B in S Area, depth to the water table averages approximately 45 feet below grade. Groundwater flow in the area is to the northeast to McQueen Branch (Figure 3-9). At the Z-Area site, average depth to the water table ranges from 70 to 60 feet. Groundwater flow below the subject site is to the northeast toward McQueen Branch (Figure 3-10).

3.2.2.2 Groundwater Use

At SRS, most groundwater production for domestic and process water comes from the intermediate/deep aquifers (i.e., the Crouch Branch and McQueen Branch Aquifers). A few lower-capacity domestic water wells pump from the shallower Gordon (Congaree) Aquifer and the lower zone of the Upper Three Runs (Barnwell-McBean) Aquifer. These wells are located in outlying areas, away from the main operations areas including guard barricades and operations offices/laboratories (DOE 1998a).

Domestic water requirements for the General Separations Area (an area that includes S and Z Areas) are supplied from groundwater wells located in A Area (Arnett and Mamatey 1998b).

From January to December 1998, the total groundwater withdrawal rate in the General Separations Area for industrial use, including groundwater from process production wells and former domestic wells (now used as process wells in F, H, and S Areas), was approximately 2.086 million gallons per day. These wells are installed in the deeper Cretaceous aquifers. During 1998, wells in H and S Areas produced approximately 1.02 million gallons per day and 49,000 gallons per day, respectively. H Area has two former domestic wells and three process production wells (Wells 1997; WSRC 1999b). S Area’s groundwater production is three process/former domestic wells (WSRC 1995a).

3.2.2.3 Hydrogeology

The aquifers of primary interest for H, S, and Z Areas are the Upper Three Runs and Gordon Aquifers. The Upper Three Runs Aquifer includes the Tinker/Santee Formation, the Dry Branch Formation, and the Tobacco Road Formation. Table 3-5 provides descriptions of the lithologic and hydrologic characteristics of these formations. The Twiggs Clay Member of the Dry Branch Formation locally acts as a confining unit (colloquially known as the “tan clay”) that separates the Upper Three Runs Aquifer into an upper and a lower zone. Averages of various types of field tests for horizontal hydraulic conductivity of the upper zone of the Upper Three Runs Aquifer ranges from 0.7 to 13 feet per day. Comparable ranges of horizontal hydraulic conductivity of the lower zone of the Upper Three Runs Aquifer are approximately 0.9 to 33.3 feet per day, although the overall average is about one-half that of the upper zone (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity of the Upper Three Runs Aquifer (upper and lower zones) is understood to be less than the horizontal.

The Gordon Confining unit (colloquially the “green clay”) that separates the Upper Three Runs and Gordon Aquifers consists of the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone. It is not a continuous unit, but consists of overlapping lenses of clay that thicken, thin, and pinch out. Beds of calcareous mud (Blue Bluff Member of the Santee Formation) locally add to the thickness of the unit (Aadland, Gellici, and Thayer 1995).

The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. Table 3-5 provides lithologic and hydrologic soil descriptions of these formations. The Gordon Aquifer is partly eroded near the Savannah River and along Upper Three Runs. This aquifer is recharged directly by precipitation in outcrop areas, at inter-stream divides in and near outcrop areas, and by leakage from overlying and underlying aquifers. Average field tests for horizontal hydraulic conductivity range between approximately 5 and 35 feet per day (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity is less than the horizontal.

