## Table 6–10
## Representative Lower Limits of Detection for Gamma Analysis of Soil, Food, Fish and Wildlife, and Vegetation Samples[a]

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| | fCi/g | | | pCi/g | pCi/L |
|---|---|---|---|---|---|
| Nuclide | Soil | Foods | Fish and Wildlife | Vegetation | Milk |
| Ce-141 | 97 | 98 | 158 | 0.4 | 3 |
| Ce-144 | 139 | 40 | 227 | 0.5 | 12 |
| Co-58 | 42 | 21 | 74 | 0.2 | 2 |
| Co-60 | 29 | 7 | 52 | 0.1 | 3 |
| Cr-51 | 771 | 979 | 1,322 | 2.9 | 19 |
| Cs-134 | 26 | 7 | 45 | 0.1 | 2 |
| Cs-137 | 24 | 7 | 42 | 0.1 | 3 |
| I-131 | 3,939 | Decayed | 6,790 | 15.0 | 3 |
| Mn-54 | 32 | 8 | 57 | 0.1 | 2 |
| Nb-95 | 84 | 74 | 147 | 0.3 | 3 |
| Ru-103 | 60 | 49 | 104 | 0.2 | 2 |
| Ru-106 | 279 | 72 | 486 | 1.1 | 23 |
| Sb-125 | 61 | 18 | 106 | 0.2 | 6 |
| Zn-65 | 66 | 21 | 117 | 0.3 | 5 |
| Zr-95 | 83 | 39 | 145 | 0.3 | 4 |

a The lower limits of detection (LLDs) are calculated at the 95% confidence level with Canberra Industries Inc.'s VAX/VMS gamma spectroscopy software. The values are based on a background measurement using a 32% relative efficiency high purity germanium detector and typical decay times and counting intervals. Chemical recoveries are assumed to be 100%. Sample sizes are 700g for soil, 1,000g for foods, 200g for fish and wildlife, 100g for vegetation, and 1 L for milk. The LLDs for actual samples may be different because of variations in the sample preparation, size, and content, and because of variations in the chemical recoveries, counting efficiencies, decay times, and instrument backgrounds.

## Table 6–11
## Representative Lower Limits of Detection for Radiological Analysis of Plutonium and Uranium by Alpha Spectroscopy[a]

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| Sample Type | Units | Pu-239 | Pu-238 | U-238 | U-234 | U-235 |
|---|---|---|---|---|---|---|
| Air filter | µCi/m³ | 2.4E–11 | 4.3E–11 | 2.4E–11 | 2.8E–11 | 2.9E–11 |
| Rainwater | µCi/m² | 3.3E–7 | 5.8E–7 | 3.1E–7 | 3.5E–7 | 3.6E–7 |
| Stream water | µCi/mL | 1.0E–11 | 1.8E–11 | 9.5E–12 | 1.1E–11 | 1.1E–11 |
| River water | µCi/mL | 1.0E–12 | 1.8E–12 | 9.5E–13 | 1.1E–12 | 1.1E–12 |
| Foodstuff | µCi/g | 1.5E–10 | 1.4E–10 | | | |
| Soil and sediment | µCi/g | 5.9E–10 | 7.3E–10 | | | |
| Vegetation | µCi/g | 7.3E–11 | 1.1E–10 | | | |
| Tissue | µCi/g | 2.4E–10 | 1.7E–10 | | | |

a The lower limits of detection (LLDs) are calculated at the 95% confidence level with Canberra Industries Inc.'s VAX/VMS alpha management spectroscopy software. The values are based on the average regent blank activity, detector efficiency, and chemical recovery for each sample matrix. The counting time is 1,000 minutes. Air filter values are for one-half of a single 47 mm particulate filter with a flow rate of approximately 2.5 cubic feet per minute (CFM) for 7 days. The rainwater values are for a collection area of 0.031m². The other sample sizes are 1 L for stream water, 10 L for river water, 10g for soil and sediment, and 100g for foodstuff, vegetation, and tissue. The LLDs for actual samples may be different because of variations in the sample preparation, size, and content, and because of variations in the chemical recoveries, counting efficiencies, batch reagent blanks, and instrument backgrounds.

## Table 6–12
## Representative Lower Limits of Detection for Radiological Analysis by Gas-Flow Proportional Counters[a] and by Liquid Scintillation[b]

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***Analysis of Gross Alpha, Nonvolatile Beta, Strontium-89,90, and Strontium-90 by Gas-Flow Proportional Counters***

| Nuclide | Typical Lower Limit of Detection (µCi/sample) |
|---|---|
| Gross alpha | 6.8E–7 |
| Nonvolatile beta | 1.52E–6 |
| Strontium-89, 90 | 2.38E–6 |
| Strontium-90 | 1.89E–6 |

***Analysis for Weak Beta Emitters by Liquid Scintillation***

| Sample | Typical Lower Limit Of Detection (µCi/mL) |
|---|---|
| Tritium[c] | 1.3E–6 |
| Tritium[d] | 4.7E–7 |
| Promethium-147 | 8.6E–9 |

a The instrument lower limits of detection (LLD) values for the gas-flow proportional counter were calculated at the 95% confidence level using the formula given in the section, "Lower Limits of Detection," in chapter 4 of the *Savannah River Site Environmental Report for 1991*. The counting efficiencies were 28% for alpha and 40% for beta, strontium-90, and strontium-89,90. The LLD for the actual sample is variable because of the effects of sample aliquot size, sample preparation, chemical recovery, counting efficiency, and radioactive decay. The sample counting time was 20 minutes.

b Instrumental LLD values for the liquid scintillation counter were calculated at the 95% confidence level using the formula given in the section, "Lower Limits of Detection," in chapter 4 of the *Savannah River Site Environmental Report for 1991*. The average counting efficiencies were 37% for tritium and 88% for promethium-147. The LLD for the actual sample is variable because of the effects of sample preparation, sample aliquot size, chemical recovery, counting efficiency, counting time, and radioactive decay.

c Routine environmental samples (e.g. stream samples and silica gels) are analyzed for tritium using a 20-minute count.

d Environmental samples such as drinking water, foodstuffs, and rainwater are analyzed using a 150-minute count.

*Chapter 7*

# Potential Radiation Doses

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THIS chapter presents the potential doses to offsite individuals and the surrounding population from 1996 Savannah River Site (SRS) atmospheric and liquid radioactive releases. Additionally, potential doses from special-case exposure scenarios—such as deer meat, fish, and goat milk consumption and crops irrigated with Savannah River water—are documented.

Unless otherwise noted, the generic term "dose" used in this report includes both the committed effective dose equivalent (50-year committed dose) from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body. Use of the effective dose equivalent allows doses from different types of radiation and to different parts of the body to be expressed on the same relative basis.

Many parameters—such as radioactive release quantities, population distribution, meteorological conditions, radionuclide dose factors, human consumption rates of food and water, and environmental dispersion—are considered in the dose models used to estimate offsite doses at SRS.

Descriptions of the effluent monitoring and environmental surveillance programs discussed in this chapter can be found in chapter 5, "Radiological Effluent Monitoring," and chapter 6, "Radiological Environmental Surveillance." A complete description of how potential doses are calculated can be found in section 1108 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC-3Q1-2, Volume 1 (SRS EM Program). Tables containing all potential dose calculation results are presented in *SRS Environmental Data for 1996* (WSRC-TR-97-0077).

Applicable dose regulations can be found in Appendix A, "Applicable Guidelines, Standards, and Regulations," of this document.

## Calculating Dose

Potential offsite doses from SRS effluent releases of radioactive materials (atmospheric and liquid) are calculated for the following scenarios:

- maximally exposed individual
- 80-kilometer (50-mile) population

**Dose to the Maximally Exposed Individual**

When calculating radiation doses to the public, SRS uses the concept of the maximally exposed individual; however, because of the conservative lifestyle assumptions used in the dose models, no such person is known to exist. The parameters used for the dose calculations are

**For airborne releases:** Someone who lives at the SRS boundary 365 days per year and consumes large amounts of milk, meat, and vegetables produced at that location

**For liquid releases:** Someone who lives downriver of SRS (near River Mile 120) 365 days per year, drinks 2 liters of untreated water per day from the Savannah River, consumes a large amount of Savannah River fish, and spends the majority of time on or near the river

To demonstrate compliance with the DOE Order 5400.5 all-pathway dose standard of 100 mrem per year, SRS conservatively combines the airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

Because the U.S. Department of Energy (DOE) has adopted dose factors only for adults, SRS calculates maximally exposed individual and collective doses as if the entire 80-kilometer population consisted of adults [DOE, 1988].

The International Commission on Radiological Protection (ICRP), in its Publications #56 and #67, has established age-specific dose factors for six age groups, ranging from 3-month-old infants to adults. However, dose factors for only a select group of radioisotopes were published, and these are applicable to only the ingestion pathway. In general, for most radioisotopes, the dose to an infant is higher than to an adult. For the radioisotopes that constitute most of SRS's radioactive releases (i.e., tritium and cesium-137), the dose to infants would be approximately two to three times higher than to adults. The dose to older children becomes progressively closer to the adult dose.

When the ICRP completes age-specific dose factors for all radioisotopes and develops an age-specific lung model for inhalation, and when DOE adopts these factors and models, doses will be calculated for the various age groups.

SRS also uses adult consumption rates for food and drinking water and adult usage parameters to estimate intakes of radionuclides [SRS Data, 1997]. These intake values and parameters were developed specifically for SRS based on an intensive regional survey [Hamby, 1991]. The survey includes data on agricultural production, consumption rates for food products, and use of the Savannah River for drinking water and recreational purposes.

## Dose Calculation Models

To calculate annual offsite doses, SRS uses radiation transport and dose models developed for the commercial nuclear industry [NRC, 1977]. The models are implemented at SRS in the following computer programs [SRS EM Program, 1996]:

- MAXIGASP: calculates maximum and average doses to offsite individuals from atmospheric releases.
- POPGASP: calculates collective doses from atmospheric releases.
- LADTAPII: calculates maximum and average doses to offsite individuals and the population from liquid releases.
- CAP88: calculates doses to offsite individuals from atmospheric releases to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) under the Clean Air Act.

The CAP88 computer code is required under the Clean Air Act to calculate offsite doses from atmospheric releases from existing and proposed facilities. SRS uses the CAP88 dose estimates to show NESHAP compliance, but not for routine dose calculations. Both the CAP88 and the MAXIGASP codes use modeling based on U.S. Nuclear Regulatory Commission Regulatory Guide 1.109.

### Meteorological Database

Meteorological data are used as input for the atmospheric transport and dose models.

For 1996, all potential offsite doses from releases of radioactivity to the atmosphere were calculated with quality-assured meteorological data for A-Area (located near the northwest SRS boundary), D-Area (located near the west-southwest site boundary), and H-Area (located near the center of the site). Meteorological data for A-Area (used for A-Area and M-Area releases) and D-Area (used for D-Area releases) were added in 1996 to improve the accuracy of the dose estimates. All of the databases were compiled for the period 1987–1991 [SRS Data, 1997]. A 5-year average database is used instead of the actual annual data because of the difficulty of compiling, inputting, and validating all the data in time to be used for the current-year dose calculations, and because there is little year-to-year variation in the meteorology at SRS [Hamby and Parker, 1991].

The wind rose developed from the 1987–1991 database is shown in figure 7–1. As can be seen, there is no prevailing wind at SRS, which is typical for the lower midlands of South Carolina. The maximum frequency that the wind blew in any one direction was 9.1 percent of the time, which occurred from the northeast blowing towards the southwest sector.

The meteorological measurements include all dispersion conditions observed during the 5-year period, ranging from unstable (considerable turbulence, which leads to rapid dispersion) to very stable (very little turbulence, which produces a narrow, undispersed plume). The data for 1987–1991 indicate that the SRS area experiences stable conditions (atmospheric stability classes E, F, G) about 21 percent of the time.

### Population Database and Distribution

Collective, or population, doses from atmospheric releases are calculated for the population within a 80-kilometer (50-mile) radius of SRS.

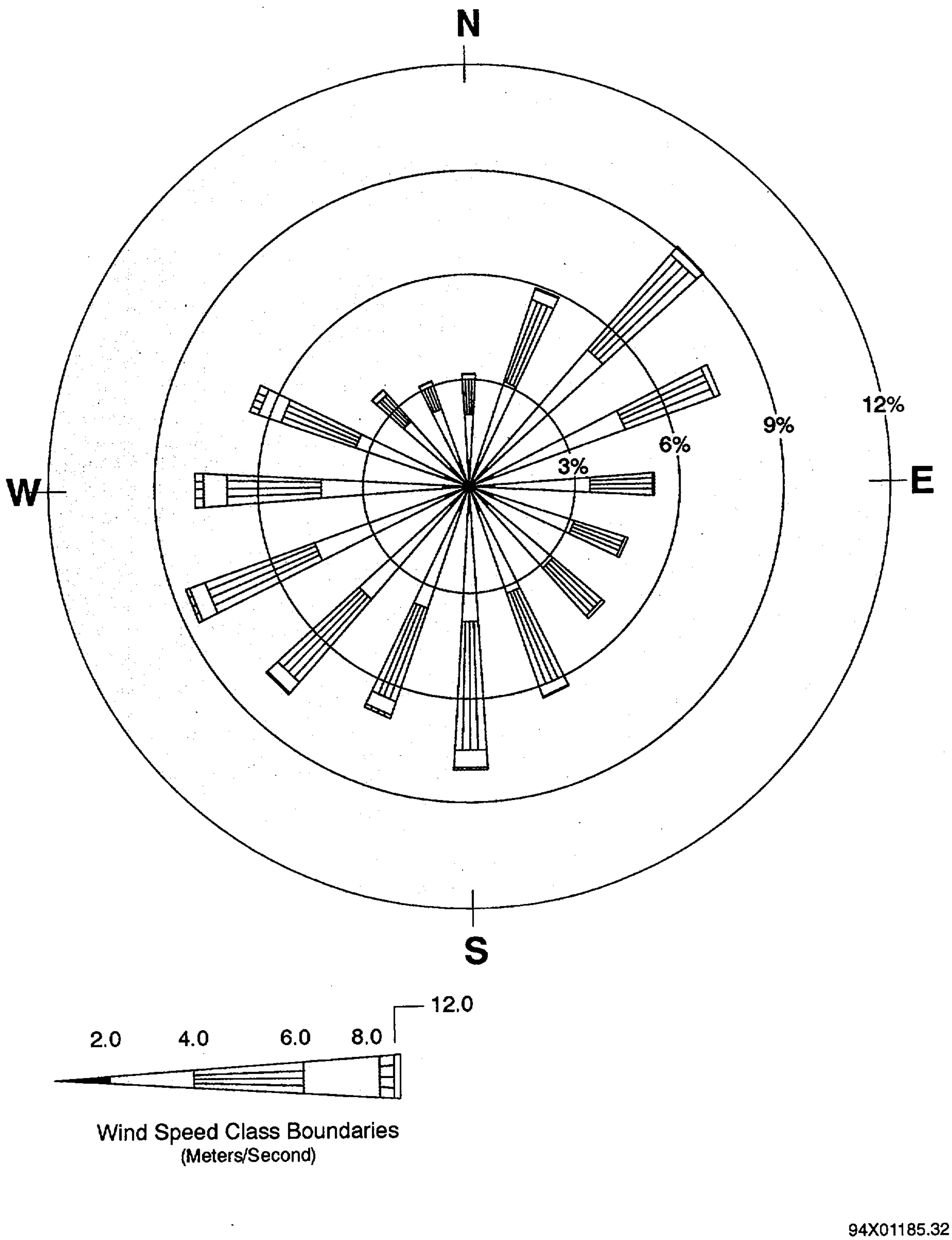


**Figure 7–1 Wind Rose for SRS, 1987–1991**

The wind rose plot shows the percent of occurrence frequencies of wind direction and speed at SRS. The plot is based on hourly averaged wind data from the SRS meteorological tower network for the 5-year period 1987–1991. Measurements were taken 200 feet above the ground. Directions indicated are *from* which the wind blows.

For 1996 dose calculations, the 1990 population database prepared by the University of South Carolina was used. This database distributes the population into a grid of cells one-second latitude by one-second longitude. This database is transformed by the POPGASP Code into polar coordinates of 16 compass sectors and varying radial distances out to 80 kilometers. The POPGASP Code can prepare a polar coordinate database for any release point put into the code in polar coordinates. A separate, fixed-polar-coordinate database was prepared for use with the CAP88 Code, which does not have the capability of transforming the grid into polar coordinates. The population database generated by the POPGASP Code is centered on the geographical center of SRS [SRS Data, 1997].

Within the 80-kilometer radius, the total population for 1990 was 620,100, compared to 555,200 for 1980, a 12-percent population growth in 10 years.

Some of the collective doses resulting from SRS liquid releases are calculated for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant (formerly Cherokee Hill Water Treatment Plant), near Port Wentworth, Georgia, and by the Beaufort-Jasper Water Treatment Plant, near Beaufort, South Carolina. In 1996, according to the treatment plant operators, the population served by the Port Wentworth facility declined from about 15,000 to approximately 10,000 persons, and the population served by the Beaufort-Jasper facility rose from about 50,000 to approximately 60,000 persons.

### River Flow Rate Data

Offsite dose from liquid effluents varies each year with the amount of radioactivity released and the amount of dilution (flow rate) in the Savannah River. Although flow rates are recorded at U.S. Geological Survey (USGS) gauging stations at the SRS boat dock and near River Mile 120 (U.S. Highway 301 bridge), these data are not used directly in dose calculations. This is because weekly river flow rates fluctuate widely (i.e., short-term dilution varies from week to week). Used instead are "effective" flow rates, which are based on measured concentrations of tritium in Savannah River water and measured concentrations in water used at the downstream water treatment plants. However, the USGS-measured flow rates are used for comparison to these calculated values.

For 1996, the River Mile 120 calculated (effective) flow rate of 8,640 cubic feet per second was used in determining doses to maximally exposed individuals, population doses from recreation and fish consumption, and potential doses from crops irrigated with river water. This flow rate was about 13 percent less than the 1995 effective flow rate of 9,973 cubic feet per second. For comparison, during 1996 the USGS-measured flow rate at River Mile 120 was 11,467 cubic feet per second, which was about 10 percent less than the 1995 measured rate of 12,750 cubic feet per second. Therefore, the calculated value is more conservative because it accounts for less dilution.

The 1996 calculated (effective) flow rate for the Beaufort-Jasper facility was 10,941 cubic feet per second, which was about 29 percent less than the 1995 rate of 15,474 cubic feet per second. This indicates that less dilution occurred in the Beaufort-Jasper canal during 1996 than during 1995.

The 1996 calculated (effective) flow rate for the Port Wentworth facility was 10,144 cubic feet per second, which was about 22 percent less than the 1995 rate of 13,000 cubic feet per second. This indicates that less dilution occurred in Abercorn Creek during 1996 than during 1995.

The 1996 calculated Savannah River estuary flow rate (12,680 cubic feet per second) was used only for calculation of dose from consumption of salt water invertebrates.

## Uncertainty in Dose Calculations

Radiation doses are calculated using the best available data. If adequate data are unavailable, then site-specific parameters are selected that would result in a conservative estimate of the maximum dose.

All radiation data and input parameters have an uncertainty associated with them, which causes uncertainty in the dose determinations. For example, there is uncertainty in the assumption that an individual eats 81 kg (179 pounds) of meat each year. Obviously, a few people will eat more than 81 kg, but most probably will eat less. Uncertainties can be combined mathematically to create a distribution of doses rather than a single number. While the concept is simple, the calculation is quite difficult. A detailed technical discussion of the method of estimating uncertainty at SRS was published in the July 1993 issue of *Health Physics* [Hamby, 1993].

# Dose Calculation Results

Liquid and air pathway doses are calculated for the maximally exposed individual and for the surrounding population. In addition, a sportsman dose is calculated separately for consumption of fish, deer, and feral hogs, which are nontypical exposure pathways. Finally, a dose is calculated for the aquatic biota found in SRS streams.

**Table 7–1**
**1996 Radioactive Liquid Release Source Terms and 12-Month Average Downriver Radionuclide Concentrations (Calculated Concentrations Are Based on Effective River Flow Rates)**

| | | 12-Month Average Concentration (pCi/L) | | |
|---|---|---|---|---|
| **Nuclide** | **Curies Released** | **Below SRS[a]** | **Beaufort-Jasper[b]** | **Port Wentworth[c]** |
| H-3 | 9.0E+03[d] | 1.2E+03[e] | 9.2E+02[e] | 9.9E+02[e] |
| Sr-89,90[f] | 2.6E–01 | 3.4E–02 | 2.7E–02 | 2.9E–02 |
| I-129 | 7.8E–02 | 1.0E–02 | 8.0E–03 | 8.6E–03 |
| Cs-137 | 1.6E–01[d] | 2.0E–02 | 1.6E–02 | 1.7E–02 |
| Pm-147 | 4.8E–04 | 6.2E–05 | 4.9E–05 | 5.3E–05 |
| U-234 | 8.2E–03 | 1.1E–03 | 8.4E–04 | 9.0E–04 |
| U-235 | 2.3E–04 | 3.0E–05 | 2.3E–05 | 2.5E–05 |
| U-238 | 1.1E–02 | 1.4E–03 | 1.1E–03 | 1.2E–03 |
| Pu-238 | 2.8E–03 | 3.6E–04 | 2.9E–04 | 3.1E–04 |
| Pu-239[g] | 2.7E–02 | 3.5E–03 | 2.7E–03 | 3.0E–03 |
| Am-241 | 7.1E–05 | 9.2E–06 | 7.3E–06 | 7.9E–06 |
| Cm-244 | 1.3E–05 | 1.6E–06 | 1.3E–06 | 1.4E–06 |

a Near Savannah River Mile 120, downriver of SRS at the U.S. Highway 301 bridge
b Beaufort-Jasper, South Carolina, drinking water
c Port Wentworth, Georgia, drinking water
d Amount of tritium released based on measured river transport values. Amount of cesium-137 released based on measured values from River Mile 120 fish.
e Measured concentrations; all other concentrations calculated using models verified with tritium measurements. H-3 concentration is from EMS [SRS Data, 1997].
f Includes unidentified beta releases
g Includes unidentified alpha releases

## Liquid Pathway

This section contains information on liquid release quantities used as source terms in SRS dose calculations, including a discussion about radionuclide concentrations in Savannah River fish. The calculated dose to the maximally exposed individual, the calculated collective (population) dose, and the potential dose from agricultural irrigation are presented.

### Liquid Release Source Terms

The 1996 radioactive liquid release quantities used as source terms in SRS dose calculations are presented in chapter 5 and summarized by radionuclide in table 7–1. In order to maintain conservatism, the river transport tritium release total of 8,950 Ci (3.3E+14 Bq), which was the highest value of the three alternative tritium release calculation methods employed at SRS (chapter 6), was used in the dose calculations.

As discussed in chapter 5, for dose calculations, releases of unidentified beta-gamma emitters were summed with strontium-89,90 releases, and unidentified alpha emitters were summed with releases of plutonium-239.

For use in dose determinations and model comparisons, concentrations of radionuclides in Savannah River water and fish were measured at several locations along the river. The measured concentrations of tritium oxide in the Savannah River near River Mile 120 and at the Beaufort-Jasper and Port Wentworth water treatment facilities are shown in table 7–1, as are the LADTAPII computer code-determined concentrations for the other released radionuclides.

The 12-month average tritium oxide concentrations measured in the Savannah River near River Mile 120 (1,160 pCi/L), and at the Beaufort-Jasper (916 pCi/L) and Port Wentworth (988 pCi/L) water treatment plants, remained below the U.S. Environmental Protection Agency (EPA) and DOE concentration standards of 20,000 pCi/L and 80,000 pCi/L, respectively.

The 1996 River Mile 120 concentration was just 9 percent less than the 1995 concentration of 1,280 pCi/L, even though the amount of tritium oxide

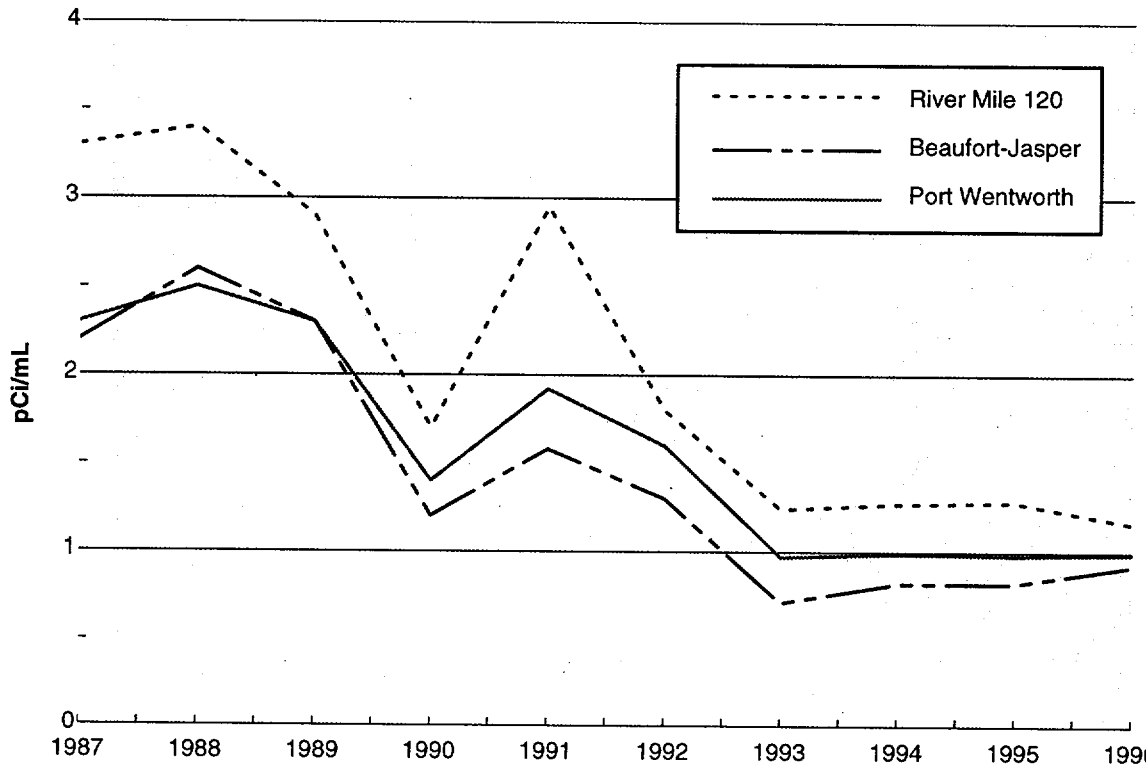


**Figure 7–2 Annual Average Tritium Concentrations at River Mile 120, Beaufort-Jasper, and Port Wentworth (1987–1996)**

released from SRS during 1996 was about 21 percent less than the amount released during 1995 (8,950 curies in 1996 versus 11,400 curies in 1995). This is because the effective River Mile 120 flow rate was about 13 percent less in 1996 than in 1995, causing less dilution to occur.

A 10-year history of annual average tritium concentrations measured at River Mile 120 and at the Beaufort-Jasper and Port Wentworth facilities is shown in figure 7–2. The data for Beaufort-Jasper and Port Wentworth are the tritium concentrations measured in the finished drinking water at each facility.

As can be seen in the figure, the water treatment plant concentrations increased slightly in 1996 because the effective river flow rates for the treatment plants was more than 20 percent lower in 1996 than in 1995. Additional information about the river's flow rates can be found in the River Flow Rate Data section of this chapter (page 108).

**Radionuclide Concentrations in River Fish** At SRS, a major dose pathway for the maximally exposed individual is from the consumption of fish. Fish exhibit a high degree of bioaccumulation for certain contaminants. For the element cesium (including radioactive isotopes of cesium), the bioaccumulation factor for Savannah River fish is approximately 3,000. That is, the concentration of cesium found in fish flesh is about 3,000 times greater than the concentration of cesium found in the water in which the fish live.

Because of this high bioaccumulation factor, cesium-137 is more easily detected in fish flesh than in river water. Therefore, the fish pathway dose from cesium-137 is based directly on the radioanalysis of the fish collected near Savannah River Mile 120, which is the assumed location of the hypothetical maximally exposed individual [SRS Data, 1997]. The fish pathway dose from all other radionuclides is based on the calculated concentrations determined by the LADTAPII code. A consumption rate of 19 kg (42 pounds) of fish per year is used in the maximally exposed individual dose calculation [Hamby, 1991]. Some fraction of this estimated dose is due to cesium-137 from worldwide fallout and from neighboring Vogtle Electric Generating Plant;

however, that amount is difficult to determine and is not subtracted from the total.

The dose determinations are accomplished in the LADTAPII code by substituting a cesium-137 release value that would result in the measured concentration in river fish, assuming the site-specific bioaccumulation factor of 3,000. A weighted average concentration (based on the number of fish in each composite analyzed) of cesium-137 in River Mile 120 fish was used for maximally exposed individual and population dose determinations. Using the above factors, the cesium-137 release value used for LADTAPII input was 0.16 Ci (5.9 E+09 Bq), which is more conservative than the measured release value of 0.12 Ci (4.4E+09 Bq).

### Dose to the Maximally Exposed Individual

The potential liquid pathway dose to the hypothetical maximally exposed individual living downriver of SRS, near River Mile 120, was determined based on intake parameters discussed earlier in this chapter.

As shown in table 7–2, the highest potential dose to the maximally exposed individual from liquid releases in 1996 was estimated at 0.14 mrem (0.0014 mSv). This dose is 0.14 percent of DOE's 100-mrem all-pathway dose standard for annual exposure.

The 1996 potential maximally exposed individual dose was the same as the 1995 dose of 0.14 mrem (0.0014 mSv). The potential dose remained the same even though the amount of tritium oxide released from SRS during 1996 was more than 21 percent less than during 1995. This was because of decreased dilution in the Savannah River due to the 13-percent decrease in the effective river flow during 1996.

Approximately 43 percent of the dose to the maximally exposed individual at the site perimeter resulted from the ingestion of cesium-137, mainly from the consumption of fish, and about 41 percent resulted from the ingestion (via drinking water) of tritium oxide [SRS Data, 1997].

**Drinking Water Pathway** Persons downriver of SRS may receive a radiation dose by consuming drinking water that contains radioactivity as a result of liquid releases from the site. In 1996, tritium oxide in downriver drinking water represented the majority of the dose (about 75 percent) received by persons at downriver water treatment plants.

The calculated doses to maximally exposed individuals whose entire daily intake of water is supplied by the Beaufort-Jasper and Port Wentworth water treatment facilities, located downriver of SRS, were determined for maximum (2 liters per day for a year) water consumption rates [SRS Data, 1997].

