per-year public dose limit. The 100-year residential scenario doses for the other three action alternatives would be much smaller and would not exceed 0.13 millirem per year.

6.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Under any of the alternatives, the proposed locations for any new facilities would be within previously disturbed and developed industrial landscapes. The existing infrastructure (e.g., roads, utilities.) within S and Z Areas would be sufficient to support the proposed facilities.

After the end of the operational life of the facilities associated with salt processing, DOE could decontaminate and decommission the facilities in accordance with applicable regulatory requirements and restore the areas to brown-field sites that would be available for other industrial use. Appropriate NEPA review would be conducted prior to the initiation of any decontamination and decommissioning activities. In all likelihood, none of the sites would be restored to a natural habitat (DOE 1998).

The project-related uses of environmental resources for the implementation of any of the proposed alternatives are characterized in the following paragraphs.

- Groundwater from Site wells would be used during both construction and operations, regardless of the alternative selected. Water would be used for process additions, cooling and flushing, product washes, and grout production. During construction, water consumption would represent just over 2 percent of water used in H-, S-, and Z-Area facilities in 1998 and 0.2 percent of the lowest estimated production capacity of

the aquifer (see Section 4.2.12.1). Groundwater use during operations would represent about 23 percent of the water used in H-, S-, and Z-Area facilities in 1998 and 1.5 percent of the lowest estimated production capacity of the aquifer (see Section 4.2.12.1). After use and treatment in the F- and H-Area Effluent Treatment Facility, this water would be released through permitted discharges into surface water streams. Therefore, the withdrawal, use, and treatment of groundwater would not affect the long-term productivity of this resource.

- Air emissions associated with any of the alternatives would add small amounts of radiological and nonradiological constituents to the air of the region. These emissions would be well below air quality or radiation exposure standards, and below applicable SRS permit limits. All concentrations would be below OSHA limits and all concentrations, with the exception of nitrogen dioxide (which could reach 78 percent of the limit), would be less than 5 percent of their respective regulatory limits. Nitrogen dioxide emissions would result from operation of diesel generators during construction and operations. Therefore, there would be no significant effects to the long-term quality of air resources.
- Radiological and nonradiological constituents could contaminate the groundwater below and adjacent to the Z-Area disposal vaults in the distant future. Some contaminants from the vaults could be transported by groundwater to the seepage of nearby streams. Beta-gamma dose, alpha concentrations, and nonradiological constituent concentrations would all be below the regulatory limit at the seepage of McQueen Branch or Upper Three Runs. Therefore, any radiological or nonradiological

releases from the disposal vaults should have no impact on the long-term productivity of the ecosystems in the receiving streams.

- The management and disposal of wastes (low-level, hazardous, mixed, industrial, and sanitary) over the project's life would require energy and space at SRS treatment, storage, and disposal facilities (e.g., Z-Area Vaults, E-Area Vaults, or Three Rivers Sanitary Landfill). The land to meet these solid waste needs would require a long-term commitment of terrestrial resources. DOE established a future use policy for the SRS for the next 50 years in the 1998 *Savannah River Site Future Use Plan* (DOE 1998). This report sets forth guidance that established appropriate land uses for SRS areas and established policies to prevent non-conforming land uses.

6.3 Irreversible and Irrecoverable Resource Commitments

Resources that would be irreversibly and irretrievably committed during the construction and operation of any salt processing alternative include those that cannot be recovered or recycled and those that are consumed or reduced to unrecoverable forms. The commitment of capital, energy, labor, and material during this time would generally be irreversible.

A maximum of 180 acres would be set aside for the vaults under any action alternative, and from 15 acres (Direct Disposal in Grout alternative) to 23 acres (all other action alternatives) would be utilized for salt processing facilities. Each tank would have a footprint of approximately 5,000 square feet. The total land required for any new tanks built under the No Action alternative has not been determined, however, impacts to all of this land could be irreversible and irretrievable once it is committed to the selected alternative and would thus be unavailable for other productive uses. However, (as stated in Section 6.2) at the end of the operational life of the facilities, DOE could decontaminate and

decommission the facilities in accordance with applicable regulatory requirements. Implementation of decontamination and decommissioning would require significant commitment of resources and the impacts of implementation would undergo appropriate NEPA review. Regardless, the land committed to vaults under the action alternatives and tanks under No Action would not be retrievable.

Energy expended would be in the form of fuel for equipment and vehicles, electricity and steam for facility operations, and labor. Construction would generate nonrecyclable materials, such as sanitary solid waste and construction debris. Implementation of any of the alternatives would generate nonrecyclable radiological and nonradiological waste streams. However, certain materials (e.g., steel, copper, stainless steel) used during construction and operation of any proposed facility could be recycled when the facility has been decontaminated and decommissioned. Some construction materials would not be salvageable, due to radioactive contamination.

The implementation of the any of the salt processing alternatives considered in this SEIS, including the No Action alternative, would require water, electricity, diesel fuel, and other energy and materials. Table 6-2 lists estimated total amounts of energy, utilities, and materials required for the construction and operation of each alternative.

Water would be obtained from onsite groundwater wells. Steam would be obtained from the D-Area Power Plant. Electricity, diesel fuel, concrete pre-mix, steel, saltstone pre-mix, sodium hydroxide, oxalic acid, tetraphenylborate (TPB), monosodium titanate (MST), crystalline silicotitanate (CST) resins, and other chemicals would be purchased from commercial vendors. The amounts required would not have an appreciable impact on available supplies or the ability to supply other industries.

6.4 Waste Minimization, Pollution Prevention, and Energy Conservation

6.4.1 WASTE MINIMIZATION AND POLLUTION PREVENTION

DOE-SR has developed and implemented an aggressive waste minimization and pollution prevention program that promotes source reduction and recycling practices that reduce the use of hazardous materials, energy, water, and other resources, while protecting resources through conservation or more efficient use. This Pollution Prevention Program also reduces the costs of the management of pollutants. As a result of this program, DOE has reduced the volumes of wastes discharged into the environment or sent to landfills and has saved money by recycling or selling usable materials.

Pollutant reduction is first accomplished by eliminating or minimizing the generation of pollutants at the source. All materials used at SRS are recycled or reused, when practical. The remaining wastes are managed to comply with Federal and state environmental regulations to reduce volume, toxicity, and/or mobility before storage or disposal.

DOE-SR, in conjunction with the Site's management and operations contractor, Westinghouse Savannah River Company and its partners, establishes SRS's pollution prevention goals and program objectives through a Solid Waste Management Council. A Pollution Prevention Group provides overall program leadership, coordination, and guidance in the development and implementation of pollution prevention systems. A Waste Minimization Subcommittee, comprised of representatives from across the Site, assists with development and implementation of waste minimization strategies and dissemination of information.

The Pollution Prevention Program is made up of the following seven elements:

Table 6-2. Estimated project total energy, utilities, and material use for the salt processing alternatives.

Phase ^a	SRS Baseline ^b	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
<i>Peak electrical power demand (megawatts)</i>					
Construction	NA	1.66	1.66	1.66	1.66
Operation	130 ^c	24	24	32	18
<i>Electricity use (gigawatt-hours)</i>					
Construction	NA	76	79	76	73
Operation	410 ^c	243	286	315	172
Project total use	NA	319	365	391	245
<i>Fuel use (million gallons)</i>					
Construction	NA	8.4	9	8.4	8
Operation	8.75 ^d	0.3	0.3	0.3	0.2
Project total use	NA	8.7	9.3	8.7	8.2
<i>Steam use (million pounds)</i>					
Construction	NA	0	0	0	0
Operation	NA	2,548	2,300	1,915	1,536
Project total use	NA	2,548	2,300	1,915	1,536
<i>Potable water use (million gallons)</i>					
Construction	NA	19	20	19	18
Operation	NA	99	95	120	75
Project subtotal use	NA	118	115	139	93
<i>Process water use (million gallons)</i>					
Construction	NA	16	17	16	15
Operation	23,000 ^e	301	271	225	181
Project subtotal use	NA	317	288	241	196
<i>Project total water use (million gallons)</i>					
		435	403	380	289
<i>Material use</i>					
Concrete pre-mix (cubic yards) ^e	NA	30,029	38,481	38,522	42,756
Saltstone pre-mix (pounds)	None	1.277 billion	1.057 billion	1.192 billion	950 million
Sodium hydroxide (pounds)	None	253,000	2,800,000	20,800,000	202,000
Oxalic Acid (pounds)	None	27,200	27,200	27,200	27,200
Sodium TPB (gallons)	None	2.84 million	None	None	None
MST (pounds)	None	47,000	47,000	47,000	47,000
CST Resin (pounds)	None	None	538,000	None	None
Stainless steel for canisters (pounds)	6,600,000	6,555,000	6,555,000	6,555,000	6,555,000

Adapted from WSRC (1999).

- The construction and operation durations for each alternative are as follows: Small Tank Precipitation – 45 months and 15 years; Ion Exchange – 50 months and 13 years; and Direct Disposal in Grout – 46 months and 13 years (adapted from Attachments 14.5, 14.3, and 14.4 of WSRC (1998a). The total project duration includes a startup time of 1.3 years for each alternative (Sessions 1999).
 - Under the No Action alternative, utility and energy use would be included in the current site baseline.
 - Halverson (1999)
 - DOE (1995)
 - Adapted from WSRC 1998b.
- NA = Not Available.

1. Solid Waste Minimization
2. Toxic Chemicals Reduction
3. Energy Conservation
4. Environmental Emissions Reduction
5. Recycle and Reuse
6. Affirmative Procurement
7. Remediation

1. Solid Waste Minimization: Between 1991 and 1999, waste generators achieved approximately an 80 percent volume reduction (760,000 cubic feet per year) of solid, hazardous, and radioactive waste. The Pollution Prevention Program has implemented over 508 pollution prevention projects since 1995 (beginning of formal pollution prevention tracking), eliminating over 490,000 cubic feet of radioactive and hazardous waste, and saving approximately \$130 million in costs for waste disposal. This reduction was primarily due to improved waste generator work practices including: improved employee awareness, substitution of reusable for consumable goods in radiological areas, enhanced work planning, non-hazardous solvent substitution, recovery of radiological areas, and use of new pollution prevention technologies.

2. Toxic Chemicals Reduction: SRS has met the Executive Order 12856 goal to reduce chemical releases by 50 percent by 1999. Reportable toxic chemical releases have been reduced by approximately 2 million pounds since 1987, when the SRS filed its first Toxic Chemical Release Inventory Report to the U.S. Environmental Protection Agency (EPA). The Site's Chemical Commodity Management Center will continue to strive to reduce chemical releases by substituting less hazardous chemicals and integrating chemical use, excess, and procurement activities.

3. Energy Conservation: SRS has adapted a plan to enhance energy efficiency and conservation in all buildings by establishing

an Energy Management Council and implementing a new Energy Services Company contract. SRS's Energy Management Program has achieved the conservation goals mandated by Executive Order 12902, *Energy Efficiency and Water Conservation at Federal Facilities*.

4. Environmental Emissions Reduction: The SRS Air and Water Programs ensure that all emissions to the environment meet regulatory requirements. Strategies are continually identified to meet compliance and environmental As Low As Reasonably Achievable (ALARA) guidelines.

5. Recycle and Reuse: SRS has an ongoing comprehensive recycling program. Since 1994, SRS has recycled more than 17,000 tons of materials through its Salvage Operations and Office Recycle Programs. Examples of materials recycled and their amounts from 1994 to 1999 include:

- Scrap metal 10,762 tons
- Office paper and cardboard 5,332 tons
- Scrap aluminum 287 tons
- Aluminum cans 99 tons
- Lead-acid batteries 210 tons
- Laser printer toner cartridges 55,809 each

6. Affirmative Procurement: This program promotes the purchase and use of products made from recovered and recycled materials. SRS met the DOE Secretarial goal to procure 100 percent of RCRA-specified products, when it was technically and economically feasible, in both 1998 and 1999. SRS has purchased more than \$6.6 million worth of products containing recovered or recycled materials.

7. Remediation: A large part of the Site's current mission is remediation of legacy waste sites. The Pollution Prevention Program identifies techniques to reduce the environmental impacts of existing waste at these sites and the means to minimize the generation of new waste during Site closure and corrective action activi-

ties. SRS strives to reduce cleanup and stabilization waste by 10 percent per year.

The Site has an approved Pollution Prevention in Design Procedure that provides the process, responsibilities, and requirements for inclusion of pollution prevention into the design phase of new facilities or modification to existing facilities. Pollution prevention in design is applied using a value-added, quality-driven, graded approach to project management. When properly applied, the expense of implementing pollution prevention changes during design is offset by the resulting cost savings over the life of the facility. Pollution prevention design activities are generally implemented at the Preliminary Design phase and not during the Preconceptual Design. The alternatives under consideration in this SEIS are at the Preconceptual Design phase. However, a number of early planning efforts have identified specific activities that could be implemented. Examples include the following:

- Benzene abatement: It is anticipated that some type of benzene abatement would be added to the Small Tank Precipitation alternative.
- Recycled solvent: The solvent used in the Solvent Extraction alternative has been identified for recycling.
- Process design: Changes would be implemented to eliminate the potential for spills.
- Recycling of construction material: Stainless steel, paint, and other construction material would be recycled, if possible.

As the design moves from Preconceptual into the Conceptual Design, Preliminary

Design, and finally the Detailed Design phase, considerable effort would be expended to identify opportunities for pollution prevention. A series of worksheets would be developed when the design reaches the Conceptual phase. Anticipated waste streams would be identified, quantified (including costs), and prioritized within a set of established criteria. These worksheets would be generated for all activities during construction, operations, and closure of the facility. Finally, the construction contractor would be selected, based in part on prior pollution prevention practices.

6.4.2 ENERGY CONSERVATION

SRS has an active energy conservation and management program. As stated in Section 6.4.1, SRS has adopted a plan to enhance energy efficiency and conservation in all buildings by establishing an Energy Management Council and implementing a new Energy Services Company contract.

Since the mid-1990s, more than 50 onsite administrative buildings have undergone energy efficiency upgrades. Representative actions include the installation of energy-efficient light fixtures, the use of occupancy sensors in rooms, the use of diode light sticks in exit signs, and the installation of insulating blankets around hot water heaters.

As stated in Section 6.4.1, pollution prevention and energy conservation measures are not specifically identified until DOE reaches the Conceptual Design phase of the project. Currently, SRS is in the Preconceptual Design phase. Regardless of the alternative selected, the incorporation of these types of energy-efficient technologies into facility Conceptual Design, along with the implementation of process efficiencies and waste minimization concepts, will facilitate energy conservation at SRS.

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CHAPTER 7. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter identifies and summarizes the major laws, regulations, Executive Orders, and U.S. Department of Energy (DOE) Orders that could apply to the Savannah River Site (SRS) salt processing alternatives. Permits or licenses could be required under some of these laws and regulations. DOE would determine the specific requirements for permits or licenses, which would depend on the alternative chosen, after consultation with the appropriate regulating agencies.

Section 7.1 describes the process that DOE will follow to determine if the low-activity salt solution produced under the salt processing alternatives can be considered waste incidental to reprocessing. Section 7.2 discusses the major Federal and State of South Carolina statutes and regulations that impose environmental protection requirements on DOE and that require DOE to obtain a permit, or permits, prior to implementing a given salt processing alternative. Each of the applicable authorities establishes how potential releases of pollutants and radioactive materials are to be controlled or monitored and include requirements for the issuance of permits for new operations or new emission sources. In addition to environmental permit requirements, the authorities may require consultations with various regulators to determine if an action requires the implementation of protective or mitigative measures. Section 7.2 also discusses the environmental permitting process and lists the environmental permits and consultations (Table 7-1) applicable to the salt processing alternatives.

Sections 7.3 and 7.4 address the major Federal regulations and Executive Orders that address issues such as emergency planning, worker safety, and protection of public health and the environment. The Executive Orders clarify issues of national policy and set guidelines under which Federal agencies must act.

DOE implements its responsibilities for protection of public health, safety, and the environment through a series of Departmental Orders (see Section 7.5) that typically are mandatory for operating contractors of DOE-owned facilities.

7.1 Waste Incidental to Reprocessing Determination

DOE Manual 435.1-1 establishes a process for making waste incidental to reprocessing determinations. This process evaluates candidate waste streams to determine if they can be managed as low-level waste (LLW) or transuranic waste (DOE Manual 435.1-1; DOE 1999). Because salt solutions at SRS originated from waste generated by reprocessing of spent nuclear fuel, they meet the source-based definition of high-level waste (HLW). However, under all alternatives in this Supplemental Environmental Impact Statement (SEIS), the low-activity fraction of the salt solution could be appropriately managed as LLW as long as the waste satisfies the waste incidental to reprocessing criteria in DOE Manual 435.1-1.

DOE Manual 435.1-1 describes two processes, a "citation" process and an "evaluation" process, for waste-incidental-to-reprocessing determinations (DOE 1999). The criteria used in the "evaluation" process are based on the treatment of the waste and the characteristics of the disposal form. Wastes can be managed as LLW if they meet the following criteria or other appropriate criteria approved by DOE.

1. Have been processed or will be processed to remove key radionuclides to the maximum extent that is technically and economically practical." DOE Guidance 435.1-1 (DOE 1999) explains that key radionuclides are generally understood to be those radionuclides that are concentration limits in 10 CFR 61.55 (i.e., the long-lived

Table 7-1. Environmental permits and consultations required by law.

Activity/Topic	Law	Requirements	Agency
Site Preparation	Federal Clean Water Act (Section 404)	Stormwater Pollution Prevention Plan for Industrial Activity	SCDHEC ^a
Industrial Waste Disposal	S.C. Pollution Control Act	Permit for Industrial Waste Disposal	SCDHEC
Wastewater Discharges	Federal Clean Water Act S.C. Pollution Control Act	Stormwater Pollution Prevention/Erosion Control Plan for construction activity	SCDHEC
		NPDES Permit(s) for Process Wastewater Discharges	SCDHEC
		Industrial Wastewater Treatment Systems Construction and Operation Permits (if applicable)	SCDHEC
		Sanitary Wastewater Pumping Station Tie-in Construction Permit; Permit to Operate	SCDHEC
Air	Clean Air Act – NESHAP ^b	Rad Emissions - Approval to construct new emission source (if needed)	EPA ^c
		Air Construction and Operation permits - as required (e.g., fire water pumps, diesel generators)	SCDHEC
		General source – stacks, vents, concrete batch plant	SCDHEC
		Air Permit - Prevention of Significant Deterioration (PSD)	SCDHEC
Domestic Water	Safe Drinking Water Act	Construction and operation permits for line to domestic water system	SCDHEC

a. South Carolina Department of Health and Environmental Control
b. National Emission Standards for Hazardous Air Pollutants
c. U.S. Environmental Protection Agency
d. U.S. Fish and Wildlife Service
e. National Marine Fisheries Service

radionuclides carbon-14, nickel-59, niobium-94, technetium-99, iodine-129, plutonium-241, and curium-242; alpha-emitting transuranic nuclides with half-lives greater than 5 years; and the short-lived radionuclides tritium, cobalt-60, nickel-63, strontium-90, and cesium-137), and any other radionuclides that are important to satisfying the performance objectives of 10 CFR 61, Subpart C (e.g., selenium-79, tin-126, neptunium-237); and

- “2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR 61, Subpart C, “Performance Objectives;” and”
- “3. Are to be managed, pursuant to DOE’s authority under the Atomic Energy Act, as amended, and in accordance with the provisions of Chapter IV of DOE Manual 435.1-1, provided 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, “Waste Classification”, or will meet alternative requirements for waste classification and characteristics, as DOE may authorize.”

DOE is conducting a research and development program, and is continuing design efforts, to determine the technical and economic feasibility of the Small Tank Precipitation, Ion Exchange, and Solvent Extraction alternatives. Through an evaluation of potential salt processing alternatives, DOE identified potential technologies that would remove key radionuclides. Variations of three of the salt processing technologies being considered (Small Tank Precipitation, Ion Exchange, and Solvent Extraction) have been evaluated previously against the incidental waste criteria. The low-activity salt solution fraction that would be produced using ion exchange has previously been characterized as incidental waste (i.e., non-HLW) (52 FR 5993, February 27, 1987). The low-activity salt solution produced using the small tank precipitation or solvent extraction process is expected to meet the same key

radionuclide removal requirements, as previously analyzed, and the other evaluation determination process.

Implementation of the Direct Disposal in Grout alternative would result in the removal of the key radionuclides, as suggested in DOE Guidance 435.1-1, except for cesium-137. It may be possible for this short-lived radionuclide to be effectively isolated by the combination of a stabilized waste form and engineered barriers for the period (about 400 years) needed for it to decay so that it no longer poses a significant hazard. The long-term performance evaluation (Section 4.2) indicates that the low-activity salt solution produced under the Direct Disposal in Grout alternative meets performance objectives comparable to those in 10 CFR 61, as required to meet the waste incidental to reprocessing criteria in DOE Manual 435.1-1. DOE is currently conducting studies to investigate the technical and economic practicality of these alternatives. Cesium removal from SRS salt solutions at a pilot or production scale, using the Small Tank Precipitation, Ion Exchange, or Solvent Extraction processes, has not been demonstrated. Cesium removal by the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternatives ultimately could prove to not be technically and economically practical. In such a case, further analysis would be needed to determine whether the criterion requiring key radionuclide removal would be considered met because the key radionuclides, other than cesium, would have been removed to the extent technically and economically practical and the waste could be properly managed as LLW, in accordance with the waste incidental to reprocessing requirements of DOE Manual 435.1-1.

Per DOE Manual 435.1-1, the DOE Field Element Manager is responsible for ensuring that waste incidental to reprocessing determinations are made consistent with either the citation or the evaluation process. A determination made using the evaluation process will include consultation and coordination with the DOE Office of Environmental Management. The U.S. Nuclear Regulatory Commission

(NRC) has participated in regulatory reviews using these evaluation criteria in the past and has expertise that is expected to complement DOE's internal review. Hence, consultation with NRC staff regarding the requirements for the evaluation process is strongly encouraged by DOE (Guidance 435.1-1). DOE plans to consult with NRC regarding an incidental waste determination for the low-activity salt solution. To facilitate the consultations, DOE will provide documentation that the low-activity salt solution satisfies criteria for management as LLW under the waste incidental to reprocessing evaluation process.

7.2 Statutes and Regulations Requiring Permits or Consultations

Environmental regulations require that the owner or operator of a facility obtain permits for the construction and operation of new (water and air) emissions sources and for new domestic drinking water systems. To obtain these permits, the facility operator must apply to the appropriate government agency for a discharge permit for discharges of wastewater to the waters of the state and submit construction plans and specifications for the new emission sources, including new air sources. The environmental permits contain specific conditions with which the permittee must comply during construction and operation of a new emission source, describe pollution abatement and prevention methods to be utilized for reduction of pollutants, and contain emissions limits for pollutants that will be emitted from the facility. Section 7.2.1 discusses the environmental statutes and regulations under which DOE will be required to obtain permits, and Table 7-1 lists the applicable permits.

7.2.1 ENVIRONMENTAL PROTECTION PERMITS

Clean Air Act, as amended, (42 USC 7401 et seq.), and implementing regulations (40 CFR Parts 50-99); South Carolina Pollution Control Act (Section 48-1-30 et seq., SCDHEC Regulation 61-62)

The Clean Air Act, as amended, is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population [42 USC 7401(b)(1)]." Section 118 of the Clean Air Act, as amended, requires each Federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, to comply with "all Federal, State, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires the U.S. Environmental Protection Agency (EPA) to define National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 USC 7409). The Act also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC 7411) and requires specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 USC 7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC 7412). Air emissions are regulated by EPA in 40 CFR Parts 50 through 99. In particular, radionuclide emissions, other than radon from DOE facilities, are regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program (see 40 CFR Part 61, Subpart H).

The EPA has overall authority for the Clean Air Act; however, it delegates primary authority to states that have established air pollution control programs approved by EPA. In South Carolina, EPA has retained authority over radionuclide emissions (40 CFR Part 61) and has delegated to the South Carolina Department of Health and Environmental Control (SCDHEC) the responsibility for the rest of the regulated pollutants under the authority of the South Carolina Pollution Control Act (48-1-10 et seq.) and SCDHEC Air Pollution Control Regulations 61-62.

Construction and operation permits or exemptions will be required for new nonradiological air emission sources (e.g., diesel generators, concrete batch plants) constructed and operated as part of SRS salt processing. The permits will contain operating conditions and effluent limitations for pollutants emitted from the facilities (Table 7-1).

DOE would determine if a NESHAP permit will be required for radiological emissions from any facilities (stacks, process vents, etc.) used in SRS salt processing. As described in 40 CFR Part 61.96, if the effective dose equivalent caused by all emissions from facility operations is projected to be less than 1 percent of the 10 millirem per year NESHAP standard, an application for approval to construct under 40 CFR Part 61.07 is not required to be filed. 40 CFR Part 61.96 also allows DOE to use, with prior EPA approval, methods other than EPA standard methods for estimating the source term for use in calculating the projected dose. If DOE's calculations indicate that the emissions from salt processing will exceed 0.1 millirem per year, DOE will, prior to the start of construction, complete an application for approval to construct under 40 CFR 61.07.

Federal Clean Water Act, as amended (33 USC 1251 et seq.); SC Pollution Control Act (SC Code Section 48-1-10 et seq., 1976) (SCDHEC Regulation 61-9.122 et seq.)

The Clean Water Act (CWA), 33 U.S.C. §§ 1251 et. seq., which originated in 1972 as

amendments to the Federal Water Pollution Control Act, establishes the basic structure for regulating discharges of pollutants to waters of the United States. Enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," the CWA gave EPA the authority to set effluent standards on an industry basis and continued existing requirements to set water quality standards for all contaminants in surface waters (33 U.S.C. § 1251). The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters of the United States unless a permit is obtained under the Act's National Pollutant Discharge Elimination System (the NPDES permit system). The NPDES system lies at the core of the administration and enforcement of the CWA. The United States government is subject to the terms and prohibitions of the CWA in essentially the same manner as any other person (33 U.S.C. § 1323).

The CWA provides for the delegation by EPA to state governments of many permitting, administrative, and enforcement aspects of the law. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities. EPA has delegated to South Carolina responsibility for administering the NPDES program.

EPA has delegated primary enforcement authority for the CWA and the NPDES Permitting Program to SCDHEC for waters in South Carolina. In 1996, SCDHEC, under the authority of the Pollution Control Act (48-1-10 et seq.) and Regulation 61-9.122, issued NPDES Permit SC0000175, which addresses wastewater discharges to SRS streams, and NPDES permit SCG250162, which addresses general utility water discharges. The permit contains effluent limitations for physical parameters, such as flow and temperature, and for chemical pollutants with which DOE must comply. DOE will apply for a discharge permit for salt processing facility operations, if the process alternative chosen results in discharges to waters of the State (Table 7-1).