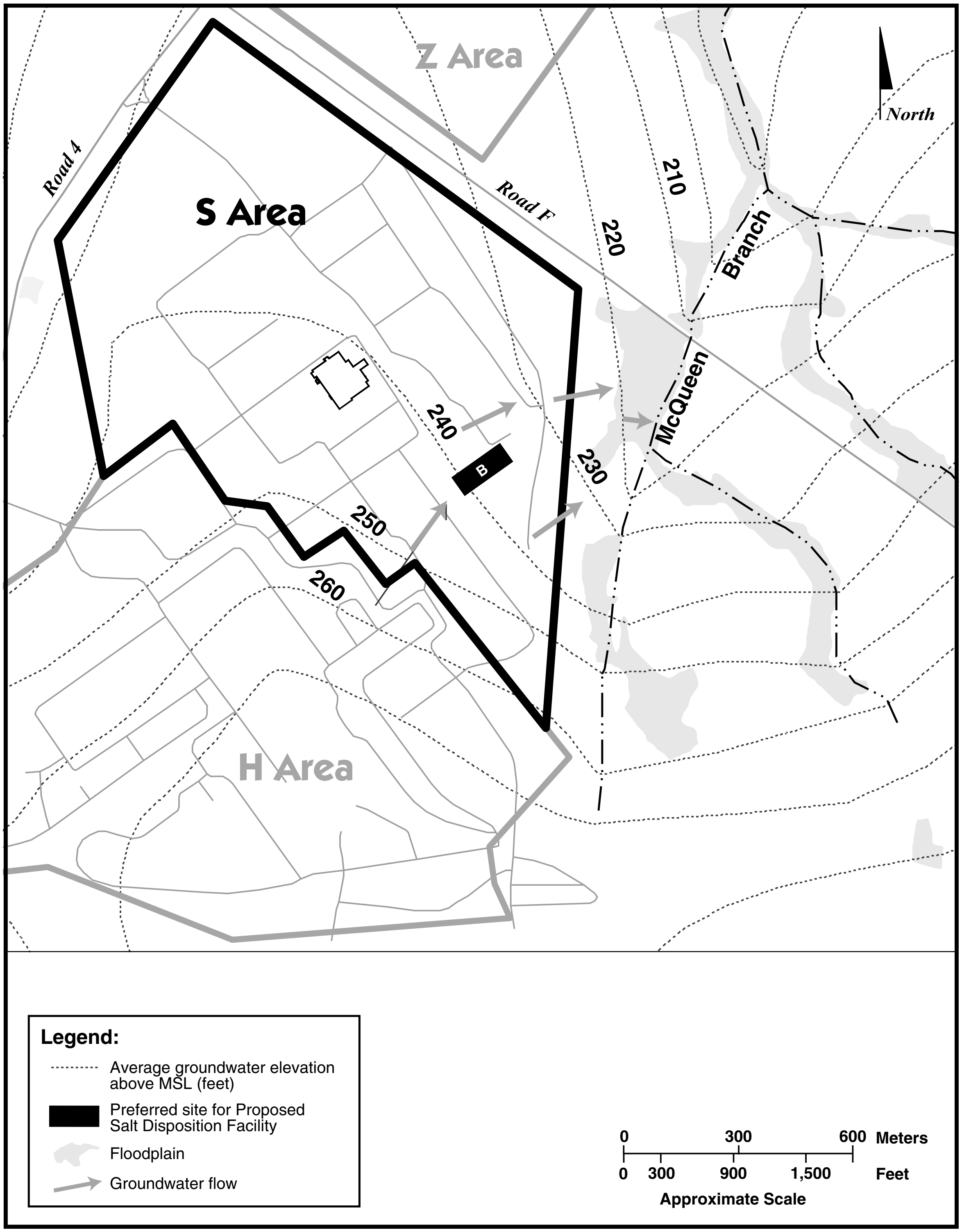

Figure 3-9. Average groundwater elevation and direction of flow in the vicinity of S Area.