At the Beaufort-Jasper Water Treatment Plant, the potential dose for maximum water consumption rates during 1996 was 0.06 mrem (0.0006 mSv); at the City of Savannah Industrial and Domestic Water Supply Plant (Port Wentworth), the potential dose also was 0.06 mrem (0.0006 mSv).

As shown in table 7–2, the maximum dose of 0.06 mrem (0.0006 mSv) is 1.5 percent of the DOE and EPA standard of 4 mrem per year from public water supplies. The 1996 maximum potential

**Table 7–2**
**Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 1996**

| | Committed Dose | Applicable Standard | Percent of Standard |
|---|---|---|---|
| **Maximally Exposed Individual** | | | |
| **At Site Boundary** (untreated river water) | 0.14 mrem | 100 mrem[a] | 0.14 |
| **At Port Wentworth** (public water supply only) | 0.06 mrem | 4 mrem[b] | 1.5 |
| **At Beaufort-Jasper** (public water supply only) | 0.06 mrem | 4 mrem[b] | 1.5 |

a All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)
b Drinking water pathway standard: 4 mrem per year (DOE Order 5400.5 and EPA, 1975)

drinking water dose was slightly more than the 1995 maximum dose of 0.05 mrem (0.0005 mSv). This increase in dose is attributed to the decrease in effective Savannah River flow during 1996.

### Collective (Population) Dose

The collective drinking water consumption dose is calculated for the discrete population groups at Beaufort-Jasper and Port Wentworth. The collective dose from other pathways is calculated for a diffuse population that makes use of the Savannah River. However, it cannot be described as being in a specific geographical location.

Potential collective doses were calculated, by pathway and radionuclide, using the LADTAPII computer code [SRS Data, 1997]. In 1996, the collective dose from SRS liquid releases was estimated at 2.2 person-rem (0.022 person-Sv). This was more than the 1995 collective dose of 1.7 person-rem (0.017 person-Sv). This increase in dose is attributed to the decrease in effective Savannah River flow during 1996.

### Potential Dose from Agricultural Irrigation

The 1990 update of land- and water-use parameters [Hamby, 1991] revealed that there is no known use of river water downstream of SRS for agricultural irrigation purposes. However, in response to public concerns, potential doses from this pathway are calculated for information purposes only and are not included in calculations of the official maximally exposed individual or collective doses. A potential offsite dose of 1.1 mrem (0.011 mSv) to the maximally exposed individual and a collective dose of 7.6 person-rem (0.076 person-Sv) were estimated for this exposure pathway. As in previous years, collective doses from agricultural irrigation were calculated for 1,000 acres of land devoted to each of four major food types—vegetation, leafy vegetation, milk, and meat [SRS Data, 1997].

## Air Pathway

This section describes the atmospheric source terms and concentrations used for dose determinations and presents the calculated dose to the maximally exposed individual, as well as the calculated collective (population) dose. Also included is a discussion about how SRS demonstrates NESHAP compliance.

### Atmospheric Source Terms

The 1996 radioactive atmospheric release quantities used as source terms in SRS dose calculations are presented in chapter 5. For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and releases of unidentified alpha emitters were summed with plutonium-239 releases [SRS Data, 1997].

Estimates of unmonitored diffuse and fugitive source terms were considered, as required for demonstrating compliance with NESHAP regulations. Most of the estimated diffuse and fugitive releases occurred at the separations areas, the reactor areas, and the Solid Waste Disposal Facility.

Atmospheric source terms are grouped by major release points for dose calculations. For the MAXIGASP code, five release locations with specific release heights were used [SRS Data, 1997].

The CAP88 code can calculate doses from collocated release heights but cannot combine calculations for releases at different geographical locations. Therefore, for CAP88 calculations, source terms were grouped for elevated releases (61 meters) and ground-level releases (0 meters), and the geographical center of the site was used as the release location for both [SRS Data, 1997].

### Atmospheric Concentrations

The MAXIGASP and CAP88 codes calculate average and maximum concentrations of all released radionuclides at the site perimeter. These calculated concentrations are used for dose determinations instead of measured concentrations. This is because most radionuclides released from SRS cannot be measured, using standard methods, in the air samples collected at the site perimeter and offsite locations. However, the concentrations of tritium oxide at the site perimeter locations usually can be measured and are compared with calculated concentrations as a verification of the dose models.

The average tritium oxide concentration in air measured at the 14 site perimeter locations during 1996 was 11 pCi/m$^3$ (0.41 Bq/m$^3$), which is a 31 percent decrease from the 1995 measured value of 16 pCi/m$^3$ (0.6 Bq/m$^3$). The 1996 measured value compares favorably with the MAXIGASP and CAP88 computer code values of 11 pCi/m$^3$ (0.41 Bq/m$^3$) and 10 pCi/m$^3$ (0.37 Bq/m$^3$), respectively.

The maximum tritium oxide concentration measured in air at the site perimeter was 19 pCi/m$^3$ (0.70 Bq/m$^3$), which occurred at the D-Area location. This value is less than, but compares favorably with, the MAXIGASP calculated value of 23 pCi/m$^3$ (0.85 Bq/m$^3$).

The CAP88 code calculated a maximum site perimeter concentration of 15 pCi/m$^3$ (0.55 Bq/m$^3$). This

**Table 7–3**
**Ten-Year History of SRS Atmospheric Tritium and Tritium Oxide Releases and Average Measured Tritium Oxide Concentrations in Air Compared to Calculated Concentrations in Air**

| | | | Average Tritium Oxide Concentrations in Air | | |
|---|---|---|---|---|---|
| Year | Total Tritium Released (Ci) | Tritium Oxide Released[a] (Ci) | Center of Site (measured at 4 locations) (pCi/m$^3$) | Site Perimeter (measured at 14 locations) (pCi/m$^3$) | Site Perimeter (calculated by dose model) (pCi/m$^3$) |
| 1987 | 595,000 | 270,000 | 1,230 | 81 | 81 |
| 1988 | 462,000 | 288,000 | 1,030 | 54 | 87 |
| 1989 | 309,000 | 218,000 | 790 | 37 | 65 |
| 1990 | 253,000 | 175,000 | 530 | 32 | 53 |
| 1991 | 200,000 | 137,000 | 310 | 21 | 42 |
| 1992[b] | 156,000 | 100,000 | 420 | 27 | 30 |
| 1993 | 191,000 | 133,000 | 450 | 30 | 37 |
| 1994[c] | 160,000 | 107,000 | 350 | 23 | 30 |
| 1995 | 97,000 | 55,000 | 300 | 16 | 16 |
| 1996 | 55,300 | 40,100 | 123 | 11 | 11 |

a Tritium oxide releases are included with elemental tritium releases in the "Total Tritium Released" column.

b During May 1992, the method for determining tritium oxide concentrations in air was changed to the use of measured humidity values instead of a single generic value. The listed concentrations are for May to December 1992.

c During 1994, because of problems with measuring location-specific humidity values, a single generic value of 11.4 g/m$^3$ was used for absolute humidity.

value is lower than the MAXIGASP code value because the CAP88 code assumes that all releases occurred from only one point, which is located at the center of the site.

In table 7–3, the average 1987–1996 tritium oxide concentrations in air—measured at four locations near the center of the site (F-Area, H-Area, SWDF North, and SWDF South) and at 14 locations along the site perimeter—are compared to the average concentrations calculated for the site perimeter, using the MAXIGASP code. These data show that the calculated site-perimeter tritium oxide concentrations are conservative in that they are higher than or equal to the measured site-perimeter concentrations. However, they consistently and reasonably approximate the measured values and therefore are appropriate for use in dose determinations.

Also shown in table 7–3 are the total tritium and tritium oxide releases from SRS for the same years. As can be seen, there is a correlation between the quantity of tritium oxide released and the measured concentration of tritium oxide in air at the monitoring locations. The 27-percent decrease in tritium oxide releases during 1996 is attributed primarily to continued improvements in operations at the state-of-the-art Replacement Tritium Facility and to decreases in tritium processing activities.

### Dose to the Maximally Exposed Individual

The potential air pathway dose to a hypothetical maximally exposed individual located at the site perimeter was determined using the MAXIGASP computer code [SRS Data, 1997]. The parameters used for the calculations were discussed earlier in this chapter.

In 1996, the estimated dose to the maximally exposed individual was 0.05 mrem (0.0005 mSv), which is about 0.5 percent of the DOE Order 5400.5 ("Radiation Protection of the Public and the Environment") standard of 10 mrem per year. This dose was approximately 17 percent lower than the 1995 dose of 0.06 mrem (0.0006 mSv) because of the 21-percent decrease in tritium oxide releases from 1995 to 1996 (chapter 5). Tritium oxide releases accounted for about 68 percent of the dose to the maximally exposed individual. Table 7–4 compares the maximally exposed individual's dose with the DOE standard.

For 1996, the MAXIGASP code determined that the west-southwest sector of the site was the location of the maximally exposed individual. Figure 7–3 shows

**Table 7–4**
**Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 1996**

| | MAXIGASP | CAP88 (NESHAP) |
|---|---|---|
| **Calculated dose** | 0.05 mrem | 0.06 mrem |
| **Applicable standard** | 10 mrem[a] | 10 mrem[b] |
| **Percent of standard** | 0.5% | 0.6% |

a DOE: DOE Order 5400.5, February 8, 1990
b EPA: (NESHAP) 40 CFR 61 Subpart H, December 15, 1989

the potential dose to the maximally exposed individual residing at the site boundary for each of the 16 compass point directions around SRS.

The major pathways contributing to the dose to the maximally exposed individual from atmospheric releases were from inhalation (38 percent) and from consumption of vegetation (40 percent), cow milk (12 percent), and meat (8 percent).

Additional calculations of the dose to the maximally exposed individual were performed substituting a goat milk pathway for the customary cow milk pathway. The maximum potential dose using the goat milk pathway was estimated at 0.06 mrem (0.0006 mSv), which is slightly more than the cow milk pathway dose.

Most of this difference is from tritium oxide because the transfer factor (fraction of the daily intake of the nuclide that appears in each liter of milk) for tritium is 17 times higher for goat milk than for cow milk [NRC, 1977]. However, because goat milk consumption is less common, the dose calculated from cow milk consumption will continue to be the

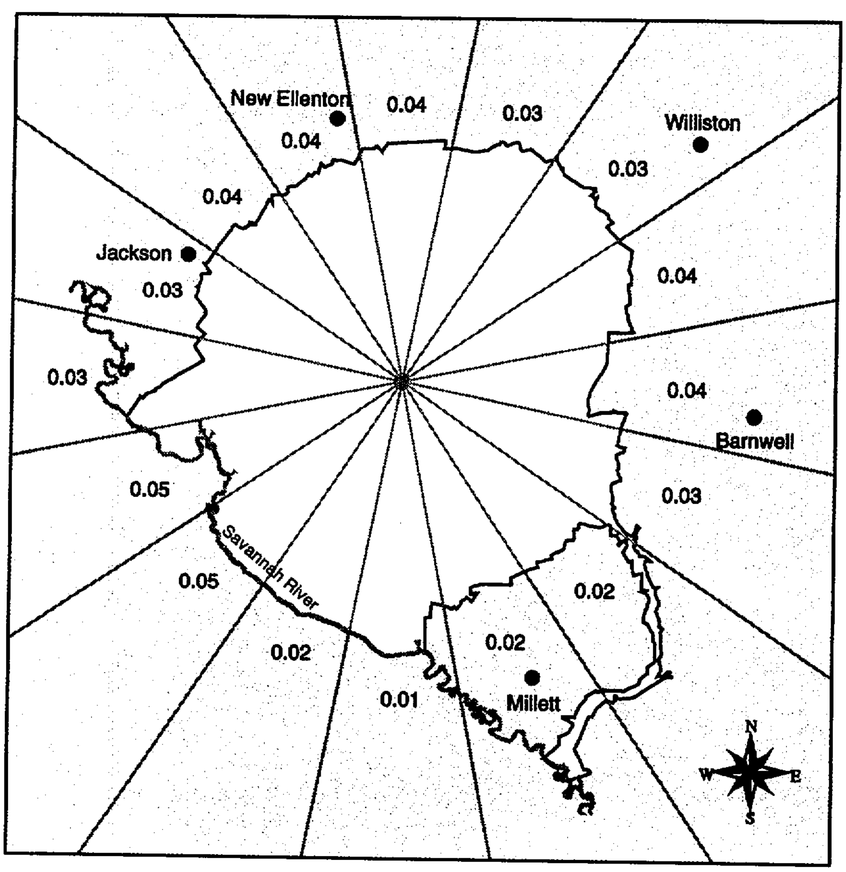


**Figure 7–3 Sector-Specific Adult Maximally Exposed Individual Air Pathway Doses (in mrem) for 1996**
Maximally exposed individual site boundary doses from airborne releases are shown for each of the 16 compass point directions surrounding SRS. As indicated by the dose totals for 1996, the west-southwest sector was the location of the highest maximally exposed individual dose.

EPD/GIS Map

primary dose used for demonstrating compliance with dose standards.

### Collective (Population) Dose

Potential doses also were calculated, by pathway and radionuclide, using the POPGASP computer code for the population (620,100 people) residing within 80 kilometers of the center of SRS [SRS Data, 1997]. In 1996, the collective dose was estimated at 2.8 person-rem (0.028 person-Sv), which is less than 0.01 percent of the collective dose received from natural sources of radiation (about 186,000 person-rem). The 1996 collective dose was approximately 20 percent lower than the 1995 collective dose of 3.5 person-rem (0.035 person-Sv)—again, mainly because of the 21-percent decrease in tritium oxide releases from 1995 to 1996. Tritium oxide releases accounted for about 75 percent of the 1996 collective dose.

### NESHAP Compliance

To demonstrate compliance with NESHAP (Clean Air Act, 40 CFR 61, Subpart H) regulations, maximally exposed individual and collective doses were calculated, and a percentage of dose contribution from each radionuclide was determined using the CAP88 computer code [SRS Data, 1997].

The dose to the maximally exposed individual, calculated with CAP88, was estimated at 0.06 mrem (0.0006 mSv), which is 0.6 percent of the 10-mrem-per-year EPA standard, as shown in table 7–4. Tritium oxide releases accounted for almost 92 percent of this dose.

The CAP88 collective dose was estimated at 6.4 person-rem (0.064 person-Sv). Tritium oxide releases accounted for about 92 percent of this dose.

As the data show, the CAP88 code estimates a higher dose than do the MAXIGASP and POPGASP codes. Most of the differences occur in the tritium dose estimated from food consumption. The major cause of this difference is the CAP88 code's use of 100-percent equilibrium between tritium in air moisture and tritium in food moisture, whereas the MAXIGASP and POPGASP codes use 50-percent equilibrium values, as recommended by the Nuclear Regulatory Commission [NRC, 1977]. A recent publication indicates that the 50-percent value is correct for the atmospheric conditions at SRS [Hamby and Bauer, 1994].

Because tritium oxide dominates the doses determined using the CAP88 code, and because the CAP88 code is limited to a single, center-of-site release location, other radionuclides (such as iodine-129, plutonium-239, and ruthenium-106) are less important—on a percentage-of-dose basis—for the CAP88 doses than for the MAXIGASP and POPGASP doses.

## All-Pathway Dose

To demonstrate compliance with the DOE Order 5400.5 all-pathway dose standard of 100 mrem per year (1.0 mSv per year), SRS conservatively combines the maximally exposed individual airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

Figure 7–4 shows a 10-year history of SRS's all-pathway doses (airborne pathway plus liquid pathway doses to the maximally exposed individual).

For 1996, the potential maximally exposed individual all-pathway dose was 0.19 mrem (0.0019 mSv)—0.05 mrem from airborne pathway plus 0.14 mrem from liquid pathway. This dose is 5 percent lower than the 1995 all-pathway dose of 0.20 mrem (0.0020 mSv), primarily because of the decrease in atmospheric tritium oxide releases during 1996.

Figure 7–5 shows that the 1996 maximum potential all-pathway dose attributable to SRS operations (0.19 mrem) contributed less than 0.1 percent of the average annual radiation dose received by a typical Central Savannah River Area (CSRA) resident.

As shown in table 7–5, the 1996 potential all-pathway dose of 0.19 mrem (0.0019 mSv) is 0.19 percent of the 100-mrem-per-year DOE dose standard.

## Sportsman Dose

DOE Order 5400.5 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem per year, which applies to all members of the public, includes doses a person receives from routine DOE operations through all exposure pathways. Nontypical exposure pathways, not included in the standard calculations of the doses to the maximally exposed individual, are considered and quantified separately. This is because they apply to low-probability scenarios, such as consumption of fish caught exclusively from the mouths of SRS streams, or to unique scenarios, such as volunteer deer hunters.

### Deer and Hog Consumption Pathway

For approximately 6 weeks each year, controlled hunts of deer and feral hogs are conducted at SRS. Hunt participants are volunteers. Before any harvested animal is released to a hunter, SRS

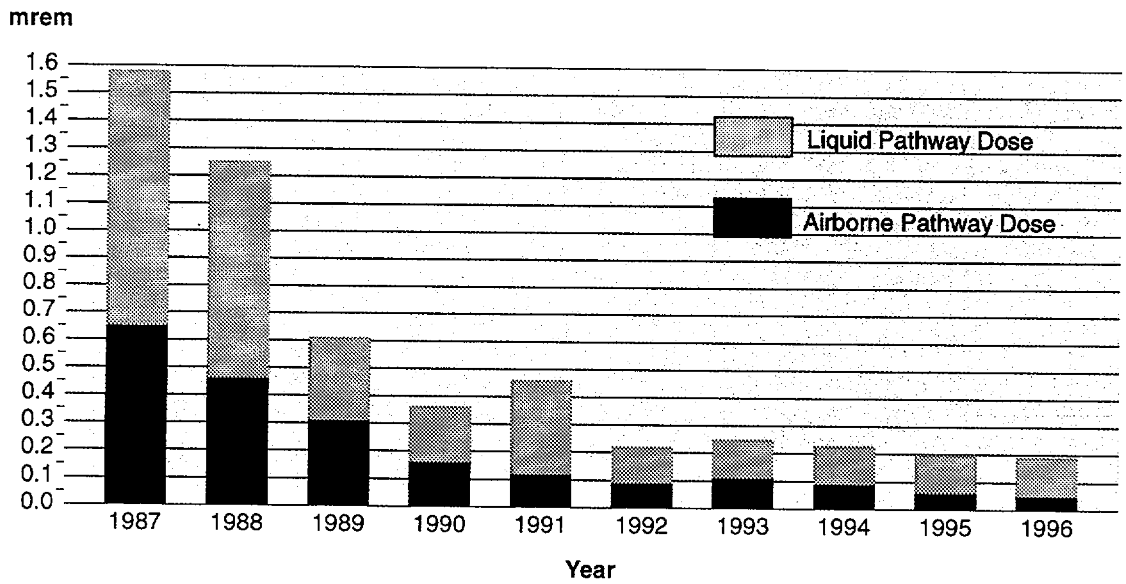


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**Figure 7–4 Ten-Year History of SRS Maximum Potential All-Pathway Doses to the Maximally Exposed Individual (Airborne plus Liquid Pathways)**

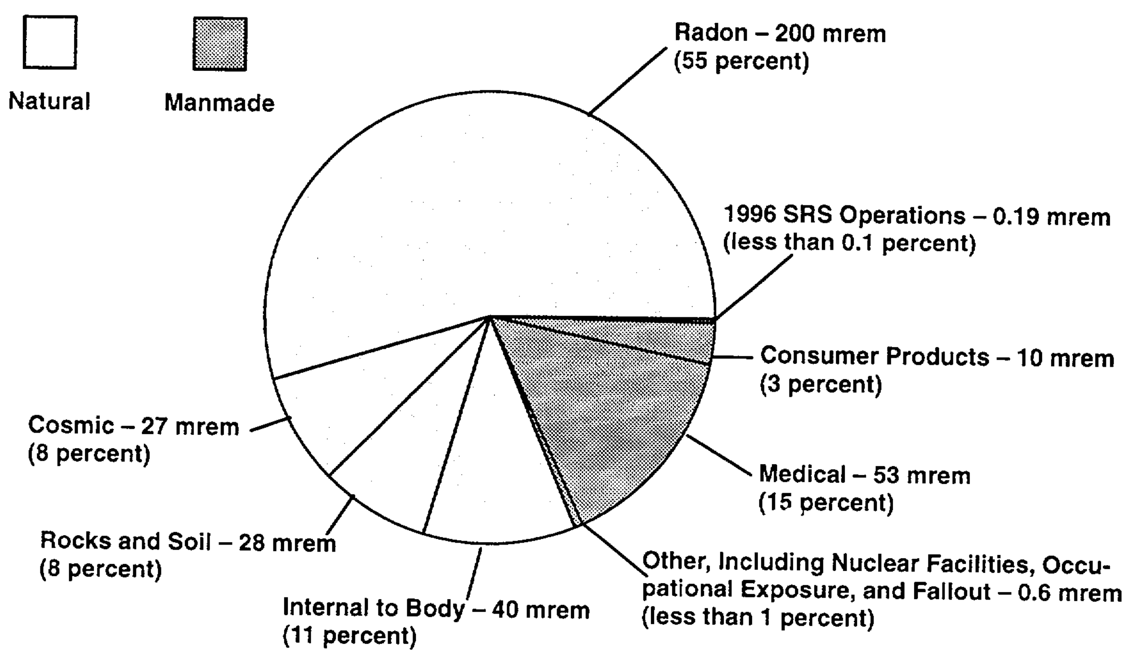


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**Figure 7–5 Contributions to the U.S. Average Individual Dose**

The major contributor to the annual average individual dose in the United States, including residents of the CSRA, is naturally occurring radiation (about 300 mrem) [NCRP, 1987]. During 1996, SRS operations potentially contributed a maximum individual dose of 0.19 mrem, which is less than 0.1 percent of the 360-mrem total annual average dose (natural plus manmade sources of radiation).

**Table 7–5**
**1996 All-Pathway and Sportsman Doses Compared to the DOE All-Pathway Dose Standard**

| | Committed Dose (mrem) | Applicable Standard[a] (mrem) | Percent of Standard |
|---|---|---|---|
| **Maximally Exposed Individual Dose** | | | |
| **All-Pathway (Liquid Plus Airborne Pathway)** | 0.19 | 100 | 0.19 |
| **Sportsman Doses** | | | |
| **Creek Mouth Fisherman** | 1.7 | 100 | 1.7 |
| **Onsite Hunter** | 21 | 100 | 21 |
| **Offsite Hunter** | 14 | 100 | 14 |

a All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)

personnel perform a field analysis for cesium-137 on the deer and hogs at the hunt site, using portable sodium iodide detectors. Like fish, deer and hogs have a high bioaccumulation factor for cesium.

The estimated dose from consumption of the harvested deer or hog meat is determined for each hunter. During 1996, the maximum potential dose that could have been received by a hunter was estimated at 21 mrem (0.21 mSv), or 21 percent of DOE's 100-mrem all-pathway dose standard (table 7–5). This dose was determined for a hunter who had harvested six animals during the 1996 hunts. The hunter-dose calculation is based on the conservative assumption that the hunter individually consumed the entire edible portion—approximately 111 kg (245 pounds)—of the animals he harvested from SRS.

An additional deer meat consumption pathway considered was for a hypothetical offsite individual whose entire intake of meat during the year was deer meat. It was assumed that this individual harvested deer that had resided on SRS, but then moved off site. The estimated dose was based on the maximum annual meat consumption rate for an adult of 81 kg per year [Hamby, 1991].

Based on these low-probability assumptions and on the gross average concentration of cesium-137 (4.5 pCi/g) in deer harvested from SRS during 1996, the potential maximum dose from this pathway was estimated at 14 mrem (0.14 mSv). As shown in table 7–5, this potential dose is 14 percent of DOE's 100-mrem all-pathway dose standard. This dose was slightly less than the 1995 dose of 15 mrem (0.15 mSv).

## Fish Consumption Pathway

For 1996, analyses were conducted of fish taken from the mouths of five SRS streams, and the subsequent estimated doses from the maximum consumption of 19 kg per year [Hamby, 1991] of these fish were determined [SRS Data, 1997]. Fish flesh was composited by species for each location and analyzed for tritium, strontium-90, cesium-137, plutonium-238, and plutonium-239.

As shown in table 7–5, the maximum potential dose from this pathway was estimated at 1.7 mrem (0.017 mSv) from the consumption of bass collected at the mouth of Steel Creek. This hypothetical dose is based on the low-probability scenario that, during 1996, a fisherman consumed 19 kg of bass caught exclusively from the mouth of Steel Creek. More than 99 percent of this potential dose was from cesium-137. Again, some fraction of this cesium-137 is from worldwide fallout and from neighboring Vogtle Electric Generating Plant; however, that amount is difficult to determine and is not subtracted from the total.

## Potential Risk from Consumption of SRS Creek Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed—in conjunction with the Georgia Department of Natural Resources (GDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), and EPA—and implemented the WSRC/EMS Fish Monitoring Plan [SRS EM Program, 1996]. Part of the reporting requirements of this plan are to perform

an assessment of radiological risk from the consumption of Savannah River fish, and to summarize the results in the annual *SRS Environmental Report.* The following sections discuss the potential radiological risks from the consumption of Savannah River fish, using SRS-published data from 1993 through 1996. Potential radiological risks are determined using both the ICRP–60 [ICRP, 1990] and the EPA [EPA, 1991] methods.

**Exposure Scenario** In EPA's risk assessment guidance document [EPA, 1991], two fish consumption pathways are considered—the recreational fisherman scenario and the subsistence fisherman scenario. Because there are no known permanent residences adjacent to, or immediately downriver of, SRS, the recreational fisherman scenario—as opposed to the subsistence fisherman scenario—is considered the more reasonable exposure scenario and is used in this assessment.

It is assumed that a recreational fisherman fishes for a single species of fish (either panfish, predators, or bottom dwellers) from the mouth of a single worst-case SRS stream. Access to upstream portions of SRS streams is prohibited by postings, fencing (where possible), and periodic patrols.

Per EPA guidance [EPA, 1991], the maximum consumption rate that should be used for determining risk to the recreational fisherman is 19 kilograms (42 pounds) per year. This is the same as the consumption rate used by SRS for demonstrating dose compliance [Hamby, 1991].

The EPA guidance document requires that critical subpopulations and fish species be considered in risk assessments. Currently, there are no known sensitive subpopulations (e.g., Native Americans) in the immediate SRS region who are known to regularly consume whole fish (edible and nonedible portions) as part of their typical diet. Also, there are no known species of fish, such as smelt, in the SRS region of the Savannah River that are commonly eaten whole. Therefore, it is reasonably assumed that the recreational fisherman consumes only the edible (fillet only) portion of the fish caught.

**Risk Factors** For the EPA method, estimates of potential risk are calculated directly by multiplying the amount of each radionuclide ingested by the appropriate risk (slope) factors provided in EPA's *Health Effects Assessment Summary Tables* (HEAST) [EPA, 1996]. The HEAST ingestion slope factors are best estimates of potential, age-averaged, lifetime excess cancer incidence (fatal and nonfatal) risk per unit of activity ingested.

For the ICRP–60 method, estimates of potential risk are determined first by calculating a radiation dose attributable to the amount of radionuclides ingested and then multiplying that dose by the ICRP–60 coefficient of risk of severe detriment of 7.3E–07 per mrem [ICRP, 1990]. Stated another way, if a group of 10,000,000 people each received a radiation dose of 1 mrem, during their collective lifetimes there would theoretically be 7.3 additional severe detrimental incidences (fatal/nonfatal cancer or severe hereditary effects), which is small compared to the 2,000,000 or more expected fatal cancer incidences from other causes during their lifetimes [BEIR V, 1990].

The ICRP–60 risk coefficient includes factors for

- fatal cancers (5.0E–07 per mrem)
- nonfatal cancers (1.0E–07 per mrem)
- hereditary effects (1.3E–07 per mrem)

**Exposure Duration** According to guidance provided by EPA, the upper bound value of 30 years can be used for exposure duration when calculating reasonable maximum residential exposures. However, the guidance states that other site-specific exposure durations may be used at the discretion of the risk assessor. This assessment compares the potential risks of exposure durations of 1 year, 30 years, and 50 years. The 30-year and 50-year exposure duration risks are simply 30 times and 50 times the 1-year exposure duration risk, respectively.

**Risk Comparisons** The maximum potential lifetime risks from the consumption of SRS creek mouth fish for 1-year, 30-year, and 50-year exposure durations are shown in table 7–6. Also shown are the potential radiation doses. For each year, the maximum recreational fisherman dose was caused by the consumption of bass collected at the mouth of Steel Creek. More than 98 percent of the doses are attributable to cesium-137.

Table 7–6 includes a comparison of radiation risks associated with the DOE Order 5400.5 all-pathway dose standard of 100 mrem (1.0 mSv) per year. The associated EPA-method risks were determined using the slope factor for cesium-137.

As indicated in table 7–6, for the ICRP–60 method, the 50-year maximum potential lifetime risks from consumption of SRS creek mouth fish range between 4.4E–05 and 6.2E–05, which are below the 50-year risk associated with the dose standard.

According to EPA practice, if a potential risk is calculated to be less than 1.0E–06 (i.e., one additional case of cancer over what would be expected in a group of 1,000,000 people), then the risk is

**Table 7–6**
**Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards (1993–1996)**

| | Committed Dose (mrem) | ICRP–60 Risk Method | EPA/CERCLA Risk Method |
|---|---|---|---|
| **1996 Savannah River Fish** | | | |
| 1-Year Exposure | 1.7 | 1.2E–06 | 1.1E–06 |
| 30-Year Exposure | 51 | 3.7E–05 | 3.3E–05 |
| 50-Year Exposure | 85 | 6.2E–05 | 5.5E–05 |
| **1995 Savannah River Fish** | | | |
| 1-Year Exposure | 1.2 | 8.8E–07 | 7.4E–07 |
| 30-Year Exposure | 36 | 2.6E–05 | 2.2E–05 |
| 50-Year Exposure | 60 | 4.4E–05 | 3.7E–05 |
| **1994 Savannah River Fish** | | | |
| 1-Year Exposure | 1.3 | 9.5E–07 | 8.2E–07 |
| 30-Year Exposure | 39 | 2.8E–05 | 2.5E–05 |
| 50-Year Exposure | 65 | 4.7E–05 | 4.1E–05 |
| **1993 Savannah River Fish** | | | |
| 1-Year Exposure | 1.3 | 9.5E–07 | 7.9E–07 |
| 30-Year Exposure | 39 | 2.8E–05 | 2.4E–05 |
| 50-Year Exposure | 65 | 4.7E–05 | 4.0E–05 |
| **Dose Standard** | | | |
| **100-mrem/year All Pathway** | | | |
| 1-Year Exposure | 100 | 7.3E–05 | 6.3E–05 |
| 30-Year Exposure | 3,000 | 2.2E–03 | 1.9E–03 |
| 50-Year Exposure | 5,000 | 3.7E–03 | 3.2E–03 |

considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is greater than 1.0E–04 (one additional case of cancer in a population of 10,000), then some form of corrective action or remediation usually is required. However, if a calculated risk falls between 1.0E–04 and 1.0E–06, which is the case with the maximum potential lifetime risks from the consumption of Savannah River fish, then the risks are considered acceptable if they are kept as low as reasonably achievable (ALARA).