Under Section 402(p) of the CWA, EPA established regulations (40 CFR Part 122.26) for issuing permits for storm water discharges associated with industrial activity. Accordingly, SCDHEC has issued a General Permit for Storm Water Discharges Associated with Industrial Activities (Permit No. SCR000000), authorizing DOE to make stormwater discharges to the waters of the State of South Carolina in accordance with effluent limitations, monitoring requirements, and conditions as set forth in the permit. This permit requires preparation and submittal of a Pollution Prevention Plan for all new and existing point-source discharges associated with industrial activity. Accordingly, DOE-Savannah River Operations Office (SR) has developed a Storm Water Pollution Prevention Plan for storm water discharges at SRS. The SRS Storm Water Pollution Prevention Plan would need to be revised to include pollution prevention measures to be implemented for salt processing operations (Table 7-1), if industrial activities are exposed to storm water. SCDHEC has issued a General Permit for storm water discharges from construction activities that are "Associated with Industrial Activity" (Permit No. SCR100000). An approved plan would be needed that includes erosion control and pollution prevention measures to be implemented for construction activities.

Section 404 of the CWA requires that a permit be issued for discharge of dredge or fill material into the waters of the United States. The authority to implement these requirements has been given to the U.S. Army Corps of Engineers. Section 401 of the CWA requires certification that discharges from construction or operation of facilities, including discharges of dredge and fill material into navigable waters, will comply with applicable water standards. This certification, which is granted by SCDHEC, is a prerequisite for the permit under Section 404. DOE does not believe that such a permit will be required for salt processing.

Section 303(d)(1)(C) of the CWA and the EPA implementing regulation (40 CFR 130.7(c)(1)) require the identification of total

maximum daily loads (TMDLs) for waters identified in Section 303(d)(1)(A) of the CWA. On December 8, 2000, EPA published a proposed TMDL for mercury in the Middle and Lower Savannah River Watershed (EPA 2000). The proposed TMDL affects the portion of the Savannah River within the State of Georgia. It does not specify wasteload allocations for South Carolina NPDES-permitted facilities or other pollution sources discharging to portions of the Savannah River Watershed within the State of South Carolina. However, the TMDL does provide a target concentration of mercury to be achieved at the mid-point of the Savannah River, which is the boundary between Georgia and South Carolina. The majority (99 percent) of the mercury loading in the Savannah River Watershed results from air deposition sources. EPA expects that the reductions in mercury deposition needed to reduce levels of mercury in the Savannah River to the TMDL can be achieved by 2010 through full implementation of the current Clean Air Act Maximum Achievable Control Technology requirements (EPA 2000). The proposed TMDL is not expected to affect implementation of the salt processing alternatives because mercury emissions from the proposed facilities would not be limited by these requirements.

Federal Safe Drinking Water Act, as amended [42 USC 300 (F) et seq., implementing regulations 40 CFR Parts 100-149]; South Carolina Safe Drinking Water Act (Title 44-55-10 et seq.), State Primary Drinking Water Regulations, (SCDHEC R.61-58)

The primary objective of the Safe Drinking Water Act (42 USC 300), as amended, is to protect the quality of the public water supplies. Safe Drinking Water Act requirements have been promulgated by EPA in 40 CFR Parts 100 through 149. The implementing regulations, administered by EPA unless delegated to the states, establish standards applicable to public water systems. They promulgate maximum contaminant levels (MCLs) (including those for radionuclides) in public water systems, which are defined as water sys-

tems that serve at least 15 service connections used by year-round residents or regularly serve at least 25 year-round residents. Construction and operation permits would be required for any major new components associated with SRS salt processing activities (Table 7-1). Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

As a regulatory practice and policy, the Safe Drinking Water Act MCLs also are used as groundwater protection standards. For example, the regulations specify that the average annual concentration of manmade radionuclides in drinking water shall not produce a dose equivalent to the total body or an internal organ dose greater than 4 millirem (mrem) per year beta-gamma activity. This radionuclide MCL is a primary performance objective for the disposal of the grouted low-activity salt solution produced under the salt processing alternatives.

On December 7, 2000, EPA published revisions to the MCLs for certain radionuclides (65 FR 76708). The new rule includes requirements for uranium, which was not previously regulated, and revisions to monitoring requirements. EPA decided to retain the current standards for combined radium-226 and -228 and gross alpha particle radioactivity. EPA also retained the current MCL for beta particle and photon radioactivity, pending further review. The new standard for uranium will be considered with the other MCLs for radionuclides in assessing impacts to groundwater from the salt processing alternatives.

EPA has delegated primary enforcement authority to SCDHEC for public water systems in South Carolina. Under the authority of the South Carolina Safe Drinking Water Act (44-55-10 *et seq.*), SCDHEC has established a drinking water regulatory program (R.61-58). SCDHEC has also established groundwater and surface water classifications and standards under R. 61-68. Along with the Federal MCLs (40 CFR 141), these South

Carolina water quality standards are the groundwater and surface water performance standards applicable to disposal of the grouted low-activity salt solution.

Resource Conservation and Recovery Act, as amended (Solid Waste Disposal Act) (42 USC 6901 et seq.); South Carolina Hazardous Waste Management Act, Section 44-56-30, South Carolina Hazardous Waste Management Regulations (R.61-79.124 et seq.)

The treatment, storage, or disposal of hazardous and nonhazardous waste is regulated under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments of 1984. Pursuant to Section 3006 of the Act, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of its program. The EPA regulations implementing RCRA (40 CFR Parts 260 through 280) define hazardous wastes and specify their transportation, handling, treatment, storage, and disposal requirements. EPA has delegated primary enforcement authority to SCDHEC, which has established hazardous waste management requirements under SC Regulation R.61-79.

The regulations imposed on a generator or a treatment, storage, or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, or disposed. The method of treatment, storage, or disposal also affects the extent and complexity of the requirements.

Under Section 3004(u) of RCRA, DOE is required to assess releases from solid waste management units and implement corrective action plans where necessary. The RCRA corrective action requirements for SRS are set forth in the Federal Facility Agreement (FFA) (Section 7.3.2).

The HLW managed in the F- and H-Area Tank Farms is considered mixed waste because it exhibits characteristics of RCRA hazardous waste (i.e., corrosivity and toxicity for

certain metals) and contains source, special nuclear, or by-product material regulated under the Atomic Energy Act. Waste removed from the tank systems will be managed in accordance with applicable RCRA requirements (i.e., treated to meet the land disposal restrictions standards prior to disposal). DOE would demonstrate that any saltstone produced by grouting the low-activity salt solution would meet applicable RCRA standards. The SRS HLW processing facilities (e.g., Tank Farms, Effluent Treatment Facility, Defense Waste Processing Facility) are exempt from the design and operating standards and permitting requirements for hazardous waste management units because they are wastewater treatment units regulated under the CWA [40 CFR 260.10, 264.1(g)(6) and 270.1(c)(2)(v)]. DOE expects that the new processing facilities for the salt processing alternatives also would be permitted as wastewater treatment units under the CWA.

The Z-Area Saltstone Disposal Facility is permitted as an industrial waste disposal facility (SCDHEC 1986). The current permit application is based on the saltstone composition that was expected to result from the In-Tank Precipitation (ITP) process. The permit application would need to be modified to reflect any differences in the composition of the saltstone resulting from any new salt processing technology. One salt processing alternative, Direct Disposal in Grout, would produce a more radioactive saltstone than the others because cesium would not be removed from the salt solution. That saltstone would be equivalent to Class C (versus Class A for the other salt processing alternatives) LLW as defined by NRC regulations (see 10 CFR 61.55). The current vault design would meet NRC regulations for Class C disposal, although the current permit restricts the average curie content of the saltstone to be within Class A limits. NRC regulations require that Class C waste be structurally stable and provided with protection against inadvertent intrusion for 500 years. The depth of burial and structural stability of the saltstone monoliths would provide the requisite protection against inadvertent intrusion. Modifications to the current vaults

would be required under certain salt processing alternatives (e.g., Direct Disposal in Grout).

The Federal Facility Compliance Act (42 USC 6921 et seq.)

The Federal Facility Compliance Act, enacted on October 6, 1992, amended RCRA. The Act waived sovereign immunity for fines and penalties for RCRA violations at Federal facilities. DOE's immunity continues for fines and penalties resulting from land-disposal-restriction storage-prohibition violations for mixed waste, if DOE prepares plans for developing the required treatment capacity for mixed waste stored or generated at each facility and meets other applicable RCRA requirements. Each plan must be approved by the host state or EPA, after consultation with other affected states, and a consent order must be issued by the regulator requiring compliance with the plan. On September 20, 1995, SCDHEC approved the Site Treatment Plan for SRS. SCDHEC issued a consent order, signed by DOE, requiring compliance with the plan on September 29, 1995. DOE provides SCDHEC with annual updates to the information in the SRS Site Treatment Plan. DOE would be required to notify SCDHEC of any new mixed waste streams generated as a result of salt processing activities.

7.2.2 PROTECTION OF BIOLOGICAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES

The following statutes pertain to protection of endangered or threatened animal and plants, and of historic and cultural resources.

Endangered Species Act, as amended (16 USC 1531 et seq.)

The Endangered Species Act provides a program for the conservation of threatened or endangered species and the ecosystems on which those species rely. All Federal agencies must assess whether the potential impacts of a proposed action could adversely affect threatened or endangered species or their habitat. If so,

the agency must consult with the U.S. Fish and Wildlife Service (part of the U.S. Department of the Interior) and the National Marine Fisheries Service (part of the U.S. Department of Commerce), as required under Section 7 of the Act. The outcome of this consultation may be a biological opinion by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service that states whether the proposed action would jeopardize the continued existence of the species under consideration. If there is a non-jeopardy opinion, but the possibility exists that some individual members of a species might be killed incidentally as a result of the proposed action, the Services can determine that such losses are not prohibited, as long as mitigation measures outlined by the Services are followed. Regulations implementing the Endangered Species Act are codified at 50 CFR Part 15 and 402.

The proposed facilities for the salt processing alternatives are located within fenced, disturbed industrial areas. Proposed salt processing activities would not disturb any threatened or endangered species, would not degrade any critical or sensitive habitat, and would not affect any jurisdictional wetland. Therefore, DOE concludes that no consultation with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service concerning the alternatives considered in this SEIS is required.

Migratory Bird Treaty Act, as amended (16 USC 703 et seq.)

The Migratory Bird Treaty Act, as amended, is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvesting of migratory birds by specifying things such as the mode of harvesting, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill...any migratory bird." Executive Order 13186 (66 FR 3853; 1/17/01) requires that environmental analyses of Federal actions required by the National Environmental Policy Act (NEPA) or other established environmental review proc-

esses evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. If impacts to migratory birds were expected, DOE would be required to consult with the U.S. Fish and Wildlife Service and to evaluate ways to avoid or minimize these effects in accordance with the U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644). The proposed facilities for the salt processing alternatives are within fenced industrial areas without habitat suitable for migratory birds. Therefore, DOE concludes that no consultation with the U.S. Fish and Wildlife Service concerning the alternatives considered in this SEIS is required.

Bald and Golden Eagle Protection Act, as amended (16 USC 668-668d)

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs anywhere in the United States (Sections 668, 668c). A permit must be obtained from the U.S. Department of the Interior to relocate a nest that interferes with resource development or recovery operations. The proposed facilities for the salt processing alternatives are within fenced industrial areas without habitat suitable for nesting eagles.

National Historic Preservation Act, as amended (16 USC 470 et seq.)

The National Historic Preservation Act, as amended, provides that sites with significant national historic value be placed on the *National Register of Historic Places*. No permits or certifications are required under the Act. However, if a particular Federal activity could impact an historic property resource, consultation with the Advisory Council on Historic Preservation will usually generate a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the South Carolina State Historic Preservation Officer ensures the proper identification of potentially significant sites and the implementation of appropriate mitigative actions. The proposed facilities for the salt processing alternatives

would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

Archaeological Resource Protection Act, as amended (16 USC 470 et seq.)

This Act requires a permit for any excavation or removal of archaeological resources from public or Native American lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. Consent must be obtained from the Indian Tribe owning lands on which a resource is located before a permit is issued, and the permit must contain terms or conditions requested by the Tribe. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

Native American Grave Protection and Repatriation Act of 1990 (25 USC 3001)

This law directs the Secretary of the Interior to assume responsibility for repatriation of Federal archaeological collections and collections held by museums receiving Federal funding that are culturally affiliated with Native American Tribes. Major actions to be taken under this law include: (1) establishing a review committee with monitoring and policy-making responsibilities, (2) developing regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims, (3) overseeing museum programs designed to meet the inventory requirements and deadlines of this law, and (4) developing procedures to handle unexpected discoveries of graves or grave goods during activities on Federal or tribal lands. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

American Indian Religious Freedom Act of 1978 (42 USC 1996)

This Act reaffirms Native American religious freedom under the First Amendment and sets U.S. policy to protect and preserve the inherent and constitutional right of Native Americans to believe, express, and exercise their traditional religions. The Act requires that Federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religion. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

In conjunction with 1991 studies related to the New Production Reactor, DOE solicited the concerns of Native Americans about religious rights in the Central Savannah River Valley. During this study, three Native American groups – the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy – expressed general concerns about SRS and the Central Savannah River Area, but did not identify specific sites as possessing religious significance. The Yuchi Tribal Organization and the National Council of Muskogee Creek are interested in plant species traditionally used in tribal ceremonies, such as redroot, button snakeroot, and American ginseng (DOE 1991). Redroot and button snakeroot are known to occur on the SRS (Batson, Angerman, and Jones 1985). The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

7.3 Statutes, Regulations, and Guidelines Related to Emergency Planning, Worker Safety, and Protection of Public Health and the Environment

7.3.1 ENVIRONMENTAL PROTECTION

National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.)

The NEPA establishes a national policy promoting awareness of the environmental consequences of human activity on human health and the environment, and consideration of environmental impacts during the planning and decision-making stages of a project. This Act requires Federal agencies to prepare a detailed statement on the environmental effects of proposed major Federal actions that may significantly affect the quality of the human environment.

This SEIS has been prepared in compliance with NEPA requirements and policies and in accordance with Council on Environmental Quality (40 CFR Parts 1500 through 1508) and DOE (10 CFR Part 1021) regulations for implementing the procedural provisions of NEPA.

Pollution Prevention Act of 1990 (42 USC 13101 et seq.)

The Pollution Prevention Act of 1990 established a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. Disposal or releases to the environment should occur only as a last resort. In response, DOE has committed to participate in the Superfund Amendments and Reauthorization Act Section 313, EPA 33/50 Pollution Prevention Program. The goal for facilities already involved in Section 313 compliance is to achieve by 1997 a 33-percent

reduction in the release of 17 priority chemicals from a 1993 baseline. On August 3, 1993, President Clinton issued Executive Order 12856, expanding the 33/50 program such that DOE must reduce its total releases of all toxic chemicals by 50 percent by December 31, 1999. In addition, DOE is requiring each of its sites to establish site-specific goals to reduce the generation of all waste types.

Comprehensive Guideline for Procurement of Products Containing Recovered Materials (40 CFR Part 247)

This guideline is issued under the authority of Section 6002 of RCRA and Executive Order 12783, which set forth requirements for Federal agencies to procure products containing recovered materials for use in their operations, using guidelines established by the EPA. The purpose of these regulations is to promote recycling by using government purchasing to expand markets for recovered materials. RCRA Section 6002 requires that any purchasing agency, when using appropriated funds to procure an item, shall purchase it with the highest percentage of recovered materials practicable. The procurement of materials to be used in the SRS salt processing activities will be conducted in accordance with these regulations.

Toxic Substances Control Act, as amended (USC 2601 et seq.) (40 CFR Part 700 et seq.)

The Toxic Substances Control Act regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statutes, particularly polychlorinated biphenyls (40 CFR Part 761), chlorofluorocarbons (40 CFR Part 762), and asbestos (40 CFR Part 763). DOE does not expect to use these materials under any of the salt processing alternatives.

7.3.2 EMERGENCY PLANNING AND RESPONSE

This section discusses the regulations that address protection of public health and worker safety and require the establishment of emer-

gency plans and coordination with local and Federal agencies related to facility operations. DOE Orders generally set forth the programs and procedures required to implement the requirements of these regulations. See Section 7.5.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)

The Atomic Energy Act of 1954, as amended, authorizes DOE to establish standards to protect health and minimize dangers to life or property with respect to activities under its jurisdiction [42 USC 2201(b)]. Through a series of Orders, DOE has established an extensive system of standards and requirements to promote the safe operation of its facilities.

Section 202(4) of the Energy Reorganization Act of 1974 (42 USC §5842(4)), which amended the Atomic Energy Act, gives the NRC licensing authority over DOE facilities authorized for long-term storage of HLW generated by DOE. DOE (Sullivan 1998) determined that NRC's licensing authority is limited to DOE facilities that are (1) authorized by Congress for the express purpose of long-term storage of HLW, and (2) developed and constructed after the passage of the Energy Reorganization Act. None of the facilities associated with the salt processing alternatives meet both criteria. Although DOE has responsibility for such determinations, the Savannah River Operations Office plans to consult with NRC on the incidental waste determination for the low-activity salt solution as described in Section 7.1.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.); Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release (10 CFR Part 30.72 Schedule C)

The list of quantities in Schedule C of 10 CFR 30.72 is the basis for both the public and private sector to determine if the radiological materials they deal with must have an emergency response plan for unscheduled releases. It establishes threshold criteria documents for

DOE Emergency Preparedness Hazard Assessments required by DOE Order 151.1, "Comprehensive Emergency Management System". An emergency response plan addressing salt processing facility operations would be prepared in accordance with this regulation.

The Disaster Relief and Emergency Assistance Amendments of 1988 (42 USC 5121 et seq.), Emergency Management and Assistance (44 CFR Part 351)

These regulations generally include the policies, procedures, and responsibilities of the Federal Emergency Management Agency, NRC, and DOE (44 CFR 351.24) for implementing a Federal Emergency Preparedness Program to include radiological planning and preparedness. An emergency response plan, including radiological planning and preparedness for salt processing facility operations, would need to be prepared and implemented, in accordance with this regulation.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC 11001 et seq.) (also known as "SARA Title III")

The Emergency Planning and Community Right-to-Know Act of 1986 (also known as "SARA Title III") requires emergency planning and notice to communities and government agencies of the presence and release of specific chemicals. EPA implements this Act under regulations found at 40 CFR Parts 355, 370, and 372. Under Subtitle A of this Act, Federal facilities provide various information (such as inventories of specific chemicals used or stored and releases that occur from these facilities) to the State Emergency Response Commission and the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. DOE's implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988. In addition, DOE requires compliance with SARA Title III as a matter of Departmental policy. DOE submits hazardous chemical in-

ventory reports for SRS to SCDHEC. The chemical inventory could change, depending on the salt processing alternative DOE implements; however, subsequent reports would reflect any change to the inventory.

Transportation of Hazardous Materials (49 USC 5101 et seq.); Hazardous Materials Tables & Communications, Emergency Response Information Requirements (49 CFR Part 172)

The regulatory requirements for marking, labeling, placarding, and documenting hazardous materials shipments are defined in 40 CFR Part 172. This regulation also specifies the requirements for providing hazardous material information and training. Materials shipped to the salt processing facilities would comply with these regulations.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (42 USC 9601 et seq.); National Oil and Hazardous Substance Contingency Plan (40 CFR Part 300 et seq.)

More popularly known as CERCLA or "Superfund," the Act and implementing regulations provide the authority for Federal and state governments to respond directly to hazardous substances incidents. The regulations require reporting of spills, including radioactive materials, to the National Response Center. DOE Orders generally set forth the programs for development of internal procedures for implementing the regulations. DOE would be required to comply with these regulations in the event of spills of hazardous substances at the salt processing facilities.

DOE, SCDHEC, and EPA have signed an FFA to coordinate cleanup at SRS, as required by Section 120 of CERCLA. Section IX of the Agreement sets forth requirements for the SRS HLW tank systems. Design and operating standards for the tank systems are found in Appendix B of the Agreement. DOE has submitted a waste removal plan and schedule for the tank systems that do not meet applicable secondary containment standards. The

approved FFA waste removal schedule appears in Appendix E of the *Savannah River Site High Level Waste System Plan* (WSRC 2000). DOE must provide an annual report on the status of the HLW tank systems being removed from service. After waste removal is completed, the tank systems are available for closure in accordance with general closure strategy for the F- and H-Area waste tank systems (DOE 1996). Implementation of salt processing is essential to meeting DOE's obligations under the FFA. Under the No Action alternative, DOE would continue to store the salt solutions. If salt processing is not operational by 2010, DOE would consider other options, as described in Section 2.3.

Occupational Safety and Health Act of 1970, as amended (29 USC 651 et seq.); Occupational Safety and Health Administration Emergency Response, Hazardous Waste Operations and Worker Right to Know (29 CFR Part 1910 et seq.)

The Occupational Safety and Health Act (29 USC 651) establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. While OSHA and EPA both have a mandate to reduce exposures to toxic substances, OSHA's jurisdiction is limited to safety and health conditions that exist in the workplace environment. In general, under the Act, it is the duty of each employer to furnish all employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. The OSHA regulations (29 CFR) establish specific standards with which employers must comply to achieve a safe and healthful working environment. This regulation sets down the OSHA requirements for employee safety in a variety of working environments. It addresses employee emergency and fire prevention plans (Section 1910.38), hazardous waste operations

and emergency response (Section 1910.120), and hazard communication (Section 1910.1200) that enable employees to be aware of the dangers they face from hazardous materials at their workplaces. DOE places emphasis on compliance with these regulations at its facilities and prescribes, through DOE Orders, OSHA standards that contractors shall meet, as applicable to their work at government-owned, contractor-operated facilities. DOE keeps and makes available the various records of minor illnesses, injuries, and work-related deaths required by OSHA regulations.

Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.

7.4 Executive Orders

The following executive orders would apply to the SRS salt processing activities. DOE Orders generally set forth the programs and procedures required to implement the requirements of the Orders.

Executive Order 11514 (Protection and Enhancement of Environmental Quality)

Executive Order 11514 requires Federal agencies to monitor and control their activities continually to protect and enhance the quality of the environment to develop procedures to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impacts, and to obtain the views of interested parties.

Executive Order 11988 (Floodplain Management)

Executive Order 11988 requires Federal agencies to establish procedures to ensure that the

potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain, and that floodplain impacts be avoided to the extent practicable.

Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 requires government agencies to avoid any short- and long-term adverse impacts on wetlands, wherever there is a practicable alternative.

Executive Order 12856 (Right-to-Know Laws and Pollution Prevention Requirements)

Executive Order 12856 requires all Federal agencies to reduce the toxic chemicals entering any waste stream. This order also requires Federal agencies to report toxic chemicals entering waste streams; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative pollution prevention technologies.

Executive Order 12898 (Environmental Justice)

Executive Order 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Executive Order 12902 (Energy Efficiency and Water Conservation at Federal Facilities)

Executive Order 12902 requires Federal agencies to develop and implement programs for conservation of energy and water resources.

7.5 DOE Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environ-

mental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE Orders. Table 7-2 lists the major DOE Orders applicable to the salt processing alternatives.

The DOE regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For purposes of this SEIS, relevant regulations include 10 CFR Part 820, *Procedural Rules for DOE Nuclear Facilities*; 10 CFR Part 830, *Nuclear Safety Management, Contractor and Subcontractor Activities*; 10 CFR Part 835, *Occupational*

Radiation Protection; 10 CFR Part 1021, *Compliance with NEPA*; and 10 CFR Part 1022, *Compliance with Floodplains/Wetlands Environmental Review Requirements*. DOE has enacted occupational radiation protection standards to protect DOE and its contractor employees. These standards are set forth in 10 CFR Part 835, *Occupational Radiation Protection*; the rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities, including those conducted by DOE contractors. The activity may be, but is not limited to, design, construction, or operation of DOE facilities.

Table 7-2. DOE Orders and Standards relevant to the salt processing alternatives.

151.1A	Comprehensive Emergency Management System
225.1A	Accident Investigation
231.1	Environment, Safety and Health Reporting
232.1A	Occurrence Reporting and Processing of Operations Information
252.1	Technical Standards Program
420.1	Facility Safety
425.1B	Startup and Restart of Nuclear Facilities
430.1A	Life Cycle Asset Management
435.1	Radioactive Waste Management
440.1A	Worker Protection Management for DOE Federal and Contractor Employees
451.1B	National Environmental Policy Act Compliance Program
460.1A	Packaging and Transportation Safety
460.2	Departmental Materials Transportation and Packaging Management
470.1	Safeguards and Security Program
471.1A	Identification and Protection of Unclassified Controlled Nuclear Information
471.2A	Information Security Program
472.1B	Personnel Security Activities
474.1A	Control and Accountability of Nuclear Materials
1270.2B	Safeguards Agreement with the International Atomic Energy Agency
3790.1B	Federal Employee Occupational Safety and Health Program
4330.4B	Maintenance Management Program
4700.1	Project Management System
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.20A	Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports

Applicable Laws, Regulations, and Other Requirements

5632.1C	Protection and Control of Safeguards and Security Interests
5660.1B	Management of Nuclear Materials
6430.1A	General Design Criteria
1020-94	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
1021-93	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
1024-92	Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities
1027-92	Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis Reports
3009-94	Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports
3011-94	Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans

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APPENDIX A
TECHNOLOGY DESCRIPTIONS

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APPENDIX A. TECHNOLOGY DESCRIPTIONS

A.1 Introduction

The Savannah River Site (SRS) currently stores 34 million gallons of aqueous high-level waste (HLW) in F- and H-Area Tank Farms (Figures A-1 and A-2; see also text box on this page). This waste comprises approximately 2.8 million gallons of insoluble sludge, 15.2 million gallons of solid salt-cake, and 16 million gallons of supernatant salt, all contained in 49 large underground steel tanks. The U.S. Department of Energy (DOE) is committed to removing this waste material from the HLW tanks and processing it for final disposal to resolve critical safety and regulatory issues.

TC | DOE has developed processes and facilities to convert the aqueous wastes into environmentally safe forms for long-term storage and final disposal (DOE 1994, 1995). Sludge components of the wastes, which contain most of the radioactive strontium and alpha-emitting actinides (such as plutonium), are washed and treated with sodium hydroxide to reduce the aluminum content, then mixed with glass frit for melting into a glass waste form in the Defense Waste Processing Facility (DWPF). Soluble salt components of the wastes were to be treated in a large waste tank, using a precipitation-sorption process denoted In-Tank Precipitation (ITP), to remove radioactive cesium (principally cesium-137) and other radionuclides for vitrification, along with sludge, in DWPF. The cesium would be precipitated

as an insoluble tetraphenylborate salt, and residual strontium and actinides would be sorbed on a particulate solid, monosodium titanate, to be filtered from the solution for transfer to the DWPF. The low activity salt solution would be fixed in a concrete-like material (saltstone) for onsite disposal in engineered vaults. After interim storage at SRS the waste glass in stainless steel canisters would be shipped to a monitored geologic repository for final disposal.