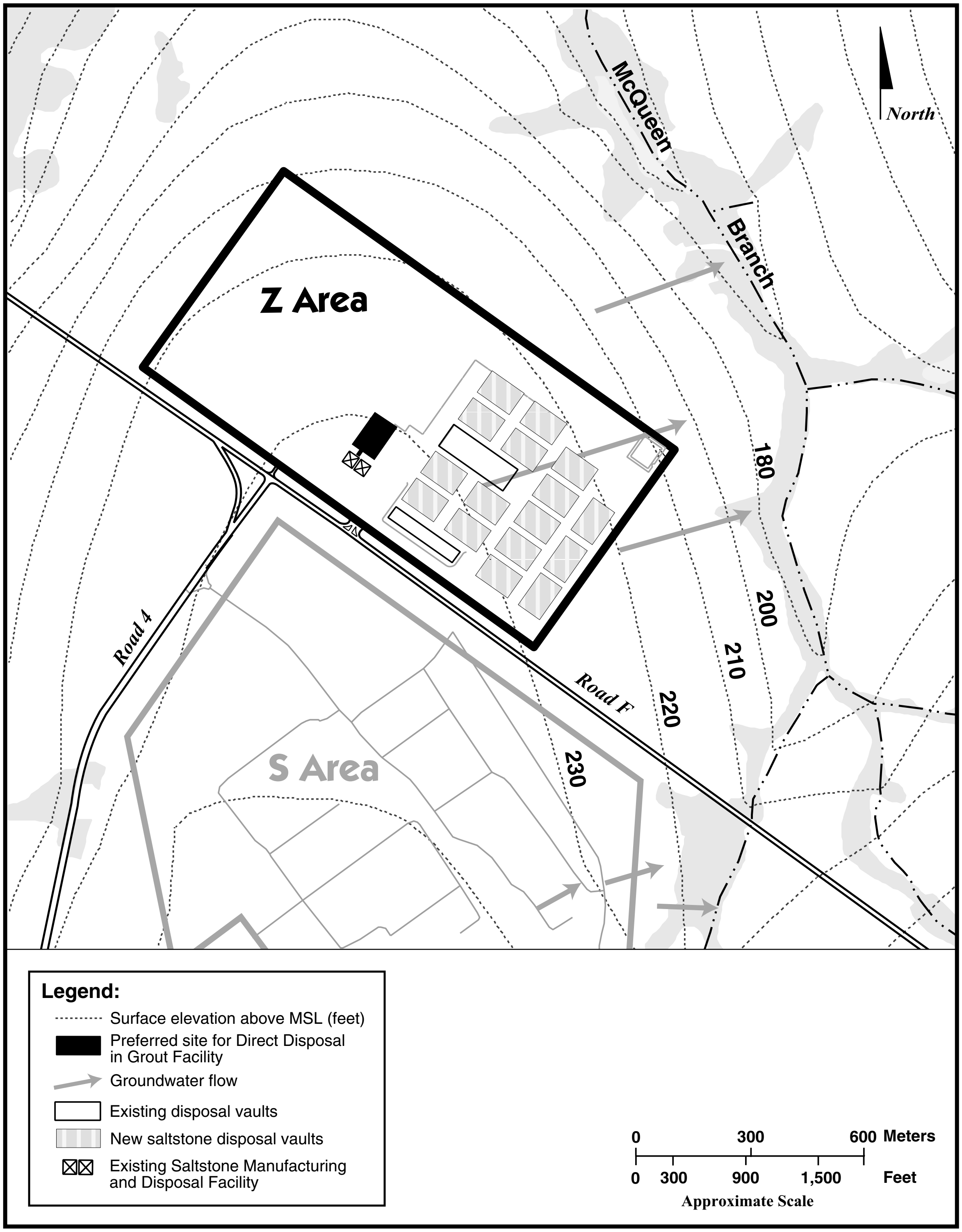

Figure 3-10. Average groundwater elevation and direction of groundwater flow in vicinity of Z Area.

Table 3-5. Soil formations of the Floridan aquifer system in F and H Areas.

Aquifer Unit	Formation	Description
Upper Three Runs Aquifer (formerly Water Table and Barnwell/McBean Aquifers)	"Upland Unit"	Poorly sorted, clayey-to-silty sands, with lenses and layers of conglomerates, pebbly sands, and clays. Clay clasts are abundant, and cross-bedding and flecks of weathered feldspar are locally common.
	Tobacco Road Formation	Moderately to poorly sorted, variably colored, fine-to-coarse grained sand, pebbly sand, and minor clay beds
	Dry Branch Formation	Variably colored, poorly sorted to well-sorted sand with interbedded tan to gray clay
	Clinchfield Formation	Light colored basal quartz sand and glauconitic, biomoldic limestone, calcareous sand and clay. Sand beds of the formation constitute Riggins Mill Member and consist of medium-to-coarse, poorly to well-sorted, loose and slightly indurated, tan, gray, and green quartz. The carbonate sequence of the Clinchfield consists of Utley Member -- sandy, glauconitic limestone and calcareous sand with indurated biomoldic facies.
	Tinker/Santee Formation	Unconsolidated, moderately sorted, subangular, lower coarse-to-medium grained, slightly gravely, immature yellow and tan quartz sand and clayey sand; calcareous sands and clays and limestone also occur in F and H Areas.
Gordon Confining Unit (green clay)	Blue Bluff Member of Santee Limestone	Micritic limestone
	Warley Hill Formation	Fine-grained, glauconitic, clayey sand, and clay that thicken, thin, and pinch out abruptly
Gordon Aquifer	Congaree Formation	Yellow, orange, tan, gray, and greenish gray, well-sorted, fine-to-coarse-grained quartz sands. Thin clay laminae occur throughout the section, with pebbly layers, clay clasts, and glauconite in places. In some places on SRS, the upper part of Congaree Formation is cemented with silica; in other places it is slightly calcareous. Glauconitic clay, encountered in some borings on SRS near the base of this formation, indicates that basal contact is unconformable
	Fourmile Formation	Tan, yellow-orange, brown, and white, moderately to well-sorted sand, with clay beds near middle and top of unit. The sand is very coarse-to-fine-grained, with pebbly zones common. Glauconite and dinoflagellate fossils occur.
	Snapp Formation	Silty, medium-to-coarse-grained quartz sand interbedded with clay. Dark, micaceous, lignitic sand also occurs. In northwestern part of SRS, this Formation is less silty and better sorted, with thinner clay interbeds.

Source: Aadland, Gellici, and Thayer (1995).

3.2.2.4 Groundwater Quality

Most contaminated groundwater at SRS occurs beneath a few facilities; the contaminants reflect the operations and chemical processes performed at those facilities. In the H, S, and Z Areas, contaminants above regulatory and DOE guidelines include tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics.

Tables 3-6 through 3-8 list concentrations of individual analytes above regulatory or SRS guidelines for the period from fourth quarter 1997 through third quarter 1998 for H, S, and Z Areas, respectively (WSRC 1997a; WSRC 1998a,b,c).

3.3 Air Resources

3.3.1 METEOROLOGY

The southeastern United States has a humid subtropical climate characterized by relatively short, mild winters and long, warm, humid summers. Summer-like weather typically lasts from May through September, when the area is subject to the persistent presence of the Atlantic subtropical anticyclone (i.e., the "Bermuda" high). The humid conditions often result in scattered afternoon and evening thunderstorms.