At SRS, the following programs are in place to ensure that the potential risk from site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are kept ALARA:

- radiological liquid effluent monitoring program (chapter 5)
- radiological environmental surveillance program (chapter 6)
- environmental ALARA program [SRS EM Program, 1996]

## Dose to Aquatic Animal Organisms

DOE Order 5400.5 establishes an interim dose standard for protection of native aquatic animal organisms. The absorbed dose limit to these organisms is 1 rad per day (0.01 Gy per day) from exposure to radioactive material in liquid effluents released to natural waterways.

Hypothetical doses to aquatic biota in SRS streams are calculated annually to demonstrate compliance with this 1-rad-per-day (0.01-Gy-per-day) dose standard. Upper-limit doses are calculated with measured radioactivity transport and minimum flow rates for each surface stream. Flow rates are chosen to maximize the biota dose. Source terms (stream transport) are provided by the site's Environmental Monitoring Section (EMS) [SRS Data, 1997].

The CRITR computer code [Soldat et al., 1974], incorporated as part of the LADTAPII code, calculates internal and external doses to aquatic biota and to higher trophic levels that depend on aquatic biota for food. The CRITR Code is one of the three aquatic biota dose codes recommended by DOE [DOE, 1991]. External doses are calculated with the same external dose factors used for man [DOE, 1988]. Internal doses are based on the physical size of the biota (effective radius) and on effective energies provided for each radionuclide for each radius. The maximum dose to biota was estimated at 0.019 rad per day (0.00019 Gy per day), which occurred in ducks in Four Mile Creek. This is 1.9 percent of the 1-rad-per-day (0.01-mGy-per-day) DOE dose limit.

## Radiological Assessment Program

The preparation of documents describing the effects of SRS operations on the environment began in 1988. The format chosen was a separate document for each major radionuclide or group of similar radionuclides. The documents describe the operating history of the site with respect to the production, storage, and release of each radionuclide. The transport of the radionuclide in air, surface water, and groundwater is explained, and a calculation of the dose estimate to individuals and the population surrounding SRS is presented. As of December 31, 1996, the following 11 documents had been published[a]:

- *Assessment of Tritium in the Savannah River Site Environment*, WSRC–TR–93–214
- *Cesium in the Savannah River Site Environment*, WSRC–RP–92–250
- *Uranium in the Savannah River Site Environment*, WSRC–RP–92–315
- *Radioiodine in the Savannah River Site Environment*, WSRC–RP–90–424–2
- *Assessment of Radiocarbon in the Savannah River Site Environment*, WSRC–TR–93–215
- *Assessment of Technetium in the Savannah River Site Environment*, WSRC–TR–93–217
- *Assessment of Strontium in the Savannah River Site Environment*, WSRC–RP–92–984
- *Plutonium in the Savannah River Site Environment*, WSRC–RP–92–879, Rev. 1
- *Assessment of Mercury in the Savannah River Site Environment*, WSRC–TR–94–0218ET
- *Assessment of Noble Gases in the Savannah River Site Environment*, WSRC–TR–95–0219
- *Assessment of Activation Products in the Savannah River Site Environment*, WSRC–TR–95–0422

A document for selected fission products is scheduled for publication in 1997.

a Copies of these documents can be obtained from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

*Chapter 8*

# Nonradiological Effluent Monitoring

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**To Read About . . . See Page . . .**



NONRADIOACTIVE air emissions originating at Savannah River Site (SRS) facilities are monitored at their points of discharge by direct measurement, sample extraction and measurement, or process knowledge. Air monitoring is used to determine whether all emissions and ambient concentrations are within applicable regulatory standards.

Nonradiological liquid effluent monitoring encompasses sampling and analysis and is performed by the Environmental Protection Department's Environmental Monitoring Section (EMS) and the Savannah River Technology Center (SRTC).

A complete description of EMS sampling and analytical procedures used for nonradiological monitoring can be found in sections 1101–1111 (SRS EM Program) of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1, which was issued in June 1995. A summary of data results is presented in this chapter; more complete data can be found in *SRS Environmental Data for 1996* (WSRC–TR–97–0077).

## Airborne Emissions

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates nonradioactive air emissions—both criteria pollutants and toxic air pollutants—from SRS sources. Each source is permitted by SCDHEC, with specific limitations identified, as outlined in various South Carolina air pollution control regulations and standards. Many of the applicable standards are source dependent, i.e., Emissions from Fuel Burning Operations, Waste Combustion and Reduction, Emissions from Process Industries, etc. However, the primary standards that govern all sources for criteria air pollutants and ambient air quality are identified in SCDHEC Air Pollution Control Regulation 61–62.5, Standard No. 2, and Regulation 61–62.5, Standard No. 8, for toxic air pollutants. Standard No. 2 lists eight criteria air pollutants commonly used as indices of air quality (e.g., sulfur dioxide, nitrogen dioxide, and lead) and provides an allowable site boundary concentration for each pollutant. Standard No. 8 identifies 257 toxic air pollutants and their respective allowable site boundary concentrations. Specific permits for operating facilities are listed in appendix B, "SRS Environmental Permits."

**Table 8–1**
**Nonradiological Airborne Emissions Standards for SRS Coal-Fired Boilers**

| | |
|---|---|
| Sulfur dioxide | 3.5 lb/$10^6$ BTU[a] |
| Total suspended particulates | 0.6 lb/$10^6$ BTU |
| Opacity | 40% |

a British thermal unit

Airborne emission standards for each SRS permitted source may differ, based on size and type of facility, type and amount of expected emissions, and the year the facility was placed into operation. For example, for powerhouse boilers constructed before February 11, 1971, the particulate emission limit is 0.6 pounds per million BTU (British thermal unit) of boiler fuel heat input. Boilers constructed after 1971 must meet more stringent standards, identified in 40 CFR 60, "New Source Performance Standards," in addition to the SCDHEC requirements. For process and diesel engine stacks in existence prior to January 1, 1986, and powerhouse stacks built before February 11, 1971, the opacity standard is 40 percent. For new sources placed into operation after these dates, the opacity standard typically is 20 percent. Table 8–1 shows typical standards for criteria pollutants from SRS coal-fired boilers, which were built before 1971.

At SRS, there are 192 permitted/exempted nonradiological air emission sources, 155 of which were in operation in some capacity during 1996. The remaining 39 sources either were being maintained in a "cold standby" status or were under construction.

## Description of Monitoring Program

Major nonradiological emissions of concern from stacks at SRS facilities include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 microns, volatile organic compounds, and toxic air pollutants. Stacks that have such emissions at SRS include those associated with diesel engine-powered equipment, package steam generators, powerhouse boilers, the Defense Waste Processing Facility (DWPF), the in-tank precipitation process, groundwater air strippers, and various other process facilities. Emissions from SRS sources are determined during an annual emissions inventory from calculations using source operating parameters such as fuel oil consumption rates, total hours of operation, and the emission factors provided in EPA's "Compilation of Air Pollution Emission Factors," AP–42. The calculation for boiler sulfur dioxide emissions also uses the average sulfur content of the coal and assumes 100 percent liberation of sulfur and 100 percent conversion to sulfur dioxide. Most of the processes at SRS are nonstandard-type sources requiring complex calculations that use process chemical or material throughputs, hours of operation, chemical properties, etc., to determine actual emissions. In addition to the annual emissions inventory, compliance with various standards is determined in several ways, as follows:

At the SRS powerhouses, stack compliance tests are performed every 2 years for each boiler by airborne emission specialists under contract to SRS. The tests include

- sampling of the boiler exhaust gases to determine particulate emission rates and carbon dioxide and oxygen concentrations
- laboratory analysis of coal for sulfur content, ash content, moisture content, and BTU output

Sulfur content and BTU output are used to calculate sulfur dioxide emissions. SCDHEC also conducts visible-emissions observations during the tests to verify compliance with opacity standards. The day-to-day control of particulate matter smaller than 10 microns is demonstrated by opacity meters in all SRS powerhouse stacks.

For the package steam generating boilers in K-Area and P-Area, compliance with sulfur dioxide standards is determined by analysis of the fuel oil purchased from the offsite vendor. The percent of sulfur in the fuel oil must be below 0.5 and is reported to SCDHEC each quarter. Compliance with particulate emission standards is demonstrated by mass-balance calculations rather than stack emission tests.

Compliance by SRS diesel engines and other process stacks is determined during annual compliance inspections by the local SCDHEC district air manager. These inspections include a review of operating parameters, an examination of continuous-emission monitors (where required for process or boiler stacks), and a visible-emissions observation for opacity.

Compliance by all toxic air pollutant and criteria pollutant sources also is determined by using U.S. Environmental Protection Agency (EPA)-approved air dispersion models. Air dispersion modeling is extremely conservative unless refined models are used. The Industrial Source Complex Version No. 2 model was used to predict maximum ground-level concentrations occurring at or beyond the site boundary for new sources permitted during 1996. Some site sources of toxic air pollutants also are required to be stack tested every 2 years.

## Monitoring Results

As noted earlier, emissions are calculated each year as part of an annual emissions inventory. In 1996, operating data were compiled and emissions were calculated for 1995 operations for all site air emission sources. Because this process, which begins in January, requires up to 6 months to complete, this report will provide a more comprehensive examination of total 1995 emissions, with only limited discussion of available 1996 monitoring results. Actual emissions for 1996 will be compiled and reported in depth in the *SRS Environmental Report for 1997*.

Two coal-fired power plants with five boilers are operated by Westinghouse Savannah River Company (WSRC) at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 8–2. The A-Area and H-Area boilers are overfeed stoker fed and use coal as their only fuel. The A-Area No. 1, H-Area No. 1, and H-Area No. 3 boilers were stack tested in 1996. The results are

**Table 8–2**
**SRS Power Plant Boiler Capacities**

| Location | Number of Boilers | Capacity (BTU/hr) |
|---|---|---|
| A-Area | 2 | 71.7E+06 |
| H-Area | 3 | 71.1E+06 |

**Table 8–3**
**Boiler Stack Test Results (D-Area, A-Area)**

| Boiler | Pollutant | Emission Rates lb/10⁶ BTU | lbs/hr |
|---|---|---|---|
| A #2 | Particulates | 0.44 | 38.30 |
| | Sulfur dioxide | 1.30 | NC[a] |
| H #1 | Particulates | 0.31 | 28.10 |
| | Sulfur dioxide | 1.08 | NC[a] |
| H #3 | Particulates | 0.26 | 20.05 |
| | Sulfur Dioxide | 0.09 | NC[a] |

a Not calculated

shown in table 8–3, and all are within the required emission standards presented in table 8–1.

SRS also has four package steam generating boilers fired by No. 2 fuel oil. These boilers are used primarily to heat buildings during cold weather. If necessary, they are used during process facility operation. The location, number of boilers, and capacity of each boiler are shown in table 8–4. During 1996 only the 76.8- and 38.0-mmBTU/hr boilers were operated. The percent of sulfur in the fuel oil burned during the year was certified by the vendor to meet the requirements of the permit.

At SRS, 125 permitted sources, both portable and stationary, are powered by internal combustion diesel engines. These sources include portable air compressors, diesel generators, emergency cooling water pumps, and fire water pumps ranging in size from 150 to 2050 kilowatts for generators and 200 to 520 horsepower for air compressor and pump engines. Fuel oil consumption for the diesel engines operated in 1996 was 805,425 gallons. Total fuel consumption for 1996 will be included in the report for calendar year 1997.

Another significant source of criteria pollutant emissions at SRS is the burning of forestry areas across the site. The Savannah River Forest Station (SRFS), a unit of the U.S. Department of Agriculture

**Table 8–4**
**SRS Package Steam Boiler Capacities**

| Location | Number of Boilers | Capacity (BTU/hr) |
|---|---|---|
| K-Area | 1 | 76.8E+06 |
| K-Area | 1 | 38.0E+06 |
| Portable | 2 | 17.0E+06 |

**Table 8–5**
**1995 Criteria Pollutant Air Emissions[a]**

| Pollutant Name | Actual Tons/Year |
|---|---|
| Sulfur dioxide | 8.73E+02 |
| Total suspended particulates | 2.41E+00 |
| PM10 (particulate matter <10 microns) | 2.25E+02 |
| Carbon monoxide | 4.21E+03 |
| Ozone (volatile organic compounds) | 5.05E+04 |
| Gaseous fluorides (as hydrogen fluoride) | 1.47E–01 |
| Nitrogen dioxide (NOX) | 5.21E+02 |
| Lead | 1.49E–02 |

a From all SRS sources (permitted and nonpermitted)

Forest Service, periodically conducts controlled burning of vegetation and undergrowth as a means of preventing uncontrolled forest fires. During 1995, SRFS personnel burned a total of 15,593 acres across the site.

Other sources of criteria pollutants, such as sulfur dioxide, oxides of nitrogen, carbon monoxide, particulate matter, and volatile organic compounds, at SRS are too numerous to discuss here by type. Table 8–5 provides the 1995 atmospheric emissions results for all permitted SRS sources, as determined by the air emissions inventory conducted in 1996. All calculated emissions were within applicable SCDHEC standards and permit limitations during 1995.

Thirty-five of the SRS permitted sources are permitted for toxic air pollutants; 29 of these were operated during 1996. Only eight of the operable toxic air pollutant sources are required to be stack tested. During 1996, two air stripper units and one soil vapor extraction/catalytic oxidation unit were stack tested to determine compliance with their respective permitted emission rates. Table 8–6 shows the test results and the permitted emission rates. The results indicate that all permit limits have been met.

Total toxic air pollutant emissions at SRS are determined annually in tons per year for each pollutant [SRS Data, 1997]. It should be noted that some toxic air pollutants regulated by SCDHEC also are, by nature, volatile organic compounds (VOCs). As such, the total for VOCs in table 8–5 includes toxic air pollutant emissions.

## Ambient Air Quality

SRS does not conduct onsite monitoring for ambient air quality; however, as a result of regulatory requirements, the site is required to show compliance with various air quality standards. To accomplish this,

**Table 8–6**
**Soil Vapor Extraction Unit (SVEU)/Catalytic Oxidation Stack Test Results**

| SVEU | Pollutant | Result lb/hr | Permitted Emission lb/hr |
|---|---|---|---|
| A–2 | HCL | 0.150 | 4.000 |
| | PCE | 0.028 | 6.400 |
| | TCE | 0.017 | 6.400 |
| M–1 | HCL | 1.380 | 5.612 |
| | PCE | 0.106 | 0.122 |
| | TCE | 0.064 | 0.214 |
| 782–7M | HCL | 0.250 | 3.750 |
| | PCE | 0.061 | 0.130 |
| | TCE | 0.010 | 0.100 |

air dispersion modeling was conducted during 1996 for new emission sources as part of the sources' construction permitting process. The modeling analysis showed that SRS air emission sources were in compliance with applicable regulations.

South Carolina and Georgia continue to monitor ambient air quality near SRS as part of the network associated with the Clean Air Act.

# Liquid Discharges

## Description of Monitoring Program

From January 1 through September 30, 1996, SRS discharged water into site streams and the Savannah River under four NPDES permits: two for industrial wastewater (SC0000175 and SC0044903) and two for stormwater runoff—SCR000000 (industrial discharge) and SCR100000 (construction discharge). A fifth NPDES permit—a no-discharge permit (ND0072125)—was issued to cover land application of sludge generated at onsite sanitary waste treatment plants. Industrial permit SC0000175 expired in 1988 and industrial permit SC0044903 expired in November 1995, but because SRS had applied for a new NPDES permit, discharges were allowed to continue under the expired permits until October 1, 1996, when the new permit (also numbered SC0000175) was issued. The new permit, which will not expire until September 30, 2001, includes the discharge points covered under the two expired industrial permits (SC0000175 and SC0044903).

Stormwater industrial permit SCR000000 covers 48 discharge locations sorted into 11 groups. A representative site from each group was sampled, as required by the permit. Construction permit SCR100000 does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site. SCDHEC did not request any such sampling in 1996.

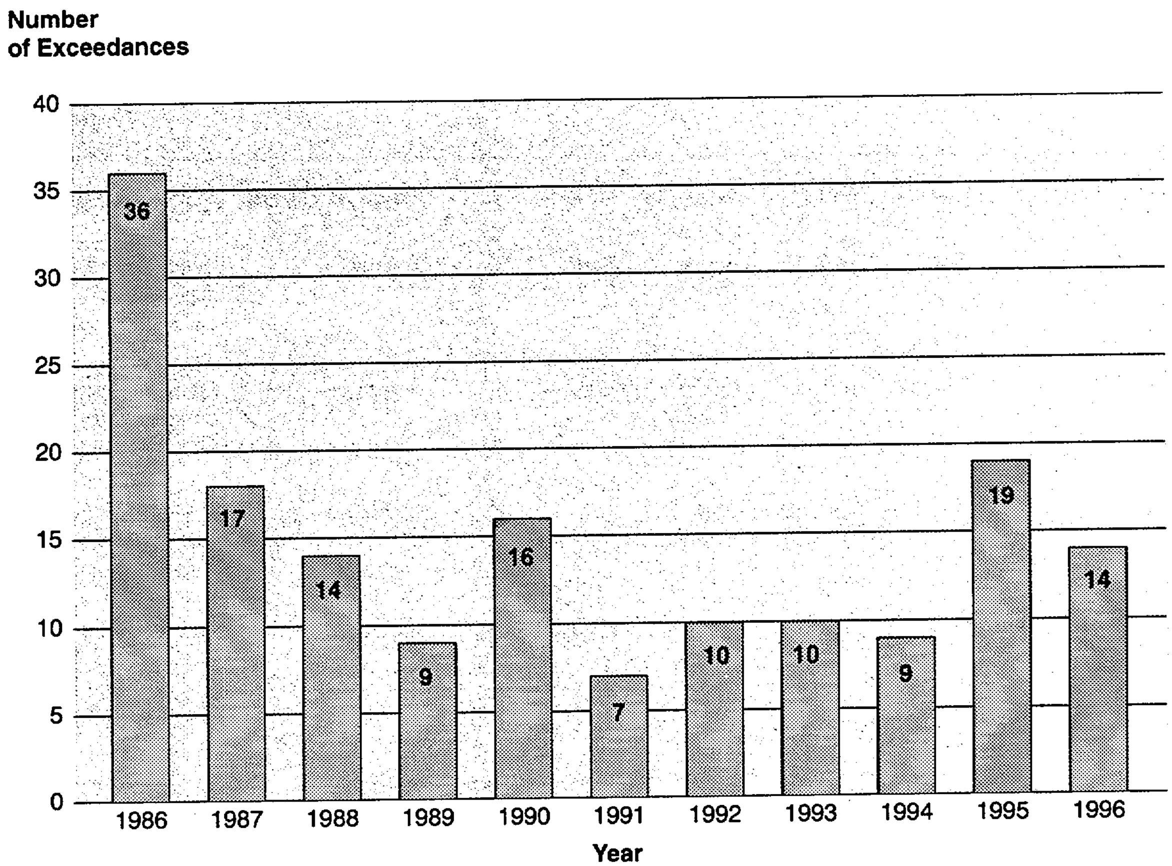
NPDES discharge points are sampled according to applicable permit requirements. The samples are preserved in the field according to 40 CFR 136, the federal document that lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant to be analyzed. Chain-of-custody procedures are followed after collection and during transport to the analytical laboratory. The samples then are accepted by the laboratory and analyzed according to procedures listed in 40 CFR 136 for the parameters required by the permit.

The effectiveness of the NPDES monitoring program is documented by a surveillance program involving chemical and biological evaluation of the waters to which effluents have been discharged. More monitoring information can be found in chapters 9, "Nonradiological Environmental Surveillance," and 12, "Special Surveys and Projects."

## Monitoring Results

SRS reports analytical results to SCDHEC through a monthly discharge monitoring report, which includes a list of exceedances or locations at which analyses showed the discharge did not meet permit requirements.

From January 1 through September 30, 1996 (under the expired NPDES permits), 68 of the 83 permitted outfalls discharged; 11 did not discharge; and 4 were not in service. From October 1 through December 31, 1996 (under the new permit), 34 of 37 permitted outfalls discharged and three did not discharge. Results from 14 of the 5,737 discharge-sample analyses performed during 1996 exceeded permit limits because of process upsets—such as overheated UV light bulbs, which caused erosion of galvanized pipes at Outfall G–010). Even with these exceedances, the site achieved a 99.8-percent compliance rate—higher than the 98-percent rate mandated by DOE. A list of the 1996 exceedances under the old permits appears in table 8–7, beginning on page 126; exceedances under the new permit appear in table 8–8, page 127. Figure 8–1 shows the NPDES exceedances at SRS from 1986 through 1996. SCDHEC has not mandated permit limits for stormwater outfalls.




| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Number of Analyses* | 6,240 | 6,560 | 6,250 | 6,859 | 6,810 | 8,329 | 7,729 | 8,000 | 7,568 | 7,515 | 5737 |
| *Compliance Rate* | 99.4% | 99.7% | 99.8% | 99.9% | 99.8% | 99.9% | 99.9% | 99.9% | 99.9% | 99.8% | 99.8% |

Ileaf Graphic

**Figure 8–1 History of NPDES Exceedances, 1986–1996**

To determine the compliance rate, the number of analyses not exceeding limits for a given year is divided by the total number of analyses. For example, 5,737 analyses were performed in 1996, with 14 exceedances. To calculate the compliance rate for that year, divide 5,723 (5,737 minus 14) by 5,737 for a quotient of .9975, or 99.8, percent.

**Table 8–7**
**1996 NPDES Exceedances Under Old Permits (January 1 through September 30)**

**Page 1 of 1**

| Department | Outfall | Date | Analysis | Result | Possible Cause | Corrective Action |
|---|---|---|---|---|---|---|
| SSD/SUD | G–010 | Jan. 15 | Acute Toxicity | Fail | Unknown | None; toxicity stopped prior to discovery of source |
| SSD/SUD | G–010 | Jan. 17 | Chronic Toxicity | Fail | Unknown | None; toxicity stopped prior to discovery of source |
| SSD/SUD | G–010 | Jan. 23 | Chronic Toxicity | Fail | Unknown | None; toxicity stopped prior to discovery of source |
| CSWE | A–005 | Feb. 27 | TSS | 45 mg/L (avg) | Unknown | None; investigation revealed no process upsets; no cause determined |
| RWMD | L–008 | Mar. 4 | TSS | 100 mg/L (avg and max) | Unknown | None; investigation revealed no process upsets; no cause determined |
| ER | A–01A | May 13 | pH | 4.3 SU (min) | Algal reduction of TCE and PCE | Under investigation |
| SSD/SUD | G–010 | June 12 | Fecal coliform | 1,960 col/100 mL (avg and max) | Bulbs overheated; fuse blew | Cleaned intake screens to ensure water flow |
| SSD/SUD | G–010 | July 10 | Fecal coliform | 1,400 col/100 mL (avg and max) | Electrical problems | Resolved electrical problems |
| RWMD | P–013 | Aug. 9 | O&G | 58 mg/L (avg and max) | Analytical result is in question; duplicate analysis was <1.0mg/L | None; upset attributed to analytical error |

*Key:* *O&G – Oil and Grease*
*PCE – Tetrachloroethylene*
*SU – Standard Units*
*TCE – Trichloroethylene*
*TSS – Total Suspended Solids*

**Table 8–8**
**1996 NPDES Exceedances Under New Permit (October 1 through December 31)**

**Page 1 of 1**

| Department | Outfall | Date | Analysis | Result | Possible Cause | Corrective Action |
|---|---|---|---|---|---|---|
| SSD/SUD | D–1A | Oct. 16 | Fecal coliform | 8,000 col/100 mL | UV bulbs burned out | UV bulbs replaced |
| SSD/SUD | D–1A | Oct. 17 | Fecal coliform | 1,800 col/100 mL | UV bulbs burned out | UV bulbs replaced |
| SSD/SUD | K–12 | Nov. 16 | Flow | 0.025 MGD (max) | Two flush valves stuck open | Valves fixed |
| LOD | X–04 | Dec. 5 | pH | 4.6 SU | Stormwater pumped to outfall | Check sump pH prior to discharge |
| SEP | F–08 | Dec. 11 | TSS | 100 mg/L (min) | Well cleaning wastewater discharged to outfall | Well cleaning discharges routed to sanitary sewer |

*Key:* *MGD – Millions of Gallons per Day*
*SU – Standard Units*
*TSS – Total Suspended Solids*

# Chapter 9

# Nonradiological Environmental Surveillance

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**To Read About . . .** **See Page . . .**



NONRADIOACTIVE environmental surveillance at the Savannah River Site (SRS) involves the sampling and analysis of surface waters (six onsite streams and the Savannah River), drinking water, sediment, groundwater, and fish. A description of the surveillance program and 1996 results for groundwater can be found in chapter 10, "Groundwater."

The Environmental Protection Department's Environmental Monitoring Section (EMS) and the Savannah River Technology Center (SRTC) perform nonradiological surveillance activities. The Savannah River also is monitored by other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR). In addition, the Academy of Natural Sciences of Philadelphia conducts special environmental surveys on the Savannah River through a program that began in 1951. The Academy's studies for 1996 are discussed in chapter 12, "Special Surveys and Projects."

A complete description of the EMS sample collection and analytical procedures used for nonradiological surveillance can be found in section 1105 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1 (SRS EM Program), which was issued in June 1995. A summary of data results is presented in this chapter; however, more complete data can be found in *SRS Data for 1996* (WSRC–TR–97–0077). Information on the rationale for the nonradiological environmental surveillance program can be found in chapter 3, "Environmental Program Information."

In 1996, approximately 8,600 nonradiological analyses for specific chemicals and metals were performed on about 1,800 samples, not including groundwater.

SRS currently does not conduct onsite surveillance for ambient air quality. However, to ensure compliance with SCDHEC air quality regulations and standards, SRTC conducted air dispersion modeling for all site sources of criteria and toxic air pollutants in 1993. This modeling indicated that all the SRS sources were in compliance with the air quality regulations and standards. Since that time, additional modeling conducted for new sources of criteria and toxic air pollutants has demonstrated continued compliance by the site with these regulations and standards. The states of South Carolina and Georgia continue to monitor ambient air quality near the site as part of a network associated with the federal Clean Air Act.

## Surface Water

SRS streams and the Savannah River are classified as "Freshwaters" by SCDHEC. Freshwaters are defined as surface water suitable for

- primary—and secondary—contact recreation and as a drinking water source after conventional treatment in accordance with SCDHEC requirements
- fishing and survival and propagation of a balanced indigenous aquatic community of fauna and flora
- industrial and agricultural uses

Appendix A, "Applicable Guidelines, Standards, and Regulations," provides some of the specific guides used in water quality surveillance, but because some of these guides are not quantifiable, they are not tracked in response form (i.e., amount of garbage found).

### Description of Surveillance Program

EMS samples site streams and the Savannah River monthly for various chemicals, metals, and physical and biological properties to ensure that water quality criteria are met [SRS EM Program, 1995]. Stream nonradiological surveillance is conducted for any evident degradation that could be attributed to the water discharges regulated by site National Pollutant Discharge Elimination System (NPDES) permits. This also helps detect materials that may be released inadvertently from sources other than routine release points.

Each SRS stream receives varying amounts of treated wastewater and rainwater runoff from site facilities. Stream locations are sampled for water quality at weekly and monthly frequencies by the conventional grab-collection technique. Each grab sample shows the water quality at the time of sampling only.

River sampling sites are located upriver of, adjacent to, and downriver of the site to compare the SRS contribution of pollutants with background levels of chemicals from natural sources and from contaminants produced by municipal sewage plants, medical facilities, and other upriver industrial facilities. Nonradiological surveillance of the river also checks for any degradation that could be attributed to the water discharges regulated by site NPDES permits.

To monitor the water quality and to ensure that water quality criteria are met, field measurements for conductivity, dissolved oxygen, pH, and temperature are taken monthly and laboratory analyses are conducted for other water quality parameters, such as metals, chemicals, and physical and biological properties.

During 1996, changes in the nonradiological water quality surveillance program were implemented following a comprehensive review of the SRS environmental monitoring program. This review, known as "Rock Hill Initiative #2," is discussed in chapter 3. The review resulted in a change in the number of sampling locations from 7 stream and 2 river to 11 stream and 5 river, effective September 1.

Pesticides and herbicides have been monitored at SRS since 1976 to assess their concentrations in surface waters from site streams and the Savannah River. Prior to the Rock Hill review, annual water samples from seven stream and two river locations were analyzed for 21 pesticides and herbicides. These samples had not been collected in 1996 prior to the review, and the review discontinued these annual samples/analyses.

However, EMS samples from four SCDHEC stream locations were analyzed monthly in 1996 (until September) for the same pesticides and herbicides and also for three volatile organic compounds. Under the new program, pesticides will be analyzed quarterly at all surveillance locations. Because of an error during implementation of the new program, fourth quarter samples were not collected.

Surface water sampling locations are shown in figure 9–1.

### Surveillance Results

The 1996 water quality data showed normal fluctuations expected for surface water. Comparison of the 1996 data with published historical data for site surface water monitoring did not indicate any abnormal deviations from past monitoring data. Analysis for pesticides, herbicides, and volatile organic compounds yielded positive results for a pesticide (dieldrin) at one location (Four Mile Creek–A7). All other analyses results were below detection limits. Coliform analysis results exceeded recommended standards 20 times in 1996 (17 in site streams and 3 in the river). The exceedances decreased in number from 1995, when site streams analysis results exceeded guides 36 times and river analysis results exceeded guides 13 times.