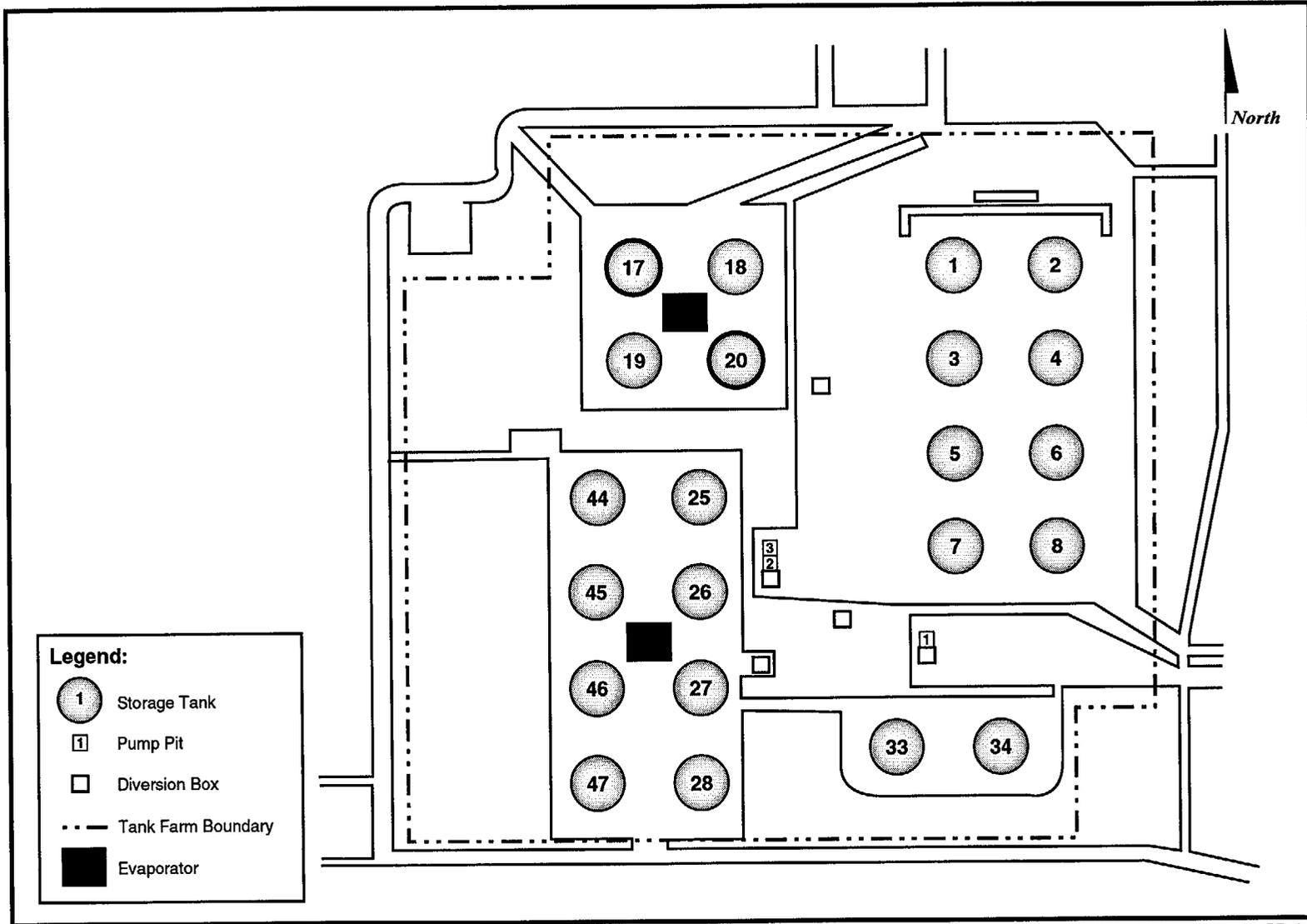
The sludge processing operations were successfully implemented and immobilization of these wastes in glass at DWPF is in progress. During startup of the ITP process, however, the decomposition of the tetraphenylborate produced benzene in amounts higher than predicted. A comprehensive process review concluded that the tetraphenylborate decomposition and benzene release associated with ITP operation could exceed the design capability of the existing facilities, preventing safety and production requirements being met in a cost-effective manner (see text box page A-4).

Evaluation of alternative technologies resulted in the identification of four candidates to replace the ITP process (WSRC 1998a):

- Small Tank Tetraphenylborate Precipitation
- Crystalline Silicotitanate Ion Exchange
- Caustic Side (non-elutable) Solvent Extraction
- Direct Disposal (of cesium) in Grout.

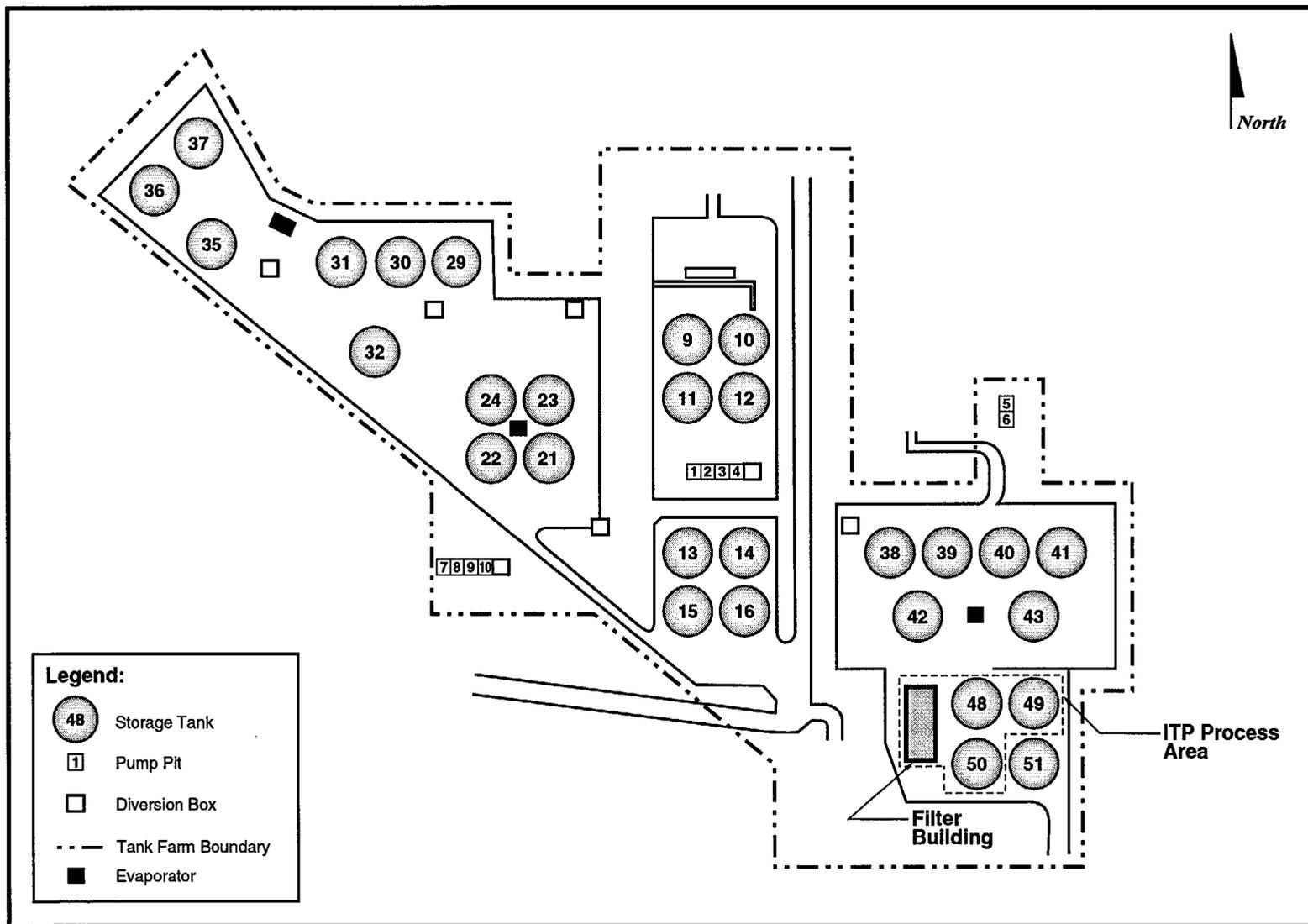
Waste Tank Concerns and Commitments

Two of the original 51 HLW storage tanks (numbers 17 and 20) at SRS had waste removed and have been closed. Of the remaining 49 tanks, 10 (numbers 1, 6, 9, 10, 11, 12, 13, 14, 15, and 16) have leaked observable quantities of liquid waste from primary to secondary containment and one tank (number 16) leaked a few tens of gallons of waste to the environment (WSRC 1998a). One other tank (number 19) has cracks in the tank wall above the level of the waste, although no waste has been observed to leak through these cracks. Tanks 1 through 24 do not meet U.S. Environmental Protection Agency (EPA) secondary containment and leak detection standards for storage of hazardous waste, effective January 12, 1987 (40 CFR 264). Removal of wastes and closure of these tanks by 2022 is required by the Federal Facility Agreement (FFA) for SRS entered into by the DOE, EPA, and the South Carolina Department of Health and Environmental Control (SCDHEC) (EPA 1993). All HLW at SRS is land-disposal-restricted waste, prohibited from long-term storage, and must be removed from the HLW tanks by the year 2028 as a result of FFA (WSRC 2000a).



NW SDA EIS/Grfx/App A/A-1 Lay F Tank.ai

Figure A-1. General layout of F-Area Tank Farm (Tanks 17 and 20 are closed).



NW SDA EIS/Griv/App A/A-2 Lay H Tank.ai

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

The environmental impacts of constructing and operating facilities for these alternative technologies are being identified and evaluated in this *Salt Processing Alternatives Supplemental Environmental Impact Statement (SEIS)* (DOE 1998a, 1999).

Need for ITP Replacement

Benzene generated during the ITP process results from the decomposition of tetraphenylborate (TPB), which is used to separate soluble radioactive cesium from the HLW salt solution. The cesium is precipitated as an insoluble solid that can be filtered from the waste solution. Under certain conditions the tetraphenylborate is subject to a radiolytic and catalytic decomposition that forms benzene and allows the separated cesium to return to the salt solution. Benzene is a toxic, flammable, and potentially explosive organic substance that must be safely controlled. The redissolution of cesium as a result of tetraphenylborate decomposition must be curtailed to achieve the required decontamination of the salt solution.

Tetraphenylborate decomposition is catalyzed by certain metals in the radioactive waste, notably the fission product palladium. The extent and rate of tetraphenylborate decomposition is affected by the chemical form of the catalyst, and increases with time of exposure to and temperature of the catalyst. Controlled release of benzene from the salt solution, as required to mitigate potential benzene hazards, is promoted by agitation or stirring. Flammability is controlled by maintaining a nitrogen gas cover that excludes oxygen above concentrations that could cause benzene combustion.

The ITP facilities were unsuitable to control tetraphenylborate decomposition and benzene generation because:

- Large volumes and long cycle times allowed excessive tetraphenylborate decomposition before the precipitate could be separated by filtration from the salt solution.
- Adequate temperature control was not possible in the large tank.
- Agitation by slurry pumps produced insufficient mixing.
- Purge of the nitrogen gas cover was inadequate because the large tank was not adaptable to positive pressure or secondary confinement.

These limitations were assessed against requirements for safely processing the large inventory of HLW salt within the time projected for completion of sludge processing in the DWPF. Based on this assessment, DOE concluded that the ITP process could not achieve safety and production requirements for the high-level radioactive waste system.

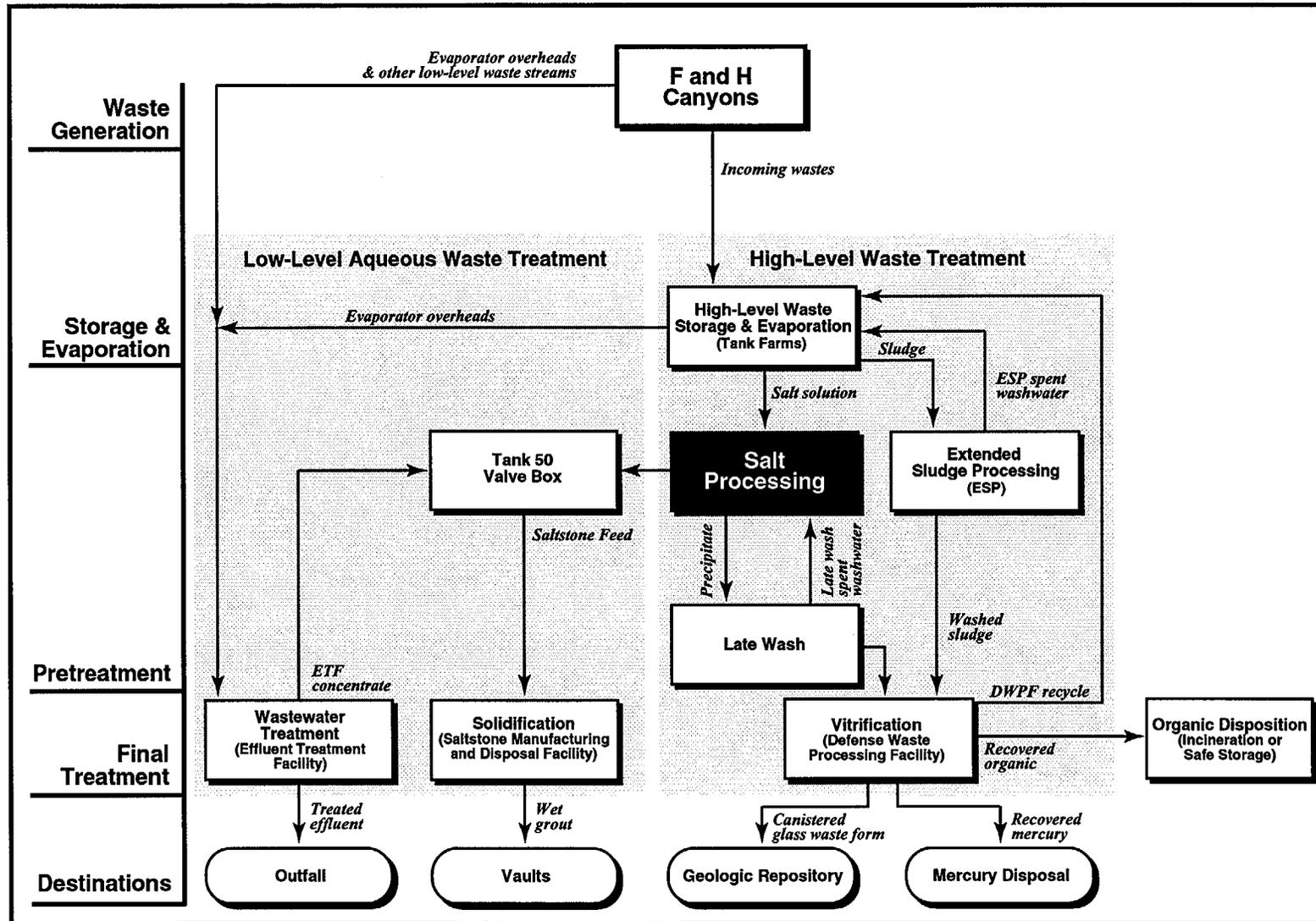
A.2 Current HLW System Configuration

The SRS HLW system was developed to receive and store radioactive wastes in a safe and environmentally sound manner and to convert these wastes into forms suitable for final disposal (DOE 1994). A schematic of the process is shown in Figure A-3 (WSRC 1998b). As planned, sludge components and the highly radioactive soluble constituents recovered from the salt components of the wastes would be immobilized in DWPF as borosilicate glass contained in stainless steel canisters for disposal in a monitored geologic repository. Low activity salt solutions would be immobilized in cementitious form (saltstone) for disposal in onsite vaults. Secondary products from these operations, including mercury derived from sludge processing and benzene released during salt processing operations, would be recovered for appropriate disposition (recycling or destruction). Miscellaneous radioactive and hazardous process wastes would be incorporated into the SRS waste management system for disposal.

A.3 Processes and Facilities

A.3.1 HLW STORAGE AND EVAPORATION

HLW from SRS chemical processing operations is received in the F- and H-Area Tank Farms as an aqueous slurry of insoluble sludge and soluble salts in alkaline solution. The tank farms concentrate (by evaporation of excess water) and store these wastes, pending further processing in other facilities. The sludge component of the alkaline wastes settles to the bottom of the storage tank, and the salt solution is decanted and concentrated by evaporation, leaving a solid saltcake and a concentrated supernatant. Evaporation reduces the volume and mobility of the wastes, enhancing long-term storage. The water driven off by evaporation is processed through the Effluent Treatment Facility (ETF) for decontamination before release to an onsite stream. No water is released from ETF to a stream unless it meets all regulatory criteria.



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Figure A-3. SRS high-level waste system configuration.

A.3.2 EXTENDED SLUDGE WASHING

The insoluble sludges accumulated in the tanks are hydraulically slurred and transferred to tank farm facilities for washing with inhibited water to remove soluble salts entrained in the sludge. (Inhibited water contains low concentrations of sodium nitrite and sodium hydroxide to inhibit corrosion of the steel waste tanks.) To reduce the quantity of glass waste formed, sludge with high levels of aluminum is treated with caustic (3 to 5 molar sodium hydroxide) to convert aluminum hydroxide to soluble sodium aluminate, which is washed from the sludge along with other soluble salts. The wash solutions are concentrated by evaporation and returned to the waste tanks as salt waste components. The washed sludge is transferred to DWPF for conversion to the borosilicate glass waste form.

A.3.3 SALT PROCESSING

In the salt processing operations, as originally projected, saltcake in the waste tanks would be redissolved and combined with concentrated supernatant, and the resulting salt solution transferred hydraulically to the ITP facilities. ITP was to be conducted in a large waste tank; tetraphenylborate would be added to the salt solution to coprecipitate radioactive cesium (along with essentially nonradioactive potassium) as an insoluble solid, and a slurry of the particulate solid monosodium titanate would be added to react with residual strontium and actinides by a sorption process. The resulting precipitate solids would be concentrated in the tank and separated by cross-flow filtration before being transferred to DWPF for melting into a glass waste form, along with sludge components of the waste. (Cross-flow filtration is a process in which the solid slurry is passed through porous membrane tubes under pressure to force the salt solution into a surrounding vessel and concentrate the solids in the slurry.) The low activity salt solution recovered by filtration would be immobilized in onsite vaults as saltstone.

A.3.4 DWPF GLASS PROCESSING

If the ITP process were operational, sludge and salt precipitate solids would be transferred as aqueous slurries to DWPF for conversion in a glass melter to the glass waste form. Currently, only sludge is being vitrified at DWPF.

In DWPF, the sludge slurry is acidified and treated chemically to extract mercury before the sludge is sent to the glass melter. The recovered mercury is stored for future disposal. If ITP operated for salt processing, the precipitate slurry would be treated in DWPF, using a hydrolysis process to decompose the tetraphenylborate solids. The hydrolysis reaction would produce an aqueous solution of inorganic salts including the radioactive cesium, several organic products (principally benzene), boric acid, and residual titanate solids. The benzene would be distilled from the mixture, washed, and collected for disposal. To avoid potential explosion hazards from benzene, the tetraphenylborate precipitate would be processed in a carbon dioxide atmosphere. The aqueous residues of the precipitate hydrolysis process would be mixed with sludge and glass frit as feed for the DWPF melter. Molten glass would be poured into stainless steel canisters about 2 feet in diameter by 10 feet long, suitable for interim onsite storage and permanent disposal in a monitored geologic repository.

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Storage of Recycle DWPF Wastes

DWPF operations produce large volumes of recycle wastes, mostly water, returned to the HLW storage tanks. Without a salt processing technology in place, the DWPF sludge-only operation will increase the volume of waste that must be stored in the HLW tanks. Management of existing tank space and equipment would allow DOE to continue sludge-only vitrification in DWPF until about 2010, the projected time for startup of salt processing plant operations (text box page 2-2).

Tank space management would include some or all of the following activities intended to reduce storage requirements in the HLW tanks (WSRC 1999a):

- Continue to evaporate liquid waste in the tanks
- Convert ITP processing tanks 49 and 50 to HLW storage
- Reduce DWPF low-level waste streams sent to the tank farms
- Implement several activities to gain small incremental volumes
- As 2010 approaches, reduce the available emergency space in the tank farms while maintaining the minimum emergency space required by the Authorization Basis.

A.3.5 SALTSTONE PROCESSING

The low activity salt solution from the ITP process would be mixed with a blend of cement, flyash, and slag in the Saltstone Manufacturing and Disposal Facility to produce a grout suitable for disposal in onsite vaults. The grout would be poured into the vaults to solidify into large saltstone monoliths.

As originally designed, the saltstone vaults are near-surface concrete containment structures that serve as forms for the cast saltstone and provide a diffusion barrier to the environment (Wilhite 1986; Wilhite et al. 1989). The vaults, 300 feet in length, 200 feet wide, and about 25 feet high, with 1.5-foot-thick sidewalls, a 2.5-foot base and a 1.5-foot cover, are sized to contain approximately 1.4 million cubic feet (40,000 m³) of saltstone within six subdivided cells of the vault. During decommissioning, clay caps would be placed over the vaults, with drainage systems installed between the caps to reduce the volume of rainwater infiltrating the disposal site.

The grout composition and the vault design were specified to minimize the release rate

of waste components into the surrounding environment (Langton 1988; Wilhite 1986). Performance criteria imposed on the saltstone vaults required that groundwater quality at the disposal site meet drinking water standards. Performance modeling, validated by field tests, demonstrated the capability of the saltstone vaults to meet these standards (Martin Marietta 1992).

A.4 Salt Processing Alternatives

Facility capabilities have been demonstrated and all waste processing operations for the SRS HLW management system are currently operational, with the exception of ITP processing and related late wash of the precipitate. In December 1995, DOE determined that the ITP process was generating benzene at higher rates than expected and operational testing was suspended in March 1996. Benzene is a flammable product of the decomposition of tetraphenylborate added to precipitate cesium from the salt solution. The excess benzene resulted from the decomposition of tetraphenylborate in the processing tank, allowing redissolution of the precipitate before it could be separated by filtration. In concurrence with a Defense Nuclear Facilities Safety Board recommendation, chemical studies were initiated that would better explain the underlying mechanisms for benzene generation and release during the tetraphenylborate precipitation process. These studies demonstrated that the process to remove cesium from the salt solution, as then configured, could not achieve production goals and meet safety requirements for processing the salt wastes.

In early 1998, DOE directed Westinghouse Savannah River Company (WSRC) to initiate a program for evaluation of alternative salt processing technologies. A High-Level Waste Salt Processing Systems Engineering Team (SET) was chartered to identify technologies to replace the ITP process, evaluate the technologies, and recommend a selected technology or technologies to convert the HLW salt solution (supernatant plus dissolved saltcake) to waste forms that could meet regulatory requirements. The SET was composed of WSRC employees with technical support from universities, several na-

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tional laboratories, independent consultants, and the DOE complex.

The initial screening of approximately 140 salt processing technologies options identified 18 for further evaluation. The 18 technologies, grouped by general category (WSRC 1998c), were:

Crystallization

Fractional Crystallization – DWPF Vitrification

Electrochemical Separation

Electrochemical Separation and Destruction – DWPF Vitrification

Ion Exchange

Elutable Ion Exchange – DWPF Vitrification

Acid Side Ion Exchange – DWPF Vitrification

Crystalline Silicotitanate Ion Exchange – DWPF Vitrification

Crystalline Silicotitanate Ion Exchange – New Facility Vitrification

Crystalline Silicotitanate Ion Exchange – Ceramic Waste Form

Zeolite Ion Exchange – DWPF Vitrification

Precipitation

Potassium Removal followed by Tetraphenylborate Precipitation – DWPF Vitrification

Reduced Temperature ITP – DWPF Vitrification

Catalyst Removal ITP – DWPF Vitrification

ITP with Enhanced Safety Features – DWPF Vitrification

Small Tank Tetraphenylborate Precipitation – DWPF Vitrification

Solvent Extraction

Caustic Side Solvent Extraction – DWPF Vitrification

Acid Side Solvent Extraction – DWPF Vitrification

Vitrification

Direct Vitrification

Supernatant Separation – DWPF Vitrification

Direct Disposal of Cesium in Grout – DWPF Vitrification

A.4.1 SCREENING

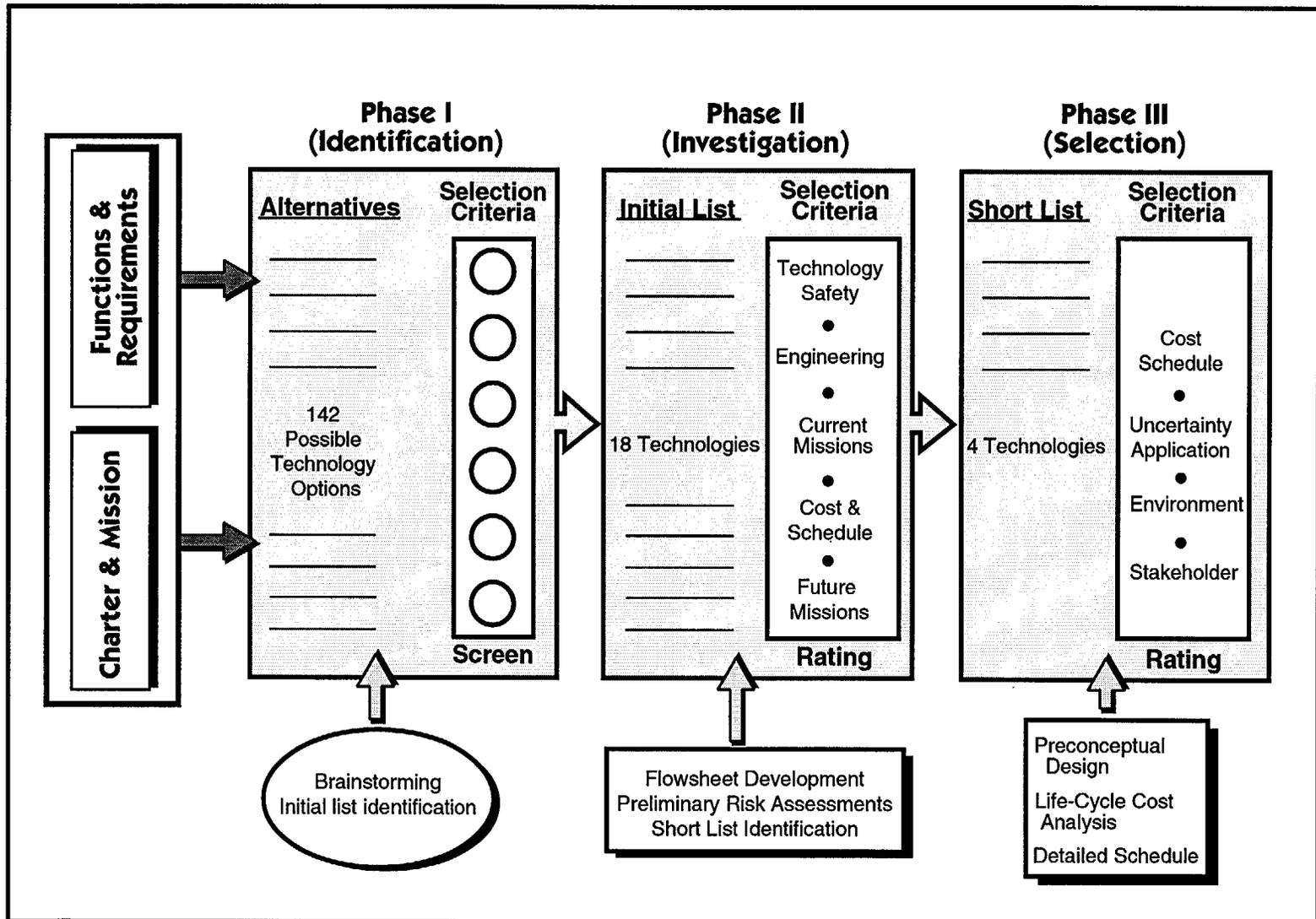
The SET employed a phased approach, as summarized in Figure A-4. In Phase I, approximately 140 possible technology options were identified to replace ITP, and meet safety and production requirements. Each option was evaluated against a set of screening criteria that established minimum requirements. This initial screening reduced the original 140 options to 18 technologies that were selected for further evaluation.