The influence of the Bermuda high starts to diminish during the fall, resulting in lower humidity and more moderate temperatures. Average seasonal rainfall is usually lowest during the fall.

During the winter months, weather conditions frequently tend to alternate between warm, moist, subtropical air from the Gulf of Mexico region and cool, dry polar air. Measurable snowfall is rare.

Spring is characterized by a higher frequency of tornadoes and severe thunderstorms than the other seasons. Spring weather is somewhat windy, with mild temperatures and relatively low humidity.

3.3.1.1 Local Climatology

Data collection sources used to characterize the climatology of SRS consist of a standard instrument shelter in A Area (temperature, humidity, and precipitation for 1961 to 1994), the Central Climatology Meteorological Facility near N Area (temperature, humidity, and precipitation), and seven meteorological towers (winds and atmospheric stability).

The average annual temperature at SRS is 64.7°F. July is the warmest month of the year, with an average daily maximum of 92°F and an average daily minimum near 72°F. January is the coldest month, with an average daily high around 56°F and an average daily low of 36°F. Temperature extremes recorded at SRS since 1961 range from a maximum of 107°F in July 1986 to -3°F in January 1985.

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

The observed wind at SRS indicates no prevailing wind direction, which is typical for the lower Midlands of South Carolina. According to wind data collected from 1992 through 1996, winds are most frequently from the northeast sector (9.7 percent) followed by winds from the north-northeast sector (9.4 percent) (Arnett and Mamatey 1998b). Measurements of air turbulence are used to determine whether the atmosphere has relatively high, moderate, or low potential to disperse airborne pollutants (commonly identified as unstable, neutral, or stable atmospheric conditions, respectively). Generally, SRS atmospheric conditions were categorized as unstable 56 percent of the time (DOE 1999a).

Table 3-6. H Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

Analyte	Concentration	Regulatory limit	
Aluminum[a]	13,000 μg/L[b]	50 μg/L[c]	
Bis (2-ethylhexyl) phthalate	142 μg/L	6 μg/L[d]	
Dichloromethane	8.45 μg/L	5 μg/L[d]	
Gross alpha	9.74×10^{-8} μCi/mL[b]	1.5×10^{-8} μCi/mL[e]	
Iodine-129	1.09×10^{-7} μCi/mL	1.0×10^{-9} μCi/mL[e]	
Iron[a]	17,100 μg/L	300 μg/L[c]	
Lead[a]	417 μg/L	50 μg/L[f]	
Manganese[a]	1,650 μg/L	50 μg/L[c]	
Mercury[a]	18.5 μg/L	2.0 μg/L[d]	
Nickel-63	4.79×10^{-7} μCi/mL	5.0×10^{-8} μCi/mL[e]	
Nitrate-nitrite as nitrogen	52,800 μg/L	10,000 μg/L[d,g]	
Nonvolatile beta	3.37×10^{-6} μCi/mL	5.0×10^{-8} μCi/mL[e]	
Phosphate	2.28 μg/L	1.7 μg/L[h]	
Radium-226	6.52×10^{-8} μCi/mL	5.0×10^{-9} μCi/mL[e,i]	
Radium-228	6.98×10^{-8} μCi/mL	5.0×10^{-9} μCi/mL[e,i]	
Radium, total alpha emitting	6.70×10^{-9} μCi/mL	5.0×10^{-9} μCi/mL[e]	
Ruthenium-106	3.81×10^{-8} μCi/mL	3.0×10^{-8} μCi/mL[e]	
Strontium-89,90	1.01×10^{-8} μCi/mL	8.0×10^{-9} μCi/mL[d]	
Strontium-90	1.24×10^{-6} μCi/mL	8.0×10^{-9} μCi/mL[d]	
Thallium[a]	1,060 μg/L	2 μg/L[d]	
Trichloroethylene	14.7 μg/L	5 μg/L[d]	
Tetrachloroethylene	12.6 μg/L	5 μg/L[d]	
Tritium	1.02×10^{-2} μCi/mL	2.0×10^{-5} μCi/mL[d]	
Uranium-233,234	4.28×10^{-8} μCi/mL	2.7×10^{-8} μCi/mL[j]	L4-5
Uranium-238	4.20×10^{-8} μCi/mL	2.7×10^{-8} μCi/mL[j]	L4-6
Vanadium[a]	139 μg/L	133 μg/L[i]	

a. Total recoverable.
b. μg/L = micrograms per liter; μCi/mL = microcuries per milliliter.
c. EPA National Secondary Drinking Water Standards (WSRC 1997a; 1998a,b,c).
d. EPA Final Primary Drinking Water Standards (WSRC 1997a; 1998a,b,c). TC
e. EPA Final Primary Drinking Water Standards; Radionuclides (65 FR 76708).
f. SCDHEC Final Primary Drinking Water Standards (WSRC 1997a; 1998a,b,c).
g. Nitrate Maximum Contaminant Level (MCL) = 10,000 μg/L; Nitrite MCL = 1,000 μg/L.
h. Drinking Water Standards do not apply. Criterion 10 × a recently published 90th percentile detection limit was used (WSRC 1997a; 1998a,b,c). L4-5
i. Radium-226, 228 combined MCL of 5.0×10^{-8} microcuries per milliliter. L4-6
j. Uranium combined MCL of 30 μg/L is equivalent to 2.7×10^{-8} μCi/mL (65 FR 76708). L11-8