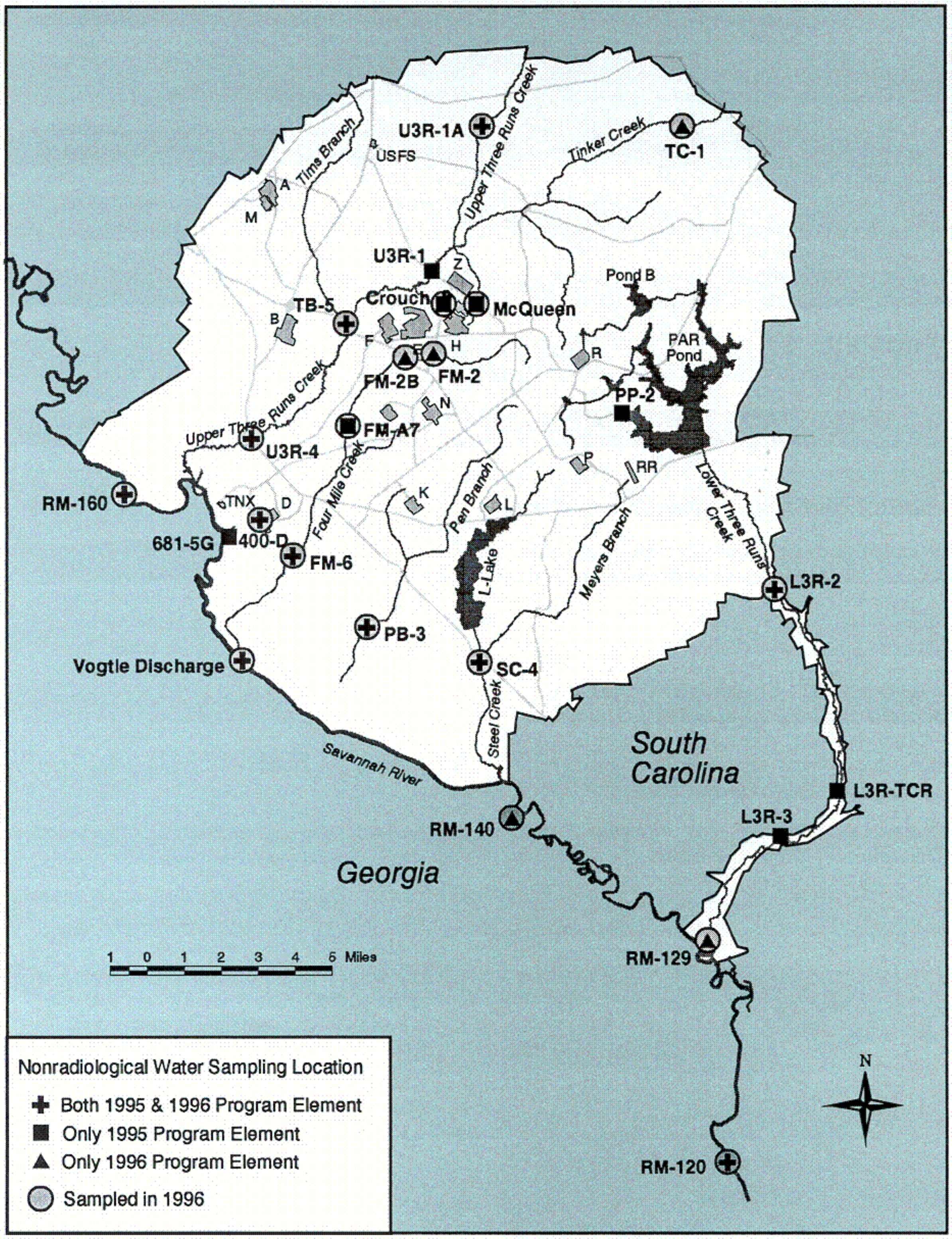
## Drinking Water

### Description of Surveillance Program

All 26 drinking water systems at SRS utilize well water pumped from the McBean, Congaree, Black Creek, and Middendorf formations. Some of the well water supplies require treatment to meet SCDHEC drinking water quality standards. Sodium hydroxide or soda ash is added for pH control, sodium hypochlorite for bacteriological control, and phosphates for corrosion control.

The following testing is performed to ensure compliance with SCDHEC water quality standards:

- The concentrations of chemicals added are monitored at least daily.
- All systems are monitored either monthly or quarterly for total coliform bacteria. The sampling frequency depends upon the population served.
- All systems are monitored semiannually for chlorocarbon concentrations.
- The 13 larger systems are monitored for lead and copper concentrations. The sampling fre-




EPD/GIS Map

**Figure 9–1 Nonradiological Surface Water Sampling Locations**
Surface water samples are collected from Savannah River and SRS stream locations. Steel Creek–4 (SC–4), Tims Branch–5 (TB–5), Four Mile Creek at Road A7 (FM–A7), and Upper Three Runs–4 (U3R–4) are EMS and SCDHEC sampling locations, from which samples also are analyzed for volatile organic compounds.

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quency varies from annually to once every 3 years, depending upon SCDHEC requirements.

- SCDHEC periodically collects samples from the 18 largest systems to determine compliance with bacteriological, chemical, synthetic organic, and volatile organic water quality limits.

### Surveillance Results

All SRS drinking water systems were in compliance with SCDHEC bacteriological, lead and copper, chemical, synthetic organic, and volatile organic water quality standards in 1996.

## Sediment

EMS's nonradiological sediment surveillance program provides a method of determining the deposition, movement, and accumulation of nonradiological contaminants in stream systems.

### Description of Surveillance Program

The surveillance of pesticides and herbicides and of inorganic contaminants, such as metals, make up the two major activities of the nonradiological sediment surveillance program.

Pesticides and herbicides were used at the location of SRS before 1950, when the U.S. Government obtained the land. Pesticides and herbicides also have been used since then as part of the site's forestry management program and for ongoing landscape and roadside maintenance.

A pesticide and herbicide surveillance program was established in 1976 to ensure that there is no buildup of these materials in the sediments of site streams or the Savannah River. Sediment samples from seven site stream and two Savannah River locations were to be analyzed for pesticides and herbicides during 1996. Due to error, samples from two site stream and the two river locations were not analyzed for pesticides and herbicides [SRS Data, 1997].

The inorganics area of the program was designed in 1993 to document the buildup, if any, of inorganic contaminants over time. Sampling locations were chosen at six site streams, two Savannah River locations, and three background locations (two stream locations and one river location). However, in 1996, one stream location, U3R–1, inadvertently was sampled in place of a river location (Vogtle Discharge). Sediment sampling locations are shown in figure 9–2.

"Rock Hill Initiative #2," discussed on page 130, brought about changes in the nonradiological sediment sampling program. This review resulted in a change in sampling locations to 11—8 stream and 3 river. The changes will be instituted in 1997.

### Surveillance Results

No pesticides or herbicides were found to be above the practical quantitation limits in 1996 in sediment samples. All sample results were below the detection limits of the U.S. Environmental Protection Agency (EPA) analytical procedures used. All inorganic contaminants results were within normal fluctuations.

**Perspective on Mercury**

Mercury in the environment can come from natural sources, such as volcanoes and venting of the earth's crust, and from manmade sources and processes, such as fungicides and fossil fuel combustion byproducts and the manufacture of chlorine, sodium hydroxide, plastics, and electrical apparatus.

An important source in the SRS region may be in releases upriver of the site. Much of the mercury detected in SRS fish has been attributed to offsite sources, such as Savannah River water [Davis et al., 1989]. Savannah River water is pumped onto the site for use as cooling water and subsequently is released into site streams and lakes.

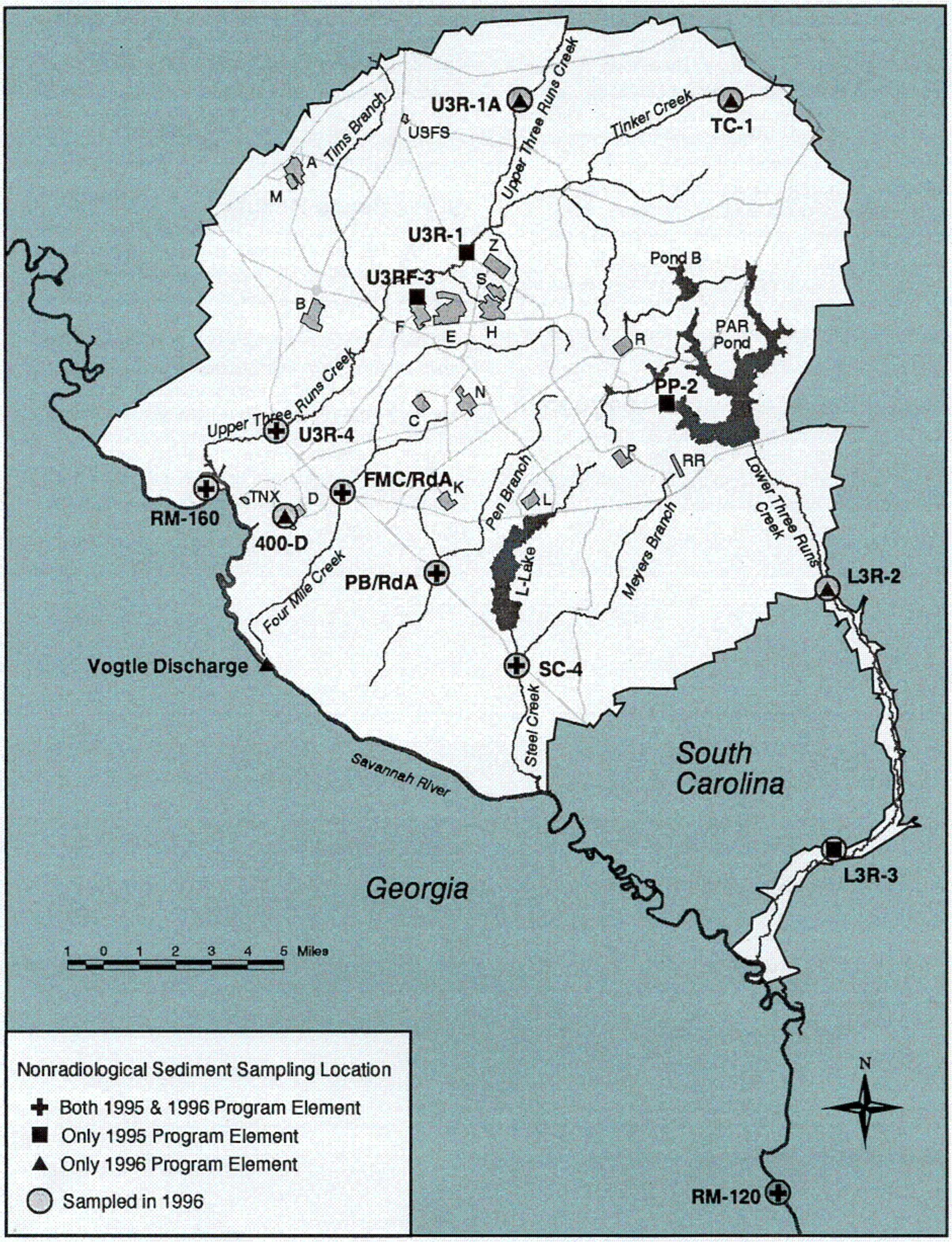
## Mercury in Fish

Mercury is a naturally occurring metal that cycles between land, water, and air. The major sources of atmospheric mercury are as follows:

- **Natural** – Degassing of the earth's crust generates 2,700 to 6,000 tons of mercury a year (WHO, 1990).
- **Manmade** – Burning of fossil fuels releases an estimated 5,000 tons of mercury per year [Klaassen et al., 1986]; industrial and other discharges account for an undetermined amount.

As mercury enters streams and rivers through rainfall, runoff, and discharges, it is converted to the chemical compound methylmercury by bacterial and other processes. As part of the natural cycling, some mercury is absorbed by plants and animals into their tissues. Fish absorb methylmercury from food they ingest and from water as it passes over their gills; the methylmercury then is bound in their tissues.

Consumption, by people, of fish containing methylmercury completes the food cycle to man. The amount of fish that can be safely eaten varies with (1) the level of methylmercury found in the fish, (2) the amount of methylmercury consumed at




EPD/GIS

**Figure 9–2 Nonradiological Sediment Sampling Locations**
Sediment is sampled from SRS streams and the Savannah River for nonradiological contaminants, including pesticides, herbicides, and inorganic contaminants.

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any given sitting, and (3) the frequency of consumption of fish containing methylmercury during a given period of time. These three (primary) factors, and others, are the basis of calculations performed during "risk analysis," which is a method used to determine how much fish can be consumed safely. State and federal regulatory agencies calculate the health risk associated with the consumption of fish and other organisms, then recommend consumption guidelines based on that risk. Adherence to these guidelines can effectively control one's exposure to methylmercury. A list of fish advisories and/or recommended consumption limits can be obtained from state environmental agencies.

## Description of Surveillance Program

EMS analyzes the flesh of fish caught from onsite streams and ponds and from the Savannah River to determine concentrations of mercury in the fish [SRS EM Program, 1996]. The fish analyzed represent the most common edible species of fish in the Central Savannah River Area (CSRA), an 18-county area in Georgia and South Carolina that surrounds Augusta, Georgia, and includes SRS. (Sampling locations for fish are depicted in a map in chapter 6, "Radiological Environmental Surveillance," page 89.)

## Surveillance Results

In 1996, 193 fish from SRS streams and ponds and the Savannah River were collected and analyzed for mercury [SRS Data, 1997].

The mercury concentrations in fish analyzed from onsite waters ranged from a high of 1.70 µg Hg/g in PAR Pond and Pond B bass to lows below the reporting limit (0.33 µg Hg/g) at several locations.

Mercury concentrations in offsite fish ranged from a high of 1.67 µg Hg/g in a bass from the Stokes Bluff Landing area to lows below the reporting limit (0.33 µg Hg/g) at several locations.

# Chapter 10
# Groundwater

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**To Read About . . . See Page . . .**



Groundwater beneath an estimated five to 10 percent of the Savannah River Site (SRS) has been contaminated by industrial solvents, tritium, metals, or other constituents used or generated by operations at SRS. Groundwater in areas indicated on figure 10–1 contains one or more of these constituents at or above the levels of Safe Drinking Water Act primary drinking water standards (DWS) of the U.S. Environmental Protection Agency (EPA).

This chapter summarizes the groundwater monitoring results for approximately 1,600 wells in 101 locations (figure 10–1) within designated areas at SRS. Only results exceeding the DWS are presented in figures and tables in this report. Most constituents are compared to the final federal primary DWS. In some cases, comparison is to the proposed primary DWS. or the interim final primary DWS. (See appendix A, "Applicable Guidelines, Standards, and Regulations," for additional information about applicable monitoring standards and appendix D, "Drinking Water Standards," for the DWS.) Some information about additional constituents is discussed in the text of this chapter.

Detailed groundwater monitoring results are presented in the following public documents: *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1996* (ESH/EMS/960056); *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1996* (ESH/EMS/950057); *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1996* (ESH/EMS/960058); and *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1996* (ESH/EMS/960059). Full results for each well sampled during a quarter are presented alphabetically in the quarterly reports.

Another public document, the *Environmental Protection Department's Well Inventory* (ESH/EMS/960488), contains detailed maps of the wells at each monitored location.

## Groundwater at SRS

When rain falls, part of the rainwater runs off of the surface of the earth into streams, and part of it soaks into the soil (figure 10–2). The water that runs off of the surface into the creeks is called direct runoff, and the water that soaks in and infiltrates the soil is called groundwater. Groundwater moves through the soil and eventually reappears at the surface in springs, swamps, rivers, or wells. Potentially hazardous substances in the soil may dissolve as the

**Overall Summary of 1996 SRS Groundwater Monitoring Results**

SRS groundwater monitoring results for 1996 indicate that ongoing remediation efforts at A-Area and M-Area have slowed the spread of contamination (primarily organics and metals) in those areas.

In most of the reactor areas (C-Area, K-Area, L-Area, and P-Area), tritium is the most widespread contaminant. Metals and organics are present near the burning/rubble pits and the chemicals, metals, and pesticides pit in L-Area. There is no evidence of tritium in R-Area, but other radionuclides and metals are present in the groundwater.

D-Area shows contaminants associated with activities at the power plant and related facilities and organics and metals near the oil disposal basin. In the TNX area, ogranics, metals, radionuclides, and other constituents are present in groundwater near disposal sites.

In the general separations and waste management areas (E-Area, F-Area, and H-Area), results indicate the presence of tritium, radionuclides, metals, organics, and other constituents. No contamination is evident in S-Area and Z-Area. The central shops area (N-Area) also indicates no contamination.

Organics, metals, tritium, and other radionuclides are present near the sanitary landfill, and tritium and gross alpha were identified in single wells in B-Area.

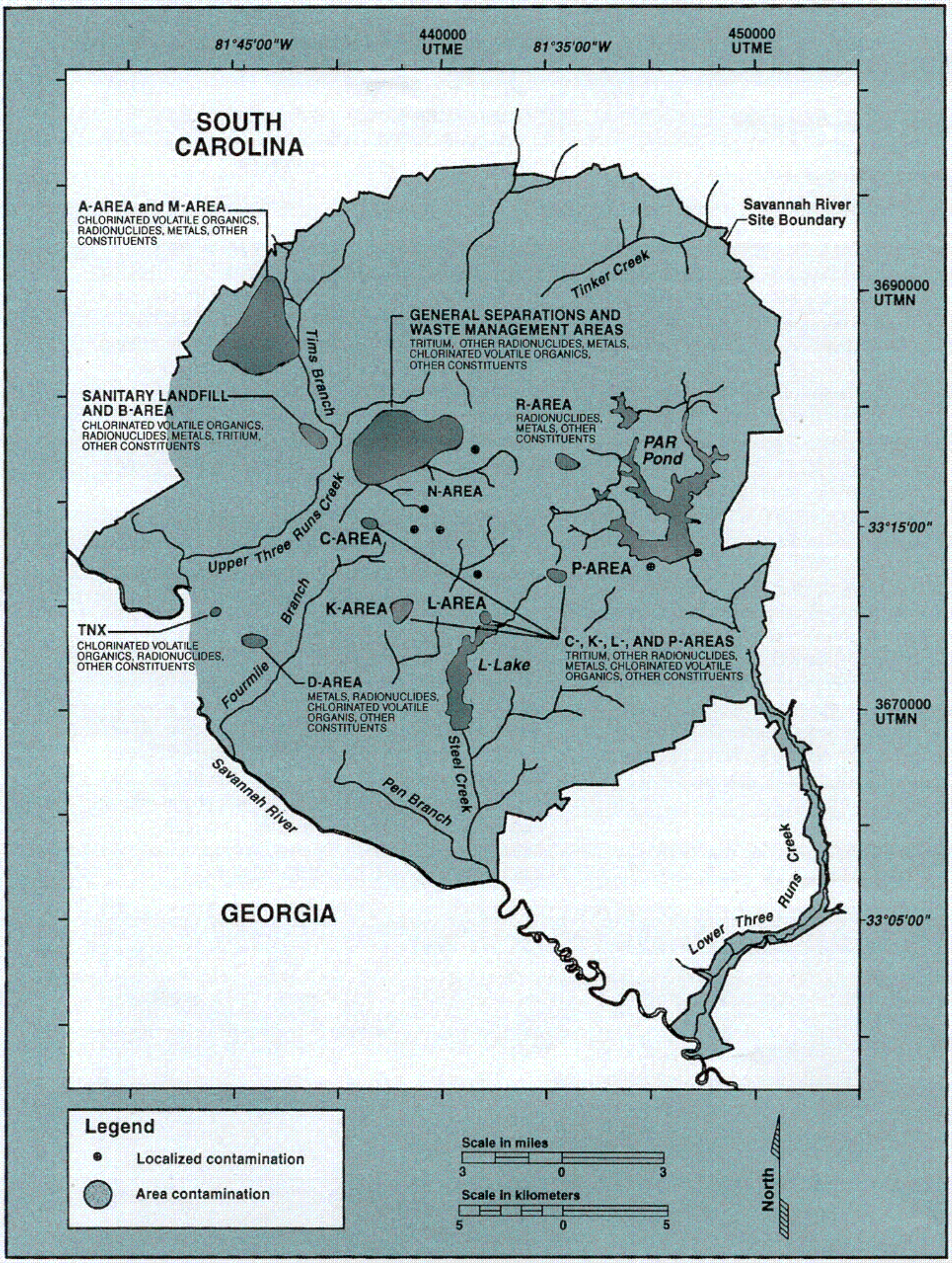


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**Figure 10–1 Facilities Monitored by the SRS Monitoring Well Network, Including Areas Having Constituents Exceeding Drinking Water Standards in 1996**

C03

## Key for Figure 10–1

### A-Area and M-Area

- A-Area and M-Area Plume Monitoring
- A-Area Background Well Near Firing Range
- A-Area Burning/Rubble Pits and A-Area Ash Pile
- A-Area Coal Pile Runoff Containment Basin
- A-Area Metals Burning Pits
- A-Area and M-Area Recovery Well Network
- Flowing Springs Site
- M-Area Hazardous Waste Management Facility
- Metallurgical Laboratory Seepage Basin
- Miscellaneous Chemical Basin
- Motor Shop Oil Basin
- Savannah River Laboratory Seepage Basins
- Silverton Road Waste Site

### General Separations and Waste Management Areas (E-Area, F-Area, H-Area, S-Area, and Z-Area)

- Burial Ground Expansion (E-Area Vaults)
- Burma Road Rubble Pit
- E-Area Vaults
- F-Area Acid/Caustic Basin
- F-Area Ash Basin
- F-Area Burning/Rubble Pits
- F-Area Canyon Building and A-Line Uranium Recovery Facility
- F-Area Coal Pile Runoff Containment Basin
- F-Area Effluent Treatment Cooling Water Basin
- F-Area Microbiology Wells
- F-Area Seepage Basins and Inactive Process Sewer Line
- F-Area Sanitary Sludge Land Application Site
- F-Area Tank Farm
- H-Area Acid/Caustic Basin
- H-Area Coal Pile Runoff Containment Basin
- H-Area Auxiliary Pump Pit
- H-Area Canyon Building
- H-Area Effluent Treatment Cooling Water Basin
- H-Area Retention Basins
- H-Area Sanitary Sludge Land Application Site
- H-Area Seepage Basins and Inactive Process Sewer Line
- H-Area Tank Farm
- Old Burial Ground
- Old F-Area Seepage Basin
- S-Area Facilities
- S-Area Vitrification Building
- Waste Solidification and Disposal Facility
- Z-Area Low-Point Drain Tank
- Z-Area Saltstone Facility Background Wells

### C-Area

- Bioremediation Facility
- C-Area Burning/Rubble Pit
- C-Area Coal Pile Runoff Containment Basin
- C-Area Disassembly Basin

### K-Area

- K-Area Acid/Caustic Basin
- K-Area Ash Basin
- K-Area Bingham Pump Outage Pit
- K-Area Burning/Rubble Pit
- K-Area Coal Pile Runoff Containment Basin
- K-Area Disassembly Basin
- K-Area Reactor Seepage Basin
- K-Area Retention Basin
- K-Area Sludge Land Application Site
- K-Area Tritium Sump

### L-Area

- L-Area Acid/Caustic Basin and L-Area Oil and Chemical Basin
- L-Area Burning/Rubble Pit
- L-Area Disassembly Basin
- L-Area Reactor Seepage Basin
- L-Area Research Wells

### P-Area

- P-Area Acid/Caustic Basin
- P-Area Burning/Rubble Pit
- P-Area Coal Pile Runoff Containment Basin
- P-Area Disassembly Basin
- P-Area Microbiology Wells
- P-Area Reactor Seepage Basins

### R-Area

- R-Area Acid/Caustic Basin
- R-Area Background Wells
- R-Area Bedrock Exploration Hydrology Wells
- R-Area Burning/Rubble Pits
- R-Area Coal Pile
- R-Area Disassembly Basin
- R-Area Reactor Seepage Basins

### Sanitary Landfill and B-Area

- B-Area Microbiology Wells
- Sanitary Landfill and Interim Sanitary Landfill

### Central Shops (N-Area)

- Chemicals, Metals, and Pesticides Pits
- Ford Building Seepage Basin
- N-Area Burning/Rubble Pits
- N-Area Burning/Rubble Pit South
- N-Area Diesel Spill
- N-Area Fire Department Training Facility
- N-Area Fuel Oil Site
- N-Area Hydrofluoric Acid Spill

### D-Area and TNX

- D-Area Burning/Rubble Pits
- D-Area Coal Pile Runoff Containment Basin and Ash Basins
- D-Area Oil Seepage Basin
- New TNX Seepage Basin
- Old TNX Seepage Basin
- TNX-Area Assessment Wells
- TNX-Area Background Wells
- TNX-Area Operable Unit Wells
- TNX-Area Recovery Wells
- TNX-Area Well Points along Seepline
- TNX Burying Ground

### Other Sites

- Background Well near Hawthorne Fire Tower
- Hazardous Waste/Mixed Waste Disposal Facility
- Interim Waste Technology Site Characterization Wells
- PAR Pond Sludge Land Application Site
- Potential New Production Reactor Site Characterization Wells
- Second PAR Pond Borrow Pit Sewage Sludge Application Site

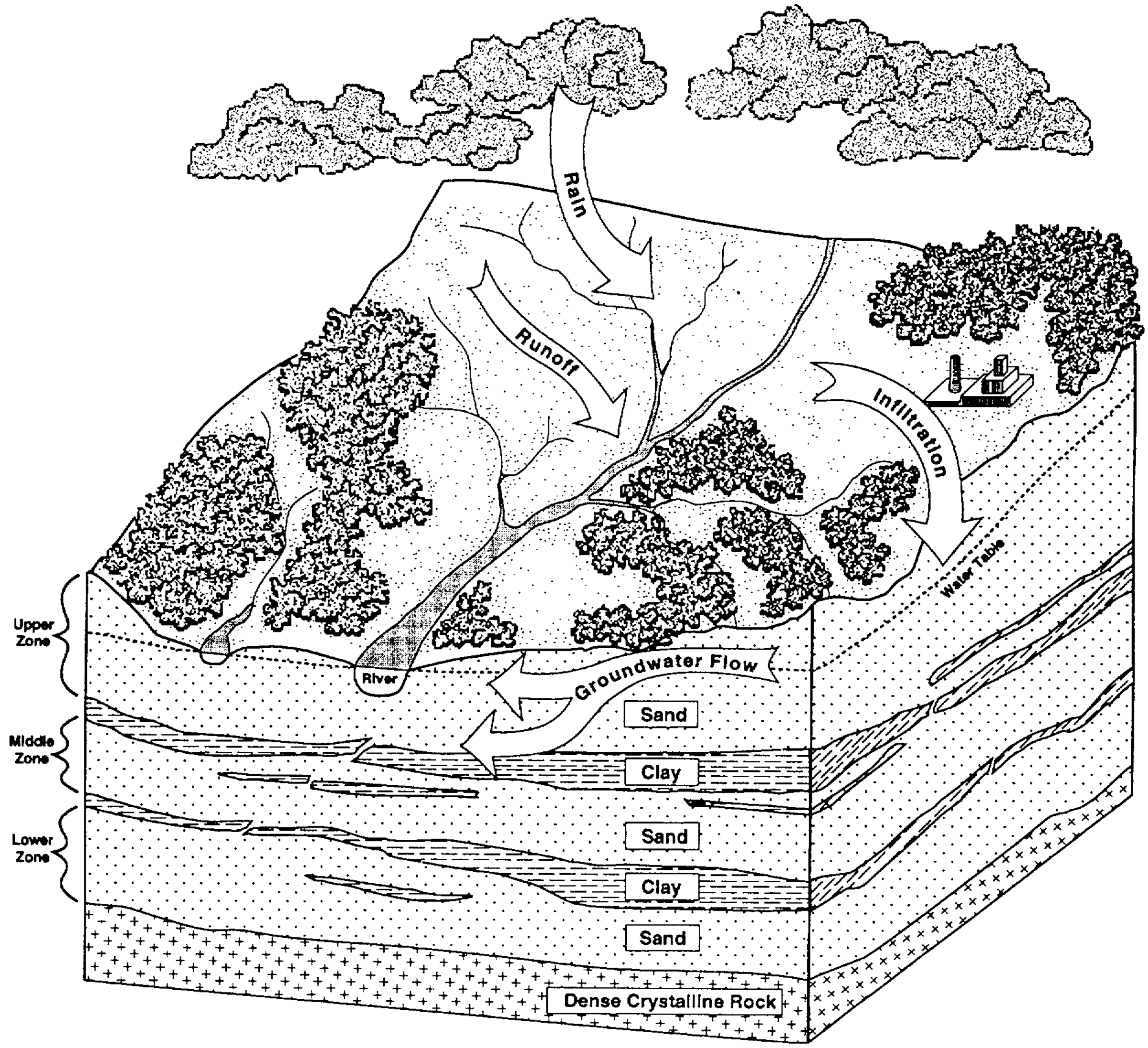


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**Figure 10–2 Groundwater at SRS**

groundwater infiltrates and moves down through the soil to the water table. In this way, contaminants in the soil can move with the groundwater and may become a health risk.

SRS is built on a 700–1,200-foot stack of sediments composed of sand, clayey sand, and clay, with a small amount of limestone. Dense crystalline rock lies under the sediments. The groundwater in the vicinity moves through the sediments, mostly in the sand layers. The clay layers allow very little groundwater to flow through them; therefore, their presence between sand layers helps direct the flow of groundwater and contaminants.

At SRS, groundwater moves in several sandy zones that are separated by less permeable clay layers. The upper zone comprises the rainwater that moves down from the surface. Water in this zone moves either laterally to discharge or downward into lower zones. Beneath the upper zone is a clay layer that retards the water moving downward into the lower zones. In some areas of SRS, this clay layer is thick and undisturbed and is effective in preventing the upper zone of groundwater from moving downward. In other areas, this clay layer is thin, broken, or missing, and the groundwater from the top zone can readily move into lower zones.

Below the upper zone is another zone of sand where the water moves relatively freely. Water in this middle zone is used for domestic water supplies. Below the middle zone is another clay layer and then a lower zone of groundwater. The lowest zone is the most important aquifer in the region and supplies water to domestic and industrial users.

Groundwater beneath SRS flows slowly—at rates ranging from inches to several hundred feet per year—toward streams and swamps on site and into the Savannah River. Figures 10–3 and 10–4 illustrate the potentiometric contours and horizontal-flow directions of the middle and lower zones beneath SRS. Similar to contour lines on a weather map that connect points of equal barometric pressure, the figures' potentiometric surface contour lines connect below-ground regions of equal hydraulic head (elevation of the water in a well or piezometer). Horizontal-flow directions of groundwater within these zones are indicated on figures 10–3 and 10–4 by bold arrows perpendicular to the contour lines. In both zones, the direction of flow beneath monitored waste sites generally is toward the Savannah River, the Savannah River Swamp, Upper Three Runs Creek, or Lower Three Runs Creek. Surface water in the swamp and creeks eventually flows into the Savannah River.

The upper zone is the most affected in general by activity at SRS. The middle zone is known to be contaminated in several areas. Contamination in the lowest zone has been identified only in A-Area and M-Area.