During Phase II of the technology selection process, the SET performed a preliminary technical and programmatic risk assessment for each of the 18 technologies to establish a short list for in-depth analysis. As part of the Phase II analysis, the SET evaluated preliminary material balances, cycle times, and impacts to the HLW system for each of the 18 technologies. A technical document (WSRC 1998d) provides supporting data and the results of this assessment, which narrowed the list of 18 technologies to four:

- Small Tank Tetraphenylborate Precipitation (Small Tank Precipitation)
- Crystalline Silicotitanate (non-elutable) Ion Exchange (Ion Exchange)
- Caustic Side Solvent Extraction (Solvent Extraction)
- Direct Disposal (of cesium) in Grout (Direct Disposal in Grout).

Phase III of the process evaluated the final four technologies in still greater detail, including life-cycle cost estimates and schedule assessments (WSRC 1998b). Some of the uncertainties and assumptions in the Phase II efforts were resolved in Phase III by additional research, literature review, calculations, and experiments. The facility components of the technologies, such as tanks and transport systems, were described in greater detail. Equipment sizing was refined and used to develop pre-conceptual facility layouts and process flow configurations. The layouts were used to develop project schedules and life-cycle cost estimates. This analysis is docu-

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Figure A-4. Phased approach to screening and selecting salt processing technologies.

mented (WSRC 1998e) and forms the basis for the environmental impact analysis presented in this SEIS.

A.4.2 RECOMMENDATION AND REVIEW

On October 29, 1998, following review by the WSRC Review Panel Team, WSRC recommended to DOE the Small Tank Precipitation process as the most reasonable replacement salt processing technology and the Ion Exchange process as a backup technology (WSRC 1998f).

A DOE Savannah River (SR) Review Team evaluated the WSRC recommendation and concluded that the remaining technical uncertainties for each of the alternatives were too significant to justify selection of a preferred technology (DOE 1998b). The DOE-SR Review Team recommended that additional research and development be conducted to address the key technical uncertainties associated with the two technologies, so that one could be identified as most reasonable. The Review Team agreed with WSRC that one of the four technologies considered in Phase III, Solvent Extraction, should be eliminated from further consideration because of its insufficient technical maturity. The DOE Review Team concluded that the Direct Disposal in Grout alternative should not be eliminated, based on its potential to reduce construction and operating costs and the high confidence in its technology, safety, and feasibility for implementation.

A DOE-Headquarters Independent Review Team concluded that both the Small Tank Precipitation and the Ion Exchange alternatives were technically feasible. This team agreed with the SET that Direct Disposal in Grout should be eliminated from further consideration, because of regulatory issues that had the potential to substantially increase the time required to implement the technology (DOE 1998c). DOE concluded that further investigations of this alternative would not be pursued as long as a cesium-

separation technology could be proved technically and economically practical.

In January 1999, DOE directed WSRC to conduct additional research and development on the Small Tank Precipitation and Ion Exchange alternatives. These additional studies concluded with WSRC maintaining its recommendation to pursue design and construction for the Small Tank Precipitation process (WSRC 1999b,c). WSRC further noted that, with additional development to reduce technical and engineering risk factors, the Ion Exchange process could also prove suitable for SRS, as well as a DOE complex-wide application for salt processing.

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During this period, the technology for the Solvent Extraction process advanced independent of the SRS alternative evaluations. This information, coupled with recommendations from the National Research Council of the National Academy of Sciences (NAS 1999, 2000) and improved understanding of tank farm water management issues (WSRC 1999a), led the Department to reconsider the potential to mature and implement this alternative in time to support HLW salt processing needs.

In February 2000, DOE requested WSRC to initiate further development of the Solvent Extraction alternative, aimed at the timely resolution of previously identified problems (DOE 2000). Consequently, the Solvent Extraction technology is included as a reasonable alternative in the SEIS.

A.4.3 PROCESS DESCRIPTIONS

A.4.3.1 Small Tank Tetraphenylborate Precipitation

In the Small Tank Precipitation technology (WSRC 1998e,g,h), the soluble salt components of the wastes would be processed using precipitation-sorption procedures analogous to the ITP process to separate cesium and other soluble constituents from the waste solutions. The process would be conducted as a continuous operation in stirred small tanks (15,000 gallons) with the solution agitated constantly to avoid excessive decomposition of tetraphenylborate and

accompanying generation of benzene before separation. In the Small Tank Precipitation technology, tetraphenylborate solution would be added to precipitate cesium and potassium, and a slurry of monosodium titanate would be added to sorb residual strontium and actinides from the salt solution. The resulting solids, along with residual sludge, would be concentrated by filtration and washed to remove soluble salts, then treated chemically to convert the precipitate to a non-flammable form for transfer to DWPF. Catalytic decomposition of the precipitate, with removal of the benzene formed, would generate a product stream containing cesium in aqueous solution and strontium and actinides sorbed onto monosodium titanate for vitrification. The low activity salt solution recovered by filtration would be transferred to the Saltstone Manufacturing and Disposal Facility for processing. The wash water would be recycled into the incoming soluble salt solution.

Small Tank Precipitation would be performed in a new facility to be constructed at Site B in S Area. Process flows for the Small Tank Precipitation alternative are shown in Figure A-5. Salt solution would be collected in an H-Area tank and pumped to the Small Tank Precipitation facility. A section of new interarea transfer line would be required to connect the new facility to the existing transfer line. The precipitation process would be conducted in two Continuous Stirred Tank Reactors. Salt solution mixed with tetraphenylborate, monosodium titanate, process water, and recycled wash water in the first tank reactor would flow to the second tank reactor, providing reaction conditions needed to maximize decontamination factors for the precipitation and sorption processes.

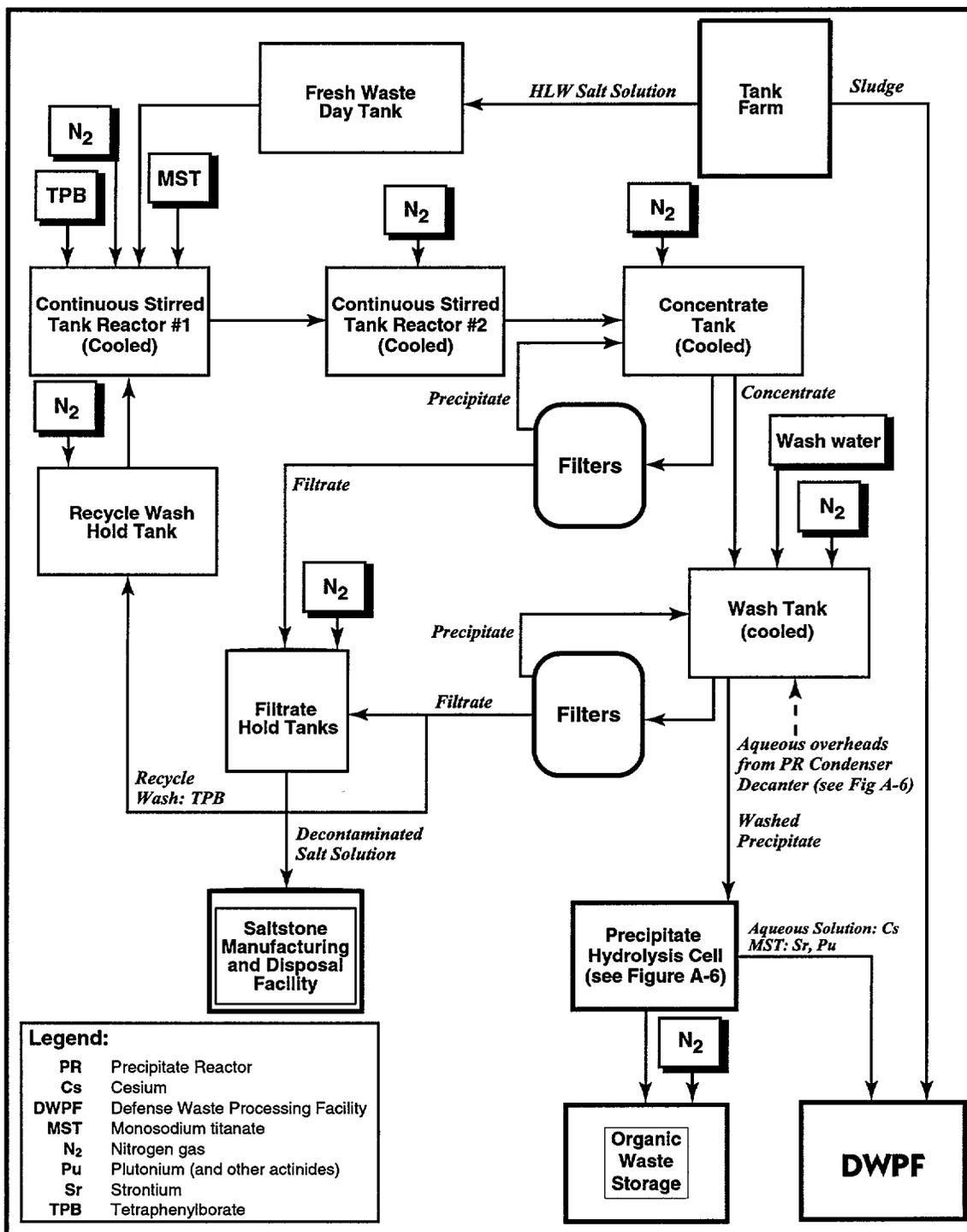
The precipitate slurry, containing about one weight percent tetraphenylborate and monosodium titanate solids, would be transferred continuously from the second tank reactor to a Concentrate Tank, where it would be con-

centrated to about 10 weight percent solids by cross-flow filtration. The resulting filtrate would be pumped to a Filtrate Hold Tank for later transfer to the Saltstone Manufacturing and Disposal Facility for immobilization in the saltstone vaults.

The precipitate slurry accumulated in the Concentrate Tank would be transferred to the Wash Tank for washing in a batch process to remove soluble sodium salts. Spent wash water would be separated from the precipitate by cross-flow filtration. The washed precipitate would be treated in the Precipitate Hydrolysis Cell (PHC) of the facility to eliminate benzene and generate an aqueous product stream termed Precipitate Hydrolysis Aqueous (PHA).

The PHC incorporates process operations formerly assigned to the Salt Processing Cell of DWPF (see text box below). Process flows for the PHC are shown in Figure A-6. In the PHC, the washed precipitate would be combined with a copper nitrate-formic acid solution in the Precipitate Reactor to catalytically decompose the tetraphenylborate precipitate. The Precipitate Reactor would be heated to boiling and the benzene would be removed as it was formed. The benzene and water vaporized during boiling would be condensed in the Precipitate Reactor Condenser, with aqueous and organic condensates separated by decantation for return to the Precipitate Evaporator and Organic Evaporator, respectively. After a period of reflux boiling, the PHA product would be concentrated by distillation, with the aqueous overheads transferred to the Precipitate Wash Tank.

A second evaporation would be conducted in the PHC to ensure that the separated organic was sufficiently decontaminated for transfer outside the containment area. Wash water would be added to the Organic Evaporator and the boiling, evaporation, and decantation cycle would be repeated, with the twice-distilled benzene collected in the Organic Evaporator Condensate Tank for transfer to the Organic Waste Storage Tank.



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Figure A-5. Small Tank Precipitation process flow diagram.

Transfer of DWPF Salt Processing Cell Operations to Small Tank Precipitation Facility

The design basis for the Small Tank Precipitation facility was modified to include the precipitate decomposition operations previously programmed for the DWPF. These operations, to be conducted in a Precipitate Hydrolysis Cell (PHC), had been tested during DWPF nonradioactive process runs, but were not employed during radioactive (sludge only) processing because of the unavailability of ITP feed. Major justifications for transferring the PHC operations to the Small Tank Processing facility are as follows:

- **Safety** – Lessons learned in DWPF design would provide PHC equipment with increased safety and control margins. As redesigned, the equipment would operate under slight positive pressure and low purge rates of inert cover gas.
- **Capacity** – Increased throughputs of PHC equipment would provide Small Tank Precipitation processing capacity needed to match required HLW salt removal schedules, with a substantial reduction in life-cycle processing time and significant cost savings.
- **Flexibility** – The vacated cell in the DWPF would become available for other potentially needed operations, including evaporation of DWPF recycle waste streams to conserve Tank Farm space pending startup of salt processing operations.
- **Organic Disposition** – Precipitate Hydrolysis Cell operations in the Small Tank Precipitation facility would confine generation and disposal of flammable organic byproducts to the process facility. This would avoid buildups of high-boiling organics in DWPF process and ventilation systems, and transfer in DWPF recycle streams to the Tank Farm. Lag storage and transfer to DWPF would be provided for the non-flammable aqueous product of the PHC operations, rather than the flammable tetraphenylborate precipitate product.

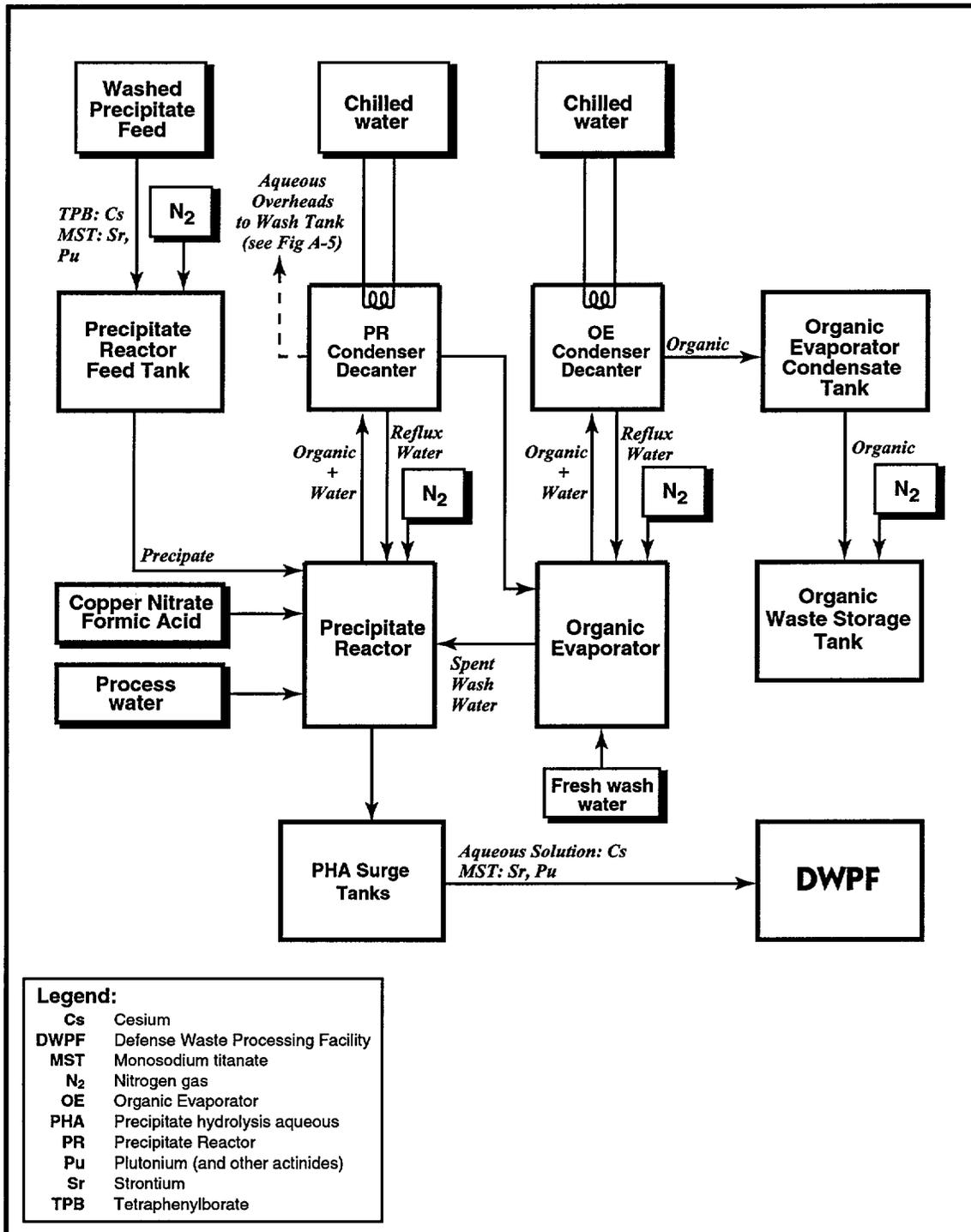
The tetraphenylborate employed in the Small Tank Precipitation process could undergo radiolytic and, under certain conditions, catalytic degradation, producing benzene before the decomposition reactions prescribed in the PHC. The Small Tank Precipitation process would require controlled benzene removal in all steps. Benzene production in the precipitation and washing operations would be limited by the continuous processing of relatively small waste volumes, by a short processing time, and by chilling the process vessels. Accumulation of benzene would be avoided by continuous agitation to prevent retention in the process mixtures and a flowing nitrogen gas blanket to sweep benzene vapors from the system. Benzene formation during precipitate decomposition in the PHC would be controlled by process constraints, with all process vessels purged with nitrogen to maintain oxygen concentrations below combustion limits.

A.4.3.2 Crystalline Silicotitanate Ion Exchange

The Ion Exchange Process (WSRC 1998e,i,j) would employ a crystalline silicotitanate particulate solid (resin) to remove

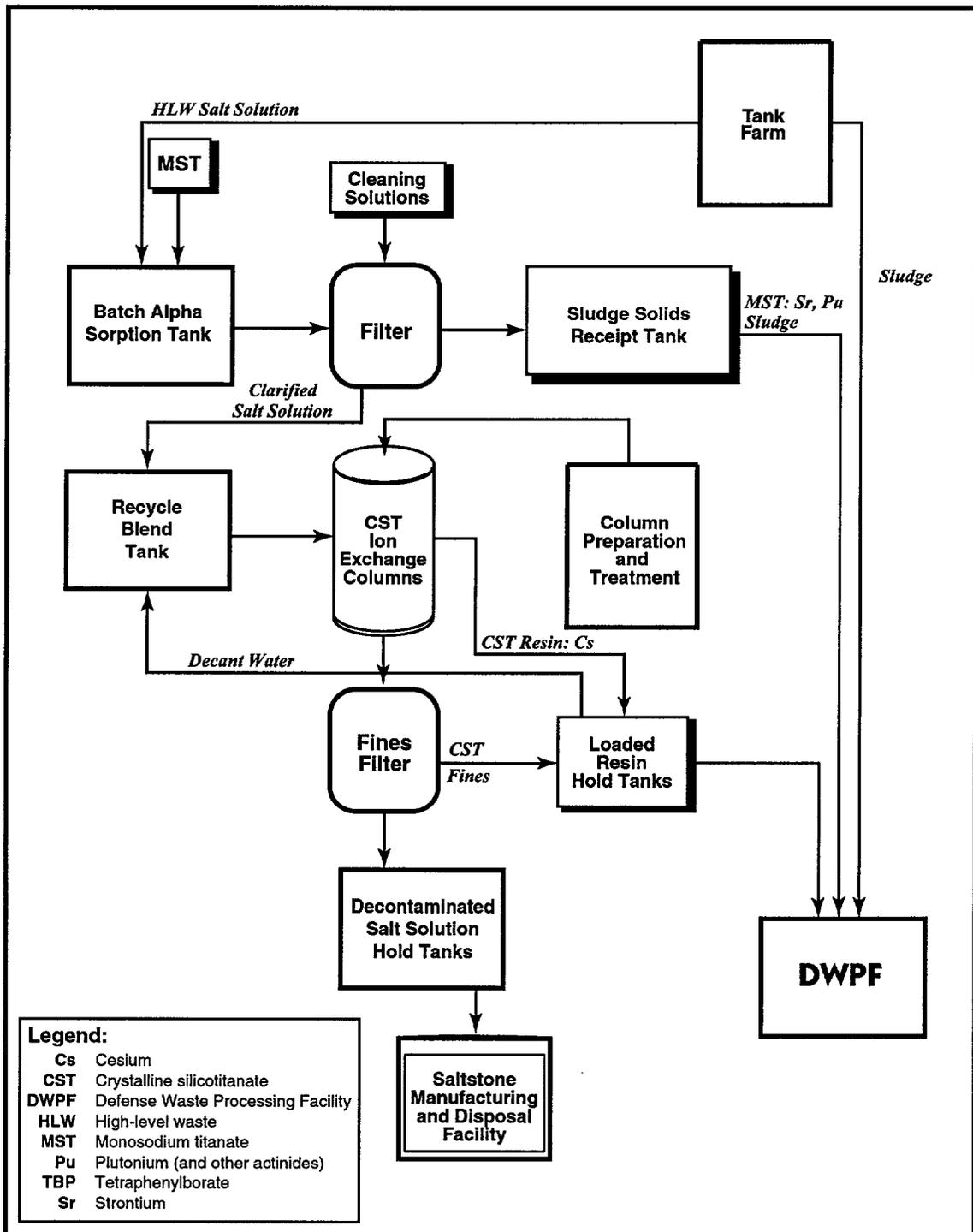
the cesium from the salt solution. In the ion exchange reaction, the radioactive cesium displaces nonradioactive constituents (sodium) of the resin. As in the Small Tank Precipitation process, residual strontium and actinides in the salt solution would be sorbed onto monosodium titanate and, in conjunction with residual sludge, filtered from the salt solution prior to the crystalline silicotitanate ion exchange treatment. The cesium-loaded crystalline silicotitanate resin and the monosodium titanate solids would be transferred to DWPF as slurries to be combined with sludge for incorporation into the glass waste form. Low activity salt solution would be immobilized as saltstone in onsite vaults at the Saltstone Manufacturing and Disposal Facility.

The Ion Exchange process would be performed in a new facility built at Site B in S Area. Process operations are illustrated in the flow diagram in Figure A-7. Salt solution would be pumped from an H-Area tank to the Ion Exchange facility. A new feed line between the existing inter-area transfer line and the Ion Exchange facility would be required for this transfer. In initial feed clarification operations in the batch Alpha Sorption Tank, the salt solution would be mixed with monosodium titanate to sorb soluble strontium and actinides and then filtered by cross-



NW SDA EIS/Gr/x/A-6 Pre Hydro.al

Figure A-6. Precipitate Hydrolysis Cell flow diagram for Small Tank Precipitation process.



NW SDA EIS/Grfx/A-7 CST Ion Flow.al

Figure A-7. Ion Exchange process flow diagram.

flow filtration to remove monosodium titanate solids and residual sludge. These clarification operations would be necessary to prevent plugging of the ion exchange columns during subsequent processing of the salt solution. The product slurry, washed and concentrated to about 5 weight percent solids, would be pumped through new and existing transfer lines to DWPF as feed for the vitrification process.

After filtration, the clarified salt solution would be transferred to the Recycle Blend Tank in the Ion Exchange facility for dilution with process water, and pumped through a series of four ion exchange columns to remove radioactive cesium. Cesium transfer from the salt solution would take place in the first three columns, with the fourth column in reserve for use when the first column in the series reached saturation (> 90 percent maximum capacity) and was taken out of service. Saturated resin in the column would be flushed with water and pumped as slurry to DWPF. The first ion exchange column would then be replenished with fresh resin and held in reserve (as the fourth column) while cesium ion exchange took place in what had been the second, third, and fourth columns. The cycle would continue with the lead column reaching saturation and the reserve column becoming the last in the series of three operating columns. Low activity salt solution recovered as effluent from the third column would be filtered to prevent any cesium-loaded fine particles from recontaminating the salt solution. The low activity salt solution would be sampled in a Product Holdup Tank prior to transfer to the Decontaminated Salt Solution Hold Tanks, to ensure that requirements for disposal as saltstone were met. The low activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal in onsite vaults. All process wastewater would be recycled and reused.

The Ion Exchange process would result in the accumulation of as much as 15 million curies of cesium within the processing cell.