Table 3-7. S Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

Analyte	Concentration	Regulatory limit
Trichloroethylene	49.2 µg/L[a]	5 µg/L[b]

a. µg/L = micrograms per liter.
b. EPA Final Primary Drinking Water Standards (WSRC 1997a; 1998a,b,c).

Table 3-8. Z Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

Analyte	Concentration	Regulatory limit
Gross alpha	9.77×10^{-8} µCi/mL[a]	1.5×10^{-8} µCi/mL[b]
Nonvolatile beta	5.26×10^{-8} µCi/mL	5.0×10^{-8} µCi/mL[c]
Radium-226	7.78×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[c,d]
Radium-228	8.09×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[c,d]
Radium, total alpha emitting	5.55×10^{-8} µCi/mL	5.0×10^{-9} µCi/mL[c]
Ruthenium-106	3.08×10^{-8} µCi/mL	3.0×10^{-8} µCi/mL[c]

a. µCi/mL = microcuries per milliliter.
b. EPA Final Primary Drinking Water Standards (WSRC 1997a; 1998a,b,c).
c. EPA Interim Final Primary Drinking Water Standard (WSRC 1997a; 1998a,b,c).
d. Radium-226, 228 combined proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.

3.3.1.2 Severe Weather

An average of 54 thunderstorm days per year were recorded by the National Weather Service in Augusta, Georgia, between 1950 and 1996. About half of the annual thunderstorms occurred during the summer.

Since operations began at SRS, 10 confirmed tornadoes have occurred on or in close proximity to the Site. Several of these tornadoes, one of which was estimated to have winds up to 150 miles per hour, did considerable damage to forested areas of SRS. None caused damage to structures. Tornado statistics indicate that the average frequency of a low-intensity tornado striking SRS is 2×10^{-4} times per year or about once every 5,000 years (WSRC 1998d). A tornado of this frequency would have a maximum wind speed (three-second gust) of 45 miles per hour. Similarly a tornado with a maximum wind speed of 120 miles per hour would occur approximately once every 25,000 years.

The highest sustained wind recorded by the Augusta National Weather Service Office is 82 miles per hour. Hurricanes struck South Carolina 36 times during the period from 1700 to 1992, which equates to an average recurrence frequency of once every 8 years. A hurricane-force wind of 74 miles per hour or greater has been observed at SRS only once, during Hurricane Gracie in 1959.

3.3.2 AIR QUALITY

3.3.2.1 Nonradiological Air Quality

The SRS is located in the Augusta-Aiken Interstate Air Quality Control Region (AQCR). All areas within this region are classified as achieving attainment with the National Ambient Air Quality Standards (NAAQS). Ambient air is defined as that portion of the atmosphere, external to buildings, to which the general public has access. The NAAQS define ambient concentration criteria or limits for sulfur dioxide (SO_2), particulate matter equal to or less than 10 micrometers in aerodynamic diameter (PM_{10}), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). These pollutants are generally referred to as “criteria pollutants”. The nearest area not in attainment with the NAAQS is Atlanta, Georgia, which is approximately 150 miles west of SRS.

All of the Aiken-Augusta AQCR is designated a Class II area with respect to the Clean Air Act's Prevention of Significant Deterioration (PSD) regulations. The PSD regulations provide a framework for managing existing clean air resources in areas that meet the NAAQS. Areas designated PSD Class II have sufficient air resources available to support moderate industrial growth. A Class I PSD designation is assigned to areas that are to remain pristine, such as national parks and wildlife refuges. Little additional impact to the existing air quality is allowed with a Class I PSD designation. There are no Class I areas within 62 miles of SRS.

SCDHEC has been delegated the authority to implement and enforce requirements of the Clean Air Act for the State of South Carolina. SCDHEC Air Pollution Regulation 62.5, Standard 2, enforces the NAAQS and sets ambient limits for two additional pollutants: total suspended particulates (TSP) and gaseous fluorides (as hydrogen fluoride, HF). SCDHEC Standard 7 implements the PSD limits. In addition, SCDHEC Standard 8 establishes ambient standards for 256 toxic air pollutants. The ambient limits found under Standards 2 and 8 are enforceable at or beyond the Site boundary.