Monitoring wells are used extensively at SRS to assess the effect of site activities on groundwater quality. Most of the wells monitor the highest groundwater zone, although wells in lower zones are present at the sites with the larger groundwater contamination plumes.

## Description of the Groundwater Monitoring Program

The groundwater monitoring program at SRS gathers information to determine the effect of site operations on groundwater quality. The program is designed to

- assist SRS in complying with environmental regulations and U.S. Department of Energy (DOE) directives
- provide data to identify and monitor constituents in the groundwater
- permit characterization of new facility locations to ensure that they are suitable for the intended facilities
- support basic and applied research projects

The groundwater monitoring program at SRS is conducted by the Environmental Geochemistry Group (EGG) of the Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) of Westinghouse Savannah River Company (WSRC). To assist other departments in meeting their responsibilities, EGG provides the services for installing monitoring wells, collecting and analyzing samples, and reporting results.

The *Savannah River Site Environmental Monitoring Plan* (WSRC-3Q1-2, Section 2000) provides details about the following aspects of the groundwater monitoring program:

- well siting, construction, maintenance, and abandonment
- sample planning
- sample collection and field measurements
- analysis
- data management
- related publications, files, and databases

The next four sections of this chapter present overviews of several of these topics, along with information specific to 1996.

### Sample Scheduling and Collection

EMS schedules groundwater sampling either in response to specific requests from SRS personnel or as part of its ongoing groundwater monitoring program. These groundwater samples provide data for reports required by federal and state regulations and for internal reports and research projects. The groundwater monitoring program schedules wells to be sampled at intervals ranging from quarterly to triennially.

- Groundwater from new wells added to the program is analyzed for environmental-screening constituents (table 10–1) for 4 consecutive quarters for only the wells identified in the *Savannah River Site Screening Program Wells* (ESH–EMS–950409).
- Environmental-screening analyses are conducted once every 3 years for only the wells identified in the *Savannah River Site Screening Program Wells* (ESH–EMS–950409).
- If their environmental-screening constituent concentrations are above certain limits, wells identi-

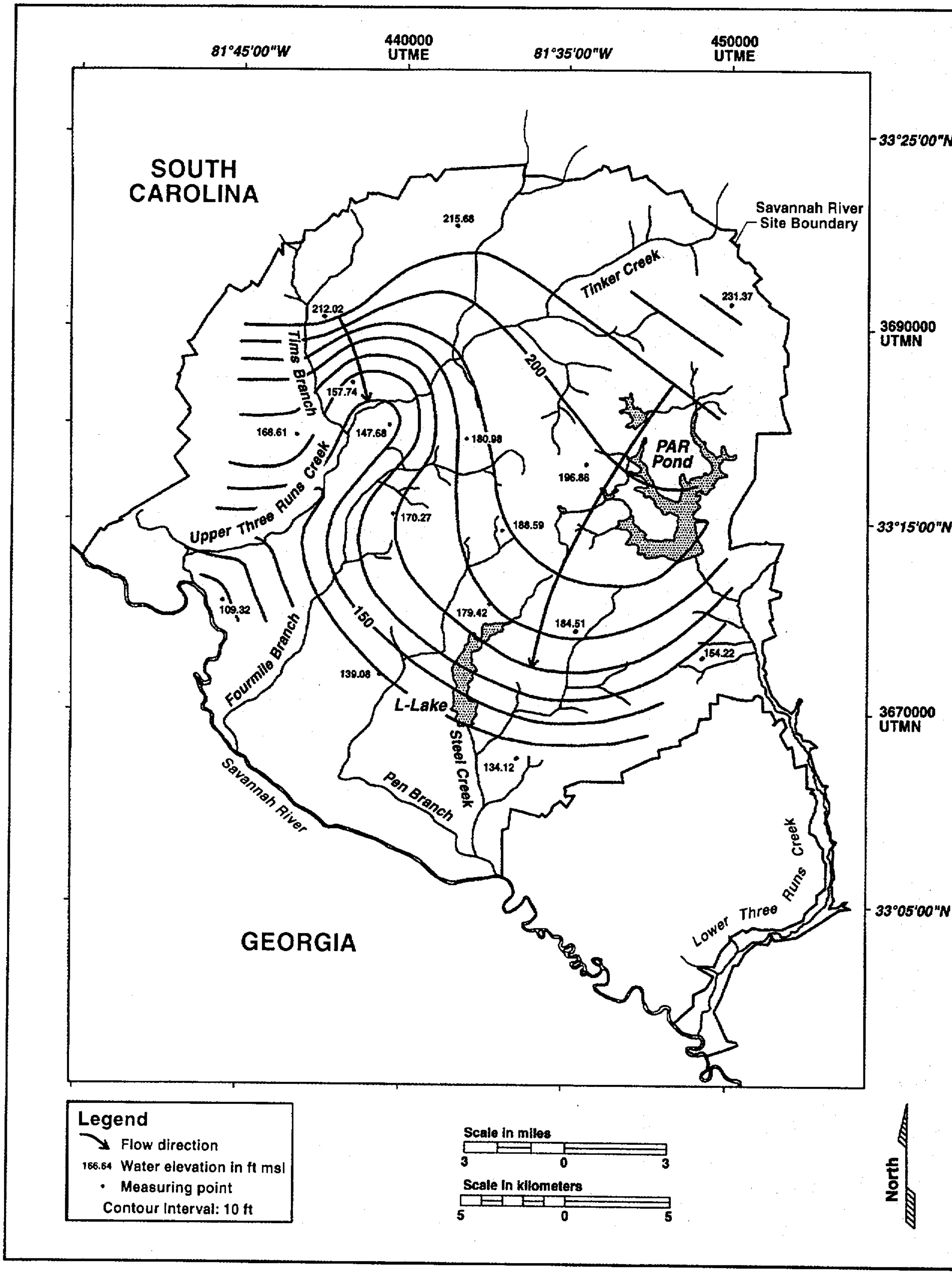


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**Figure 10–3 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Middle Zone at SRS During the First Quarter of 1996**

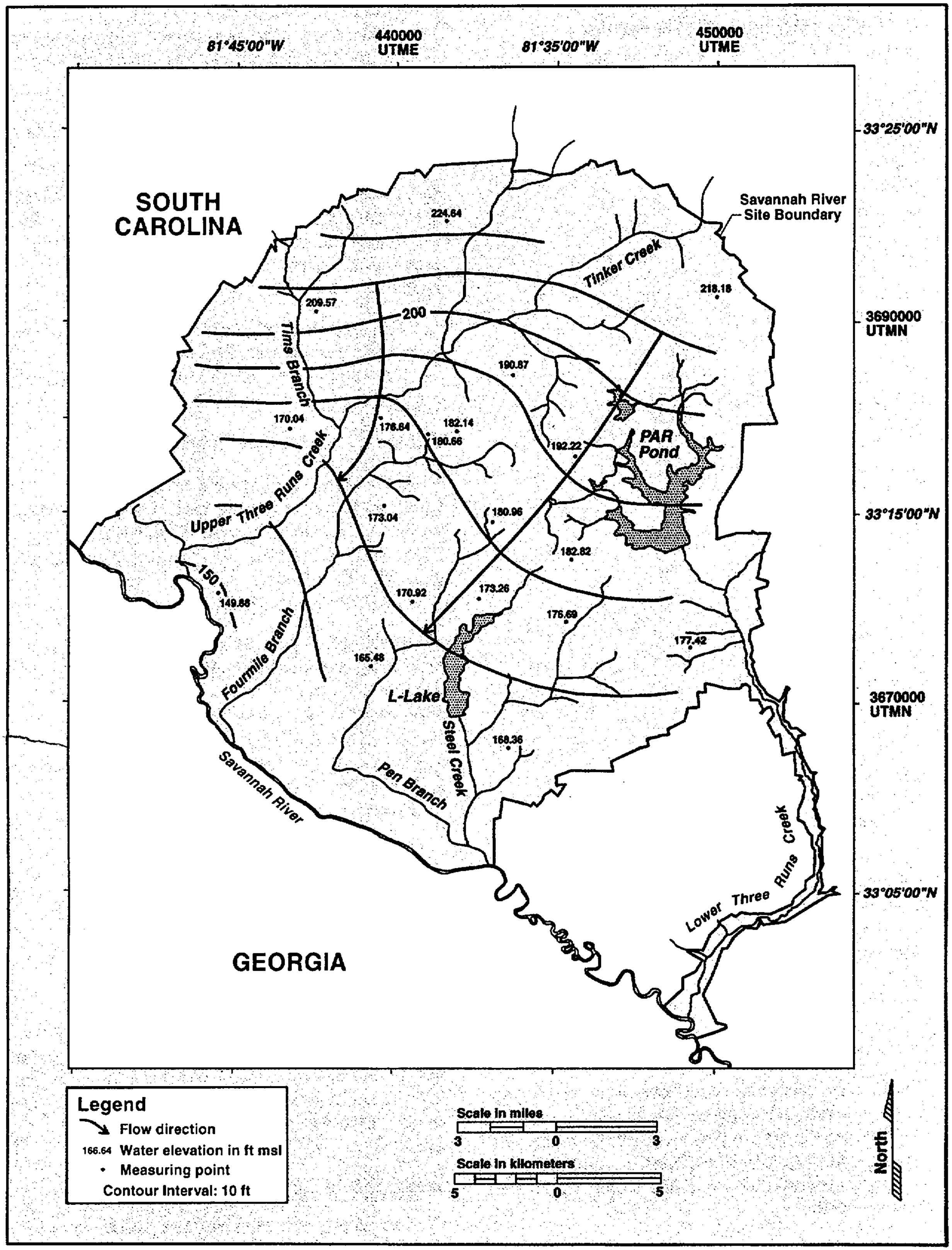


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**Figure 10–4 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Lower Zone at SRS During the First Quarter of 1996**

**Table 10–1 Environmental-Screening Constituents**

| |
|---|
| Aluminum |
| Arsenic |
| Barium |
| Boron |
| Cadmium |
| Calcium |
| Chloride |
| Chromium |
| Fluoride |
| Gross alpha |
| Iron |
| Lead |
| Lithium |
| Magnesium |
| Manganese |
| Mercury |
| Nitrate-nitrite as nitrogen |
| Nonvolatile beta |
| Potassium |
| Selenium |
| Silica |
| Silver |
| Sodium |
| Sulfate |
| Total dissolved solids |
| Total organic carbon |
| Total organic halogens |
| Total phosphates (as P) |
| Tritium |

fied in the *Savannah River Site Screening Program Wells* (ESH–EMS–950409) are then sampled annually.

Personnel outside EMS may request sample collection as often as weekly. In addition to environmental-screening constituents, constituents that may be analyzed by request include suites of herbicides, pesticides, additional metals, volatile organics, and others. Radioactive constituents that may be analyzed by request include gamma emitters, iodine-129, strontium-90, radium-228, uranium isotopes, and other alpha and beta emitters.

Groundwater samples are collected from monitoring wells, generally with either pumps or bailers dedicated to the well to prevent cross-contamination among wells. Occasionally, portable sampling equipment is used; this equipment is decontaminated between wells.

Sampling and shipping equipment and procedures are consistent with EPA, South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Transportation (DOT) guidelines. EPA-recommended preservatives and sample-handling techniques are used during sample storage and transportation to both onsite and offsite analytical laboratories. Potentially radioactive samples are screened for total activity (alpha and beta emitters) prior to shipment to determine appropriate packaging and labeling requirements.

Deviations (caused by dry wells, inoperative pumps, etc.) from scheduled sampling and analysis for 1996 are enumerated in the SRS quarterly groundwater monitoring reports cited on the first page of this chapter.

In 1996, approximately 49,000 radiological analyses and 328,000 nonradiological analyses were performed on groundwater samples collected from approximately 1,600 monitoring wells.

## Analytical Procedures

In 1996, General Engineering Laboratories of Charleston, South Carolina, performed most of the groundwater analyses. Roy F. Weston, Inc., of Lionville, Pennsylvania, also performed groundwater analyses. The contracted laboratories are certified by SCDHEC to perform specified analyses.

The EMS radiological laboratory at SRS screened potentially radioactive samples for total activity prior to shipment. General Engineering Laboratories subcontracted radiological analyses to Environmental Physics of Charleston; Roy F. Weston, Inc., subcontracted radiological analyses to TMA/Eberline of Oak Ridge, Tennessee, and Analytical Technologies, Inc., of Ft. Collins, Colorado.

Full lists of constituents analyzed, analytical methods used, and the laboratories' estimated quantitation limits are given in the SRS quarterly groundwater reports referenced earlier.

## Evaluation of Groundwater Data

EMS receives analytical results and field measurements as reports and as ASCII files that are loaded into databases at SRS. Logbooks track receipt and transfer of data to the Geochemical Information Management System (GIMS) database, and computer programs present the data in a format that can be validated.

Quality control practices include the following:

- verification of well names and sample dates for field and analytical data
- verification that all analyses requested on the chain-of-custody forms were completed by each laboratory

- identification of data entry problems (e.g., duplicate records, incorrect units)
- comparison of analytical data to historical data and review of the data for transcription, instrument, or calculation errors
- comparison of blind replicates and laboratory in-house duplicates for inconsistencies
- identification of laboratory blanks and blind blanks with elevated concentrations

Possible transcription errors and suspect results are documented and submitted to the appropriate laboratory for verification or correction. No changes are made to the database until the laboratory documents the problem and solution. Changes to the database are recorded in a logbook.

The quarterly groundwater monitoring reports identify queried results verified by the laboratory and list groundwater samples associated with blanks having elevated results. These reports also present the results of intralaboratory and interlaboratory quality assurance comparisons (chapter 11, "Quality Assurance").

## Changes to the Groundwater Monitoring Program during 1996

### Well Abandonments and Additions to the Sampling Schedule

During 1996, 43 wells were abandoned for the following reasons:

- One well at the Mixed Waste Management Facility was abandoned and replaced at the Burial Ground in preparation for the closure of the Low-Level Radioactive Waste Disposal Facility.
- Seventeen wells in the Sanitary Landfill were abandoned to accommodate a closure cap. Five wells were replaced in locations that would not interfere with the cap.
- Ten wells were abandoned in the F-Area acid/caustic basin because SCDHEC approved clean closure of the basin.
- Three wells in the H-Area acid/caustic basin were abandoned because SCDHEC approved clean closure of the basin.
- Seven wells in the K-Area acid/caustic basin were abandoned because SCDHEC approved clean closure of the basin.
- Four wells in the P-Area acid/caustic basin were abandoned because SCDHEC approved clean closure of the basin.
- One well in the miscellaneous chemical basin was abandoned and replaced because it did not produce enough water for sampling.

The following 71 wells were monitored for the first time in 1996:

- Four new wells were installed at the A-Area metals burning pit for sampling in conjunction with the Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) project in the miscellaneous chemical basin/metals burning pit.
- Five new wells in the A/M recovery well network were monitored for the first time in compliance with the RCRA permit.
- One new well was installed in the C-Area burning/rubble pit for RFI/RI characterization.
- Two new wells were installed in the chemicals, metals, and pesticides pits for RFI/RI characterization.
- Three new wells were installed at the old F-Area seepage basin to comply with RFI/RI requirements.
- Two new wells were installed in the K-Area Bingham pump outage pit to be sampled in compliance with requests from EPA and SCDHEC.
- Three new wells were installed in the K-Area burning/rubble pit to comply with RFI/RI characterization requirements.
- Two new wells were installed in the K-Area seepage basin to comply with the RFI/RI project at the basin.
- Five replacement wells were installed in the Sanitary Landfill in compliance with South Carolina Hazardous Waste Management Regulations, Solvent Rag Settlement (91–51–SW), and the 1995 version of the Groundwater Quality Assurance Plan.
- Ten new wells were installed in the miscellaneous chemical basin for sampling in conjunction with the RFI/RI project in the miscellaneous chemical basin/metals burning pit.
- One new replacement well was installed at the M-Area Hazardous Waste Management Facility in compliance with the RCRA permit.
- Two new wells were installed in N-Area to determine if fuel oil had reached the uppermost aquifer.
- Seven new wells were installed at the R-Area reactor seepage basins as part of an RFI/RI project.

- One new well was installed at the Savannah River Ecology Laboratory flowing springs site to monitor a previous diesel fuel tank site.
- Nine new wells were installed at the TNX Operative Unit to support RFI/RI characterization and future investigative studies.
- Ten TNX well points along the seepline were monitored to support the RFI/RI process.
- Four new recovery wells were installed in TNX to comply with provisions of the TNX Effectiveness Monitoring Strategy.

### Changes in Scheduling Policy

During 1996, herbicides/pesticides, phenols, pH, and specific conductance laboratory analyses were no longer included as environmental-screening constituents. These analyses will be conducted only as special requests. Herbicides/pesticides and phenols are contaminants that historically have not been found at SRS. They were removed from the list of environmental screening constituents to reduce costs. Specific conductance and pH are measured in the field. In addition, to meet the goal of providing background data on groundwater quality, only new wells that have been designated as groundwater screening program wells will be assigned four quarters of environmental screening. All other wells will be sampled only by special request.

### Changes in Scheduling Procedures

During 1996, the only constituents scheduled for analyses based on previous concentrations above certain limits were environmental-screening analyses and gas chromatographic volatile organic analyses (table 10–1). These were to be scheduled only for wells in the environmental-screening program (*Savannah River Site Screening Program Wells* (ESH–EMS–950409).

## Groundwater Monitoring Results at SRS

This section summarizes groundwater monitoring results during the first three quarters of 1996 for each of the following areas at SRS:

- A-Area and M-Area
- C-Area
- D-Area and TNX
- General separations and waste management areas (E-Area, F-Area, H-Area, S-Area, and Z-Area)
- K-Area
- L-Area and chemicals, metals, and pesticides pits
- N-Area
- P-Area
- R-Area
- Sanitary Landfill and B-Area

Groundwater monitoring results for each area in the above list are (1) illustrated with a figure showing the extent of contamination, (2) described in the text, and (3) summarized with a table.

The figure (from each area) that shows facilities of interest at or near the site and illustrates areas of notable contamination above DWS is presented first. The figures do not specify every contaminant identified through groundwater monitoring, but they illustrate contamination above DWS.

Each figure is followed by a brief description of the sites and facilities of interest in the area, an explanation of groundwater flow, and the nature of contamination in the area.

The description of contamination at each area concludes with a table that summarizes the following information:

- major groups of constituents
- percent of wells sampled that contained constituents above drinking water standards
- number of wells sampled for each constituent group
- sources of contamination

Substantial areas of contamination identified in the tables are illustrated in more detail, in some cases, in the accompanying figures. For example, a table may identify metals contamination, and the figure may show that most of that contamination is lead.

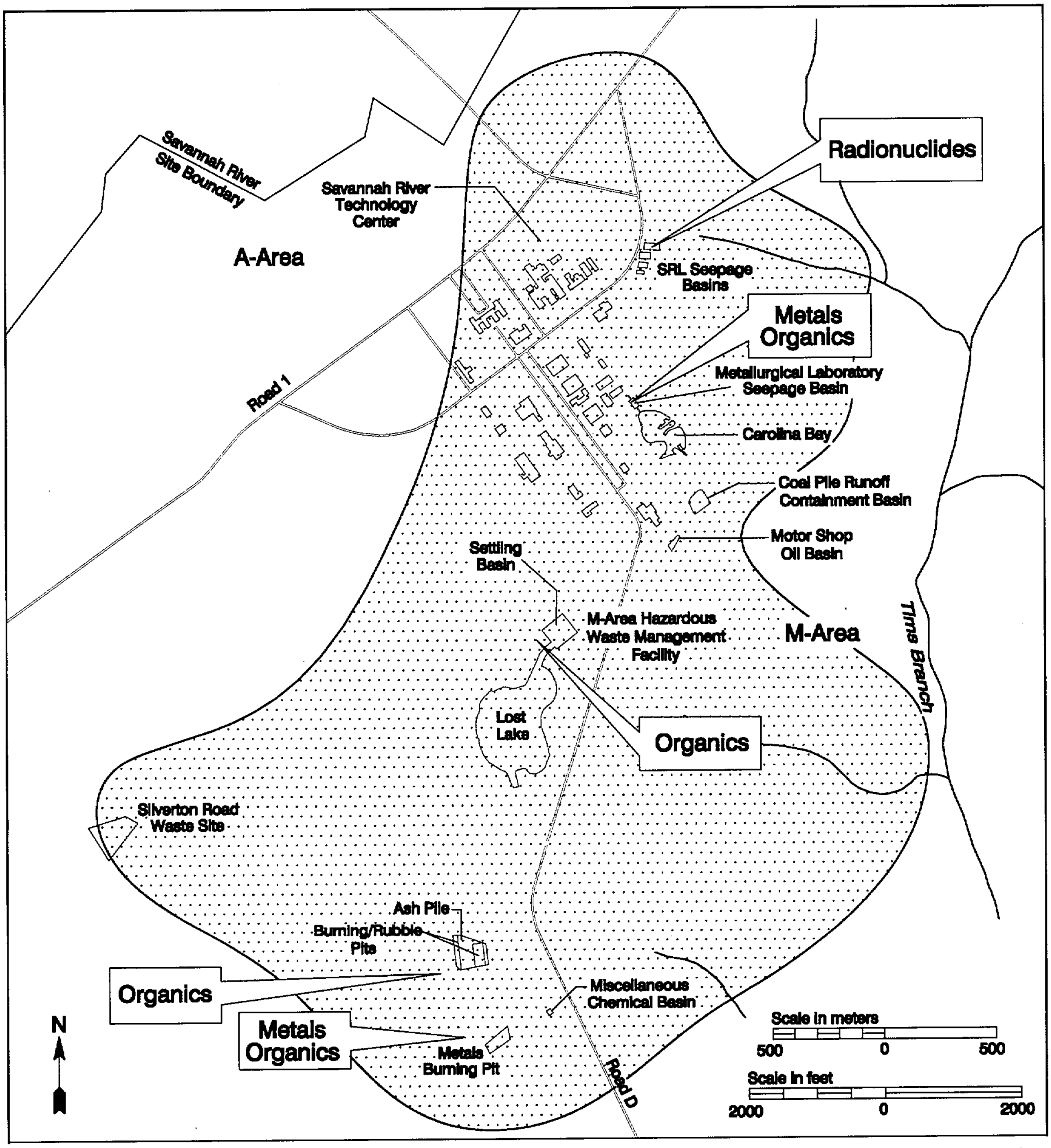


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**Figure 10–5 Extent of Groundwater Contamination Beneath A-Area and M-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at A-Area and M-Area

### Location and Facilities

The administration and manufacturing areas, A-Area and M-Area, are located in the northwest portion of SRS. A-Area houses administrative and research facilities, including the Savannah River Technology Center. M-Area was used for production of nuclear fuels, targets, and other reactor components.

A-Area and M-Area include the following facilities associated with the groundwater monitoring program:

- A-Area burning/rubble pits
- A-Area ash pile
- A-Area coal pile runoff containment basin
- A-Area metals burning pit
- M-Area Hazardous Waste Management Facility
- Metallurgical Laboratory seepage basin
- Miscellaneous chemical basin
- Motor Shop oil basin
- Savannah River Laboratory seepage basins
- M-Area settling basin
- Silverton Road waste site

### Nature of Contamination

Surface drainage in A-Area and M-Area is toward Tims Branch, approximately to the east, and toward valleys to the northwest and southwest that lead to the Savannah River.

The water table in this vicinity slopes to the southeast, south, and southwest toward Tims Branch and other discharge points. Most of the water of the upper saturated zone migrates downward into lower water-bearing zones.

Figure 10–5 shows the extent of contamination and the location of the various contaminant groups at A-Area and M-Area. There is a large groundwater contamination plume under and downgradient of A-Area and M-Area. Organic constituents—the primary contaminants—are found throughout the area and account for the largest percentage of contaminated wells. Trichloroethylene, tetrachloroethylene, and other organic compounds were used as degreasers during manufacturing and research. After use, organic wastes, metals, and other contaminants were placed into unlined basins, from which they slowly seeped into the groundwater. Contaminants also entered the groundwater as the result of spills or leaking pipes.

The highest concentrations of organics and metals generally are found beneath seepage and settling basins in central and southern portions of the area. The entire contaminant plume covers approximately 3 square miles and is approximately one-third mile from the SRS boundary.

Due to the chemical nature of trichloroethylene and tetrachloroethylene and the groundwater conditions in the upper aquifer zone, the contaminant movement generally is downward into deeper aquifers. Once in the deeper aquifers, these contaminants may be moved horizontally by faster groundwater flow rates.

Table 10–2 summarizes 1996 groundwater monitoring results for A-Area and M-Area.

### Remediation

Ongoing remediation efforts have substantially altered the groundwater and contaminant flow patterns in the upper, middle, and lower aquifer zones beneath A-Area and M-Area. Remediation efforts include capping the basins and extracting and processing volatile organics from the groundwater. At the end of second quarter 1996, approximately 2.3 billion gallons of groundwater had been pumped and approximately 312,000 pounds of volatile organics removed. Remediation efforts also included pumping contaminated air to five units, where the volatile organic compounds were destroyed. At the end of second quarter 1996, approximately 37,000 pounds of degreaser solvent had been removed. While ongoing remediation never will clean up contaminated groundwater zones completely, it can slow the spread of contamination and minimize the impact to the environment.

**Table 10–2 Constituent Groups Above Drinking Water Standards at A-Area and M-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | 0 | 14 | None |
| Metals | 7% | 294 | Burning/rubble pit, Met Lab, metals burning pit, several basins |
| Organics | 57% | 296 | Burning/rubble pits, Met Lab seepage basin, several basins |
| Pesticides/PCBs | 0 | 73 | None |
| Tritium | 2% | 52 | Burning/rubble pits |
| Other radionuclides | 4% | 295 | Coal pile runoff containment basin, SRL seepage basin |
| Other constituents | 7% | 289 | Several basins |

**Note:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

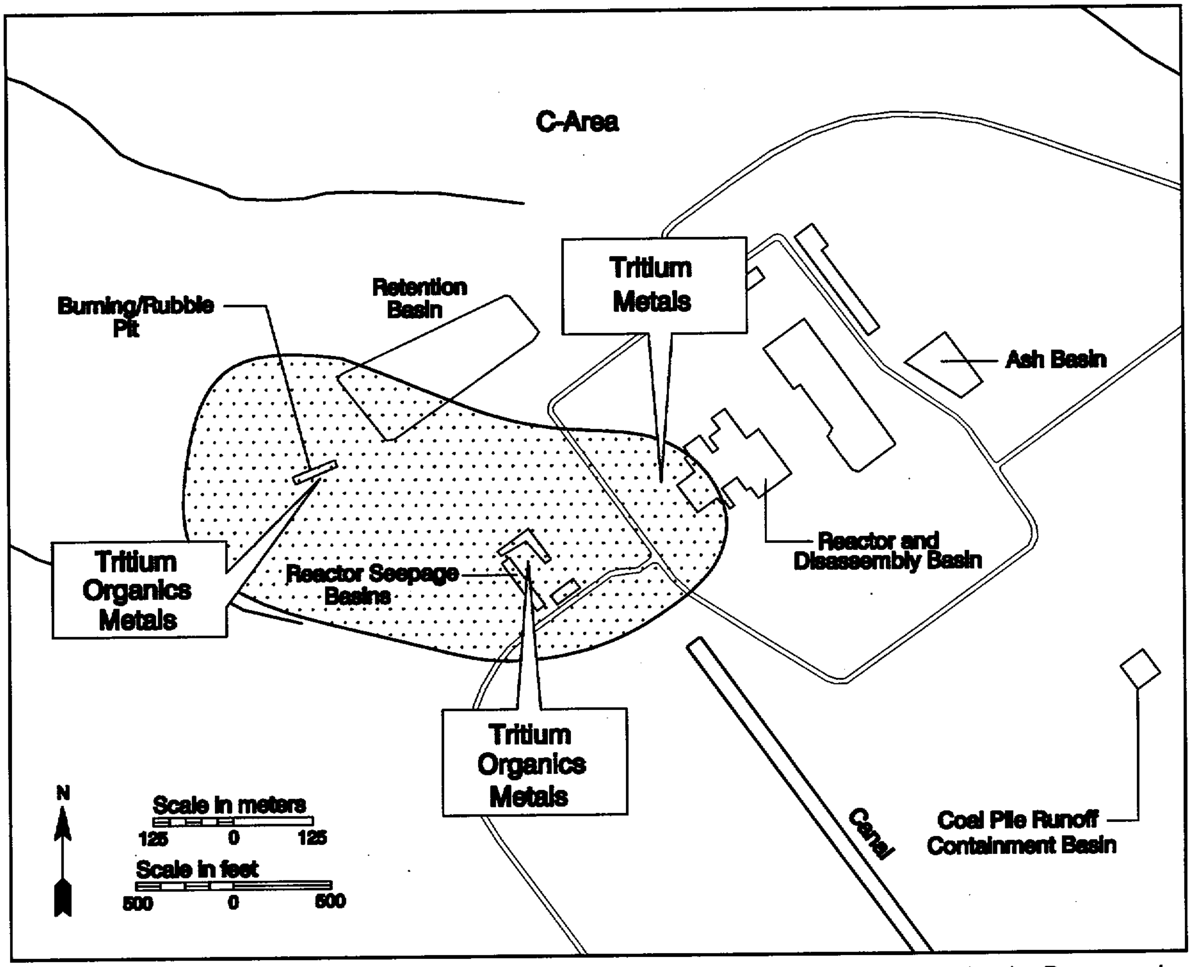


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**Figure 10–6 Extent of Groundwater Contamination Beneath C-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at C-Area

### Location and Facilities

C-Area, which is in the west-central part of SRS, contains the C-Area reactor. The C-Area reactor achieved criticality in March 1955 and was shut down in 1985 for maintenance. It was placed on cold standby in 1987, followed by cold shutdown.

C-Area includes the following facilities associated with the groundwater monitoring program:

- C-Area ash basin
- C-Area burning/rubble pit
- C-Area coal pile runoff containment basin
- C-Area disassembly basin
- C-Area reactor
- C-Area reactor seepage basins
- C-Area retention basin

### Nature of Contamination

Groundwater flow beneath C-Area tends to be strongly influenced by incised creeks near the area. Horizontal flow generally is west toward Four Mile Creek (also known as Fourmile Branch), and surface drainage is predominantly west toward a tributary of Four Mile Creek.

During routine reactor operations, the radioactivity level from tritium built up in the disassembly basins that held activated target rods. Periodically, the water from these basins was purged to limit worker exposure. During different time periods, the water was discharged to the reactor seepage basins or to surface streams. Tritium also escaped from the disassembly basins.

The C-Area burning/rubble pit and basins also received materials that could cause groundwater contamination.