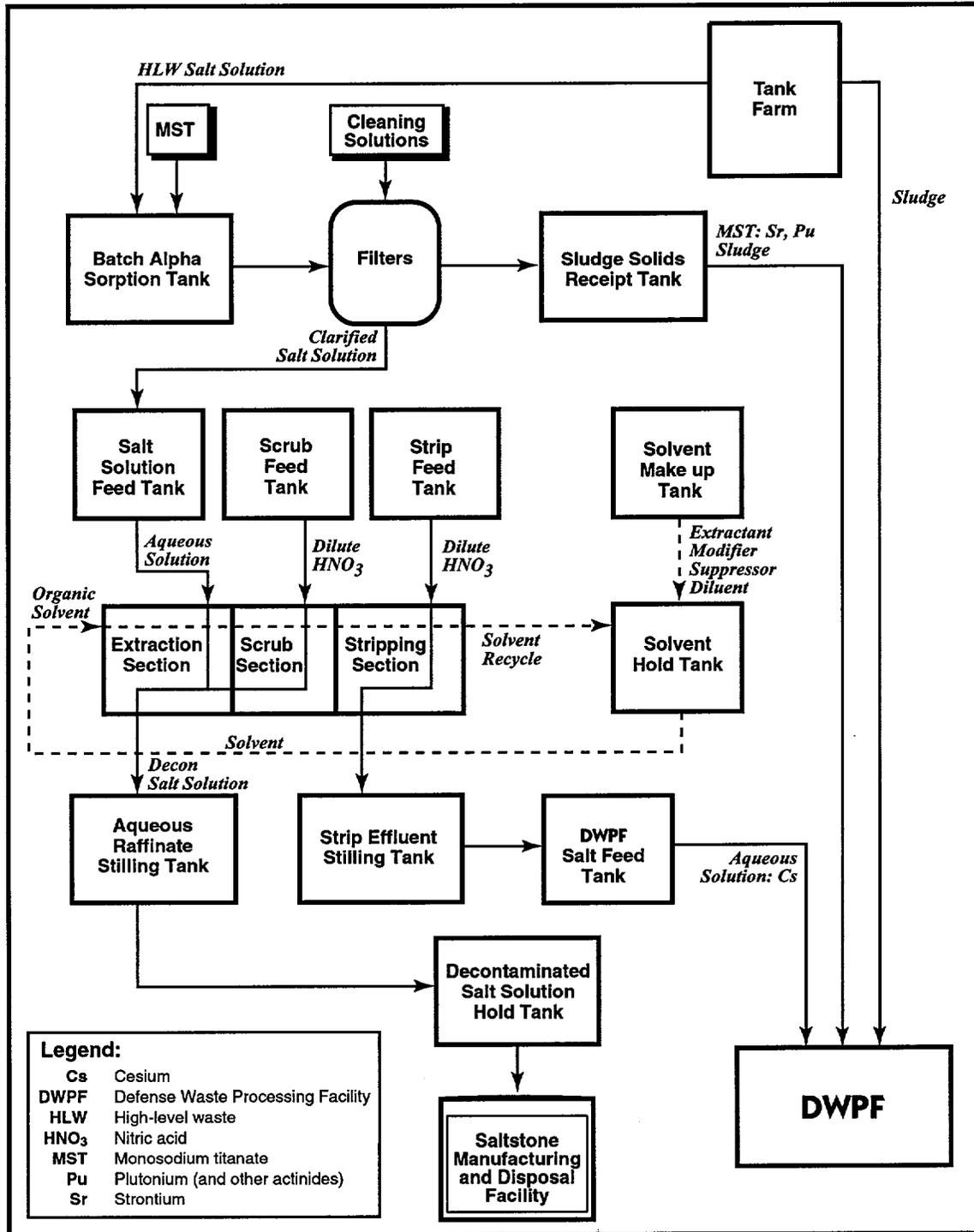
This radioactive loading would necessitate stringent shielding requirements and operational controls because of the generation of hydrogen and other gases.

A.4.3.3 Caustic Side Solvent Extraction

In the Solvent Extraction process (WSRC 1998e, 1999d), radioactive cesium would be separated from the caustic HLW salt solution by extracting it from the aqueous phase into an insoluble organic phase, thereby generating a low activity salt solution for immobilization in saltstone. The separated cesium, recovered from the organic phase by back extraction (stripping) into an acidic aqueous solution, would be transferred to DWPF for incorporation, along with HLW sludge, into the glass waste form. Prior processing of the HLW salt solution by monosodium titanate to remove soluble strontium and actinides, followed by filtration of monosodium titanate solids and residual sludge, would be necessary to meet saltstone acceptance limits and avoid interference of residual solids in the solvent extraction process.

The organic phase into which the cesium would be extracted is a kerosene-like solvent (diluent) containing an organic extractant (termed BoB-CalixC6) and a diluent modifier (typically Cs-7SBT). The extractant is highly specific for cesium, permitting separation from sodium by a factor of 10^4 (10,000) and from potassium by a factor of 10^2 (100). The diluent modifier increases the cesium extraction capability by increasing extractant solubility in the diluent. The subsequent stripping of separated cesium back into an aqueous solution is promoted by addition of a suppressor constituent, typically trioctylamine (TOA), to the organic phase. The TOA also mitigates the deleterious effects of impurities in the aqueous solution. Chemical structures and concentrations of the additions to the diluent organic phase are specified in the text box on page A-18.

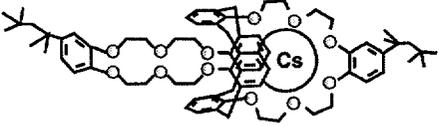
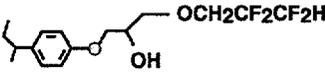
The Solvent Extraction process would be performed in a new facility at Site B in S Area. Process operations are represented by the flow diagram in Figure A-8. In operations similar to



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Figure A-8. Solvent Extraction process flow diagram.

Components of Organic Phase used in Solvent Extraction Process

Chemical Type	Concentration in Solvent	Function
Diluent Blend of alkane hydrocarbons "Isopar® L"	Principal component	Organic phase solvent
Cesium Extractant (with complexed Cs)	0.01 M	Highly specific Cs extraction into organic phase from caustic aqueous solution
		
Calix[4]arene-bis(tert-octylbenzo-crown-6) "BoBCalixC6"		
Diluent Modifier	0.5 M	Increases extractant strength for Cs, prevents precipitation and third phase formation
		
Aromatic fluoroalcohol "Cs-7SBT"		
Suppressor $N(C_8H_{17})_3$ Trioctylamine "TOA"	0.001 M	Promotes back extraction of Cs from organic to aqueous phase during stripping operation

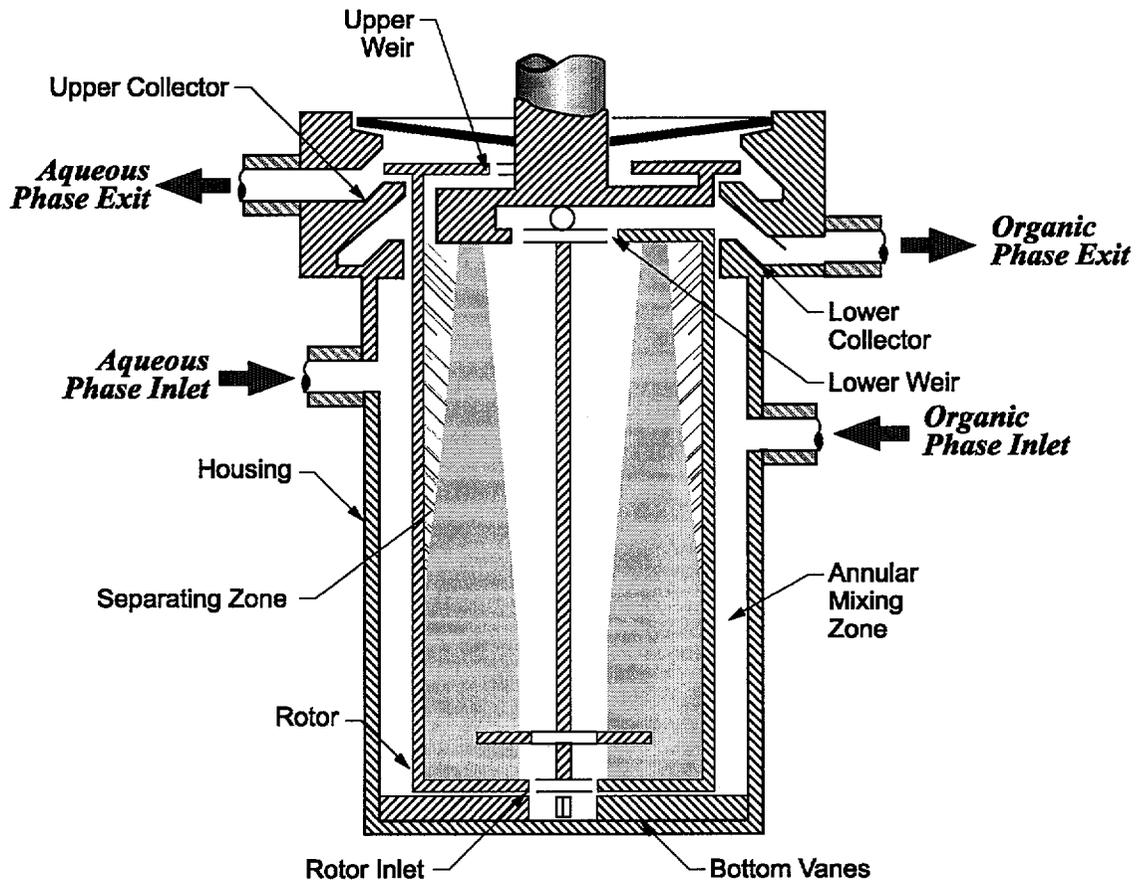
NW SDA EIS/Grfv/App A/Comp organic.al

that for the Ion Exchange process, initial clarification of the salt solution in the Batch Alpha Sorption Tank would remove strontium and actinides by sorption onto monosodium titanate, followed by filtration of the monosodium titanate solids and any residual sludge, for transfer to DWPF. The separation of radioactive cesium from the salt solution by solvent extraction would take place in a multi-stage countercurrent extraction facility. The facility consists typically of an assembly of centrifugal two-phase contactors for extraction of cesium into the organic phase, scrub contactors for removing non-cesium salt constituents from the organic phase, and strip contactors for back extrac-

tion of the cesium into an acidic aqueous stream. The design and operation of the centrifugal contactors is shown in the text box on page A-19.

The cesium-containing caustic salt solution injected into the contactor assembly at the head end of the extraction section (between extraction and scrub sections) would be progressively depleted of cesium as the aqueous phase moves through the extraction contactors, and would emerge at the back end of the extraction section as a salt solution with very low cesium content. The organic phase (solvent), injected at the back end of the extraction section for countercurrent

Centrifugal Contactor Design and Operation



The separation of radioactive cesium from a high-level waste salt solution by solvent extraction utilizes countercurrent centrifugal contactors to provide high surface area interaction between the organic solvent and aqueous solution. These contactors consist of a rapidly rotating inner chamber (rotor) contained within a stationary housing, allowing mixing of organic and aqueous phases as an emulsion in the outer chamber, followed by centrifugal separation of the lesser density organic phase from the greater density aqueous phase in the rotor. The organic and aqueous phases are injected into the housing for transport through an annular mixing zone to an inlet at the bottom of the rotor. Centrifugal separation of the two phases occurs in the rotor as the emulsion flows upward, collected at the top as aqueous phase from the outer circumference and as organic phase from the center of the rotor. For extraction cycles, the cesium is transferred from the caustic aqueous phase to the organic phase and for stripping cycles it is transferred from the organic phase to an acidic aqueous phase during contactor operation.

NW SDA EIS/Gr/x/App A/Centrifugal.ai

movement through the contactors, would be progressively concentrated in cesium, scrubbed to remove other salt constituents, then stripped of cesium by contact with a dilute acid aqueous stream. The strip effluent would emerge from the back end of the stripping section as a concentrated-cesium-containing aqueous solution. The organic solvent recovered from the stripping operation would be washed with dilute caustic to remove degradation products, and recycled through the extraction process, with losses made up by replacement. Occasional purging of degraded solvent during washing would generate a low-volume organic waste stream that would be stored for appropriate disposal.

Following solvent extraction separations, both decontaminated salt (raffinate) and concentrated cesium solutions (strip effluent) would be processed through stilling tanks, to float and decant entrained organic (mostly diluent) before transferring the solutions to final disposition. The decontaminated raffinate solution would be consigned to a hold tank for processing to saltstone and the strip effluent solution, assuming no concentration by evaporation, would be transferred to a hold tank for vitrification in DWPF. The wash solutions from the organic solvent cleanup would be processed to saltstone.

A.4.3.4 Direct Disposal in Grout

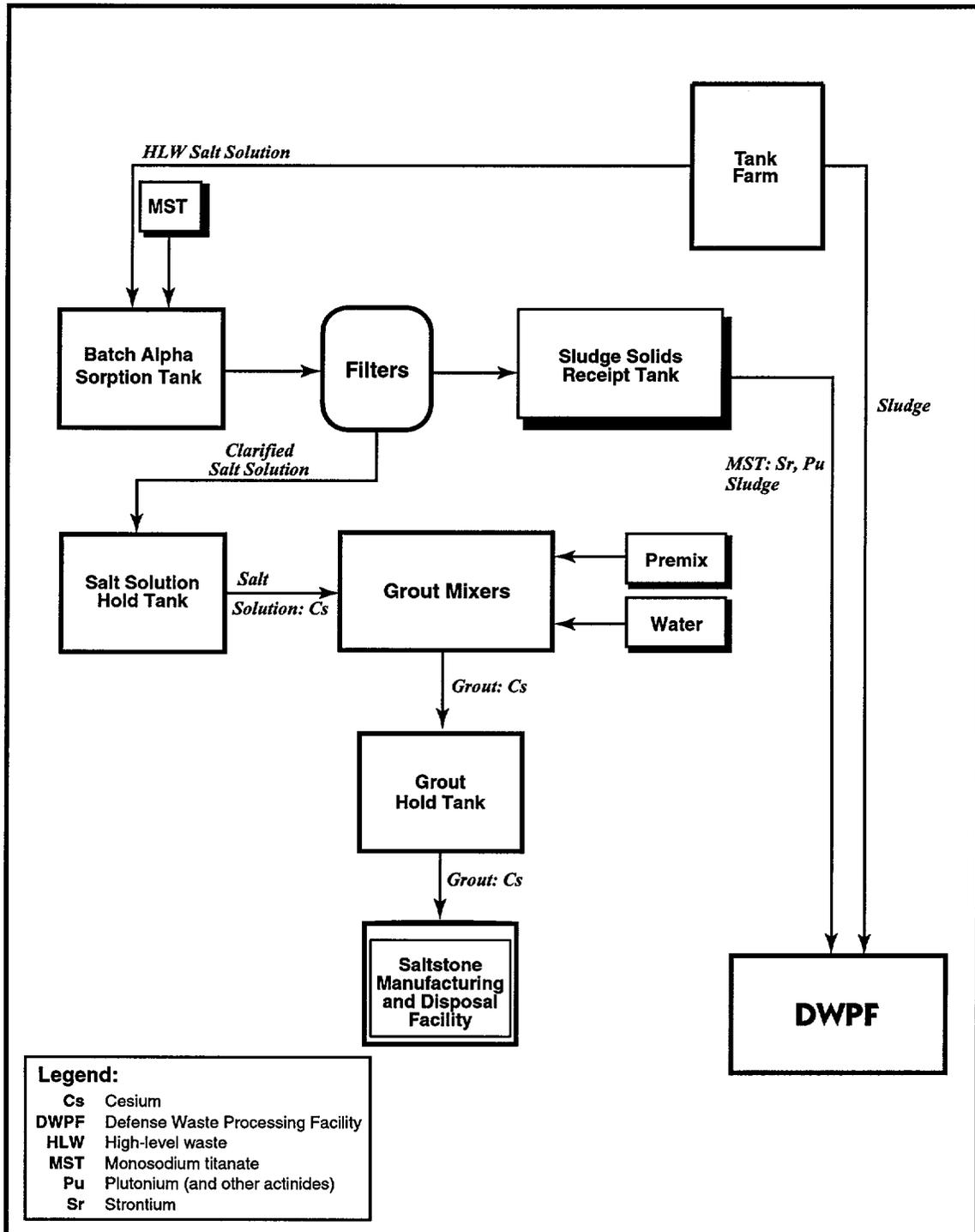
In the Direct Disposal (of cesium) in Grout alternative (WSRC 1998e), the HLW salt solution would be immobilized in saltstone vaults without separation of the radioactive cesium. The saltstone produced would meet acceptance criteria for near-surface disposal of low-level radioactive Class C waste (as defined in 10 CFR 61.55), but would exceed limits for Class A wastes. Treatment of the salt solution to remove strontium and actinides, as well as residual sludge, would still be required to meet restrictions on alpha-emitting radionuclides and HLW constituents in the saltstone.

If saltstone waste containing radioactive cesium was disposed in Z-Area vaults, revision of saltstone disposal procedures would be required. The existing permit issued by SCDHEC requires waste disposed in Z-Area vaults to be within Class C limits as defined in 10 CFR 61.55. SRS practice, established by DOE to minimize long-term environmental impacts, further restricts the overall average concentration of long-lived radionuclides in the Z-Area vaults at or below Class A limits. This restriction does not preclude occasional disposal of waste with higher radionuclide content if it can be shown that the waste would not produce unacceptable radiation exposure to the public, onsite workers, or inadvertent intruders. SCDHEC must be informed if the radiological content of the waste exceeds Class A limits (Martin Marietta 1992).

For the Direct Disposal in Grout alternative, a new facility would be constructed in Z Area, using grout production equipment modified to provide radiation shielding and enable remote operation and maintenance, because of the anticipated radioactive cesium concentrations. Direct Disposal in Grout process operations are illustrated in the flow diagram in Figure A-9. The salt solution would be collected in an H-Area tank and pumped to the Direct Disposal in Grout facility through a new Low Point Drain Tank (LPDT) facility, using the existing inter-area line. The new LPDT would be required to provide adequate shielding for the higher radioactivity in the waste stream than is present in the current feed.

In the new Direct Disposal in Grout facility, salt solution would be fed into a large Batch Alpha Sorption Tank for treatment with monosodium titanate to remove soluble radioactive contaminants other than cesium (strontium and actinides). The monosodium titanate and entrained sludge solids would be separated from the salt solution by cross-flow filtration and washed. The washed solids, collected as slurry in the Sludge Solids Receipt Tank, would be pumped through new and existing transfer lines to the DWPF melter for conversion into the glass waste form. This would be the only Direct Disposal in Grout waste stream incorporated into the DWPF waste glass production operation.

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NW SDA EIS/Grfx/A-9 Dir Disp Flow.ai

Figure A-9. Direct Disposal in Grout process flow diagram.

The clarified salt solution resulting from monosodium titanate treatment in the Direct Disposal in Grout facility would be transferred to a Salt Solution Hold Tank to be processed to saltstone.

During saltstone processing, the filtered salt solution would be pumped to a mixer and combined with flyash, cement, and slag to form a batch of grout for disposal in the saltstone vaults. The grout mixture would be pumped to a Grout Hold Tank serving as the feed tank for the Grout Feed Pumps transferring the grout to the saltstone vaults. Thirteen additional vaults would be constructed in Z Area to accommodate Direct Disposal in Grout processing. After each batch of grout was processed and transferred to a vault, the grout transfer lines, Grout Hold Tank, and Grout Feed Pumps would be flushed to remove any residual material for recycle through the process. Direct Disposal in Grout would generate no secondary waste streams.

Chemical composition of the saltstone from the Direct Disposal in Grout process is compared with that from Small Tank Precipitation, Ion Exchange, and Solvent Extraction processes in Table A-1. Expected concentrations of major radionuclides in the saltstone are shown in Table A-2. The values are from an earlier characterization of saltstone, produced for ITP processing of HLW salt solutions (Martin Marietta 1992) and adjusted for dilution by the new salt processing alternatives, based on the sodium concentrations of the saltstone feed streams.

A.4.3.5 Process Inputs and Product Streams

A general objective of the salt processing operations is the disposition of about 80 million gallons of HLW salt solution. The processing rates of the process facilities are specified to maintain a long-term average drawdown of salt solution by about 6 million gallons per year at 75 percent attainment, allowing completion of processing of reconstituted salt solution within about

13 years after facility startup. Processing within this time period is necessary to integrate the high-radioactivity salt waste components into the DWPF vitrification operations for processing with radioactive sludge components of the waste. (See key milestones textbox in Chapter 2). The throughput of all action alternatives is limited to 6 million gallons per year due to the physical constraints of removing waste from the waste tanks.

Process throughput streams for the salt processing alternatives are compared in Table A-3.

The capacity throughputs are somewhat higher than the required long-term average throughputs for Small Tank Precipitation, Ion Exchange, and Solvent Extraction facilities to allow for DWPF outages during melter changeout. The Direct Disposal in Grout facility, not closely coupled to DWPF operation, can operate at capacity throughput equal to the required long-term average throughput (6 million gallons per year).

The product outputs of the process facilities, including high-radioactivity solids slurry or solution to DWPF, processed salt solution to grout, and saltstone generated by the salt processing alternatives, are compared in Table A-4. The Solvent Extraction process would deliver a greater volume of product to DWPF than the other alternative processes because of the high volume of cesium solution (strip effluent) in the product output of that process. Salt solutions to grout and saltstone produced would be about the same for each alternative, with the ratio of saltstone volume produced to salt solution volume uniform at about 1.8.

In addition to the principal product outputs specified in Table A-4, the Small Tank Precipitation process would generate by-product benzene. About 60,000 gallons (200 metric tons) of liquid benzene would be produced annually by decomposition of the tetraphenylborate salt in the process facilities.

In the Small Tank Precipitation process, gaseous benzene would also be generated in the process facilities, to be dispersed into the atmosphere.

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Table A-1. Chemical composition of saltstone for salt processing alternatives.

Component	Composition, weight percent ^a			
	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
H ₂ O	33.70	32.88	34.03	32.57
NaNO ₃	6.60	7.60	6.20	8.00
NaOH	1.90	2.20	1.80	2.40
NaNO ₂	1.60	1.90	1.50	2.00
NaAl (OH) ₄	1.20	1.40	0.94	1.40
NaCO ₃	0.65	0.75	0.61	0.79
Na ₂ SO ₄	0.65	0.75	0.61	0.79
Na ₂ C ₂ O ₄	0.07	0.08	0.07	0.09
NaCl	0.05	0.05	0.05	0.06
Na ₃ PO ₄	0.05	0.05	0.05	0.06
Na ₂ SiO ₃	0.03	0.03	0.03	0.03
NH ₄ NO ₃	0.03	0.04	0.03	0.04
NaB (C ₆ H ₅) ₄	0.03	-	-	-
Na ₂ CrO ₄	0.02	0.02	0.02	0.02
NaF	0.02	0.03	0.02	0.03
CaSO ₄	0.02	0.02	0.02	0.02
NaHgO (OH)	(b)	(b)	(b)	(b)
KNO ₃	(b)	(b)	(b)	(b)
Salt Solution Total	46.61	47.80	45.98	48.30
Dry Blend ^c	53.39	52.20	54.02	51.70
Total	100	100	100	100

- a. The values presented are taken from a previous characterization of saltstone produced during ITP processing of HLW salt solution (Martin Marietta 1992), adjusted for dilution in the new salt processing alternatives using sodium concentrations of 4.58 molar for Small Tank Precipitation, 5.31 molar for Ion Exchange, 4.30 molar for Solvent Extraction, and 5.63 molar for Direct Disposal in Grout processing, compared to 4.58 molar for ITP processing.
- b. Expected present; concentration less than 0.01 weight percent.
- c. Dry Blend is cement, flyash, and slag.

Issues associated with gaseous benzene generation have resulted in a number of design features that would reduce or mitigate this problem. Controlled benzene removal, because of flammability concerns, would be accomplished by operating the process vessels with a nitrogen atmosphere. The tank vent systems would be equipped with both primary and backup nitrogen purge systems (WSRC 1998e). The Ion Exchange, Solvent Extraction, and Direct Disposal in Grout processes do not have the same benzene concerns. Rather, the issue for these alternatives is radiolytic decomposition of water into hydrogen and oxygen. Air sweeps of tanks are generally considered sufficient to eliminate the danger of explosions (WSRC 1998i). However, since the consequences of

an explosion are unacceptable, due to the high radioactive loading within the process tanks, the design for Ion Exchange, Solvent Extraction, and Direct Disposal in Grout facilities would include both primary and backup purge systems, comparable to those used in the Small Tank Precipitation facility.

The Solvent Extraction process would also generate a liquid organic waste requiring disposal (WSRC 2000c). The total solvent inventory for the process, consisting primarily of the diluent Isopar[®]L, is projected to be 1,000 gallons. This inventory is conservatively assumed to be replaced once per year. For an operational time of 13 years, the accumulated total volume of solvent requiring disposition would be 13,000 gallons.

Table A-2. Radionuclide content of saltstone for salt processing alternatives.

Radionuclide	Concentration (nCi/g)			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Technetium-99	33	38	31	40
Ruthenium-106+d ^a	17	20	16	21
Cesium-137+d ^a	10	12	9	254,000 ^b
Tritium	10	12	9	12
Antimony-125	3.3	3.8	3.1	4.0
Promethium-147	2.0	2.3	1.9	2.4
Samarium-151	1.0	1.2	0.95	1.2
Strontium-90+d ^a	0.35	0.40	0.33	0.42
Europium-154	0.33	0.38	0.31	0.40
Selenium-79	0.16	0.19	0.15	0.20
Europium-155	0.16	0.19	0.15	0.20
Cobalt-60	0.11	0.12	0.10	0.13
Tellurium-125m	0.10	0.12	0.09	0.12
Tin-126+d ^a	0.07	0.08	0.07	0.08
Cesium-134	0.03	0.04	0.03	440
Tin-121m	0.01	0.02	0.01	0.02
Iodine-129	0.01	0.01	0.01	0.01
Nickel-63	0.01	0.01	0.01	0.01
Antimony-126	0.01	0.01	0.01	0.01
Carbon-14	0.003	0.004	0.003	0.004
Cesium-135	0.00002	0.00002	0.00003	0.26
Other beta gamma	3.3	3.8	3.1	4.0
Plutonium-238	0.03	0.03	0.03	0.03
Plutonium-241	0.02	0.02	0.02	0.02
Americium-241	0.07	0.08	0.07	0.08

nCi/g = nanocuries per gram.

a. +d = with daughter product.

b. Cesium-137+d content of the saltstone for Direct Disposal in Grout alternative corresponds to 225 Ci/m³ of cesium-137 (WSRC 1998a,k).

Table A-3. Salt solution processed.

Alternative	Required processing rate (million gallons) ^a per year	Long-term average throughput capacity (million gallons per year) ^a	Throughput limitation
Small Tank Precipitation	6.9	6.0	Salt removal rate from waste tanks
Ion Exchange	6.9	6.0	Salt removal rate from waste tanks
Solvent Extraction	6.9	6.0	Salt removal rate from waste tanks
Direct Disposal in Grout	6.0	6.0	Salt removal rate from waste tanks

Source: WSRC (1998e).

a. The required processing rate for the salt processing facilities exceeds the long-term average to allow for downtime when DWPF is not operating, except for the Direct Disposal in Grout facility which can operate at the required salt removal rate even when DWPF is not operating.

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Table A-4. Product outputs.

Alternative	Annual			Life cycle		
	Solids slurry (and solution) to DWPF (gallons per year)	Salt solution to Grout (million gallons per year)	Grout produced (million gallons per year)	Solids slurry (and solution) to DWPF (million gallons)	Salt solution to Grout (million gallons)	Grout produced (million gallons)
Small Tank Precipitation (13 years) ^a	223,000	8.0	14.5	2.9	104	188
Ion Exchange (13 years) ^b	200,000	6.6	12.0	2.6 ^f	86	156
Solvent Extraction (13 years) ^c	677,000 ^e	7.5	13.5	8.8 ^e	97	175
Direct Disposal in Grout (13 years) ^d	154,000	5.9	10.8	2.0	77	141

- a. WSRC (1998i; 2000b).
- b. WSRC (1998m).
- c. WSRC (1998n; 2000b).
- d. WSRC (1998k).
- e. Includes 154,000 gal/yr solids slurry and 523,000 gal/yr solution (strip effluent without evaporation) (WSRC 1998e).
- f. Includes 2 million gallons monosodium titanate slurry and 600,000 gallons crystalline silicotitanate slurry (WSRC 1998e,m).