The EPA promulgated new standards for ground-level ozone and particulate matter, that became effective on September 16, 1997 (62 FR 138). However, on May 14, 1999, in response to challenges filed by industry and others, a three-judge panel from the U.S. Court of Appeals for the District of Columbia Circuit issued a split opinion (2 to 1) directing EPA to develop a new particulate matter standard (meanwhile reverting back to the previous PM_{10} standard) and ruling that the new ozone standard "cannot be enforced" (EPA 1999). The full (11-member) Court revised the decision of the panel somewhat, but did not take action to render the proposed new standards enforceable. The EPA has asked the U.S. Department of Justice to appeal this decision and the U.S. Supreme Court has decided the case and upheld the decision. Therefore, it is uncertain at this time when new ozone and particulate matter standards will become enforceable.

Prior to 1991, ambient monitoring of SO_2, NO_2, TSP, CO, and O_3 was conducted at five sites across SRS. Because there is no regulatory requirement to conduct air quality monitoring at SRS, all of these stations have been decommissioned. Ambient air quality data collected during 1997 from monitoring stations operated by SCDHEC in Aiken County and Barnwell County, South Carolina, are summarized in Table 3-9. These data indicate that ambient concentrations of the measured criteria pollutants are generally much less than the standard.

Significant sources of criteria and toxic air pollutants at SRS include coal-fired boilers for power and steam production, diesel generators, chemical storage tanks, DWPF, groundwater air strippers, and various other process facilities. Another source of criteria pollutant emissions at SRS is the prescribed burning of forested areas across the Site by the U.S. Forest Service (Arnett and Mamatey 1998a). Table 3-10 shows the actual atmospheric emissions from all SRS sources in 1997.

SCDHEC also requires dispersion modeling as a means of evaluating local air quality. Periodically, all permitted sources of regulated air emissions at SRS must be modeled to determine estimates of ambient air pollution concentrations at the SRS boundary. The results are used to demonstrate compliance with ambient standards and to define a baseline from which to assess the impacts of any new or modified sources. Table 3-11 provides a summary of the most recent regulatory compliance modeling for SRS emissions. These calculations were performed with EPA's Industrial Source Complex air dispersion model and site-wide maximum potential emissions data from the 1998 air emissions inventory. Model estimates of ambient SRS boundary

Table 3-9. SCDHEC ambient air monitoring data for 1997.

Pollutant	Averaging time	SC Standard ($\mu g/m^3$)	Aiken Co. ($\mu g/m^3$)	Barnwell Co. ($\mu g/m^3$)
Sulfur dioxide	3-hr[a]	1,300	60	44
	24[a]	365	21	10
	Annual[b]	80	5	3
Total suspended particulates	Annual	75	36	--
Particulate matter (≤10 µm)	24-hr[a]	150	45	44
	Annual[b]	50	21	19
Carbon monoxide	1-hr[a]	40,000	5,100[c]	--
	8-hr[a]	10,000	3,300[c]	--
Ozone	1-hr	235	200	210
Nitrogen dioxide	Annual	100	9	8
Lead	Max. quarter	1.5	0.01	--

Source: SCDHEC (1998).
a. Second highest maximum concentration observed.
b. Arithmetic mean of observed concentrations.
c. Columbia, Richland County, South Carolina (nearest monitoring station to SRS).

Table 3-10. Criteria and toxic/hazardous air pollutant emissions from SRS (1997).

Pollutant	Actual tons/year
Criteria pollutants[a]	
Sulfur dioxide	490
Total suspended particulates	2,000
Particulate matter (≤10 µm)	1,500
Carbon monoxide	5,200
VOCs[b]	290
Oxides of nitrogen	430
Lead	0.019
Toxic/hazardous air pollutants[c]	
Benzene	13
Beryllium	0.0013
Biphenyl	0.013
Mercury	0.039
Methyl alcohol (methanol)	0.73

Source: Mamatey (1999). Includes actual emissions from all SRS sources (permitted and unpermitted).
a. Includes an additional pollutant, PM-10, regulated under SCDHEC, Standard 2. Note: gaseous fluoride is also regulated under Standard 2, but is not expected to be emitted as a result of salt processing activities.
b. VOCs are not criteria pollutants, but they are reported here because they are precursors to ozone, which is regulated.
c. Pollutants listed include only air toxics of interest to salt processing activities. A complete list of air toxic emissions from SRS can be found in Mamatey (1999).
VOCs = volatile organic compounds

Table 3-11. SRS baseline air quality for maximum potential emissions and observed ambient concentrations.