Figure 10–6 shows the extent of contamination and the location of the various contaminant groups at C-Area. Tritium is the most widespread contaminant; the highest activities are in the groundwater downgradient of the reactor seepage basins. Lead and trichloroethylene also are present in many wells. Thallium is present in wells near the burning/rubble pits, and other constituents are elevated in a few wells. Monitoring results are consistent with those of previous years.

Table 10–3 summarizes 1996 groundwater monitoring results for C-Area.

**Table 10–3 Constituent Groups Above Drinking Water Standards at C-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 63% | 19 | Burning/rubble pit, disassembly basin, reactor seepage basins |
| Organics | 56% | 18 | Burning/rubble pit, reactor seepage basins |
| Pesticides/PCBs | 0 | 12 | None |
| Tritium | 56% | 18 | Burning/rubble pit, disassembly basin, reactor seepage basins |
| Other radionuclides | 9% | 11 | Burning/rubble pit, disassembly basin, reactor seepage basins |
| Other constituents | 0 | 12 | Burning/rubble pit, disassembly basin, reactor seepage basins |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans were not sampled at C-Area during 1996.

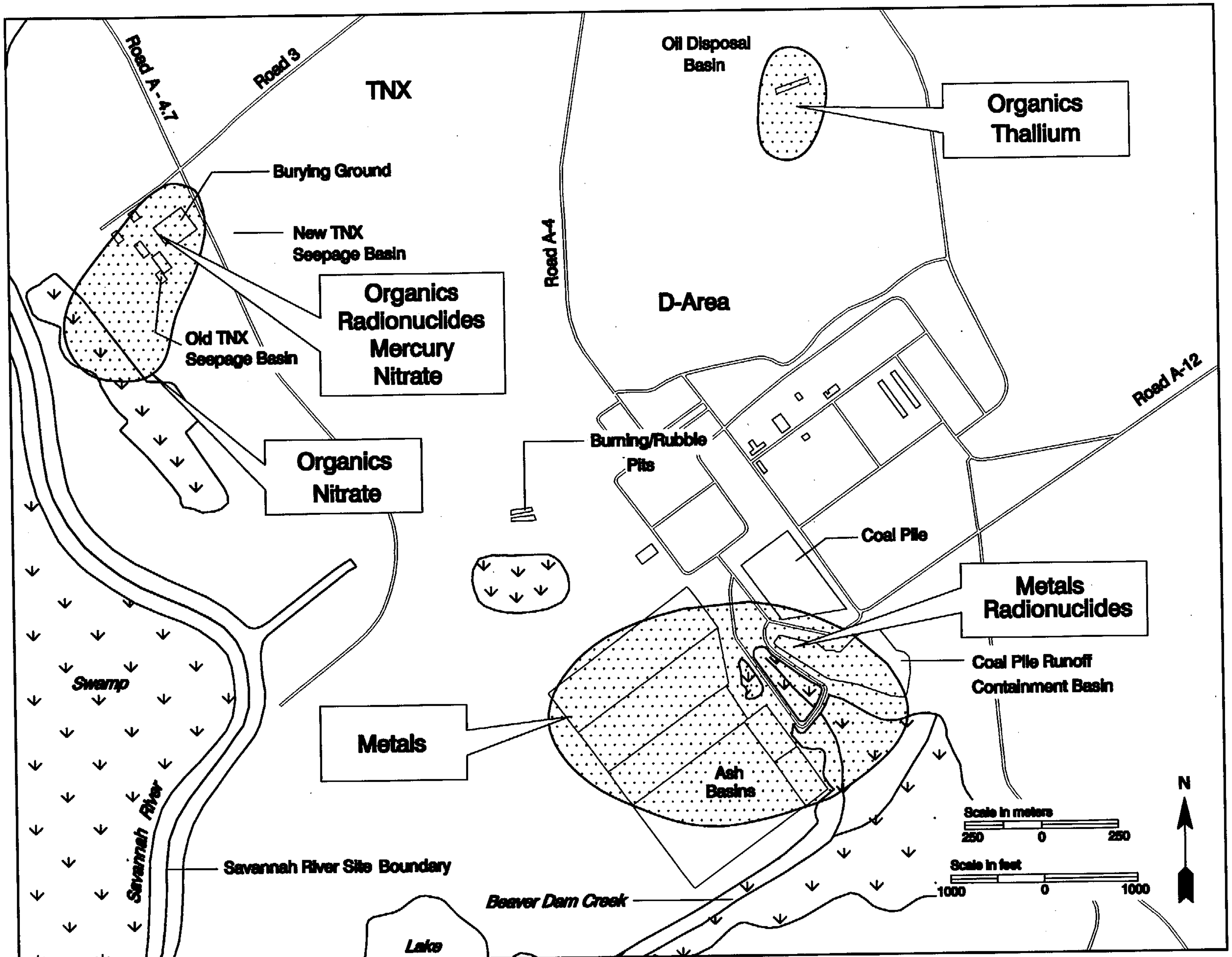


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**Figure 10–7 Extent of Groundwater Contamination Beneath D-Area and TNX in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at D-Area and TNX

### Location and Facilities

D-Area, located in the southwest part of SRS, includes a large coal-fired power plant and the inactive heavy-water facilities.

D-Area includes the following facilities associated with the groundwater monitoring program:

- D-Area burning/rubble pits
- D-Area coal pile, coal pile runoff containment basin, and ash basins
- D-Area oil disposal basin

TNX, also located in the southwest part of SRS—and operated by the Savannah River Technology Center—tests equipment prior to installation and develops new designs. The nearest SRS boundary is the Savannah River, approximately one-quarter mile to the west.

Facilities in TNX include the following:

- New TNX seepage basin
- Old TNX seepage basin
- TNX burying ground

### Nature of Contamination

The water table in D-Area discharges to the Savannah River and to a nearby swamp along Beaver Dam Creek. The water table surface in the vicinity of the coal pile runoff containment basin in D-Area is very close to the ground surface and drains to Beaver Dam Creek, which flows into the Savannah River Swamp.

Figure 10–7 shows the extent of contamination and the location of the various contaminant groups at D-Area and TNX. There is substantial contamination of the groundwater near the coal pile, the coal pile runoff containment basin, and the ash basins. The water is characterized by high conductivity and total dissolved solids. Elevated levels of metals, alpha-emitting radionuclides, sulfate, and fluoride are present. The contamination is consistent with the leaching of coal and coal ash.

A separate plume of contaminated groundwater is present near the D-Area oil disposal basin. Volatile organics and thallium have been detected above DWS.

The water table in TNX discharges to the Savannah River and the nearby Savannah River Swamp.

There is a plume of contaminated groundwater underneath much of TNX and downgradient into the Savannah River Swamp. Volatile organic compounds and nitrate are the most widely distributed contaminants. Mercury and alpha-emitting radionuclides also are present near the known disposal sites.

Table 10–4 summarizes 1996 groundwater monitoring results for D-Area and TNX.

Table 10–4 **Constituent Groups Above Drinking Water Standards at D-Area and TNX in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | 0 | 8 | None |
| Metals | 20% | 76 | D-Area coal facilities, oil disposal basin, TNX burying ground |
| Organics | 40% | 75 | Oil disposal basin, old TNX seepage basin, TNX burying ground |
| Pesticides/PCBs | 0 | 59 | None |
| Tritium | 0 | 60 | None |
| Other radionuclides | 12% | 60 | Coal pile runoff containment basin, TNX burying ground |
| Other constituents | 15% | 73 | Coal pile runoff containment basin, old TNX seepage basin, TNX burying ground |

**Note:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

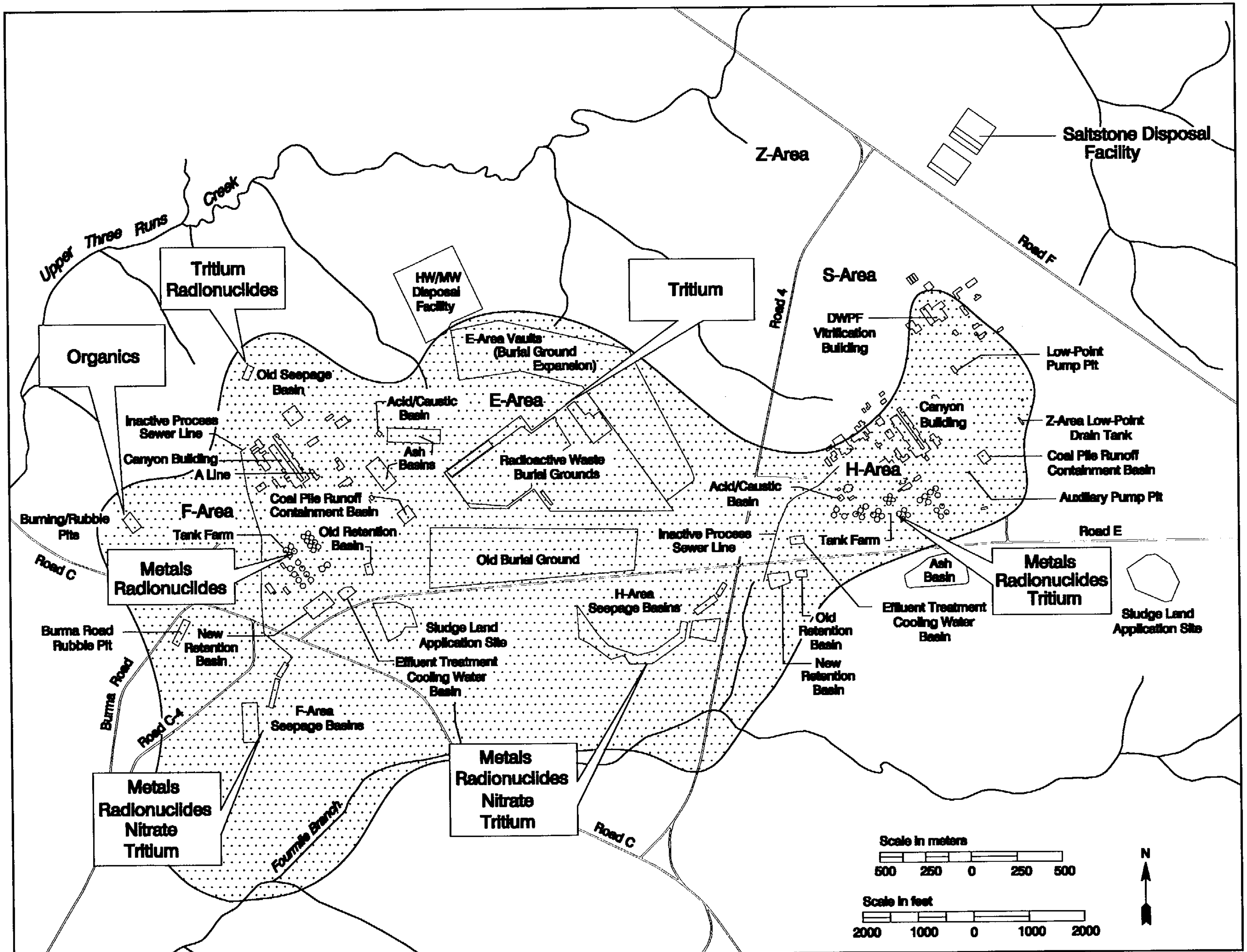


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**Figure 10–8 Extent of Groundwater Contamination Beneath the General Separations and Waste Management Areas in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at the General Separations and Waste Management Areas

### Location and Facilities

The separations and waste management areas, which include E-Area, F-Area, H-Area, S-Area, and Z-Area, are located in the central part of SRS. Reactor-produced materials are processed in the chemical separations plants in F-Area and H-Area, where uranium, plutonium-238, and plutonium-239 are separated from each other and from fission products. These areas also have facilities for purification and packaging of tritium and for storage of fission wastes.

The separations and waste management areas include the following facilities associated with the groundwater monitoring program:

#### E-Area

- Burial Ground expansion (E-Area Vaults)
- E-Area Hazardous Waste/Mixed Waste Disposal Facility
- Old Burial Ground
- Radioactive Waste Burial Ground (also known as Solid Waste Disposal Facility)

#### F-Area

- F-Area acid/caustic basin
- F-Area Burma Road rubble pit
- F-Area burning/rubble pits
- F-Area canyon building and A-Line Uranium Recovery Facility
- F-Area coal pile runoff containment basin and ash basins
- F-Area effluent treatment cooling water basin
- F-Area retention basin
- F-Area seepage basins and inactive process sewer line
- F-Area sludge land application site
- F-Area tank farm
- Old F-Area retention basin
- Old F-Area seepage basin

#### H-Area

- H-Area acid/caustic basin
- H-Area auxiliary pump pit
- H-Area canyon building
- H-Area coal pile runoff containment basin and ash basin
- H-Area effluent treatment cooling water basin
- H-Area retention basin
- H-Area seepage basins and inactive process sewer line
- H-Area sludge land application site
- H-Area tank farm
- Old H-Area retention basin

#### S-Area

- Defense Waste Processing Facility
- S-Area auxiliary pump pit
- S-Area low-point pump pit

#### Z-Area

- Z-Area low-point drain tank
- Z-Area Saltstone Disposal Facility

### Nature of Contamination

Surface drainage in these areas of SRS is to Four Mile Creek to the south and Upper Three Runs Creek and its tributaries to the north and west.

E-Area, F-Area, and H-Area are located on the groundwater divide between Four Mile Creek and Upper Three Runs Creek. Near-surface groundwater in the southern portions of these areas discharges to Four Mile Creek and its tributaries. Near-surface groundwater in the northern portions of these areas discharges to Upper Three Runs Creek and its tributaries to the north.

S-Area and Z-Area are located on the groundwater divide between Upper Three Runs Creek and its tributaries to the west.

Figure 10–8 shows the extent of contamination and the location of the various contaminant groups at the general separations areas. The facilities at E-Area, F-Area, and H-Area have been sources of substantial groundwater pollution. In the past, the seepage and retention basins in F-Area and H-Area have been used to dispose of liquids containing radionuclides, metals, organics, and nitrates. Radioactive liquids have leaked into the groundwater below the tank farms. Tritium and metals have leached from materials buried in E-Area. Several stabilization and closure programs have been implemented to reduce the impact of the sources of groundwater contamination. The newer facilities in S-Area and Z-Area are not known to produce any groundwater pollution.

Many groundwater contamination plumes overlap in the area. Plumes from the Old Burial Ground and the F-Area and H-Area seepage basins discharge radionuclides, metals, and nitrates into Four Mile Creek. An extensive tritium plume is migrating north from the Solid Waste Disposal Facility. Other plumes are under the buildings, tank farms, and other waste disposal areas.

Table 10–5 summarizes 1996 groundwater monitoring results for the general separations and waste management areas.

**Table 10–5 Constituent Groups Above Drinking Water Standards at the General Separations and Waste Management Areas in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | 0 | 14 | None |
| Metals | 24% | 414 | Seepage basins, tank farms |
| Organics | 12% | 376 | Burial Ground, burning/rubble pit, canyon buildings, seepage basins |
| Pesticides/PCBs | 0 | 31 | None |
| Tritium | 54% | 435 | Burial Ground, canyon buildings, seepage basins |
| Other radionuclides | 39% | 422 | Burning/rubble pit, canyon buildings, seepage basins, tank farms |
| Other constituents | 28% | 339 | Seepage basins |

**Note:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

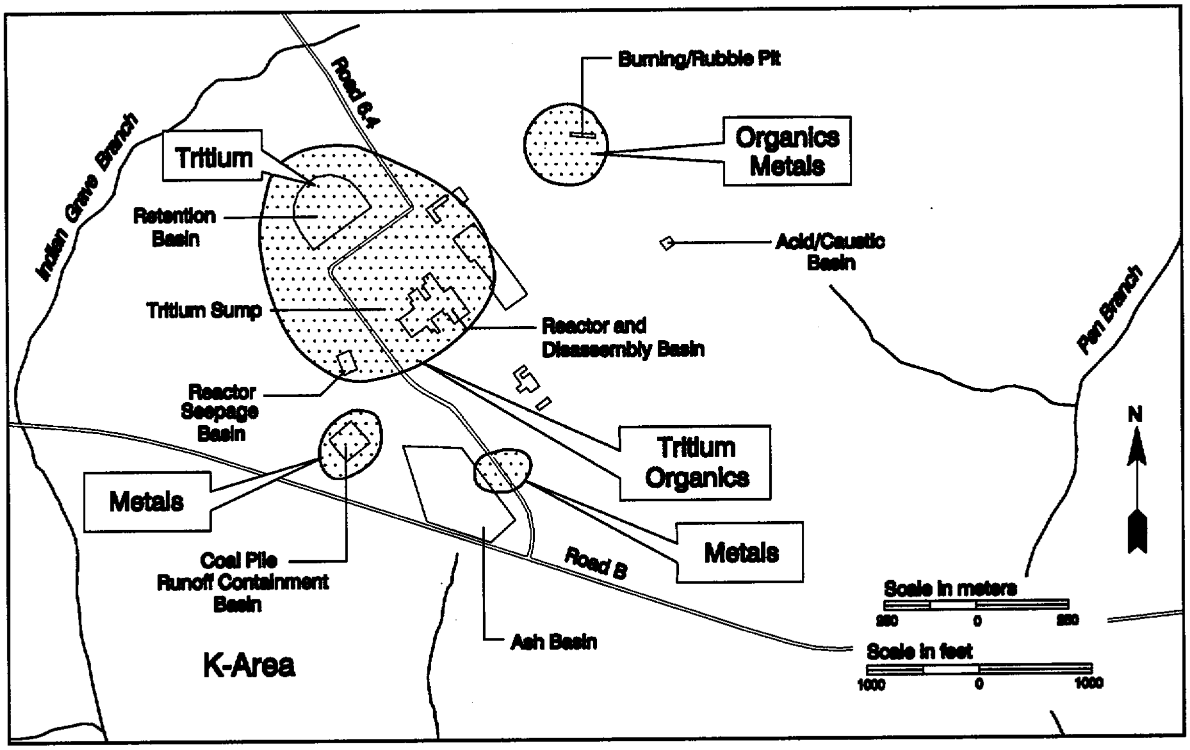


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**Figure 10–9 Extent of Groundwater Contamination Beneath K-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at K-Area

### Location and Facilities

K-Area is in the south-central part of SRS and contains the K-Area reactor, which achieved criticality in 1954 and was shut down in 1988 for maintenance. The reactor was placed in cold shutdown in February 1996.

K-Area includes the following facilities associated with the groundwater monitoring program:

- K-Area acid/caustic basin
- K-Area ash basin
- K-Area Bingham pump outage pit
- K-Area burning/rubble pit
- K-Area coal pile runoff containment basin
- K-Area diesel tank spill
- K-Area disassembly basin
- K-Area reactor
- K-Area reactor seepage basin
- K-Area retention basin
- K-Area sludge land application site
- K-Area tritium sump

### Nature of Contamination

The bisection of Pen Branch and Indian Grave Branch isolates the near-surface groundwater. Deeper groundwater flows toward the Savannah River.

Figure 10–9 shows the extent of contamination and the location of the various contaminant groups in K-Area. Several plumes of contaminated groundwater are at K-Area. The largest plume consists of tritium-contaminated water around the disassembly basin, the reactor seepage basin, and the retention basin. As described in the C-Area discussion, these sites are known sources of tritium. Low levels of volatile organics are detected in some wells that monitor this plume.

Some groundwater under and near the ash basin and the coal pile runoff containment basin have metals and gross-alpha contamination. These are typical contaminants leached from coal and coal ash.

The groundwater underneath the burning/rubble pit is contaminated with tetrachloroethylene, and lead and thallium were detected above the DWS.

Table 10–6 summarizes 1996 groundwater monitoring results for K-Area.

**Table 10–6 Constituent Groups Above Drinking Water Standards at K-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 18% | 33 | Ash basin, coal pile runoff containment basin |
| Organics | 31% | 16 | Burning/rubble pit, disassembly basin, reactor seepage basin, retention basin |
| Pesticides/PCBs | 0 | 5 | None |
| Tritium | 63% | 24 | Disassembly basin, reactor seepage basin, retention basin |
| Other radionuclides | 4% | 27 | Ash basin, coal pile runoff containment basin |
| Other constituents | 0 | 16 | None |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans were not sampled at K-Area during 1996.

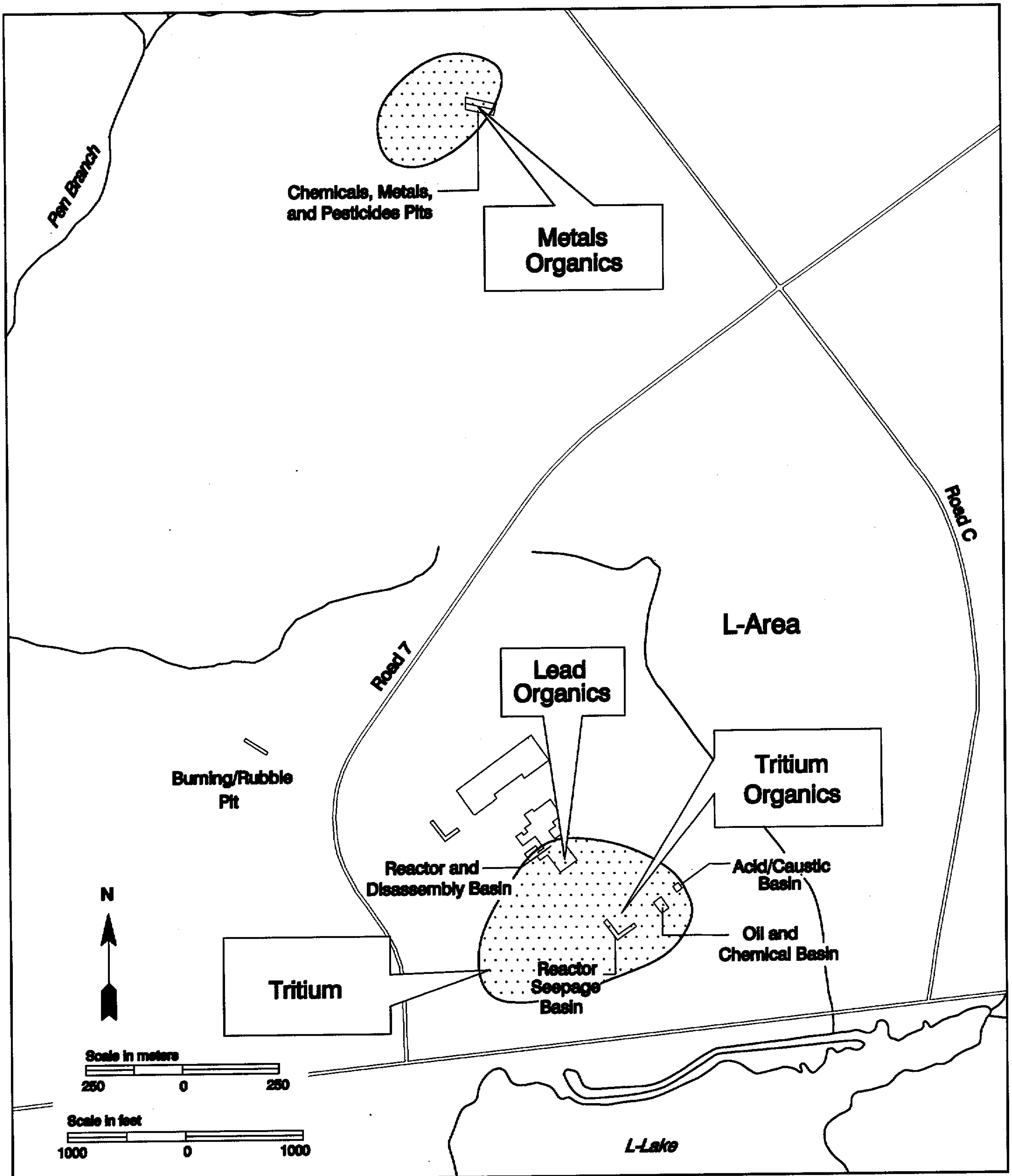


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**Figure 10–10 Extent of Groundwater Contamination Beneath L-Area and the Chemicals, Metals, and Pesticides Pits in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at L-Area and the Chemicals, Metals, and Pesticides Pits

### Location and Facilities

L-Area is in the south-central part of SRS and contains the L-Area reactor, which achieved criticality in 1954 and continued production until 1968, when it was placed in warm standby. It subsequently operated from 1985 until 1988, when it was shut down for maintenance. It was placed in warm standby in December 1991 to be put into operation as a backup to K-Reactor, if necessary, but since has been placed in cold shutdown.

L-Area includes the following facilities associated with the groundwater monitoring program:

- L-Area acid/caustic basin
- L-Area Bingham pump outage pit
- L-Area burning/rubble pit
- L-Area disassembly basin
- L-Area oil and chemical basin
- L-Area reactor
- L-Area reactor seepage basin

The chemicals, metals, and pesticides (CMP) pits are near the head of Pen Branch. The pits were used from 1971 to 1979 to dispose of waste consisting of drummed oil, organic solvents, and small amounts of pesticides and metals. In 1984, the pits were excavated to form two trenches, backfilled, and capped. During excavation, most of the contaminated material was removed to the Hazardous Waste Storage Facility.

### Nature of Contamination

Figure 10–10 shows the extent of contamination and the location of the various contaminant groups at L-Area and the CMP pits. There is a plume of contaminated groundwater downgradient between the L-Area reactor buildings and L-Lake. Tritium is the most extensive contaminant, and lead and volatile organics are present in low concentrations. Tritium activity in a monitoring well about 1,000 feet southwest of the reactor building has increased substantially since 1994. Volatile organic compounds are present near the disassembly basin and the oil and chemical basin.

Several small tributaries of Steel Creek receive surface drainage from L-Area. The near-surface groundwater discharges to Steel Creek and Pen Branch.

A plume of groundwater underneath the CMP pits is contaminated with volatile organics and metals. Monitoring results from 1996 were similar to those of previous years.

Surface drainage at the CMP pits is to the north toward Pen Branch and to the south toward a tributary of Pen Branch. Groundwater flows downward and horizontally away from the pits.

Table 10–7 summarizes 1996 groundwater monitoring results for L-Area and the CMP pits.

**Table 10–7 Constituent Groups Above Drinking Water Standards at L-Area and the Chemicals, Metals, and Pesticides Pits in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 19% | 26 | CMP pits, disassembly basin |
| Organics | 25% | 20 | CMP its, disassembly basin, oil and chemical basin |
| Pesticides/PCBs | 0 | 13 | None |
| Tritium | 25% | 24 | Disassembly basin, oil and chemical basin, reactor seepage basin |
| Other radionuclides | 0 | 18 | None |
| Other constituents | 0 | 13 | None |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans were not sampled at L-Area or the CMP pits during 1996.

## Groundwater Contamination at N-Area

### Location and Facilities

N-Area, also called the Central Shops area, is located in the central part of SRS and provides supply, maintenance, and other support services.

N-Area includes the following facilities associated with the groundwater monitoring program:

- Fire Department Training Facility
- Ford Building seepage basin
- N-Area burning/rubble pits
- N-Area diesel spill
- Hydrofluoric acid spill

Surface drainage in N-Area is to tributaries of Four Mile Creek to the north, west, and south and to tributaries of Pen Branch to the east. Four Mile Creek, Upper Three Runs Creek, and several other incised creeks are located between N-Area and the SRS boundary and are areas of groundwater discharge.

Groundwater monitoring results for 1996, shown in table 10–8, indicate no evidence of contamination.

**Table 10–8 Constituent Groups Above Drinking Water Standards at N-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 0 | 8 | None |
| Organics | 0 | 1 | None |
| Pesticides/PCBs | — | — | |
| Tritium | 0 | 6 | None |
| Other radionuclides | 0 | 3 | None |
| Other constituents | 0 | 3 | None |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans and pesticides/PCBs were not sampled at N-Area during 1996.

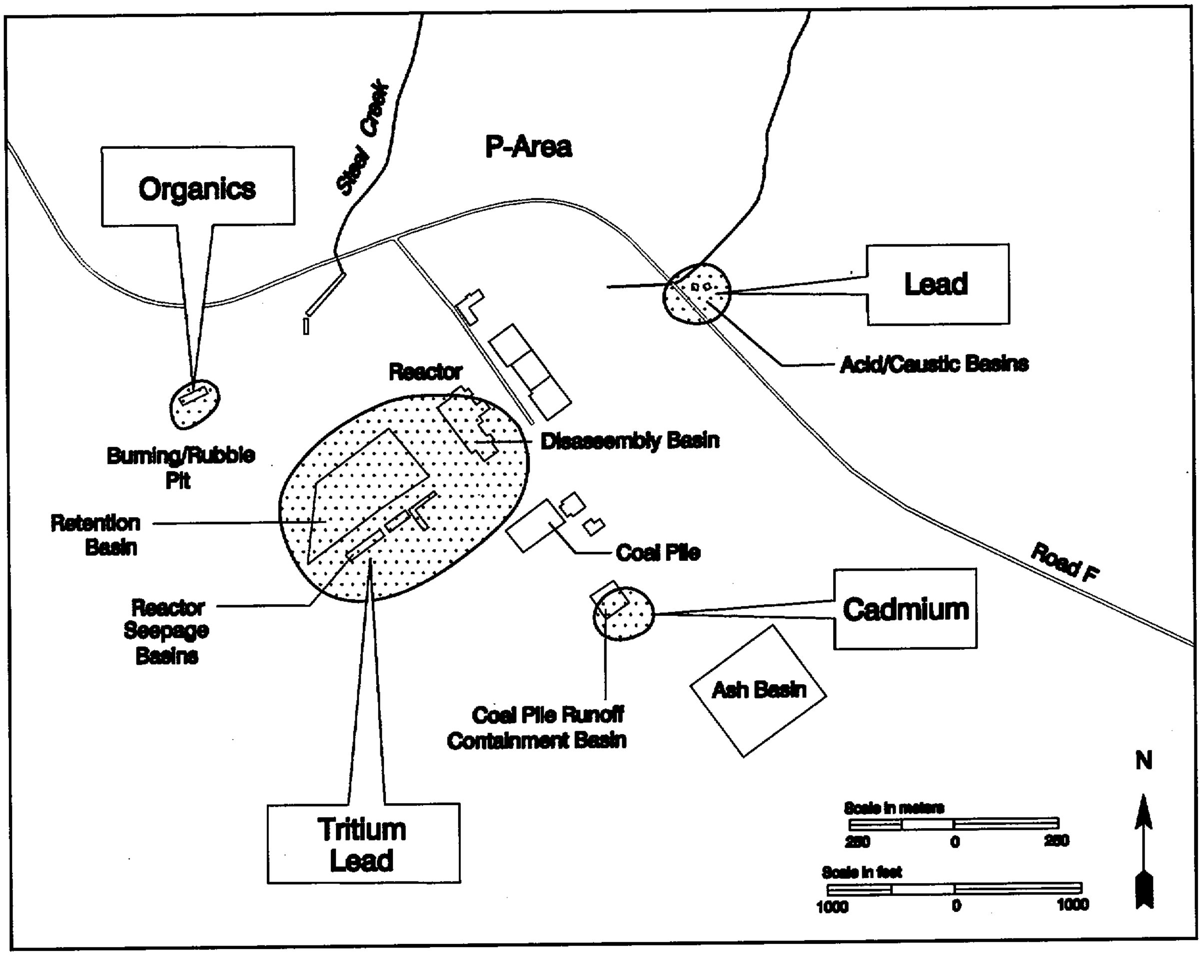


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**Figure 10–11 Extent of Groundwater Contamination Beneath P-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at P-Area

### Location and Facilities

P-Area, located in the south-central part of SRS, houses the P-Area reactor, which achieved criticality in 1954, was shut down for maintenance in 1987, and has since been placed in cold shutdown.