Note: Material balance estimates are ± 25 percent.

Radionuclide	Concentration in Saltstone (Ci/m ³)	Concentration Limit (Ci/m ³)		
		Class A	Class B	Class C
Long-Lived Activities				
Technetium-99	0.07	0.3	-	3.0
Iodine-129	0.00002	0.008	-	0.08
Total alpha	0.0002	0.02	-	0.2
Short-Lived Activities				
Tritium	0.02	40	(a)	(a)
Strontium-90	0.0004	0.04	150	7,000
Cesium-137	225	1	44	4,600

a. No limit.
Ci/m³ = curies per cubic meter.

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A.5 Process Facilities

A.5.1 PROCESS BUILDINGS

New shielded process buildings (WSRC 1998e,o) would be constructed for each salt processing alternative. The process buildings for the Small Tank Precipitation, Ion

Exchange, and Solvent Extraction alternatives would be at Site B in S Area and for the Direct Disposal in Grout alternative, in Z Area.

In each case, the process buildings would be constructed of reinforced concrete and include the shielding required for handling highly radioactive materials. The facilities would be sized to

Technology Descriptions

contain large feed, storage, and product hold tanks to ensure an average processing rate of 25,000 gallons per day of salt solution. The size of the tanks would also serve to decouple or buffer the continuous flows of the Small Tank Precipitation, Ion Exchange, and Solvent Extraction processes from the batch flows of the tank farms, and ensure the capability to process the expected average 6 million gallons-per-year of salt solution.

The building specifications would be similar for each of the four salt processing alternatives. Preliminary design dimensions are provided in Table A-5. The buildings would range from 60 to 70 feet above ground level, with crane maintenance bays up to 110 feet high. They would extend down to as much as 40 feet below ground level, allowing shielded, remotely operated, chemical processing cells to be located partially below grade. Site requirements for each alternative process facility are presented in Table A-6.

Adjacent operating areas above grade would extend around the perimeter of the processing cells and contain chemical feed pumps

and tanks, radioactive and non-radioactive laboratories for sample testing, electrical and mechanical equipment areas, and a truck unloading area. Shielded maintenance areas would be provided for remote equipment laydown, equipment decontamination, and crane maintenance. Figure A-10 presents the floor plan for the Small Tank Precipitation facility, and Figure A-11 presents the elevation for the facility. Figures A-12 and A-13 present the corresponding plans for the Ion Exchange facility, Figures A-14 and A-15 for the Solvent Extraction facility, and Figures A-16 and A-17 for the Direct Disposal in Grout facility.

The process cells would contain equipment required for the respective process alternatives. These include precipitate and sorption reactor tanks; chemical storage, feed, and product hold tanks with associated transfer and sample pumps; pass-through filter assemblages; and grout mixers and transfer equipment. In the case of the Ion Exchange alternative, the ion exchange columns for cesium removal would also be housed in the process cells. In the case of the Solvent Extraction process alternative, the centrifugal contactors would be housed in the process cells.

Table A-5. Building specifications for each action alternative.

	Process Alternative ^a			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Length, ft.	310	280	300	220
Width, ft.	140	140	120	120
Height, ft.	60 (100 ft. bay)	60 (100 ft. bay)	70 (110 ft. bay)	60 (90 ft. bay)
Depth below grade, ft.	40	40	40	20
Floor Area, ft. ²				
including processing cells	66,000	60,000	62,000	54,000
excluding processing cells	50,000	48,000	48,000	43,000
Volume, ft. ³				
including processing cells	4,500,000	4,200,000	4,500,000	1,800,000
excluding processing cells	4,500,000	3,600,000	3,900,000	1,200,000
Processing cell floor area, ft. ²	16,000	12,000	13,000	11,000
Processing cell volume, ft. ³	640,000	550,000	600,000	570,000

Source: WSRC (1998o, 2000c).

a. Building specifications rounded to two significant figures.

Table A-6. Site requirements for the process building and required support facilities.

Small Tank Precipitation, Ion Exchange, and Solvent Extraction Alternatives	Direct Disposal in Grout Alternative
Clear 23 acres in S Area	Clear 15 acres in Z Area
Construct 5,000 linear feet of access roads	Same
Construct 1,000 linear feet of site roads	Same
Construct a paved parking area for 200 cars (40,000 square feet)	Same
Construct a storm sewer system	Same
Construct site security fence with two vehicle gates	Same
Construct a security fence around the substation	Same
Construct 2,500 feet of sewer line to tie into the existing sewer system	Same
Construct 3,000 feet of water line to tie into the existing potable water system	Construct 2,000 feet of water line
Construct 7,500 feet of power line	Construct 700 feet of power line
Construct a 13.8-kV to 480-V switchyard	Same
Install yard piping for water and sewer distribution systems	Same
Install electrical ductbank distribution system	Same
Install security lighting	Same

Source: WSRC (1998o).

Sumps with leak detection and collection capability would be provided in the cells. The cells would be protected by concrete cell covers and accessible by a remotely-operated crane. The building configurations would allow crane or manipulator access to all shielded process, maintenance, and sampling areas. The cell components would be designed for remote maintenance, replacement, and later decommissioning.

Safety features for each salt processing alternative incorporated into facility design would include:

- Systems to detect leaks in processing piping and vessels
- Structurally strengthened process buildings and process cells to protect process vessels and equipment in case of seismic or other natural phenomena hazard events
- Process vessel vent or purge systems
- Systems to cover process vessels with inert gases, to prevent catastrophic fires
- Leak detection systems and engineered safety features, designed to automatically stop the process before material is released to the environment, if a leak is detected
- Primary confinement of process piping and vessels that could withstand natural phenomena hazard events
- Secondary confinement systems, including ventilation systems, designed to prevent or mitigate unscheduled events and to continue operating, even in the event of a loss of power
- Seismically-qualified equipment, including vessels and piping
- Remote operations
- Adequate shielding
- Temperature monitoring systems to alert operators to any loss of cooling for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction processes
- Radiation and airborne contamination monitors.

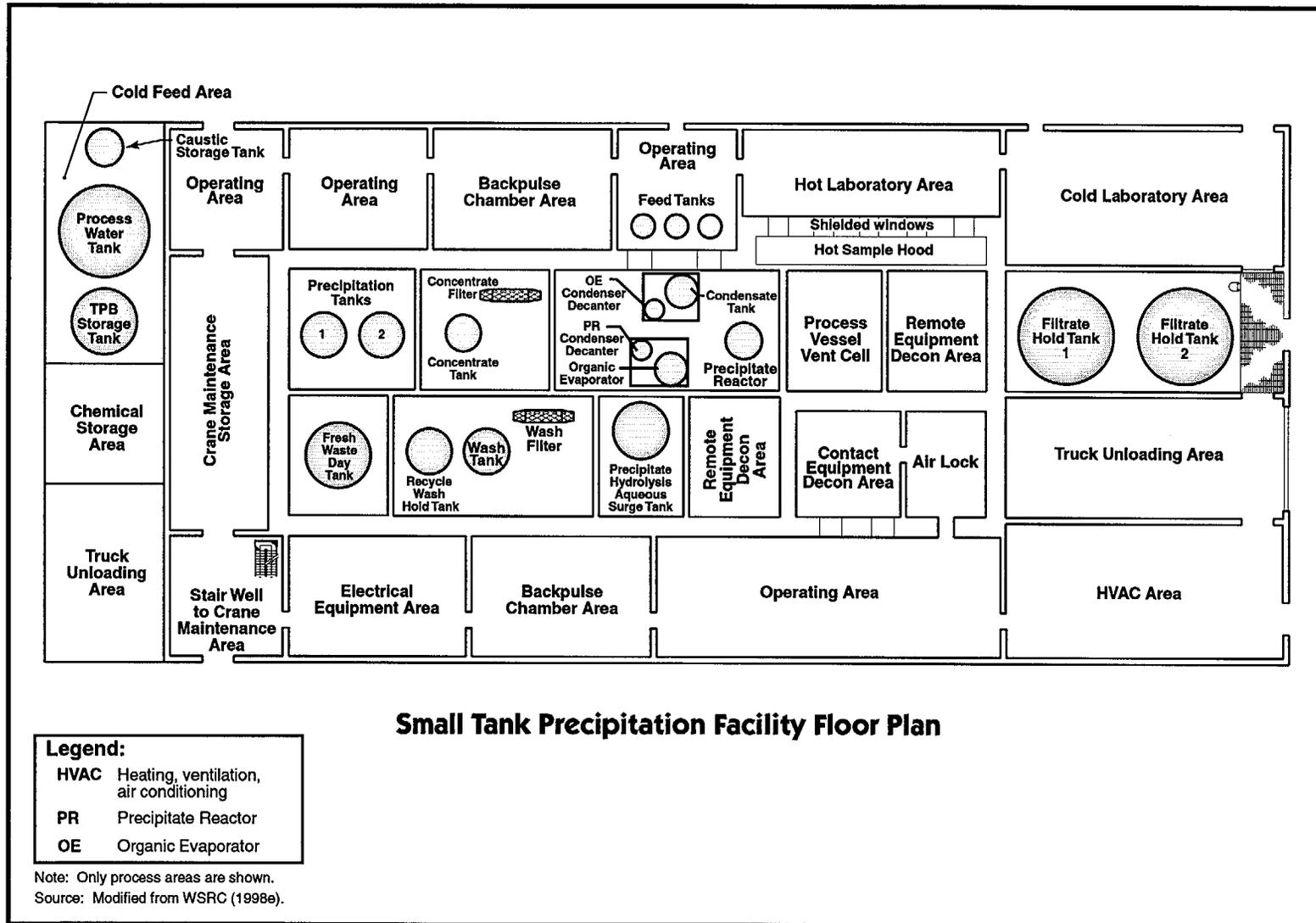
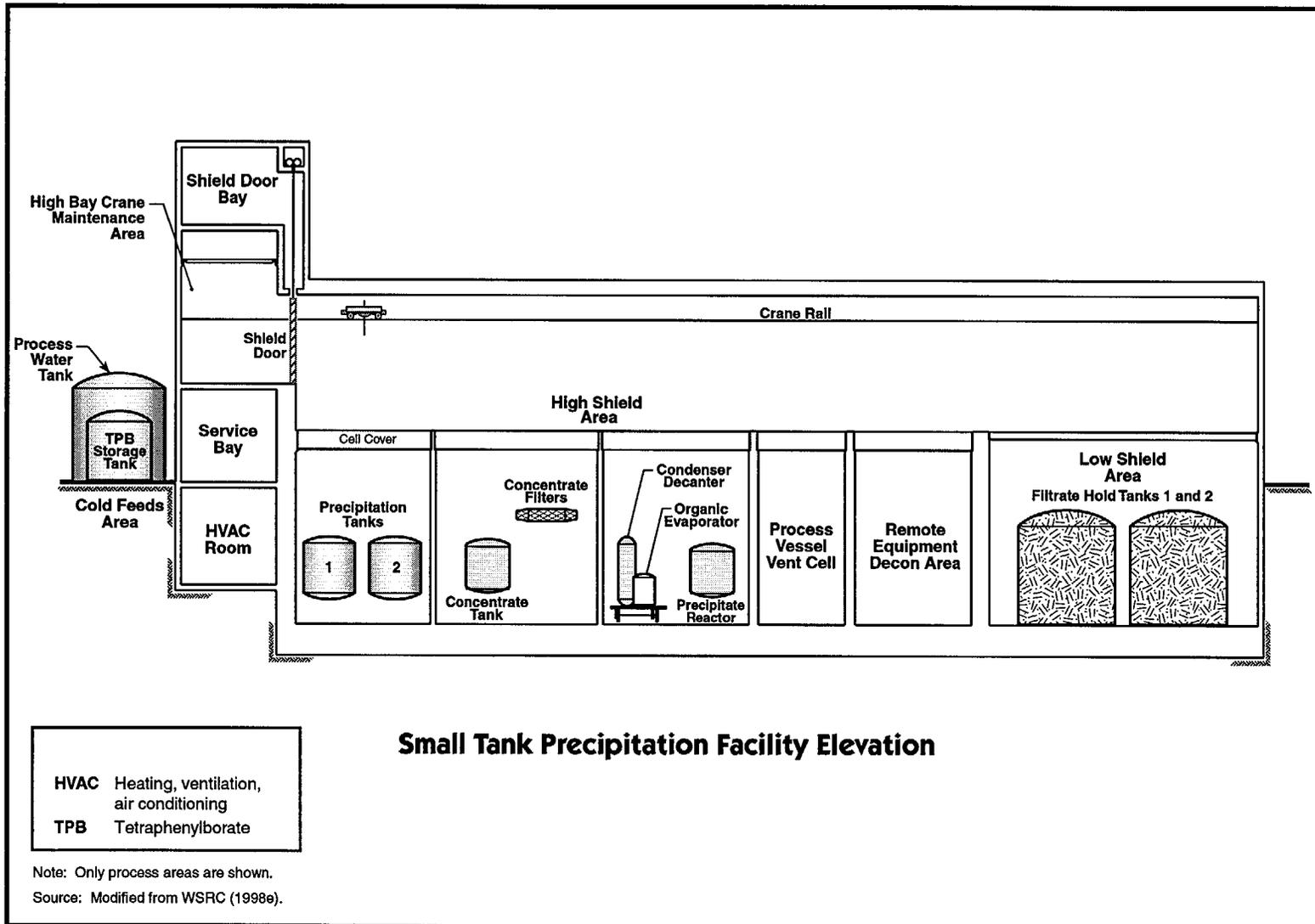


Figure A-10. Floor plan for Small Tank Precipitation facility.

NW SDA EIS/Grtx/App_A/A-10 Sm Tank view.ai



NW SDA EIS/Grfx/App_A/A_11 Elev Sm T.ai

Figure A-11. Elevation Plan for Small Tank Precipitation facility.

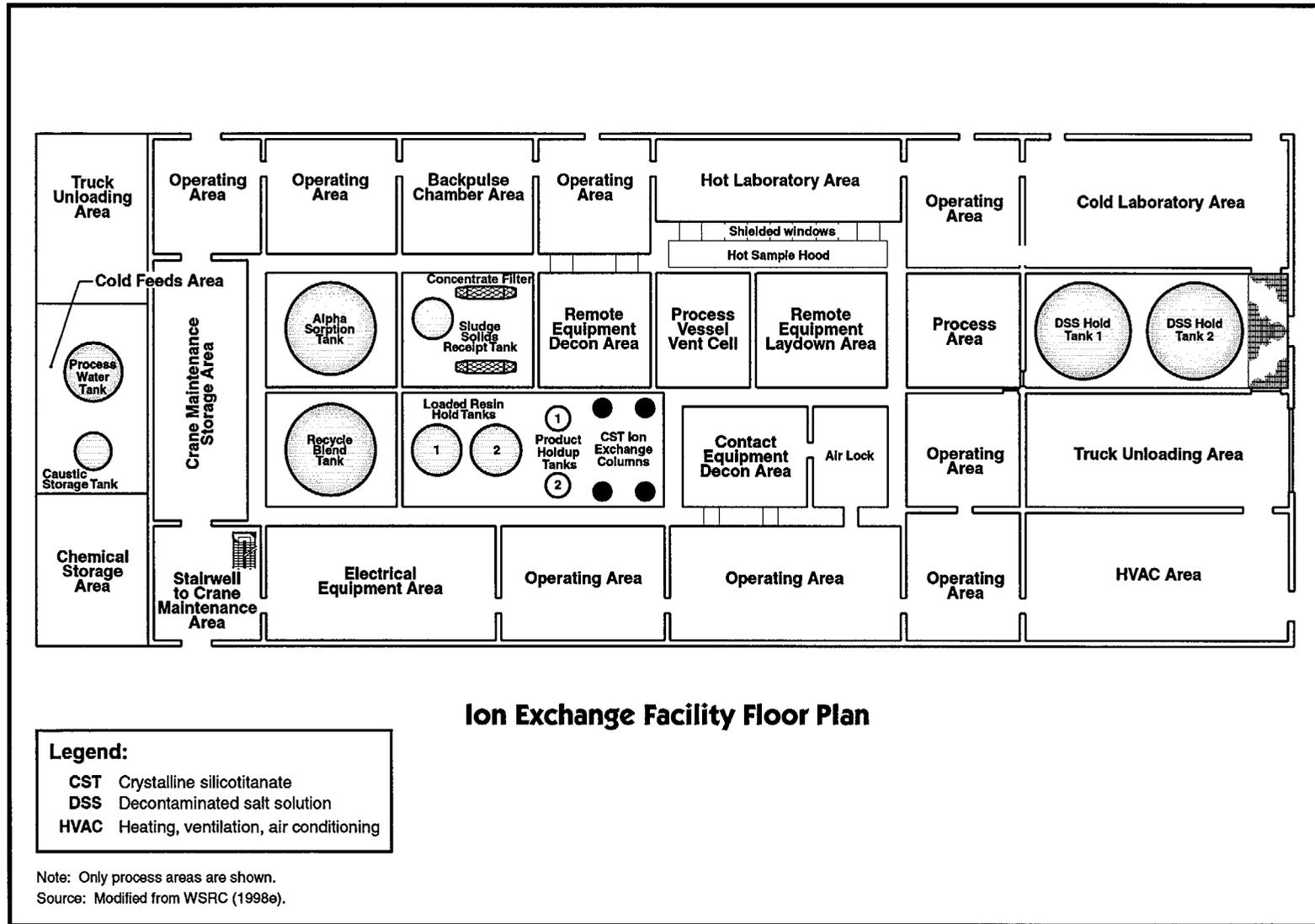


Figure A-12. Floor plan for Ion Exchange facility.

NW SDA EIS/Grfx/App_AJA-12 FI CST Ion.ai

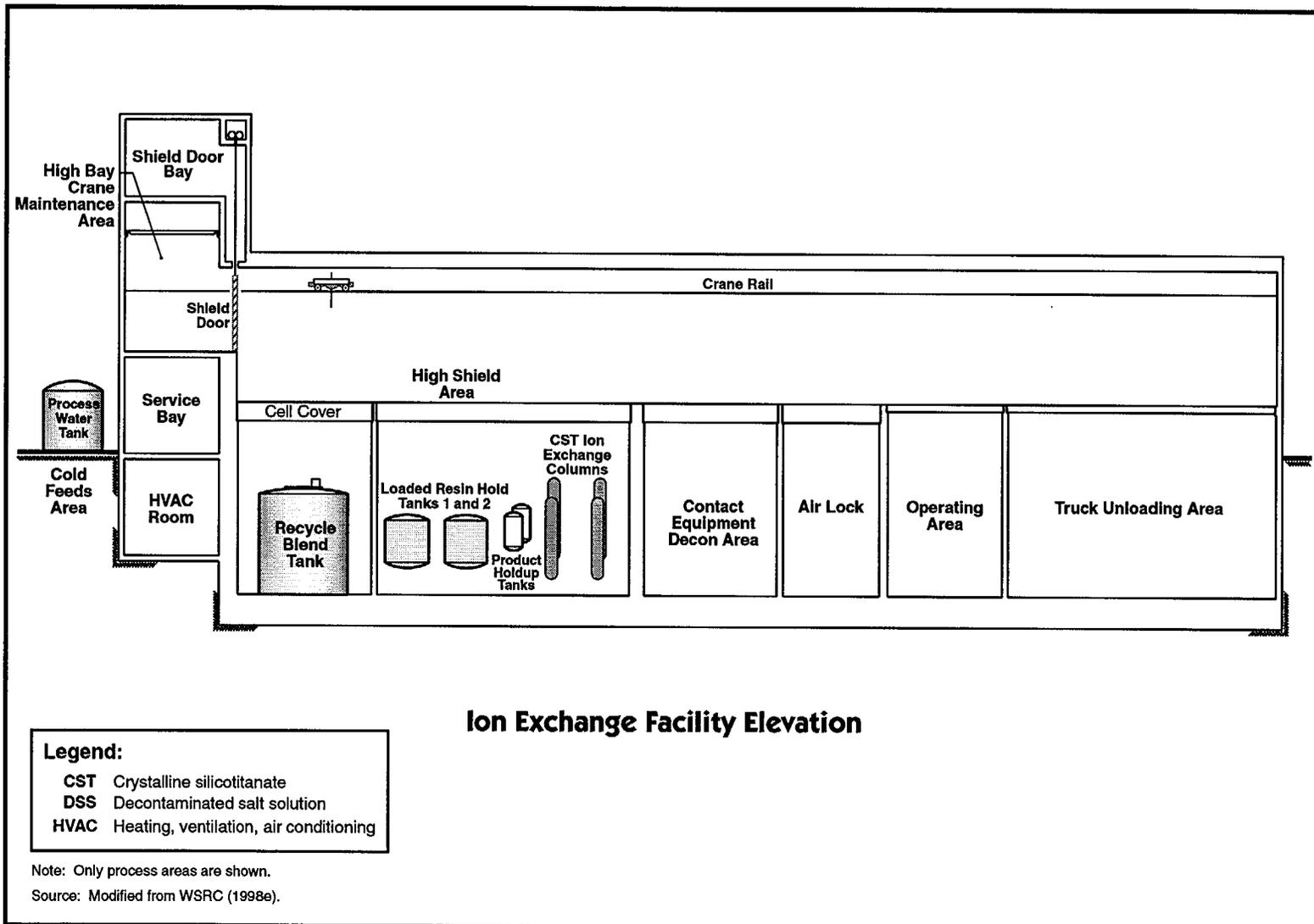
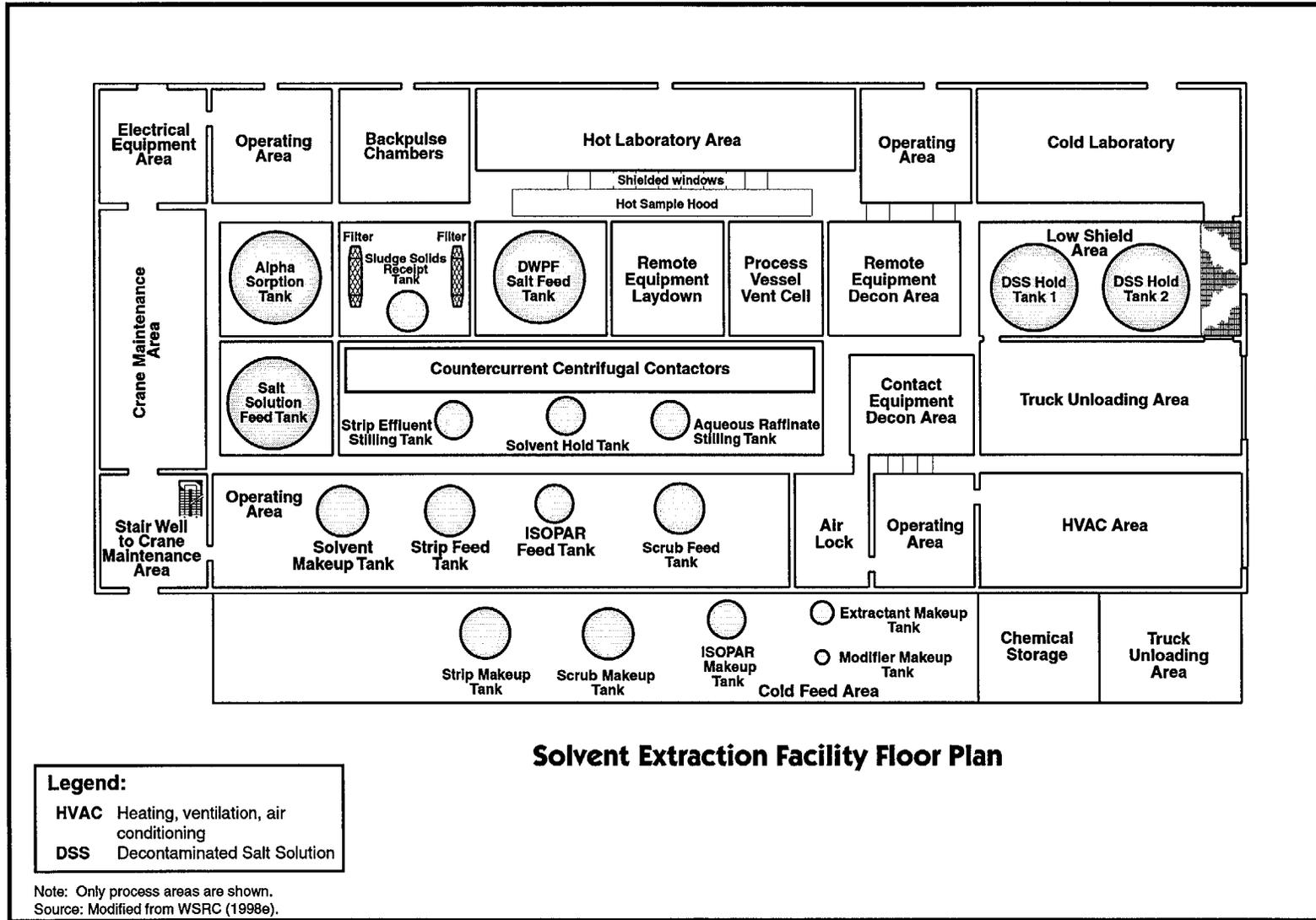


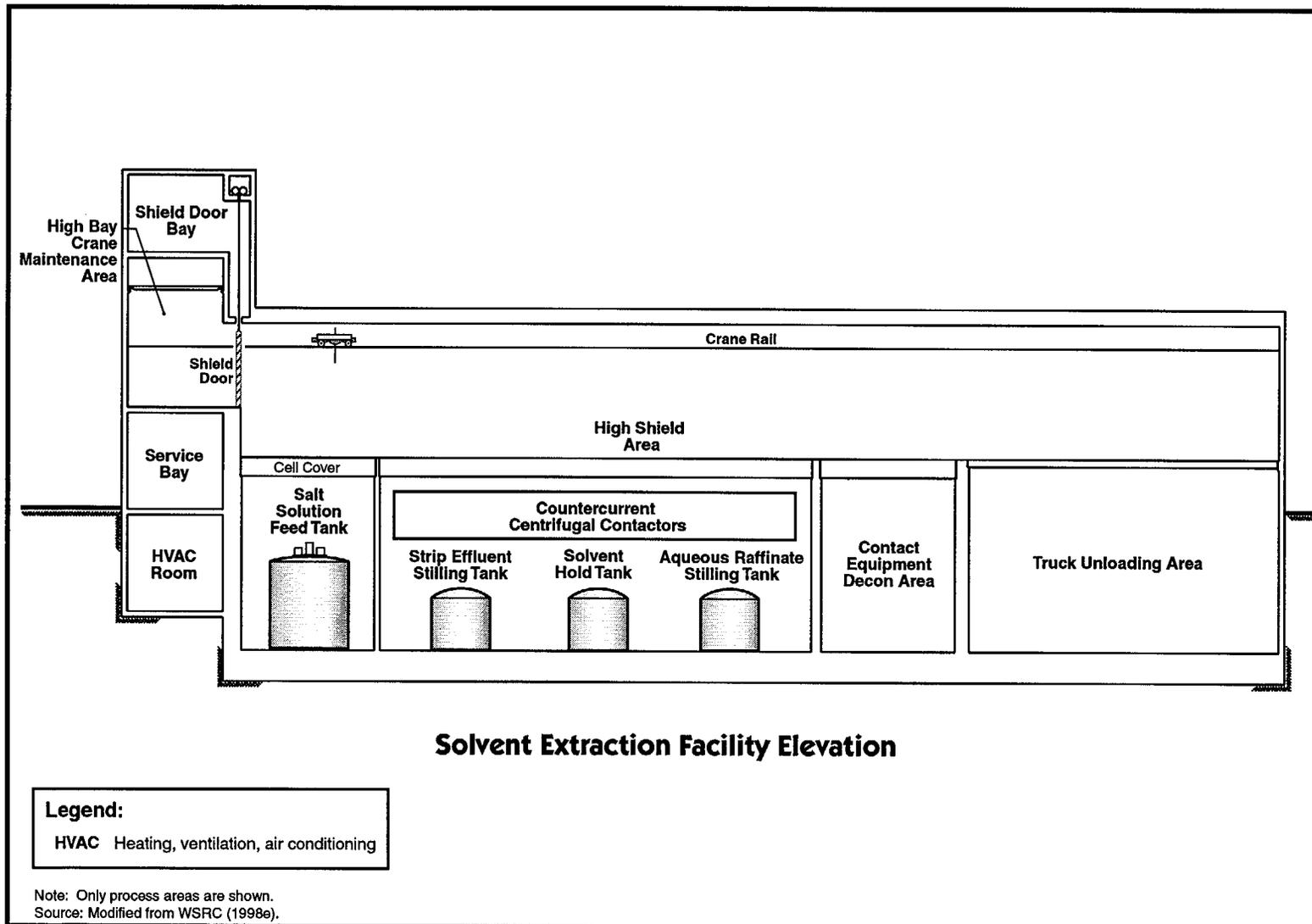
Figure A-13. Elevation plan for Ion Exchange facility.