Pollutant	Averaging time	SCDHEC ambient standard (µg/m^3)[a]	Estimated SRS baseline concentration (µg/m^3)[b]
Criteria pollutants			
Sulfur dioxide[c]	3-hr	1,300	1,200[c]
	24-hr	365	350
	Annual	80	34
Total suspended particulates	Annual	75	67
Particulate matter (≤10 µm)[d]	24-hr	150	130
	Annual	50	25
Carbon monoxide	1-hr	40,000	10,000
	8-hr	10,000	6,900
Nitrogen dioxides[e]	Annual	100	26[e]
Lead	Calendar Quarterly mean	1.5	0.03
Ozone[f]	1-hr	235	220
Toxic/hazardous air pollutants			
Benzene	24-hr	150	4.6
Beryllium	24-hr	0.01	0.009
Biphenyl	24-hr	6	0.02
Mercury	24-hr	0.25	0.03
Methyl alcohol (methanol)	24-hr	1,310	0.9
Formic acid	24-hr	225	0.15

a. Source: SCDHEC Standard 2, "Ambient Air Quality Standards," and Standard 8, "Toxic Air Pollutants" (SCDHEC 1976).
b. Source: Hunter (2000). Concentration is the sum of modeled air concentrations using the permitted maximum potential emissions from the 1998 air emissions inventory for all SRS sources not exempted by Clean Air Act Title V requirements and observed concentrations from nearby ambient air monitoring stations.
c. Based partly on dispersion modeling of emissions for all oxides of sulfur (SO_x).
d. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 µg/m^3 and an annual average limit of 15 µg/m^3) will become enforceable during the life of this project.
e. Based partly on dispersion modeling of emissions for all oxides of nitrogen (NO_x).
f. New NAAQS for ozone (8 hours limit of 0.08 parts per million) will become enforceable during the life of this project.

concentrations for all air pollutants emitted at SRS are less than their respective ambient standards.

3.3.2.2 Radiological Air Quality

In the SRS region, airborne radionuclides originate from natural sources (i.e., terrestrial and cosmic), worldwide fallout, and SRS operations. DOE maintains a network of 23 air sampling stations on and around SRS to determine concentrations of radioactive particulates and aerosols in the air (Arnett and Mamatey 1998b).

DOE provides detailed summaries of radiological releases to the atmosphere from SRS operations, along with resulting concentrations and doses, in a series of annual environmental data reports. Table 3-12 lists 1997 radionuclide releases from each major operational group of SRS facilities. All radiological impacts are within regulatory requirements.

Atmospheric emissions of radionuclides from DOE facilities are limited under the EPA regulation "National Emission Standards for Hazardous Air Pollutants (NESHAP)," 40 CFR Part 61, Subpart H. The EPA annual effective dose

Table 3-12. Radiological atmospheric releases by operational group for 1997.

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Gases and Vapors								
H-3 (oxide)	12.3 years	5.2×10^{3}	3.3×10^{4}		350		150	3.9×10^{4}
H-3 (elem)	12.3 years		1.9×10^{4}					1.9×10^{4}
H-3 Total	12.3 years	5.2×10^{3}	5.2×10^{4}		350		150	5.8×10^{4}
C-14	5.73×10^{3} years		3.1×10^{-2}				1.9×10^{-8}	3.1×10^{-2}
Kr-85	10.73 years		9.6×10^{3}					9.6×10^{3}
I-129	1.57×10^{7} years		7.1×10^{-3}				1.2×10^{-7}	7.1×10^{-3}
I-131	8.040 days		2.9×10^{-5}			2.98×10^{-5}		5.9×10^{-5}
I-133	20.8 hours					4.92×10^{-4}		4.9×10^{-4}
Particulates								
Na-22	2.605 years						1.1×10^{-9}	1.1×10^{-9}
Mn-54	312.2 days						4.8×10^{-12}	4.8×10^{-12}
Co-57	271.8 days		2.2×10^{-7}				1.0×10^{-9}	2.1×10^{-7}
Co-58	70.88 days						1.7×10^{-12}	1.7×10^{-12}
Co-60	5.271 years		3.5×10^{-7}				9.1×10^{-7}	1.3×10^{-6}
Ni-59	7.6×10^{4} years						3.2×10^{-10}	3.2×10^{-10}
Ni-63	100 years						2.3×10^{-9}	2.3×10^{-9}
Zn-65	243.8 days						3.7×10^{-12}	3.7×10^{-12}
Se-79	6.5×10^{4} years						2.2×10^{-10}	2.2×10^{-10}
Sr-89,90[e]	29.1 years	1.8×10^{-3}	2.2×10^{-4}	4.2×10^{-5}	1.8×10^{-4}		8.2×10^{-5}	2.3×10^{-3}
Zr-95	64.02 days						2.1×10^{-5}	2.1×10^{-5}
Nb-95	34.97 days						1.6×10^{-15}	1.6×10^{-15}
Tc-99	2.13×10^{5} years						3.6×10^{-8}	3.6×10^{-8}
Ru-106	1.020 years						0.070	0.070
Sn-126	1×10^{5} years						3.4×10^{-15}	3.4×10^{-15}
Sb-124	60.2 days						3.4×10^{-12}	3.4×10^{-12}
Sb-125	2.758 years						5.9×10^{-7}	5.9×10^{-7}
Cs-134	2.065 years		1.4×10^{-6}				1.2×10^{-9}	1.4×10^{-6}
Cs-137	30.17 years	2.5×10^{-4}	4.2×10^{-4}		2.9×10^{-6}		4.2×10^{-3}	4.9×10^{-3}
Ba-133	10.53 years						3.0×10^{-12}	3.0×10^{-12}
Ce-144	284.6 days		4.2×10^{-6}				6.1×10^{-6}	1.0×10^{-5}
Pm-144	360 days						1.3×10^{-12}	1.3×10^{-12}

Table 3-12. (Continued).