P-Area includes the following facilities associated with the groundwater monitoring program:

- P-Area acid/caustic basins
- P-Area ash basin
- P-Area Bingham pump outage pit
- P-Area burning/rubble pit
- P-Area coal pile and coal pile runoff containment basin
- P-Area disassembly basin
- P-Area reactor
- P-Area reactor seepage basins
- P-Area retention basin

### Nature of Contamination

Lower Three Runs Creek to the east, Steel Creek to the southwest, and Meyers Branch to the south and east isolate the near-surface groundwater in P-Area. The horizontal hydraulic gradients vary across P-Area and increase near a tributary to PAR Pond. The horizontal gradients also increase near a tributary to Steel Creek to the southeast.

Figure 10–11 shows the extent of contamination and the location of various contaminant groups at P-Area. The largest plume of contaminated groundwater in P-Area consists of tritium contamination near the disassembly basin and the reactor seepage basins.

Lead was elevated in a few wells near the seepage basins. These results are consistent with past years and are expected, based on the tritium disposal at these sites.

As in the past, low levels of trichloroethylene were detected in the groundwater near the burning/rubble pits. Also, lead was detected above the DWS near the acid/caustic basins, and cadmium was elevated near the coal pile runoff containment basin.

Table 10–9 summarizes 1996 groundwater monitoring results for P-Area.

**Table 10–9 Constituent Groups Above Drinking Water Standards at P-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 20% | 20 | Acid/caustic basin, coal pile runoff containment basin, seepage basin |
| Organics | 25% | 4 | Burning/rubble pit |
| Pesticides/PCBs | — | — | |
| Tritium | 67% | 15 | Disassembly basin, seepage basin |
| Other radionuclides | 0 | 6 | None |
| Other constituents | 0 | 13 | None |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans and pesticides/PCBs were not sampled at P-Area during 1996.

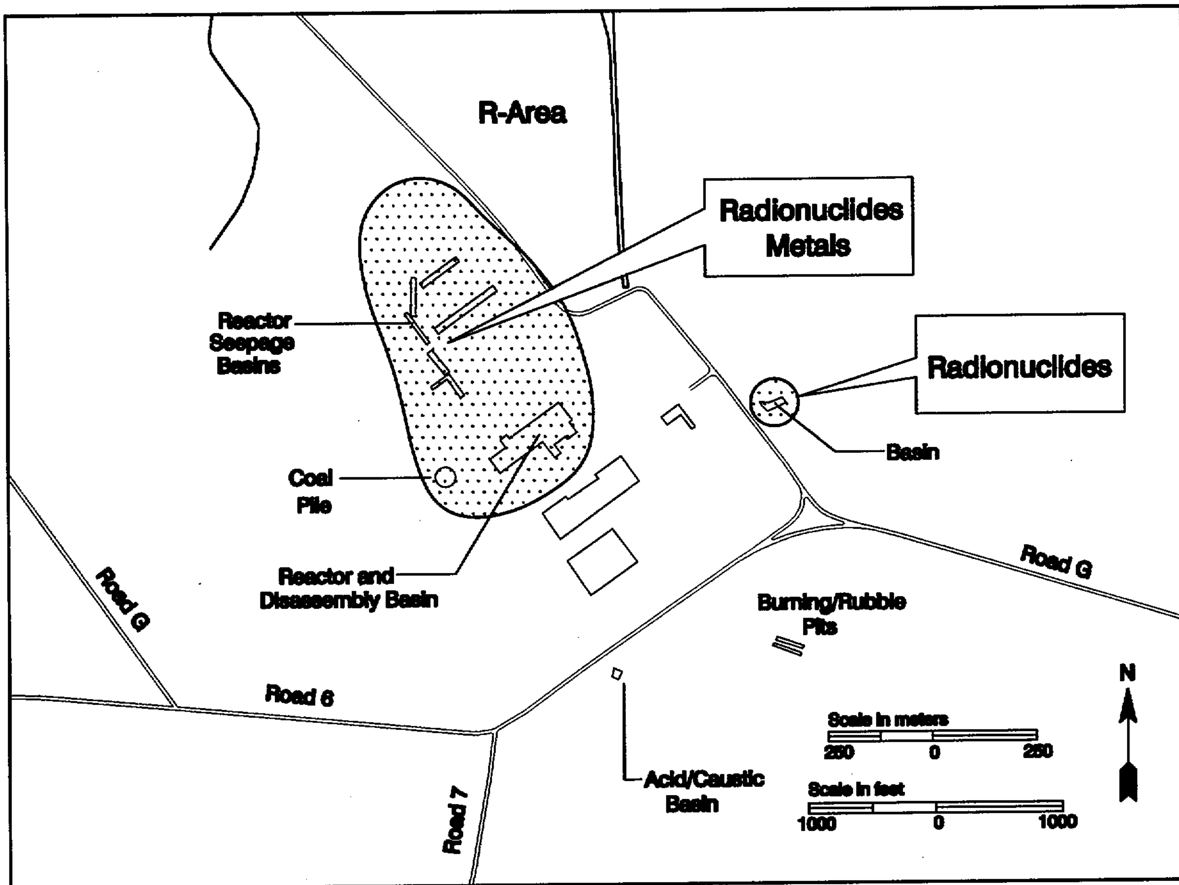


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**Figure 10–12 Extent of Groundwater Contamination Beneath R-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at R-Area

### Location and Facilities

R-Area, located in the east-central part of SRS, houses the R-Reactor, which achieved criticality in 1953 and was shut down permanently in 1964.

R-Area includes the following facilities associated with the groundwater monitoring program:

- R-Area acid/caustic basin
- R-Area Bingham pump outage pit
- R-Area burning/rubble pits
- R-Area coal pile
- R-Area disassembly basin
- R-Area reactor
- R-Area reactor seepage basins

### Nature of Contamination

Surface drainage in R-Area is to the northwest and northeast toward Mill Creek and Pond A and to the southeast and southwest toward tributaries of Pond 4 and Pond 2.

Incised tributaries, streams, and PAR Pond separate near-surface groundwater at R-Area from the site boundary to the east. R-Area is near a groundwater divide between Mill Creek and PAR Pond. The groundwater just north of R-Area naturally discharges to Mill Creek to the northwest and to the R-Area Canal of Pond A to the northeast. The groundwater from the southern part of R-Area naturally discharges to a tributary of Pond 4 south of R-Area.

Figure 10–12 shows the extent of contamination and the location of various contaminant groups at R-Area. The only substantial groundwater contamination at R-Area consists of radionuclides, cadmium, and other metal contamination surrounding the reactor disassembly basin and the seepage basins. This

contamination is consistent with that of previous years and with the history of the site.

On November 8, 1957, an experimental fuel element failed during a calorimeter test in the emergency section of the R-Area disassembly basin. Following this incident, the original seepage basin received approximately 2,700 Ci of gross beta activity, including strontium-90 and cesium-137, each of which has a half-life of about 30 years. Much of the released radioactivity was contained in that basin, which was backfilled in December 1957. Five more basins were placed in operation in 1957 and 1958 to assist in containing the radioactivity.

Table 10–10 summarizes 1996 groundwater monitoring results for R-Area.

**Table 10–10 Constituent Groups Above Drinking Water Standards at R-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | — | — | |
| Metals | 25% | 16 | Disassembly basin, reactor seepage basin |
| Organics | 0 | 6 | None |
| Pesticides/PCBs | 0 | 6 | None |
| Tritium | 0 | 13 | None |
| Other radionuclides | 18% | 17 | Disassembly basin, reactor seepage basin |
| Other constituents | 8% | 13 | Disassembly basin, reactor seepage basin |

**Notes:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Dioxins/furans were not sampled at R-Area during 1996.

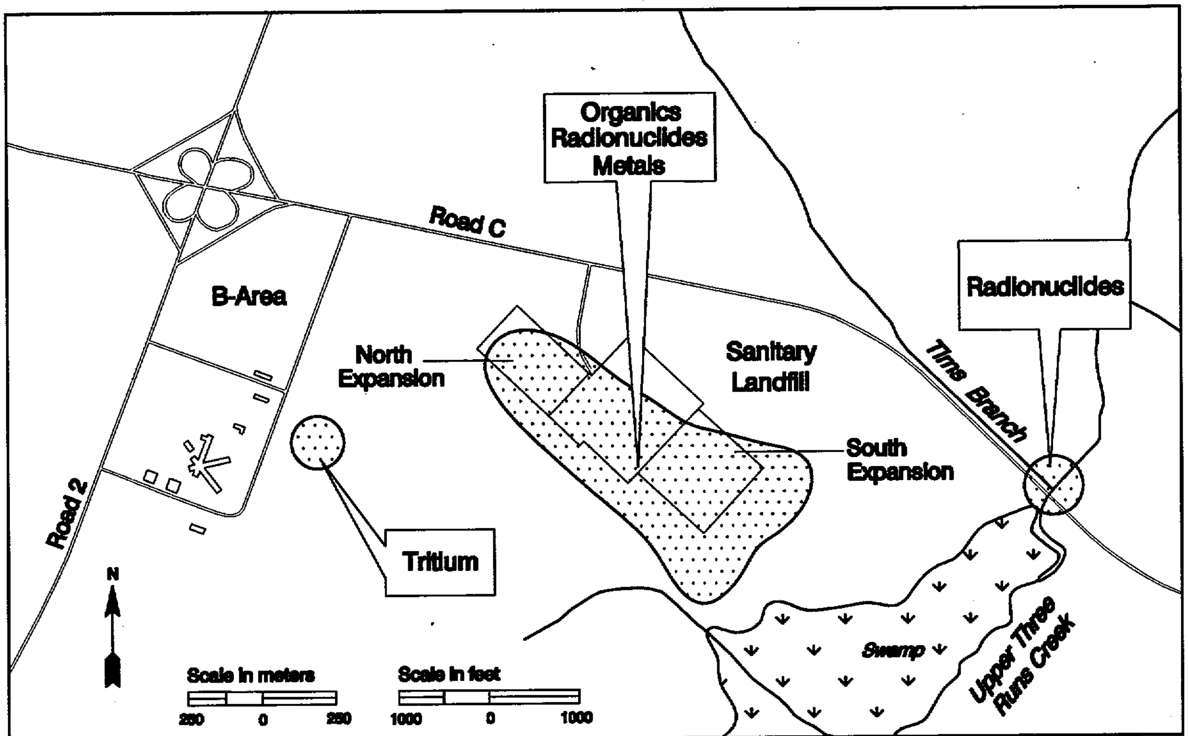


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**Figure 10–13 Extent of Groundwater Contamination Beneath the Sanitary Landfill and B-Area in 1996 and Location of Noteworthy Sources of Contamination Exceeding Drinking Water Standards**

## Groundwater Contamination at the Sanitary Landfill and B-Area

### Location and Facilities

The Sanitary Landfill is south of Road C, about midway down the slope from the Aiken Plateau to Upper Three Runs Creek.

The Sanitary Landfill began receiving waste from office, cafeteria, and industrial activities during 1974. Materials such as paper, plastics, rubber, wood, cardboard, rags, metal debris, pesticide bags, empty cans, carcasses, asbestos in bags, and sludge from SRS's wastewater treatment plant were placed in unlined trenches and covered daily with soil or a fabric substitute. The original section of the landfill and its southern expansion, with a total area of approximately 54 acres, have been filled. The portion of approximately 16 acres known as the northern expansion, or the interim sanitary landfill, ceased operations in November 1994.

### Nature of Contamination

Surface drainage at the Sanitary Landfill is to the south-southeast, toward Upper Three Runs Creek. Horizontal groundwater flow is to the southeast, toward Upper Three Runs Creek.

Sanitary landfills are intended to receive only nonradioactive, nonhazardous waste. However, until October 1992, some hazardous wastes (specifically, solvent-laden rags and wipes used for cleaning, decontamination, and instrument calibration) were buried in portions of the original 32-acre landfill and its southern expansion.

Figure 10–13 shows the extent of contamination and the location of various contaminant groups at the Sanitary Landfill and near B-Area. There is a substantial plume of contaminated groundwater under and downgradient of the Sanitary Landfill. Organic compounds are the most widespread contaminants, but metals, tritium, and other radionuclides also are present.

Tritium was detected in one well above the DWS near B-Area. Gross alpha was elevated in one well near Upper Three Runs Creek.

Table 10–11 summarizes the 1996 groundwater monitoring results for the Sanitary Landfill and B-Area.

**Table 10–11 Constituent Groups Above Drinking Water Standards at the Sanitary Landfill and B-Area in 1996**

| Constituent Groups | Percent of Wells with Results above Standards | Number of Wells Sampled | Sources of Contamination |
|---|---|---|---|
| Dioxins/furans | 0 | 4 | None |
| Metals | 10% | 51 | Sanitary Landfill |
| Organics | 21% | 61 | Sanitary Landfill |
| Pesticides/PCBs | 0 | 45 | None |
| Tritium | 11% | 45 | B-Area, Sanitary Landfill |
| Other radionuclides | 7% | 45 | Sanitary Landfill |
| Other constituents | 2% | 47 | Sanitary Landfill |

**Note:** Drinking Water Standards refer to federal final primary DWS, proposed primary DWS, and interim final primary DWS.

Chapter 11

# Quality Assurance

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**Walt Kubilius, and Stuart Stinson**
*Environmental Protection Department*

**To Read About . . . See Page . . .**



THE Environmental Monitoring Section (EMS) of the Savannah River Site's (SRS) Environmental Protection Department maintains a quality assurance/quality control (QA/QC) program to continuously verify the integrity of data generated by its own environmental monitoring program and by its subcontracted laboratories. Each aspect of the monitoring program, from sample collection to data reporting, must address QA, QC, and quality assessment standards defined in the *Savannah River Site Environmental Monitoring Program Quality Assurance Plan*, section 8000, WSRC–3Q1–2. This chapter summarizes the QA/QC program. Tables containing the 1996 QA/QC data can be found in *SRS Environmental Data for 1996*, WSRC–TR–97–0077. A more complete description of the EMS QA/QC program can be found in section 1110 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1 (SRS EM Program).

Guidelines and applicable standards for the QA/QC environmental monitoring program can be found in appendix A, "Applicable Guidelines, Standards, and Regulations," of this document. Figure 11–1 illustrates the hierarchy of relevant guidance documents that support the EMS QA/QC program. Detailed information about federal, state, and local QA regulations and standards can be found in the SRS EM Program.

## QA/QC for EMS Laboratories

General objectives of the QA/QC program include validity, traceability, and reproducibility of reported results; comparability of results within data bases; representativeness of each sample to the population or condition being measured; and accuracy and precision.

### Training for Personnel

EMS personnel must understand and comply with all requirements applicable to the activities with which they are involved. Consequently, appropriate training courses nurture the employees' understanding and fulfillment of their responsibilities. Courses include training on applicable QA procedures, Occupational Safety and Health Administration-mandated training, and General Employee Training. Regulations and procedures that govern the environmental monitoring program are emphasized.

EMS technicians begin with specific training determined by job assignment. The section's technical work is based on procedures in the WSRC–3Q1 series of manuals:

- "Environmental Sampling Procedures," WSRC–3Q1–3
- "Environmental Radiochemistry Procedures," WSRC–3Q1–4
- "Environmental Water Quality Procedures," WSRC–3Q1–5
- "Environmental Counting Room Procedures," WSRC–3Q1–6
- "Environmental Data Management and Computer Support Procedures," WSRC–3Q1–10

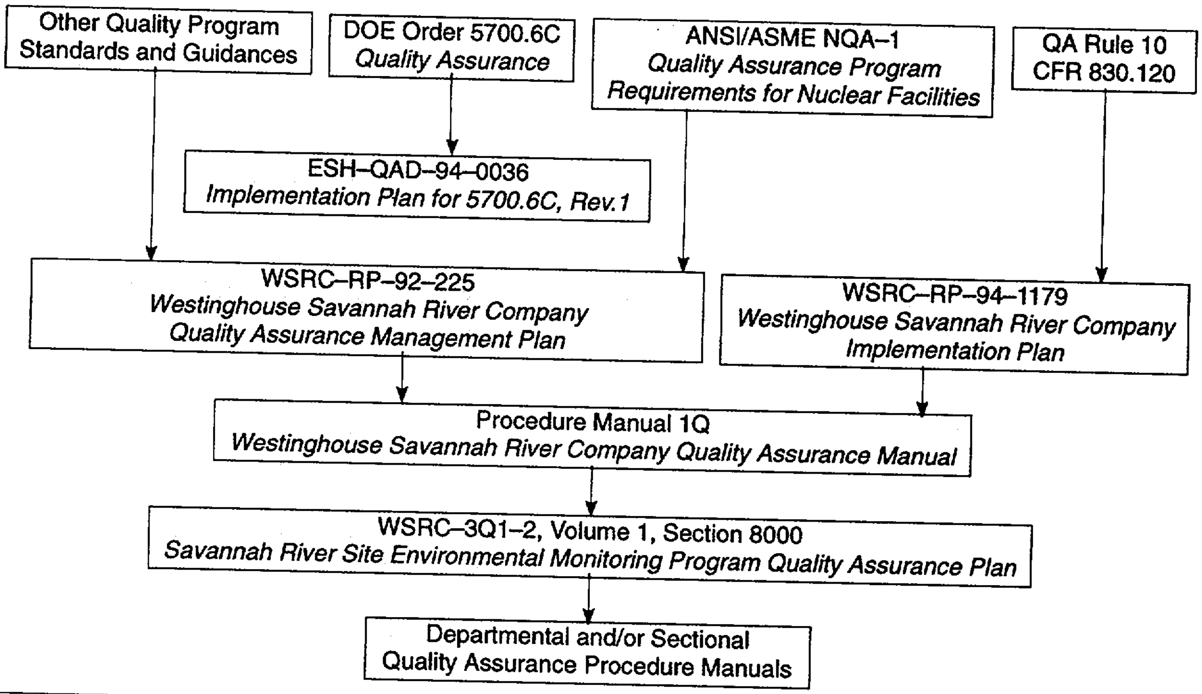
## Internal QA Program

Specific QA checks and accepted practices are conducted by each EMS group, as described in the following paragraphs.

#### Field Sampling Group

**Blind Sample Program** EMS routinely conducts a blind sample program for field measurements of pH and conductivity to assess the quality and reliability of field data measurements. Conductivity and pH measurements are taken in the field using the same equipment as is used for routine measurements.

During 1996, blind pH field measurements were taken for 33 samples, and blind conductivity field measurements were taken for 25 samples. All field pH measurements were within the U.S. Environmental Protection Agency's (EPA) suggested




**Guidance Documents that Support Programs**

- International Organization for Standardization (ISO) 9000 Series of Standards
- *Specifications and Guidelines for Environmental Data Collection and Environmental Technology Programs,* ANSI/ASQC E–4
- General Requirements for the Competence of Calibration and Testing Laboratories ISO/IEC Guide 25–1990

**Figure 11–1 SRS EM Program QA/QC Document Hierarchy/Relevant Guidance Documents**

acceptable control limit of ± 0.4 pH units of the true (known) value. All field conductivity measurements differed from the true value by less than 15 percent, which is the EMS internal QA/QC control limit.

**Instrumentation Calibration** EMS personnel also measure chlorine, dissolved oxygen, and temperature in water samples; but because of the difficulties in providing field standards, these measurements are not suitable for a blind sample program. Therefore, quality control of these analyses relies instead on instrumentation calibration, per the WSRC–3Q1 procedure series.

## Chemistry and Counting Laboratories

Laboratory performance is evaluated through instrument checks, control charts, and data analyses. In the chemistry group, graphical and numerical trending is conducted on technician and method performance, with reports generated for sample results that exceed warning limits. The Counting Laboratory runs source checks and instrument backgrounds and performs calibrations regularly to monitor and characterize instrumentation.

Routine samples prepared and counted in EMS laboratories are subject to a variety of QC checks to assess and ensure validity. These checks make up 30 percent of the analytical workload. The Environmental Chemistry and Analysis group prepares spikes, blanks, duplicates, and blind samples to check the performance of routine analyses. Spikes and blanks are used to calculate a recovery efficiency of an analytical method, to adjust for background radiation, and to evaluate counting equipment performance.

Blind samples, the radionuclide composition of which is unknown to the technicians preparing or counting the samples, provide a constant check on the proficiency of the chemistry and counting laboratories. Based on matrix availability, blind and spiked samples are prepared from National Institute of Standards and Technology-traceable material or standardized against National Institute of Standards and Technology material. Upon completion of

**Statistical Terms Used in this Chapter**

**coefficient of variation** measure of precision calculated as the standard deviation divided by the average of a set of values; usually multiplied by 100 to be expressed as a percentage

**mean** measurement of central tendency, commonly called the average

**mean relative difference** measure of reproducibility of identical chemical analyses

**median** middle value of a set of data when the data are ranked in increasing or decreasing order

**percent difference** measure of accuracy used to compare "known" values with laboratory measurements; represents the absolute difference between the known and measured value divided by the true value; usually multiplied by 100 to be expressed as a percentage

**standard deviation** indication of the dispersion of a set of results around the average of samples collected

analyses, ratios between the measured and true values are calculated, and the results are added to control charts to identify trends. To address the high relative error of radioactive measurements at low levels, the difference between measured and true values is evaluated against standard deviation units of the true value. During 1996, blind samples were analyzed for tritium and gamma-emitting radionuclides. All tritium data were within the control limits except one, whose low-activity level was near the EMS minimum detectable activity. All gamma data were within the control limits. The results of these blind samples were used to validate analytical work in the chemistry and counting laboratories.

### Data Verification and Validation

Results received from the Counting Laboratory are electronically evaluated by the Environmental Monitoring Computer Automation Project (EMCAP). Sample parameters—such as air flows, counting aliquots, and decay times—are flagged if values exceed preset limits or vary significantly from previous entries. Also, maximum and minimum radioactive acceptance levels, based on historical results, are calculated for all routine environmental samples. Sample results outside the acceptance range are submitted for individual review, which frequently results in analytical reruns, recounts, recalculations, or resampling for verification.

Before data are reported, they must be reviewed and validated by qualified personnel. Electronic verification is performed on 100 percent of the data stored in EMS data bases. Through this verification, data anomalies are removed or data are rejected if there is disagreement with EMS QA/QC policies. The validation methods and criteria are documented in QAP 21–1 of WSRC–1Q and in the EMS "Environmental Geology Procedures," WSRC–3Q1–7. Quality control requirements for managing, evaluating, and publishing environmental monitoring data are defined in WSRC–3Q1–2, section 8250.

## External QA Program

The EMS laboratory participates in three interlaboratory comparison programs to track performance accuracy. Under these programs, the U.S. Department of Energy (DOE) and EPA send samples to participating laboratories throughout the year and compare the laboratories' results to true values. These comparisons not only test the accuracy of procedures, but compare SRS with other laboratories nationwide.

The DOE Quality Assurance Program (QAP) tests the quality of environmental data reported to DOE by its contractors. Reference samples for this program—including soil/sediment, water, vegetation, and air filter samples—are prepared by the DOE/EML (Environmental Measurements Laboratory) and sent to participating laboratories. Analytical results are reported to EML within 90 days and compared with the test results of other laboratories. The DOE/EML evaluates the results and distributes them to the participating laboratories.

The second program is administered by the Quality Assurance Division (QAD) of the EPA Environmental Monitoring System Laboratory in Las Vegas. This division is responsible for QC of environmental radiological measurements. EPA provides participating laboratories with water, air filter, and milk samples that contain a variety of radionuclides with activity concentrations near environmental background levels. The QAD program enables EMS to document the accuracy of radiological analysis data, to identify instrument and

procedural problems, and to compare analysis performance with other participating laboratories.

Control charts are maintained for the QAD results according to EPA control limits. For QAP results, the control charts are maintained according to DOE/EML control limits. Historical trends alert EMS to a method bias that may be occurring in its laboratories.

Most of the results reported by EMS in the QAD program were within EPA control limits. The results reported by EMS in the QAP program generally fell within the DOE/EML control limits. The results generally showed the greatest bias in samples with low activity levels and in difficult matrices for chemical separation. Air filter samples for strontium showed low bias, and the problem is being investigated. Both the QAD and QAP programs indicate that 95 percent of the EMS analyses fall within the applicable limits, according to the standards of intercomparison agencies, and that they compare favorably with those of other environmental laboratories.

The third intercomparison program, Gamma Spectrometry Data Validation, begun in 1996, provides DOE an assessment of the capabilities of the participating laboratories in performing routine gamma-ray spectra analysis required for EML projects and site characterizations. Previous studies have demonstrated that gamma-ray spectrometry software supplied by commercial manufacturers when tested with complex spectra may provide spurious results.

Participants in the program receive a data disk or tape containing synthetic spectra designed to test the sensitivity and capability of the spectrometry analysis system. The disk/tape contains sample spectra, which the spectroscopist is asked to identify and quantify accurately. The synthetic spectra includes calibration, background, and sample spectra. Participating laboratories are asked to identify and quantify the sample spectra. The spectra tests both the gamma-ray spectrometry software and the ability of the user to use the software properly. Participants' results must be reported to EML within 60 days. The expected results are compiled after the reporting deadline, and an evaluation report is issued within 90 days.

The first set of data in this program, composed of synthetic data simulating spectra obtained from air filters, was analyzed during July 1996. The resulting evaluation shows that EMS successfully identified and quantified the sample spectra. The evaluation also shows the capability and sensitivity of the EMS high-purity germanium (HPGe) spectrometry PROCOUNT data reduction system in producing accurate results.

**Table 11–1**
**Subcontracted Laboratories for 1996**

**General Engineering Laboratories**
- groundwater
- soil/sediment
- waste characterization

**Roy F. Weston, Inc.**
- groundwater
- soil/sediment
- metals analyses for SRS streams and the Savannah River
- waste characterization

**Environmental Physics**
- groundwater radiological analyses
- soil/sediment
- waste characterization

**ThermoNUtech**
- subcontracted groundwater radiological analyses for Roy F. Weston, Inc.
- soil/sediment
- waste characterization

**Shealy Environmental Services**
- NPDES analyses
- metals analyses for SRS streams and the Savannah River
- soil/sediment
- domestic water analysis

One gamma line in the synthetic spectra was not identified in the evaluation report; however, it produced two false positive identifications in the EMS analysis. Four isotopes were not detected because they were not included in the EMS gamma analysis library.

## QA/QC for Subcontracted Laboratories

Subcontracted laboratories providing analytical services must have a documented QA/QC program and meet the quality requirements defined in WSRC–1Q. The subcontracted laboratories used during 1996 and the types of analyses performed are listed in table 11–1.

EMS personnel perform an annual evaluation of each subcontracted laboratory to ensure that the laboratories maintain technical competence and follow the required QA programs. Each evaluation includes an examination of laboratory performance with regard to sample receipt, instrument calibration, analytical procedures, data verification, data reports, records management, nonconformance and corrective actions, and preventive maintenance. EMS provides reports of the findings and recommendations to each laboratory and conducts followup evaluations as necessary.

## Nonradiological Liquid Effluents

Nonradiological liquid effluent samples are collected at each permitted SRS outfall according to requirements in the National Pollutant Discharge Elimination System (NPDES) permit issued by the South Carolina Department of Health and Environmental Control (SCDHEC). Effluent samples are analyzed by EMS for temperature, pH, dissolved oxygen, and chlorine and by a subcontracted laboratory for other constituents, such as fecal coliform, metals, organics, and oil and grease. Shealy Environmental Services was the primary subcontractor for the NPDES program throughout 1996.

### Interlaboratory Comparison Program

Interlaboratory comparison studies are used to compare the quality of results between laboratories performing the same analyses. During 1996, Shealy and EMS participated in interlaboratory comparison studies conducted by EPA.

All subcontracted laboratories analyzing NPDES samples must participate in the EPA Discharge Monitoring Report Laboratory Performance Evaluation program. Under this program, EPA sends—to participating laboratories—performance samples containing constituents normally found in industrial and municipal wastewaters.

These water samples have known chemical parameters, such as chemical oxygen demand, and contain known concentrations of constituents, such as total suspended solids, oil and grease, and certain trace metals. EPA provides a final comprehensive report to the program participants. The report contains a statistical analysis of all data, as well as documentation of the known sample value, with stated acceptance limits and warning limits. Accepted variations from the known sample value depend on a variety of factors, including the precision of the analysis and the extent to which the results can be reproduced.

In 1996, Shealy ran analyses for 32 parameters under the EPA program. EMS performed analyses for only three of the EPA parameters—chlorine, total suspended solids, and pH. Shealy was outside acceptance limits for two analyses—beryllium and cyanide. EMS was outside acceptance limits for pH. EMS performed additional analyses for pH and is waiting for results from EPA.

### Intralaboratory Comparison Program

The intralaboratory program compares performance within a laboratory by analyzing duplicate and blind samples throughout the year. Shealy analyzed 471 duplicates samples for various parameters during 1996. Percent difference calculations showed that 398 of these samples were within the EMS internal QA/QC requirements of 20 percent. Forty-nine exceedances involved either total suspended solids, oil and grease, or biological oxygen demand, the analyses of which typically produce highly variable results. Thirteen exceedances occurred because results at or near the analytical detection limit produce large percent variations for small differences in actual data. The remaining 11 exceedances appeared to be related to analytical error at the subcontracted laboratories, sample contamination, or improper sampling technique.

Shealy also analyzed 53 blind samples submitted by EMS. Percent difference calculations showed that 46 of these samples were within the acceptable range of 20 percent. Of the seven exceedances, four were for biological oxygen demand and oil and grease; one other—for zinc—was the result of data at or near the analytical detection limit; and the remaining two—for ammonia and zinc—appeared to be related to analytical error at the subcontracted laboratory, sample contamination, or improper sampling technique.