Solvent Extraction Facility Floor Plan

Figure A-14. Floor plan for Solvent Extraction facility.

NW SDA EIS/GrTx_NW_SDAEIS/App_A/A-14 FI Plan CS.ai



Solvent Extraction Facility Elevation

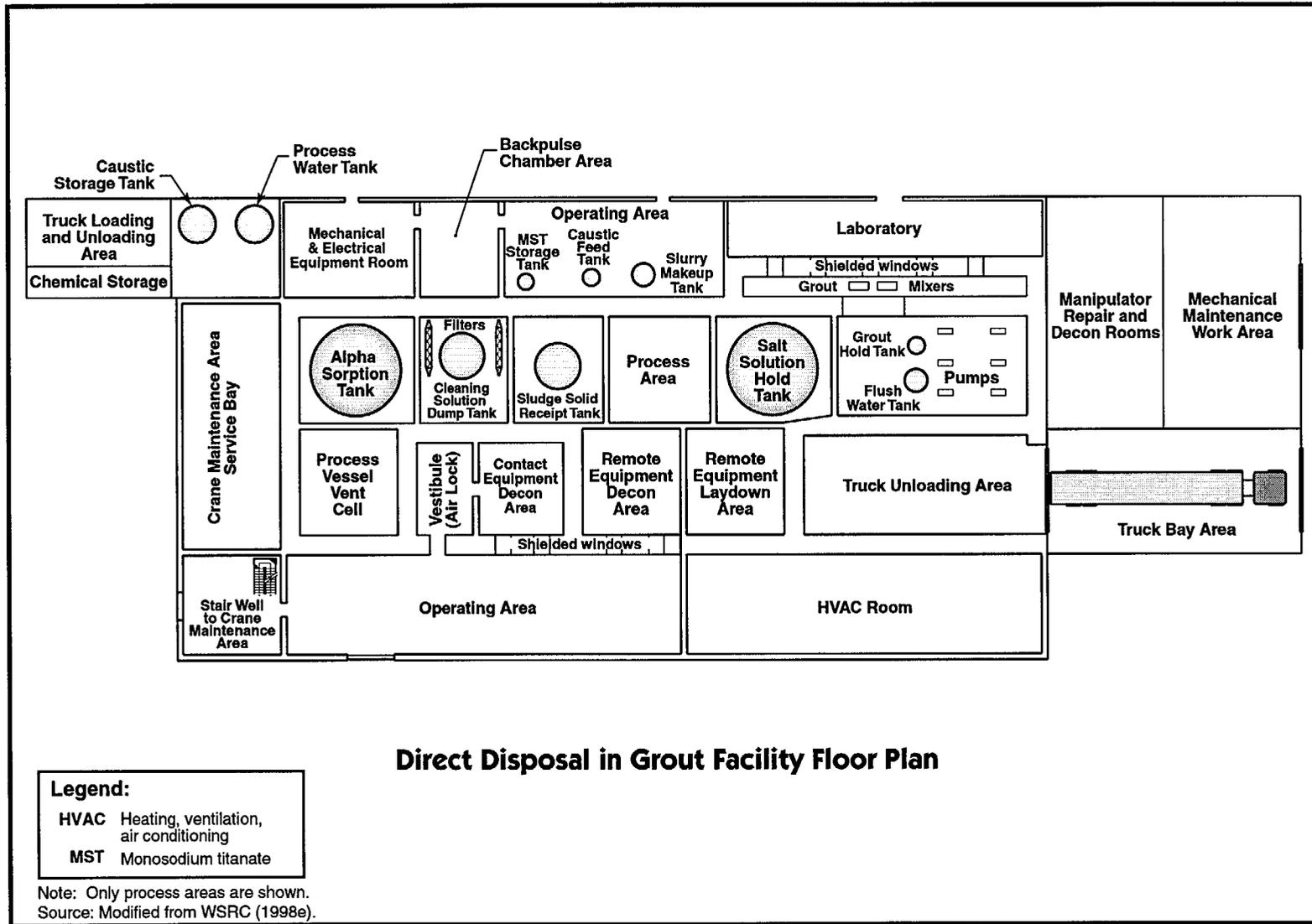
Legend:

HVAC Heating, ventilation, air conditioning

Note: Only process areas are shown.
 Source: Modified from WSRC (1998e).

NW SDA EIS/Grnx/App_A/A-15 Elev plan CS.ai

Figure A-15. Elevation plan for Solvent Extraction facility.



Direct Disposal in Grout Facility Floor Plan

Figure A-16. Floor plan for Direct Disposal in Grout facility.

NW SDA EIS/Grnt/App_A/A-16 FI Dir Disp.ai

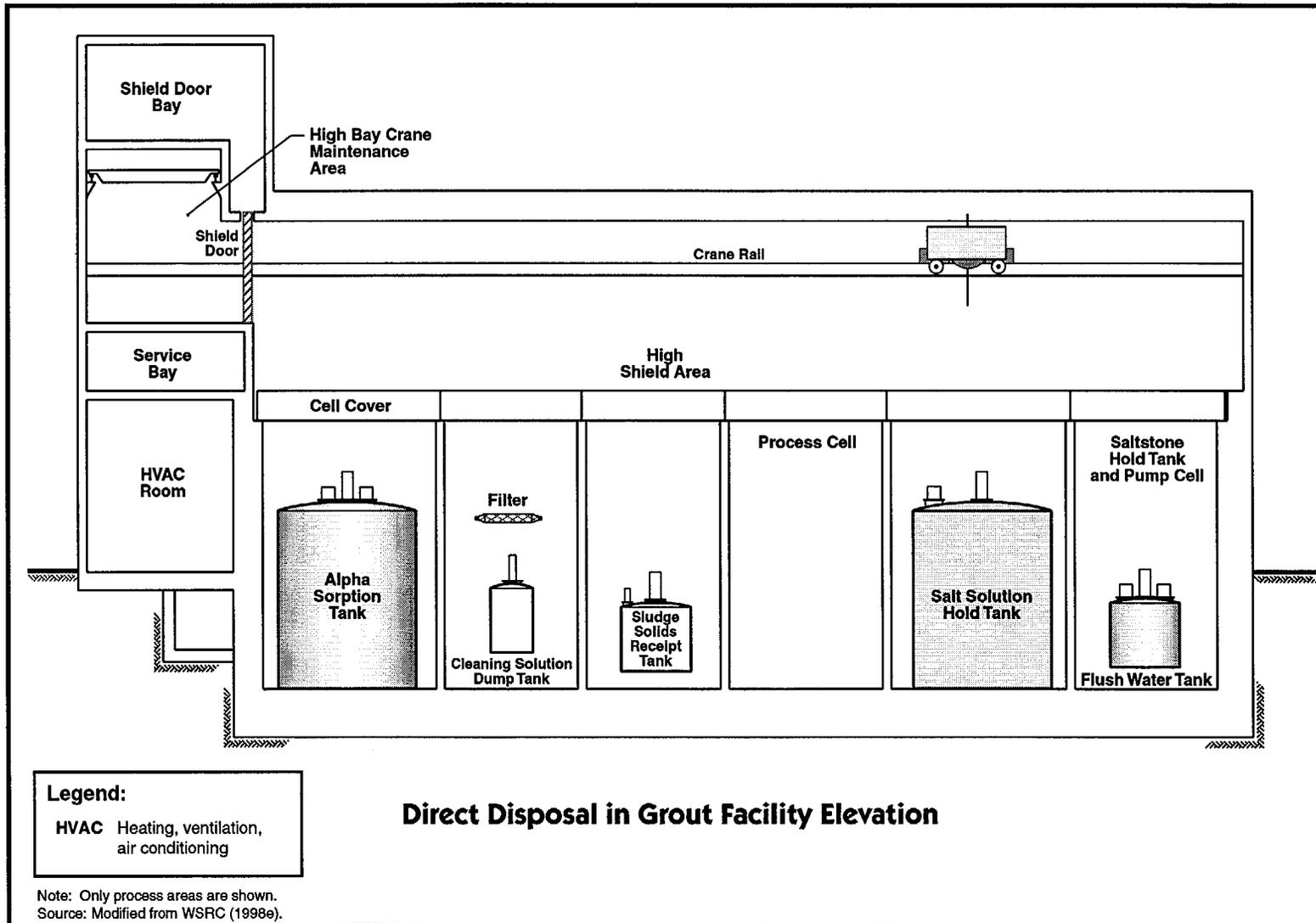


Figure A-17. Elevation plan for Direct Disposal in Grout facility.

NW SDA EIS/Grfx/App_A/A-17 Dir Disp elev.ai

A.5.2 TANK REQUIREMENTS

The types and sizes of process and storage tanks and vessels needed for facility operations would depend on the salt processing alternative utilized. Summary listings of the tanks required for the Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout processes are given in Tables A-7, A-8, A-9, and A-10, respectively (WSRC 2000d). The characteristics of these tanks form the basis for development of accident scenarios and consequences projected in Appendix B.

A.5.3 TRANSFER FACILITIES

New transfer facilities would be required to direct the flow of process streams among the various facilities employed in the salt processing alternatives. These include feed lines to the facilities, transfer lines between facilities, and several valve boxes, diversion boxes, and pump pits directing the stream flows (WSRC 1998o, 2000c). Details of the processing-related transport facilities are described in Table A-11. The integration of these new facilities into existing facilities is illustrated in Figures A-18 through A-21 (WSRC 1998e, 1999c).

A.5.4 SUPPORT FACILITIES

Each alternative would require other support facilities including service, office, and substation buildings. The service building would be a single-story, 21,000-23,700-square-foot steel-framed structure with concrete or brick siding. This building would contain electrical and mechanical maintenance shops, control rooms for the process and for the remote crane, a health physics office, conference room, and offices for operations personnel. The structure would also house two 500-kilowatt (kW) diesel generators and associated equipment (WSRC 1998o). The office building would typically be a 22,500-square-foot single-story structure capable of providing personnel emer-

gency shelter protection. It would house offices, a conference area, cafeteria, and restroom facilities for support personnel (e.g., engineering support, facility management, and clerical staff). The support facilities for each technology would include a process simulator building.

An electrical substation building, encompassing 600 square feet, would be needed for each alternative. A chemical storage area would be located on a concrete slab adjacent to the process building and add approximately 30 feet to the length of the process building. The area would be protected from the elements and contain storage tanks for chemicals used in the process. Dikes would be located around the tanks to contain any potential spills and to prevent inadvertent mixing of chemicals.

A.5.5 SALTSTONE VAULTS

As many as 16 saltstone disposal vaults beyond the currently existing two vaults would be constructed in Z Area to support the salt disposal alternatives (Figure A-22). Nominal dimensions of the additional vaults would be 300 feet long by 200 feet wide by 25 feet high. Each vault would consist of six cells, 100 feet long by 100 feet wide, to contain about 6,600 cubic meters of saltstone grout per cell. Interior and exterior walls would be 18 inches thick and the base slab would be 30 inches thick. The roof slab would be 18 inches thick. The interior floor and walls for each cell would be painted with epoxy to inhibit infiltration of moisture during grout curing. Any voids left in the grout in a cell would be filled with nonradioactive grout prior to final vault closure to help ensure structural integrity. All vaults would be equipped with cameras and lights to monitor filling, and thermocouple assemblies to monitor heat generation during the curing process. The six-cell configuration of the vaults would facilitate a pouring rotation that would meet grout-cooling requirements. As with the existing saltstone vaults, the additional vaults would be considered near-surface containment structures and covered with soil after vault closure for additional shielding.

| TC

Table A-7. Tanks for Small Tank Precipitation Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
MST Storage Tank	400	1	No	MST	Natural
Process Water Tank	80,000	1	No	Well water	Natural
NaTPB Storage Tank	20,000	1	No	NaTPB solution	100
Copper Nitrate Feed Tank	500	1	No	15 wt% Copper Nitrate	Natural
Formic Acid Feed Tank	500	1	No	90 wt% Formic Acid	Natural
Fresh Waste Day Tank	25,000	1	Yes	Feed	100
Precipitation Tank	15,000	2	Yes	Feed/PPT	10
Concentrate Tank	10,000	1	Yes	PPT	10
Filtrate Hold Tanks	100,000	2	Yes	DSS	10
Wash Tank	10,000	1	Yes	PPT	10
Recycle Wash Hold Tank	10,000	1	Yes	Feed/DSS ^a	10
Precipitate Reactor Feed Tank	10,000	1	Yes	PPT	10
Precipitate Reactor	10,000	1	Yes	PPT/PHA	10
Precipitate Reactor Condenser	610	1	Yes	PHA	(b)
Precipitate Reactor Decanter	610	1	Yes	PHA	(b)
Precipitate Reactor Overheads Tank	7,500	1	Yes	Dilute PHA ^c	10
Precipitate Hydrolysis Aqueous Surge Tank	40,000	1	Yes	PHA	10
Organic Evaporator	1,750	1	Yes	Benzene ^d	10
Organic Evaporator Condenser	610	1	Yes	Benzene ^d	(b)
Organic Evaporator Decanter	610	1	Yes	Benzene ^d	(b)
Organic Evaporator Condensate Tank	1,000	1	Yes	Benzene ^d	(b)
Salt Cell Vent Condenser	310	1	Yes	Benzene ^d	(b)
Organic Waste Storage Tank	40,000	1	Yes	Benzene ^d	10
Cleaning Solution Dump Tanks	1,000	2	Yes	0.01 × PPT ^e	10

DSS = Decontaminated Salt Solution, cfm = cubic feet per minute, PPT = Precipitate slurry, PHA = Precipitate Hydrolysis Aqueous, NaTPB = sodium tetraphenylborate.

- Recycled wash water will hold a diluted DSS but with higher cesium concentration. This stream is conservatively chosen to be feed for radionuclide emissions and DSS for chemical emissions.
- Condensers and decanters do not have independent ventilation. The vapor stream that enters each of these devices includes the nitrogen purge of each of the originating vessels.
- The final processing step in the precipitate reactor concentrates PHA by evaporation. This is the only time the precipitate reactor overheads tank receives any waste. The condensed overheads consists of water and entrained PHA. The amount of entrainment is assumed the same as any other boiling interface, $DF=4.4 \times 10^6$.
- Benzene includes minor quantities of other, heavier organic compounds including biphenyl. The radionuclide concentration in the solution is less than dilute PHA and make an insignificant contribution to radionuclide emissions.
- Cleaning solution is used to clean the cross flow filters and may be contaminated with some dilute mixture of PPT slurry. This stream is conservatively chosen to be 0.01 times the concentrations for PPT slurry.

Table A-8. Tanks for Ion Exchange Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation Flow per tank (cfm)
Process Water Tank	20,000	1	No	Well Water	Natural
MST Storage Tank	400	1	No	MST	Natural
Caustic Feed Tank	5,000	1	No	1 M NaOH	100
Resin Make-up Tank/Column Preparation Tank	2,000/ 3,000	1	No	CST	100
Oxalic Acid Feed Tank	200	1	No	2% H ₂ C ₂ O ₄	100
Caustic Feed Tank	500	1	No	1 M NaOH	100
Loaded Resin Hold Tank	15,000	2	Yes	CST	100
Ba-137 Decay Tanks/ Product Holdup Tank	2,000/ 5,000	2	Yes	DSS	100
DSS Hold Tanks	100,000	2	Yes	DSS	100
Resin Hold Tank	10,000	1	Yes	CST Slurry	Existing tank in DWPF ^a
Alpha Sorption Tank	100,000	1	Yes	Feed	100
Recycle Blend Tank	100,000	1	Yes	CSS	100
Sludge Solids Receipt Tank	10,000	1	Yes	Feed/MST Slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	0.01 × MST Slurry ^b	100
Wash Water Hold Tank	25,000	1	Yes	0.25 × CSS ^c	100
CST Ion Exchange Column	3,000	2	Yes	CST Slurry,	10
	3,000	2	Yes	DSS ^d	10

CSS = Clarified Salt Solution; DSS = Decontaminated Salt Solution; MST = Monosodium Titanate; CST = Crystalline Silicotitanate ion exchange resin, cfm = cubic feet per minute.

- This change at DWPF is not expected to impact DWPF stack emissions.
- Cleaning solution is used to clean the cross flow filters may be contaminated with some dilute mixture of MST slurry. This stream is conservatively chosen to be 0.01 time the concentrations for MST slurry.
- The wash water hold tank will hold wash water from the sludge solids receipt tank. The solution washed from the sludge is CSS, which is diluted by the washed water. The dilution is conservatively chosen to be 0.25.
- Two columns are assumed loaded at any one time and the other two are assumed to contain only DSS-resin slurry.

TC

For the Direct Disposal in Grout alternative, in which the grout would contain a large amount of radioactive cesium, special equipment would be used to control contamination during vault filling operations. A 500-cubic-foot-per-minute air flow ventilation system would be equipped with a pre-filter, high-efficiency particulate air (HEPA) filter and fan, and connected ductwork. Radiation monitors and dampers would be included (WSRC 1998e,o).

A.5.6 PILOT PLANT

To achieve pilot scale testing a salt processing process, a pilot plant would be

needed, as specified in Chapter 2 (Section 2.7.6). DOE intends to only construct and operate a Pilot Plant for the selected alternative. However, in the event that DOE decides to demonstrate more than one technology, the Pilot Plant units would be developed and operated in series. Therefore, impacts associated with more than one Pilot Plant would not occur at the same time, but would extend over a longer period. The pilot plant would provide scaled process data, utilizing equipment ranging from 1/100 to 1/10 the size of the full-scale facility (WSRC 2000e). Process streams would consist of real radioactive waste from various HLW tanks to

M4-3
M4-10
M4-11

Table A-9. Tanks for Solvent Extraction Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
Process Water Tank	20,000	1	No	Well water	Natural
MST Storage Tank	400	1	No	MST	Natural
Caustic Feed Tank	5,000	1	No	1 M NaOH	10
Oxalic Acid Feed Tank	200	1	No	2% H ₂ C ₂ O ₄	10
Caustic Feed Tank	500	1	No	1 M NaOH	10
Caustic Dilution Feed Tank	15,000	1	No	2.0 M caustic	10
Caustic Storage Tank	5,000	1	No	50% caustic	10
Filter Cleaning Caustic Tank	500	1	No	1 M NaOH	10
Caustic Makeup Tank	1,000	1	No	0.5 M NaOH	10
Solvent Wash Solution Makeup Tank	1,000	1	No	0.5 M NaOH	10
Nitrate Acid Feed Tank	1,000	1	No	50% HNO ₃	10
Nitrate Acid Charge Tank	1	1	No	50% HNO ₃	Natural
Strip Feed Tank	4,000	1	No	0.005 M HNO ₃	
Chem Additive Tank	100	1	No	Process water	10
Isopar Makeup Tank	2,000	1	No	Isopar [®] L	10
Isopar Hold Tank	5,000	1	No	Isopar [®] L	10
Isopar Feed Tank	500	1	No	Isopar [®] L	10
Modifier Makeup Tank	500	1	No	1.0 M Cs7SBT in Isopar [®] L	10
Extractant Makeup Tank	50	1	No	0.2 M BobCalix in Isopar [®] L	10
Trioctylamine Tank	5	1	No	Trioctylamine	10
Solvent Makeup Tank	1,000	1	No	0.01 BobCalix, 0.5 M Cs7SBT, and 0.001 M TOA in Isopar [®] L	10
Alpha Sorption Tank	125,000	1	Yes	Feed	100
Salt Solution Feed Tank	125,000	1	Yes	Clarified salt solution	100
Strip Stages (15)	114	1	Yes	Organic phase	None
Strip Effluent Stilling Tank	500	1	Yes	Strip solution	100
Strip Make-up Tank	25,000	1	Yes	Strip solution	100
Strip Organic Removal Stages (2)	15	1	Yes	Strip solution	100
Wash Water Hold Tank	25,000	1	Yes	~2M Na salt solution, 1/4 dilution of CSS	100
Ba-137 Decay Tanks	2,500	2	Yes	DSS	100
Caustic Solvent Wash Tank	1,000	1	Yes	DSS	100
Solvent Hold Tank	1,000	1	Yes	Organic phase	100

Technology Descriptions

Table A-9. (Continued).

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
Solvent Wash Tank	1,000	1	Yes	Organic phase	100
Kerosene Still	1,000	1	Yes	Organic phase	None
Kerosene Condensate Tank	1,000	1	Yes	Organic phase	None
Re-alkaline Stages (2)	15	1	Yes	Organic phase	None
Solvent Acid Wash Stages (2)	15	1	Yes	Organic phase	None
Scrub Stages (2)	15	1	Yes	Organic phase	None
Raffinate Organic Removal Stages (2)	15	1	Yes	DSS	None
Extraction Stages (15)	114	1	Yes	Clarified salt solution	None
DWPF Salt Feed Tank	100,000	1	Yes	Strip solution	100
Aqueous Raffinate Stilling Tank	500	1	Yes	DSS	100
DSS Hold Tanks	100,000	2	Yes	DSS	100
Sludge Solids Receipt Tank	10,000	1	Yes	Feed/MST slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	0.01 × MST slurry ^a	100

CSS = Clarified Salt Solution; DSS = Decontaminated Salt Solution; MST = Monosodium Titanate.

a. Cleaning solution is used to clean the cross flow filters and may be contaminated with some dilute mixture of MST slurry. This stream is conservatively chosen to be 0.01 times the concentrations for MST slurry.

Table A-10. Tanks for Direct Disposal in Grout Process.

Tank	Tank Size (gallons)	Number of Tanks	Radioactive	Stream Characteristics	Ventilation Flow (cfm)
MST Storage Tank (non-rad)	400	1	No	MST	natural
Process Water Tank (non-rad)	5,000	1	No	Well Water	natural
Oxalic Acid Feed Tank (non-rad)	200	1	No	2% H ₂ C ₂ O ₄	natural
Caustic Feed Tank (non-rad)	500	1	No	1M NaOH	100
Caustic Storage Tank (non-rad)	500	1	No	50% NaOH	natural
Alpha Sorption Tank	100,000	1	Yes	Feed	100
Sludge Solids Receipt Tank	10,000	1	Yes	MST Slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	(a)	100
Salt Solution Hold Tank	100,000	1	Yes	CSS	100
Flush Water Receipt Tank	10,000	1	Yes	CSS ^b	100
Saltstone Hold Tank	500	1	Yes	CSS with gout	100

CSS = Clarified Salt Solution; MST = Monosodium Titanate; cfm = cubic feet per minute.

a. Cleaning solution used to clear cross flow filters may be contaminated with MST slurry. Stream chosen to be 0.01 times concentration for MST slurry.

b. Flush water receipt tank holds water used to flush process lines at the mixer and saltstone hold tank, thus, will contain a diluted form of CSS. This stream is conservatively chosen to be 0.01 times the concentrations for CSS.

Table A-11. New transfer facilities.

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
	Processing facility at Site B ^a	Processing facility at Site B ^a	Processing facility at Site B ^a	Processing facility in Z Area ^a
Interarea feed line from H-Area Tank Farm to new processing facility	Extension of interarea feed line from the H-Area Tank Farm to the processing facility, consisting of a 150-foot-long double-walled pipe ^b , installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A feed line from the interarea feed line to the processing facility, consisting of a double-walled pipe ^b , approximately 500 feet long, installed 6 feet underground
Saltstone feed line	A pipe line from the processing facility to the feed line from H-Area Tank Farm to Saltstone Manufacturing and Disposal Facility, connecting at a valve box. Line is a double-walled pipe ^b , approximately 150 feet long, installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Vault feed line	A feed line from the Saltstone Manufacturing and Disposal Facility to the vaults consisting of a galvanized carbon steel pipe, 300 feet long, laid in a concrete trench 5 feet deep, 3 feet wide, with 1.5-foot-thick sides and top	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A feed line identical in specifications to the Small Tank Tetraphenylborate Precipitation vault feed line that would run from the new grout processing facility to the saltstone vaults
ETF Bottoms Holding Tank	A 50,000-gallon ETF Bottoms Holding Tank constructed between ETF and the Saltstone Manufacturing and Disposal Facility	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A 50,000-gallon Bottoms Holding Tank constructed between ETF and the H-Area Tank Farm
Precipitate Hydrolysis Aqueous transfer line	A pipe line from the processing facility to the existing Low Point Pump Pit, connecting with existing feed line to DWPF. Line is a double-walled pipe 2,300 feet long, buried 6 feet below grade	NA	NA	NA

Table A-11. (Continued).