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Particulates (continued)								
Pm-147	2.6234 years						1.0×10^{-8}	1.0×10^{-8}
Eu-152	13.48 years						5.3×10^{-9}	5.3×10^{-9}
Eu-154	8.59 years		1.5×10^{-7}				6.4×10^{-6}	6.6×10^{-6}
Eu-155	4.71 years		4.9×10^{-6}				1.7×10^{-6}	6.6×10^{-6}
Ra-226	1.6×10^{3} years						1.2×10^{-8}	1.2×10^{-8}
Ra-228	5.76 years						1.8×10^{-10}	1.8×10^{-10}
Th-228	1.913 years						2.2×10^{-10}	2.2×10^{-10}
Th-230	7.54×10^{4} years						2.0×10^{-10}	2.0×10^{-10}
Th-232	1.40×10^{10} years						1.4×10^{-10}	1.4×10^{-10}
Th-234	24.10 days						2.3×10^{-10}	2.3×10^{-10}
Pa-231	3.28×10^{4} years						1.0×10^{-9}	1.0×10^{-9}
Pa-234	6.69 hours						2.3×10^{-10}	2.3×10^{-10}
U-233	1.592×10^{5} years						2.1×10^{-8}	2.1×10^{-8}
U-234	2.46×10^{5} years		8.0×10^{-6}	4.0×10^{-6}			1.5×10^{-5}	2.7×10^{-5}
U-235	7.04×10^{8} years		6.3×10^{-7}	6.4×10^{-7}			4.8×10^{-7}	1.8×10^{-6}
U-236	2.342×10^{7} years						4.8×10^{-7}	4.8×10^{-7}
U-238	4.47×10^{9} years		1.9×10^{-5}	1.7×10^{-6}			3.5×10^{-5}	5.6×10^{-5}
Np-237	2.14×10^{6} years						1.4×10^{-9}	1.4×10^{-9}
Np-239	2.35 days						2.2×10^{-7}	2.2×10^{-7}
Pu-238	87.7 years		3.3×10^{-5}	4.4×10^{-9}			3.6×10^{-4}	3.9×10^{-4}
Pu-239[f]	2.410×10^{4} years	2.9×10^{-4}	5.1×10^{-5}	6.9×10^{-6}	2.3×10^{-5}	2.5×10^{-6}	6.9×10^{-6}	3.8×10^{-4}
Pu-240	6.56×10^{3} years						1.1×10^{-6}	1.1×10^{-6}
Pu-241	14.4 years						5.2×10^{-5}	5.2×10^{-5}
Pu-242	3.75×10^{5} years						3.7×10^{-11}	3.7×10^{-11}
Am-241	432.7 years		1.4×10^{-5}	1.2×10^{-8}			8.7×10^{-7}	1.5×10^{-5}
Am-243	7.37×10^{3} years						1.8×10^{-5}	1.8×10^{-5}

Table 3-12. (Continued).

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Particulates (continued)								
Cm-242	162.8 days						8.2×10^{-12}	8.2×10^{-12}
Cm-244	18.1 years		2.5×10^{-5}	2.0×10^{-10}			1.3×10^{-4}	1.5×10^{-4}
Cm-245	8.5×10^{3} years						1.9×10^{-12}	1.9×10^{-12}

Source: Arnett and Mamatey (1998a).

a. H = hydrogen (H-3 = tritium), C = carbon, Kr = krypton, I = iodine, Na = sodium, Mn = manganese, Co = cobalt, Ni = nickel, Zn = zinc, Se = selenium, Sr = strontium, Zr = zirconium, Nb = niobium, Tc = technetium, Ru = ruthenium, Sn = tin, Sb = antimony, Cs = cesium, Ba = barium, Ce = cerium, Pm = promethium, Eu = europium, Ra = radium, Th = thorium, Pa = protactinium, U = uranium, Np = neptunium, Pu = plutonium, Am = americium, Cm = curium.

b. Includes F- and H-Area releases.

c. SRTC = Savannah River Technology Center.

d. Estimated releases from minor unmonitored diffuse and fugitive sources.

e. Includes unidentified beta emissions.

f. Includes unidentified alpha emissions.