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
Valve box	A valve box constructed between the processing facility and the Saltstone Manufacturing and Disposal Facility, providing tie-in for feed lines from processing facility and ETF	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Feed line from ETF to valve box	A feed line from the ETF Bottoms Holding Tank to the new valve box, consisting of a double-walled pipe ^b , approximately 1 mile long, installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Low Point Pump Pit	NA	A new Low Point Pump Pit to transfer resin between the processing facility and DWPF	A new Low Point Pump Pit between the processing facility and DWPF to transfer monosodium titanate/sludge slurry	NA
Resin transfer line	NA	A feed line from the processing facility through the new Low Point Pump Pit to the DWPF, consisting of a double-walled pipe ^b , 2,300 feet long, installed 6 feet underground	NA	NA
Monosodium Titanate/Sludge Slurry transfer line	NA	A pipe line from the processing facility to the existing Low Point Pump Pit, connecting with existing feed line to DWPF. Line is a double-walled pipe 2,300 feet long, buried 6 feet below grade	A pipeline from the processing facility through the new Low Point Pump Pit to the DWPF Line is a double-walled pipe, 2,300 feet long, buried 6 feet below grade	NA

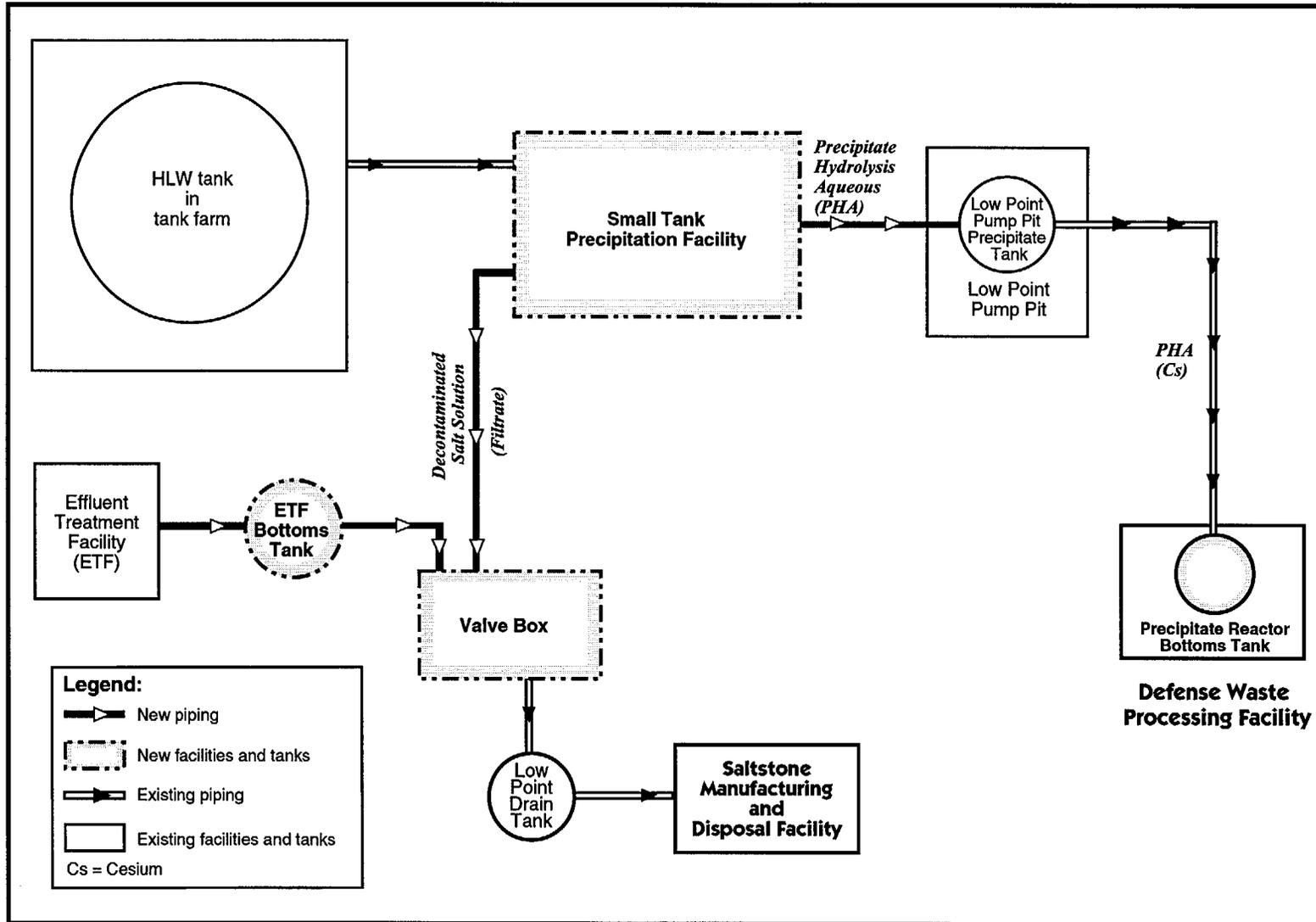
Table A-11. (Continued).

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
Monosodium Titanate/Sludge Receipt Tank in DWPF	NA	A 15,000-gallon tank installed in the DWPF	Same as Crystalline Silicotitanate Ion Exchange	Same as Crystalline Silicotitanate Ion Exchange
Resin Hold tank in DWPF	NA	A 10,000-gallon tank installed in the DWPF	NA	NA
Cesium Strip Effluent transfer line	NA	NA	A pipe line from the processing facility to the existing Low Point Pump Pit connecting with the existing feed line to the DWPF	NA
Cesium Strip Effluent Hold Tank in DWPF	NA	NA	A 10,000-gallon tank installed in the DWPF	NA
Low Point Drain Tank facility	NA	NA	NA	A Low Point Drain Tank Facility to serve transfer lines between the H-Area Tank Farm and the processing facility and between the processing facility and DWPF. It would be used to transfer salt solution to the grout facility and monosodium titanate/sludge slurry to DWPF
Monosodium Titanate/Slurry feed line to DWPF	NA	NA	NA	A feed line from the processing facility through the Low Point Drain Tank Facility to DWPF, consisting of a doubled-walled pipe 1 mile long, installed 6 feet underground

a. See text for description of the proposed facilities.

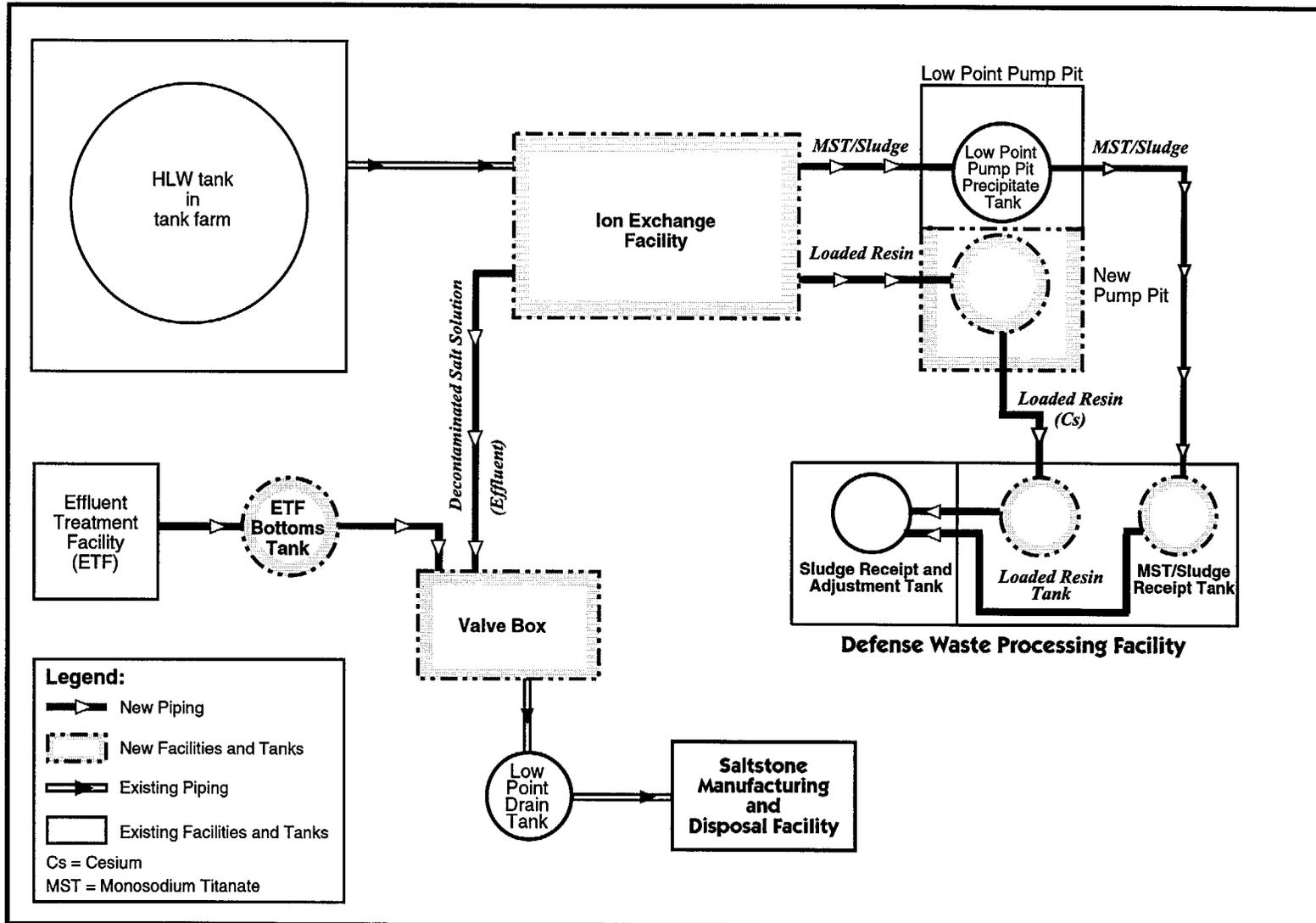
b. All double-walled transfer lines, comprised of 3-in.-diameter, schedule 40 (or 80), Type 304L stainless steel inner pipe and 6-in.-diameter, schedule 40, carbon steel outer pipe.

NA = not applicable.



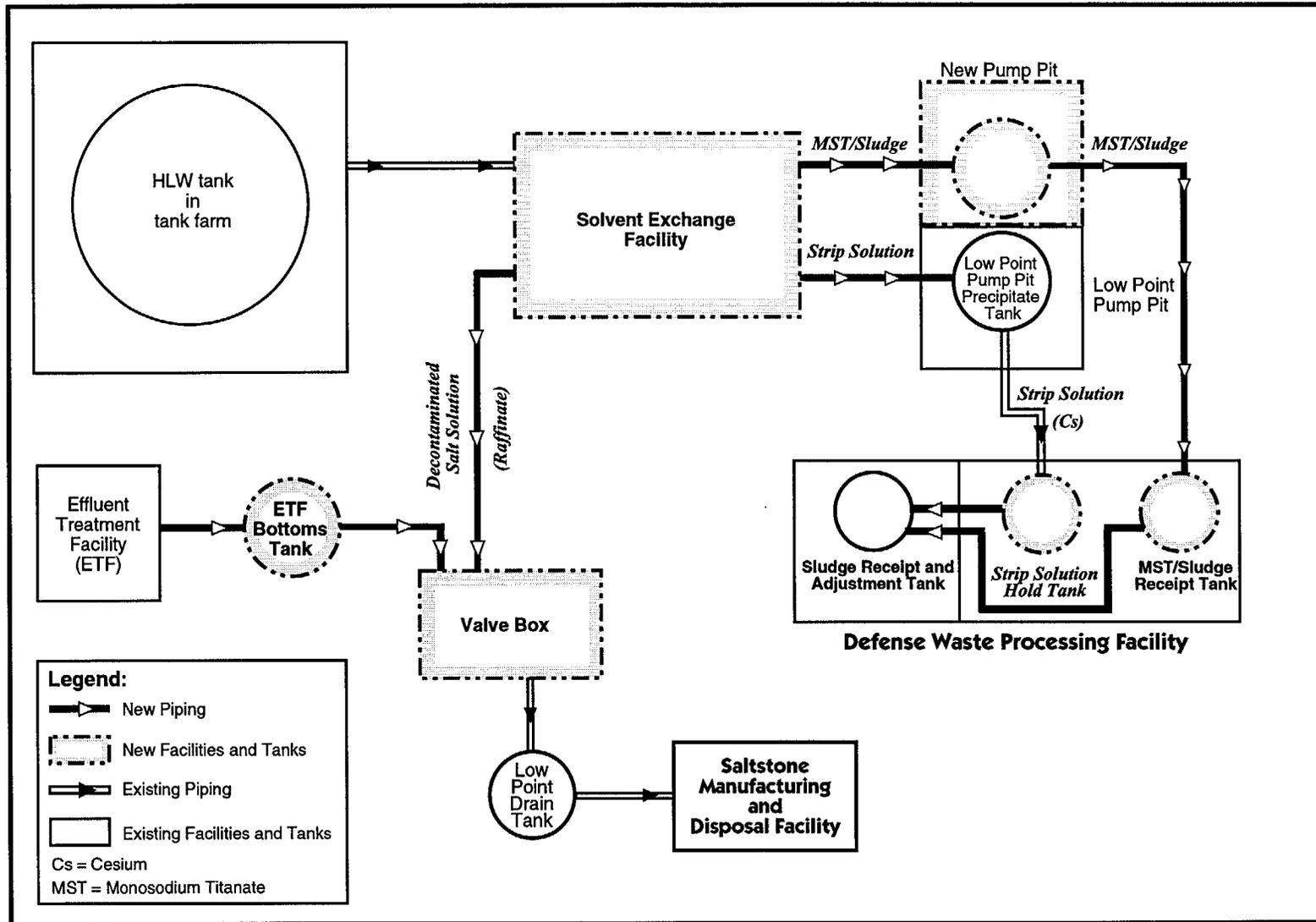
NW SDA EIS/Grfx/App A/A-18 Trans Sm Tank.al

Figure A-18. Transfer facilities for Small Tank Precipitation alternative.



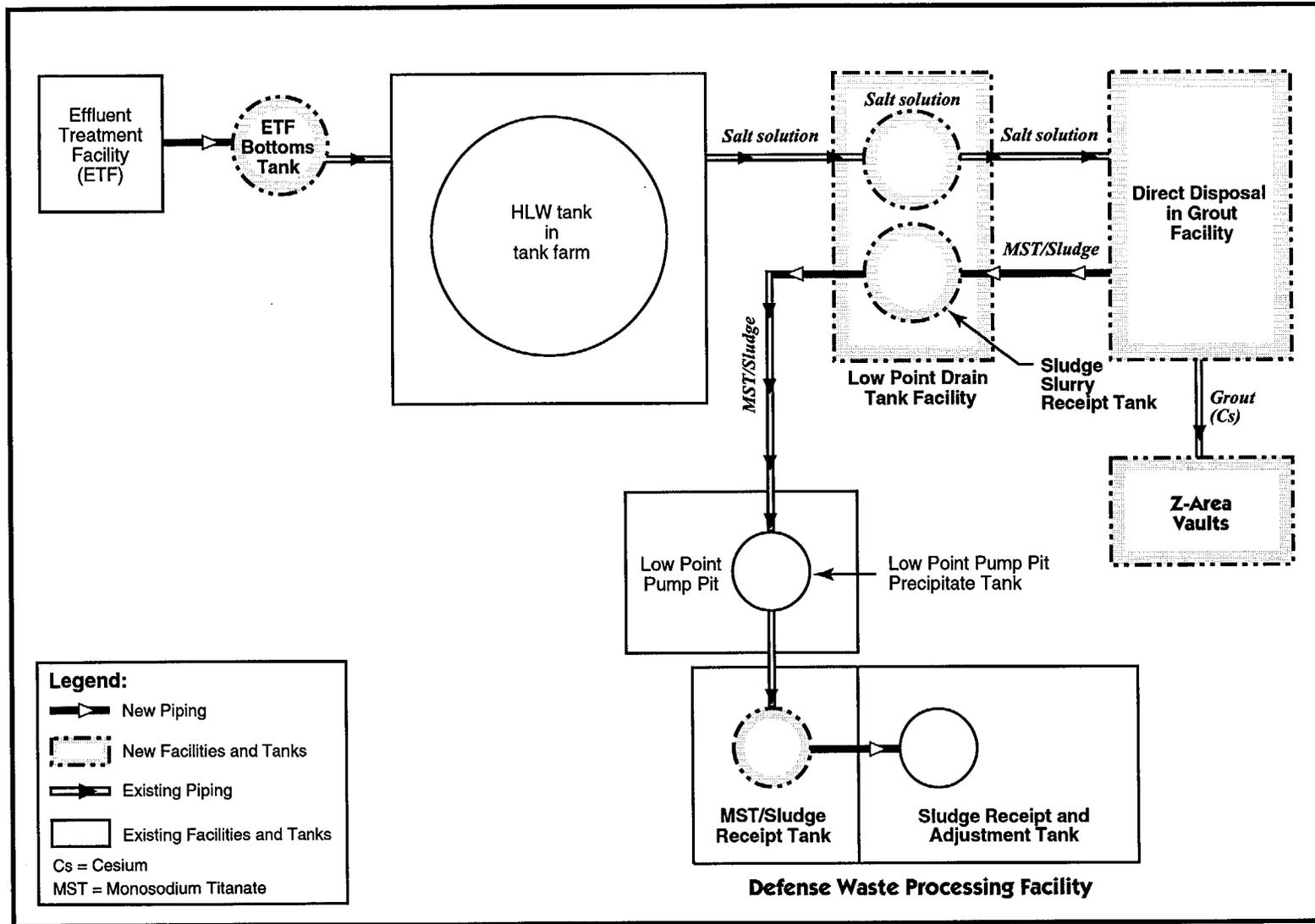
NW SDA EIS/Grfx/App A/A-19 Trans CST.ai

Figure A-19. Transfer facilities for Ion Exchange alternative.



NW SDA EIS/Grfx/App A/A-20 Trans CST Solv.ai

Figure A-20. Transfer facilities for Solvent Extraction alternative.



NW SDA EIS/Gr/x/App A/A-21 Trans Dir Disp.ai

Figure A-21. Transfer facilities for Direct Disposal in Grout alternative.

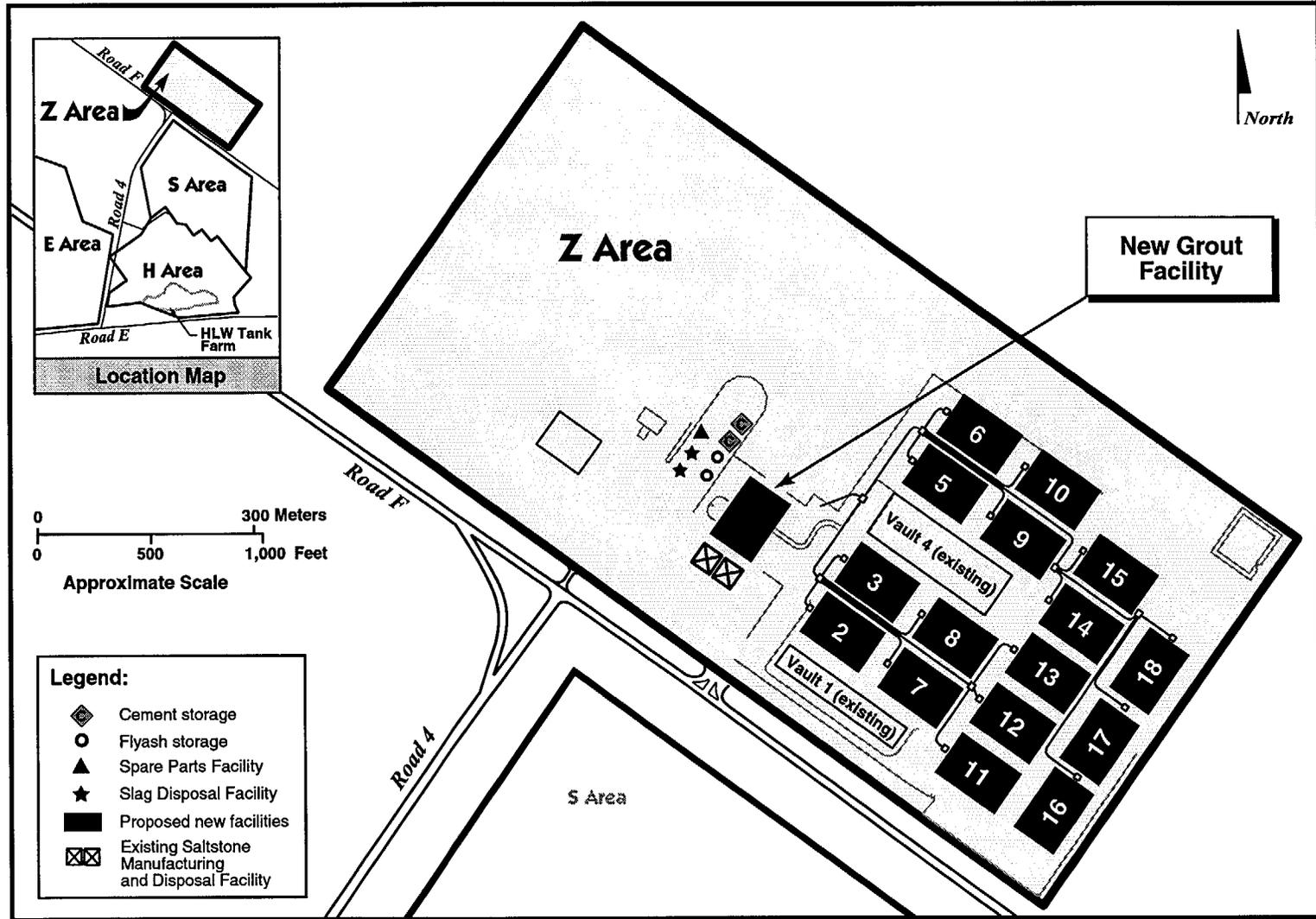


Figure A-22. Proposed location of new Grout Facility and saltstone disposal vaults in Z Area.

demonstrate required decontamination factors (DF), as follows:

- Cs-137 DF 40,000
- Sr-90 DF 100 or greater
- Pu-238 DF 10 or greater

Capability for appropriate waste disposal would be required in the pilot plant.

Installation of pilot plant process equipment in the existing Late Wash Facility provided for ITP is projected. The Late Wash Facility has three highly shielded cells designed to contain up to 5,000 gallons of concentrated precipitate slurry, into which salt processing equipment mounted in frames could be installed. If additional shielded space was required, the filter cell previously provided to support ITP operations would be considered.

Test runs designed to demonstrate the process flowsheet for the selected salt processing alternative would be conducted in the pilot plant. Functional process flows would parallel those for the full-scale facility. Major equipment would be tested to confirm vessel sizing and design constraints, and process parameters would be evaluated to ensure satisfactory resolution of problems encountered during process development.

Process demonstrations would be designed to meet the following objectives:

Small Tank Precipitation – Validity of design parameters, as determined by kinetics of cesium precipitation by tetraphenylborate, and strontium and actinide sorption on monosodium titanate; feed stream mixing rates; and excess tetraphenylborate recovery. Resolve processing uncertainties related to the activation of tetraphenylborate decomposition catalysts at operating temperatures, and foam formation.

Major equipment would include:

- Process Feed Tank

Precipitation Tanks (Continuous Stirred Tank Reactors 1 and 2)

Concentrate Tanks

Concentrate Filter and Cleaning System

Filtrate Hold Tank

Wash Tank

Wash Filter and Cleaning System

Precipitate Surge Tank

Recycle Wash Hold Tank

Cold Feeds and Facilities

Laboratory Facilities

Ion Exchange – Resolve key issues, including the kinetics of strontium and actinide sorption onto monosodium titanate; filtration of monosodium titanate solids; the kinetics of cesium removal on crystalline silicotitanate as function of temperature and waste composition; and design parameters for the ion-exchange columns. Resolve processing uncertainties relating to hydrogen generation in the ion-exchange columns at high cesium loadings; desorption of cesium from the crystalline silicotitanate ion exchange resin; resin stability; and extraneous solids formation.

Major equipment would include:

Alpha Sorption Tank

Alpha/Sludge Filter and Cleaning System

Sludge Solids Receipt Tank

Recycle Blend Tank

Crystalline Silicotitanate Columns in series (1 ft diam × 16 ft length)

Loaded Resin Hold Tank

Decontaminated Salt Solution Hold Tank

Cold Feeds and Facilities

Laboratory Facilities

Solvent Extraction – Demonstrate or confirm the kinetics of strontium and actinide sorption onto monosodium titanate with removal by filtration; cesium separation and concentration in centrifugal contactor operation with minimal long-term chemical and radiolytic degradation of solvent; solvent cleanup and recycle capabilities, in-

cluding self purification by back extraction to aqueous phase; and final separation of organics from aqueous raffinate and strip effluent product streams.

Major equipment would include:

- Alpha Sorption Tank
- Alpha/Sludge Filter and Cleaning System
- Sludge Solids Receipt Tank
- Salt Solution Feed Tank
- Solvent Extraction Contactors in Series
- Solvent Hold Tank and Cleaning System
- Raffinate Stilling Tank
- Strip Effluent Stilling Tank
- Decontaminated Salt Solution Hold Tank

Direct Disposal in Grout – A requirement for the demonstration of the Direct Disposal in Grout alternative has not been confirmed. Because this technology is better developed than the other alternatives and has been thoroughly demonstrated by the existing Saltstone Manufacturing and Disposal Facility, it is not anticipated that any further demonstration of this technology would be necessary.

A.5.7 DECONTAMINATION AND DECOMMISSIONING

Any new facility would be designed and constructed to limit the generation and dispersion of radioactive and hazardous materials and to facilitate its ultimate decontami-

nation and decommissioning or reuse. Areas of the facility that might become contaminated with radioactive or other hazardous materials under normal or off-normal operating conditions would incorporate design features to simplify their decontamination. Items such as service piping, conduits, and ductwork would be minimized in these areas and arranged to facilitate decontamination. Facility design would include a dedicated area for decontamination of tools and some equipment. Design features that would be incorporated into any of the facilities are described below.

- Modular confinement would be used for radioactive and hazardous materials to preclude contamination of fixed portions of the structure.
- Long runs of buried piping that would carry radioactive or hazardous materials would be minimized to the extent possible, and provisions would be included in the design to allow the inspection of the integrity of joints in buried pipelines. The facility would be designed to facilitate dismantlement, removal, and packaging of contaminated equipment.
- Modular shielding would be used in interior areas to permit modification to larger shielded areas for future use.
- Lifting lugs would be used on equipment to facilitate remote removal from the contaminated process cells.
- The piping systems that would carry hazardous products would be fully drainable.

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