## Stream and River Water Quality

Metals analyses of samples from SRS streams and the Savannah River are also performed by a subcontracted laboratory. The water quality program requires quality checks of 10 percent of the samples to verify the analytical results. Split samples were sent for metals analyses to subcontractor laboratory Shealy and to verifying laboratory Roy F. Weston, Inc. (Weston). For the first quarter, the results from Shealy for aluminum, manganese, sodium, and zinc were significantly less than the results from Weston. For the second quarter, the results from Shealy for calcium, sodium, and zinc were significantly less than the results from Weston. For the third quarter, the results from Shealy for aluminum, copper, iron, and zinc were significantly less than the results from

Weston. This consistent pattern indicates a systematic bias between the two laboratories.

In response to a continued trend of result discrepancies between the subcontract laboratory and the verifying laboratory, blind certified test samples were sent to both laboratories as part of an investigation to determine the cause of the discrepancies. Shealy was outside acceptance limits on 60 percent of analytes for the first blind sample and 80 percent for the second blind sample. All results were lower than the actual values of the blind samples. An audit of Shealy was performed to identify the root cause of the errors. The primary finding was that the subcontract laboratory and verifying laboratory were using different sample digestion methods. Shealy used an aggressive digestion—as required by NPDES analytical methods—that can result in loss of analyte in the sample. Environmental Resource Associates, the vendor that provided the blind sample, verified that aggressive digestion should not be performed on the blind sample. Secondary factors included blank contamination of reagent blanks and an incorrect application of interelement correction factors. After performing corrective actions for the identified problems, More than 80 percent of Shealy's results on subsequent blind samples have been within acceptance limits. The EMS QA/QC program will be modified to prevent future occurrences of error due to incorrect digestion methodology.

Laboratory methodology and analysis reproducibility between the subcontracted and the verifying laboratories were checked during the first three quarters of 1996. For the first two quarters, water samples from all EMS water quality field locations were composited into one sample, then split into three duplicates for the subcontracted laboratory and three for the verifying laboratory. For the third quarter, program changes were instituted that reduced the amount of sample available for compositing. As a result, only two duplicates were sent to each laboratory for analysis. For all three quarters, each sample was analyzed for a group of 12 metals. No samples were submitted for the fourth quarter because of programmatic changes. The subcontracted laboratory was Shealy and the verifying laboratory was Weston.

Mean relative difference (MRD) calculations exceeded 20 percent in 10 instances, indicating a lack of agreement between the subcontracted and verifying laboratories. Metals found not in agreement included aluminum and sodium for all three quarters and copper and zinc for the second and third quarters.

In general, the average percent coefficient of variation was below 10 percent for both the subcontracted laboratory and the verifying laboratory throughout the year, indicating that result reproducibility was satisfactory. The one exception occurred in the subcontract laboratory's (Shealy) first-quarter results, producing a percent coefficient of variation of 15.14 percent. For individual analyses, there were four instances in the first quarter and two instances in the second and third quarters in which the coefficient of variation exceeded 20 percent. In four instances, the actual analytical data were at or near the detection limit for the analyses. Small differences in results at or near the detection limit can cause large statistical calculation fluctuations that do not actually indicate a problem with reproducibility. Duplicate instances occurred for aluminum (Shealy in the first and third quarters and Weston in the second quarter) and for zinc (Weston in the first and second quarters and Shealy in the third quarter).

## Groundwater

Groundwater analyses at SRS are performed by subcontracted laboratories. During 1996, General Engineering Laboratories and Weston were the primary subcontractors for nonradiological analyses. Environmental Physics and ThermoNUtech were the primary subcontractors for radiological analyses.

During 1996, approximately 5 percent of the samples collected (radiological and nonradiological) were submitted to the primary laboratory for analysis as blind duplicates and to a different laboratory as a QA check. Blind blanks, representing 5 percent of the samples sent to each laboratory, were submitted to General Engineering and Weston. The laboratories' results were evaluated on the basis of the percentage within an acceptable concentration range of certified values.

A statistical measure, the MRD, is calculated to assess result reproducibility and laboratory performance. The laboratories also analyze approximately 10 percent of samples as intralaboratory QA checks. Interlaboratory comparisons were conducted between General Engineering/Weston and Environmental Physics/ThermoNUtech.

As in past years, General Engineering and Weston results for QC standard samples were within the 80-percent acceptance range utilized by the EMS QA/QC program. Laboratories that fall outside this range are reevaluated by EMS.

During 1996, General Engineering and Weston participated in EPA water pollution studies. Of 75 samples analyzed for the studies, General

Engineering reported one sample of chloride outside the acceptable range. During 1996, Weston analyzed 79 different constituents as part of its water pollution studies and reported that all were within the acceptable range.

Full results for all these QA/QC evaluations, including MRD calculations where appropriate, can be found in the following groundwater reports:

- *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1996* (ESH–EMS–960056)
- *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1996* (ESH–EMS–960057)
- *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1996* (ESH–EMS–960058)
- *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1996* (ESH–EMS–960059)

## Soil/Sediment

Environmental investigations of soils, sediments, and surface waters, primarily for Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) units, are performed by subcontracted laboratories. Table 11–1 (page 172) lists the primary subcontractors for soil/sediment analyses.

EMS personnel validated and managed approximately 600,000 analytical records during soil/sediment investigations in 1996. Data are validated according to EPA/CERCLA validation guidelines for Definitive Data (formerly QA Objective 3 Data) unless specified otherwise by site customers. EMS delivered 26 project summary reports in 1996; each included

- a project QA/QC summary
- a discussion of validation findings
- tables of validated and qualified data

Although *Data Quality Objectives Process for Superfund* (EPA–540–R–93–071) identifies QA issues to be addressed, it does not formulate a procedure for how to evaluate these inputs, nor does it propose pass/fail criteria to apply to data and documents. Hence, the validation program necessarily contains elements from—and is influenced by—several sources, including

- *Data Quality Objectives Process for Superfund*, EPA final guidance, EPA–540–R–93–071
- *QA/QC Guidance for Removal Activities*, interim final guidance, EPA–540–G–90–004
- *National Functional Guidelines for Organic Data Review*, Multi-Media, Multi-Concentration (OLM 01.0), and Low Concentration Water (OLC 01.0), draft, June 1991
- *Test Methods for Evaluating Solid Waste*, EPA, November 1986, SW–846, Third Edition
- *Data Validation Procedures for Radiochemical Analysis*, WHC–SD–EN–SPP–001

Data management personnel in the soil/sediment program perform additional functions to ensure the quality of the data released by EMS. Two people enter the data for each entry to help eliminate errors, and all field, shipping, invoice, and analytical data are 100 percent verified.

Relative percent difference for the soil/sediment program is calculated for field duplicates and laboratory duplicates. A summary of this information can by found in each project report prepared by the Environmental Geochemistry Group of EMS, through which the reports are available upon request. A detailed description of the activities performed during validation of soil/sediment data can be found in the Environmental Geochemistry Group Operating Handbook, ESH–EMS–950061.

## Laboratory Data Record Reviews

In addition to an annual evaluation, laboratory data record reviews are performed once per quarter for groundwater and once per project for soil/sediment. A predetermined percentage of the analyses for the indicated time frame is selected for inspection by a team of validators. The samples selected for review usually have been flagged by the electronic verification of the data. At the review, analyses with quality assurance deficiencies are identified and flagged appropriately. Results for record reviews are included as a section in the project reports delivered to the customer. A description of the activities performed during a record review, an example check list, and a report description can be found in the Environmental Geochemistry Group Operating Handbook, mentioned above.

*Chapter 12*

# Special Surveys and Projects

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**To Read About . . .** **See Page . . .**



IN addition to routine sampling and special sampling during nonroutine environmental releases, special sampling for radiological and nonradiological surveys is conducted on and off site by personnel from the Savannah River Site (SRS) Environmental Protection Department's Environmental Monitoring Section (EMS) and from other groups, such as the Savannah River Technology Center (SRTC) the Academy of Natural Sciences of Philadelphia (ANSP), and the U.S. Geological Survey (USGS).

Both short- and long-term radiological and nonradiological surveys are used to monitor the effects of SRS effluents on the environment at SRS and in the site's immediate vicinity

All conclusions discussed in this chapter are based on samples and analyses that have been completed. Because of sampling and/or analytical difficulties, some sample analyses may be missing, but these analyses typically represent only a very small number of samples overall. Details about the number of samples analyzed and the results of those analyses appear in *SRS Environmental Data for 1996* (WSRC–TR–97–0077).

## Savannah River Swamp Survey

In the 1960s, an area of the Savannah River Swamp between Steel Creek Landing and Little Hell Landing was contaminated by failed fuel elements that leaked activity into the P-Area storage basin; occasionally, this water was discharged to Steel Creek (figure 12–1). During high river flow, Steel Creek flowed along the lowlands comprising the swamp and discharged into the Savannah River at Little Hell Landing. Consequently, approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60 were deposited into the swamp. The contaminated area extends beyond the SRS boundary into private property known as Creek Plantation; this area is uninhabited and not easily accessible.

In 1974, 10 sampling trails were established so that specific locations could be monitored to determine changes in the amount or distribution of radioactivity in the swamp (figure 12–2). Fifty-four locations were established along these trails and are identified by distance (in feet) from the river bank.

Surveys have been conducted annually (water levels permitting) since 1974 and are divided into two types: comprehensive and cursory. Comprehensive surveys provide analysis of samples collected at all 54 monitoring locations, while cursory surveys provide interim monitoring through analysis of samples from a subset (one location per trail) of the 54 locations. Comprehensive surveys are performed at 5-year intervals, cursory surveys during the interim years. The comprehensive survey scheduled for 1995, however, had to be delayed until 1996 because of high water levels in the swamp.

During the 1996 comprehensive survey, shallow soil (0–3 inches) and vegetation samples were scheduled for collection from each of the 54 monitoring locations, but could not be collected from all locations. Also, 12-inch core samples were collected from one location per trail; these locations correspond to the cursory survey sampling locations and are those areas on each trail that historically have exhibited the highest activity levels. The core samples were divided into 3-inch segments for analysis; this provides an indication of the vertical distribution of activity. All samples were analyzed for gamma-emitting radionuclides and strontium-89,90.

## Gamma-Emitting Radionuclides

In both soil and vegetation samples, cesium-137 was the predominant manmade gamma-emitting radionuclide quantified. It was detected in 80 of the 81 soil samples and 40 of the 46 vegetation samples. The maximum observed cesium-137 concentrations were 98.8 pCi/g in soil and 63.8 pCi/g in vegetation. Cobalt-60 was the only other manmade gamma-emitting radionuclide that could be quantified, appearing in 40 of the 81 soil samples and 6 of the 46 vegetation samples. The maximum observed cobalt-60 concentrations were 0.4 pCi/g in soil and 0.3pCi/g in vegetation.

Generally, cesium-137 concentrations were significantly higher than cobalt-60 concentrations; however, a consistent distribution or ratio between the two radionuclides was not evident in either soil or vegetation. Radionuclide concentrations were higher in soil than in vegetation, but the concentrations in vegetation generally followed the same trend as those in soil.

The vertical profile of cesium-137 in the soil column of some samples did not consistently decrease with increasing depth. In an undisturbed environment, cesium-137 concentration would be expected to decrease with increasing depth, as was observed during the 1990 comprehensive survey. However, the shallow core samples examined during 1996 indicated a more homogenous distribution. The current observations may be an indication of either vertical migration through the soil or continued deposition of contaminated sediments during flood conditions.

## Strontium

Strontium was quantified in 10 of the 81 soil samples and 9 of the 46 vegetation samples. The maximum strontium concentration in soil was 0.28 pCi/g, while the maximum in vegetation was 1.61 pCi/g. The available data set is relatively small, but it shows that the detectable strontium concentrations in vegetation are greater than those in soil. This may be an indication of uptake and concentration of strontium by the swamp vegetation; however, only one

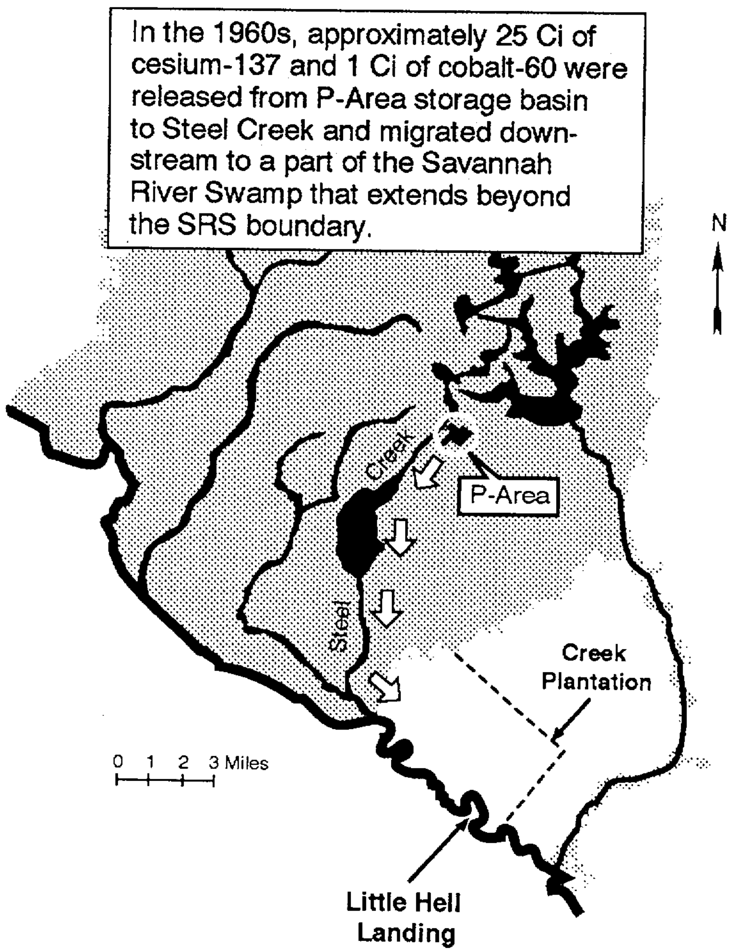


**Figure 12–1 Swamp Contamination**
Radioactivity released from SRS operations contaminated the Savannah River Swamp between Steel Creek and Little Hell Landing during the 1960s.

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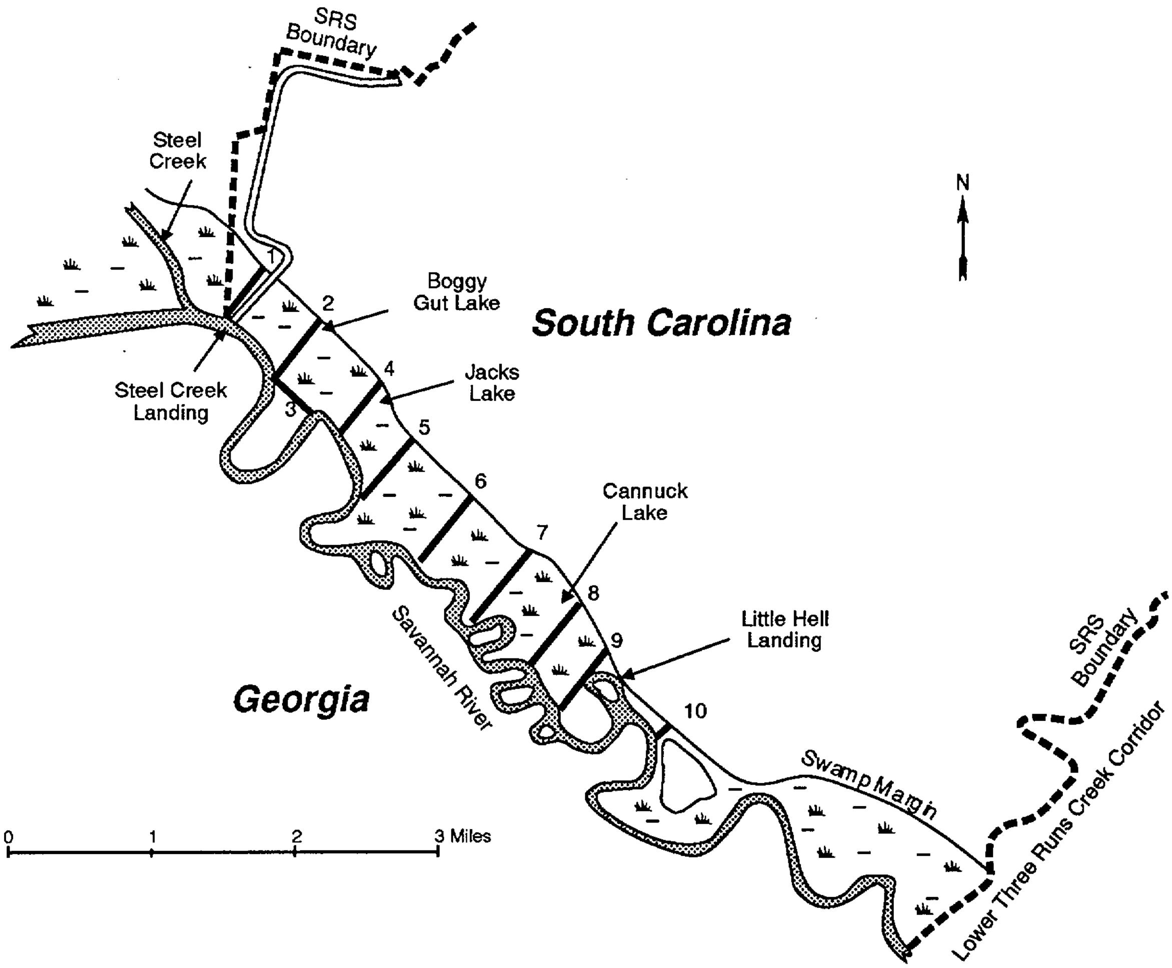



**Figure 12–2 Savannah River Swamp Sampling Trails**
Ten sampling trails were established in the Savannah River Swamp in 1974 so that surveys could be conducted of the movement of contamination from SRS operations.

sampling location had detectable strontium in both soil and vegetation. The limited data set allows for few other conclusions on the partitioning or distribution of strontium.

## Conclusions

The 1996 survey results generally followed trends observed in previous surveys. Over time, some changes in the spatial distribution of activity throughout the swamp have been observed, which indicates that some localized movement of activity may be occurring. However, there has been little change in the results from downstream locations T–9 and T–10, which implies that activity is not migrating out of the identified contaminated area. Relative to the 1990 comprehensive survey, concentrations in shallow core samples generally were lower, while concentrations in vegetation appeared higher. However, the core samples show a fairly uniform vertical distribution of activity. Overall, these results show that although some limited spatial and vertical migration of activity may be occurring, the activity is remaining in the swamp area.

# Mitigation Action Plan for Pen Branch Reforestation

The final Environmental Impact Statement for the continued operation of K-Reactor, L-Reactor, and P-Reactor at SRS [DOE, 1990] predicted several unavoidable impacts to the site's wetlands and resulted in the development of a Mitigation Action Plan (MAP) that documented DOE's approach to mitigating these impacts. The subsequent reduction in the production mission of the SRS reactors has

resulted in the reevaluation of the mitigation strategies identified in the 1991 MAP and its 1992 update. The Mitigation for Wetlands Adversely Impacted by Operations is the only section of the original MAP that remains as an active program element; other program elements either have been completed or deemed unnecessary. At the direction of DOE, it has been agreed by all parties involved with the reporting process that the *SRS Environmental Report* will be used as the document to report annual progress on the reforestation portion of the commitment.

A precise history of the regulatory commitment for the reforestation can be found in the MAP 1992 update [DOE, 1992]. Since that time, the change in mission relating to K-Reactor and the increased technical information on the extent of damage and natural recovery in the Pen Branch corridor and delta have altered details of the reforestation effort. The following paragraphs describe 1996 reforestation mitigation actions.

## Reforestation of the Pen Branch Corridor and Delta by Natural Succession

Natural revegetation has been occurring in the Pen Branch delta since K-Reactor last operated for an extended period of time (1988). Through the use of aerial photography and aircraft-acquired multispectral data, it was determined in 1992 that 583 acres was included in the swamp and marsh area that either had been or could be affected, resulting in tree canopy loss or vegetation damage from K-Reactor thermal discharges [Blohm, 1995]. This is a substantial reduction from the 670 acres estimated in the final Environmental Impact Statement [DOE, 1990].

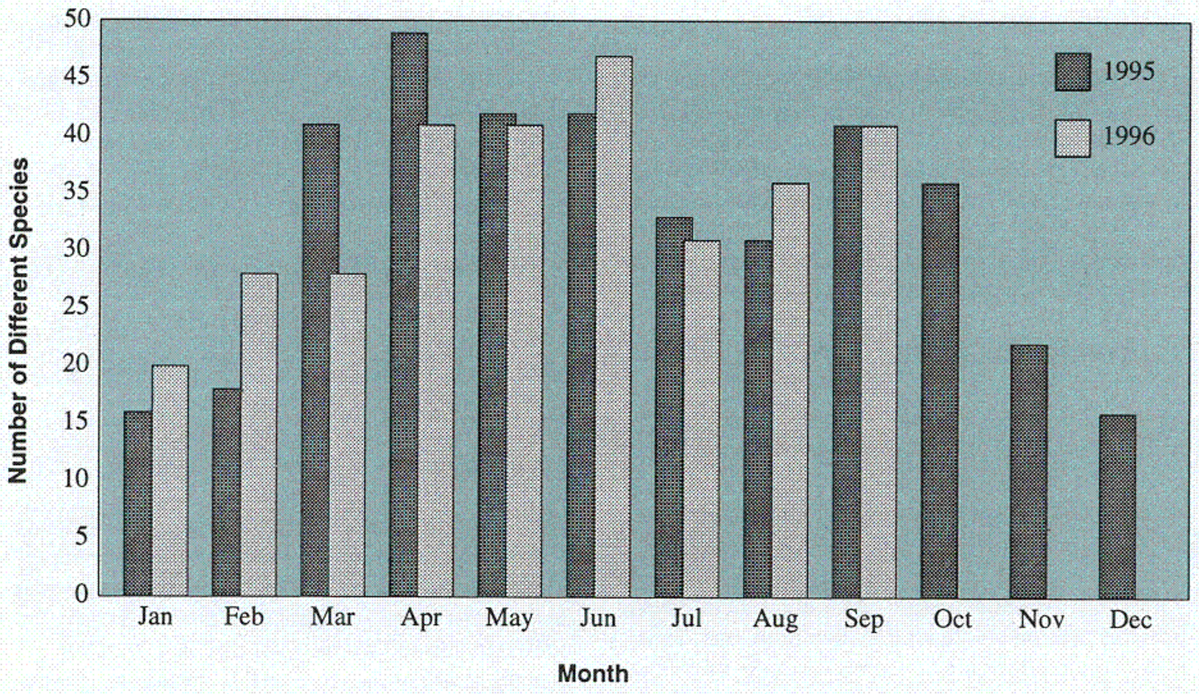
During 1995, an extensive survey of natural regeneration of forest species was conducted around the outer perimeter of the delta region of Pen Branch. Results of that survey indicated that approximately 100 acres of the delta had sufficient bald cypress (*Taxodium distichum*) seedlings and saplings to consider the areas reforested. Preliminary stocking tallies taken in 1996 continue to show the vigor and high densities of this natural regeneration. These areas are included in a Geographic Information System layer for mapping of the Pen Branch area. All areas of the Pen Branch corridor above Risher Pond Road (A–13.2) also are considered to have been reforested by natural regeneration to a bottomland hardwood forest type.

## Reforestation of the Pen Branch Corridor and Delta by Planting

The Pen Branch corridor and delta are being reforested using indigenous wetlands species. Seeds were collected from individual trees at SRS and in the Upper Coastal Plain during 1992–1993 to ensure appropriate genetic material for use in the project. The seeds were planted and grown at a State of Georgia nursery during 1993–1995 for use in the Pen Branch seedling planting program. These seedlings—of species appropriate to the area being reforested—subsequently were transplanted to the Pen Branch wetland areas. The reforested areas will be managed until successful reforestation has been achieved. This is the preferred method of mitigation for Pen Branch because of the brief restoration time frame required by DOE commitments. Recent (1994–1995) observations indicate that cypress and tupelo are becoming reestablished naturally in portions of the Pen Branch delta, as noted above. Intervention into this natural process will be considered only to maximize survival of the desired species.

The initial and secondary seedling plantings of the entire corridor and delta areas, which it was determined would require intervention for successful mitigation, have been completed. This intervention consisted of planting approximately 31 acres of the lower corridor with a mixture of flood-tolerant hardwood species and cypress seedlings in 1993. An additional 47 acres of the upper corridor was planted with a mixture of bottomland hardwood species seedlings in 1994. Species planted have included water and pignut hickory, sycamore, green ash, swamp and water tupelo, black gum, persimmon, cherrybark and water oak, bald cypress, and swamp chestnut oak. In 1995, the upper corridor section was replanted with seedlings because of the mortality that resulted from feral hog predation on the original planted seedlings. Also in 1995, the delta area was planted for the first time with bald cypress, water tupelo, and—on drier ridges—green ash seedlings. Approximately 90 acres were planted at densities of 450–500 seedlings per acre. Approximately 85,000 seedlings have been planted during the 3 years of planting (1993–1995) in the corridor and delta areas. A regeneration survey conducted in 1996 found that approximately 250 seedlings per acre were becoming established in the corridor region. It is anticipated that this stocking level will provide sufficient numbers of trees to ensure reforestation success.

Within each of the areas that have been planted, there are areas that will serve as untreated controls to assess the effectiveness of the reforestation effort. Twenty-eight acres of the delta and 20 acres in the




Ileaf Graphic

**Figure 12–3 Monthly Reptile and Amphibian Species Diversity in the Pen Branch Corridor**
Studies to identify species composition and relative abundance were concluded in September 1996.

corridor were left in these control sections. This has allowed research efforts on the success of the restoration to compare the treated and untreated areas for the purpose of measuring differences in ecological responses to the treatments. This control acreage is part of that committed to in the MAP. It will be assessed to determine if it will reforest naturally because of its proximity to the mitigated acreage; if it will not, it may receive plantings at a later date.

Because of the control/restoration comparison areas, a number of research and baselining activities have been conducted to document the recovery of the faunal component of the wetland system. Studies of aquatic macroinvertebrates and fish are occurring in the corridor reaches of the stream. Observations of neotropical bird utilization of the habitats were concluded during the spring of 1996. Studies to identify species composition and the relative abundance of small mammals, amphibians, and reptiles were concluded in the fall of 1996 to quantify recolonization of the bottomland hardwood forest. Figure 12–3 illustrates the species diversity findings with respect to reptiles and amphibians. Results indicated that species diversity in the Pen Branch system was slightly greater than in unimpacted systems. As the Pen Branch system matures, however, the diversity is expected to diminish.

These studies have been conducted by Clemson University, the University of South Carolina, the University of Georgia, the Savannah River Ecology Laboratory (SREL), and the University of South Carolina at Aiken. Additional modeling of hydrology has been completed by the Waterways Experiment Station of the U.S. Army Corps of Engineers. During 1996, a symposium was organized by the Environmental Sciences Section of the Savannah River Technology Center to provide all parties involved in the restoration, monitoring, and research efforts the opportunity to share their findings. Additional topics of discussion included the identification of data gaps to document successful restoration and assessment criteria. The symposium's proceedings subsequently were published and distributed [Nelson, 1996].

An establishment report detailing all activities associated with the reforestation was issued in 1996 and serves as the operational guidebook of what silvicultural activities have occurred to accomplish the mitigation to this point [Dulohery, 1996]. Additional updates on the seedling growth and survival will be included in the *SRS Environmental Report for 1997* to fulfill reporting requirements.

C04

### Compensatory Mitigation

This option would provide equivalent mitigation at sites other than Pen Branch—either by enhancing degraded wetlands or by creating new wetlands. The option will be considered following evaluation of the success of reforesting the Pen Branch corridor and delta in the year 2000. However, it is the least desired option and will be implemented only should the existing efforts in Pen Branch prove unsuccessful.

## Trans-River Flow Project

Many regions of the United States are planning for increased water supply demands as a result of population and industrial growth. Groundwater often is the most practical source of new water supply because of its general good quality and availability near the source of need. However, groundwater is vulnerable to contamination and, once contaminated, presents near insoluble remediation problems. Thus, many communities are concerned about maintaining the quality of their groundwater reservoirs. One area of such concern is along the South Carolina-Georgia state line near SRS.

The site has produced nuclear materials for national defense since the early 1950s, and a variety of hazardous materials—including radionuclides (such as tritium), volatile organic compounds, and trace metals—are disposed of or stored at SRS locations. As a result, groundwater beneath an estimated 5 to 10 percent of the site has been contaminated.

The Trans-River Flow Project was initiated in 1988 to address Georgia officials' concerns about the possibility that tritium-contaminated groundwater was migrating from SRS to Georgia. USGS research has confirmed that no threat exists from the tritium in question [Heffner, 1997]. However, the USGS, in cooperation with the U.S. Department of Energy (DOE) and the Georgia Department of Natural Resources (GDNR) is continuing the DOE–funded Trans-River Flow Project, which describes groundwater flow and quality near the Savannah River. Detailed information about the project will be published in the proceedings of the 1997 Georgia Water Resources Conference, to be held March 20–22 at the University of Georgia, Athens [Clarke, 1997].

## Academy of Natural Sciences of Philadelphia River Quality Surveys

### Overview

The Environmental Research Division of ANSP has been conducting biological and water-quality surveys of the Savannah River since 1951. These surveys are designed to assess potential effects of SRS contaminants and warm water discharges on the general health of the river and its tributaries. This is accomplished by looking for patterns of biological disturbance that are geographically associated with the site, and for patterns of change over seasons or years that indicate improving or deteriorating conditions.

### Results

Results of the 1996 ANSP studies on the Savannah River have been delayed pending finalization of a new contract based on recommendations of the 1996 "Rock Hill Initiative #2" review, which is discussed in detail in chapter 3, "Environmental Program Information." It is expected that results of analyses of the 1996 data will be compiled after the new contract is placed—and that both 1996 and 1997 results will be reported in the *SRS Environmental Report for 1997*.

*Appendix A*

# Applicable Guidelines, Standards, and Regulations

THE Savannah River Site (SRS) environmental monitoring program is designed to meet state and federal regulatory requirements for radiological and nonradiological programs. These requirements are stated in U.S. Department of Energy (DOE) orders 5400.1, "General Environmental Protection Program," and 5400.5, "Radiation Protection of the Public and the Environment"; in the National Emission Standards for Hazardous Air Pollutants (NESHAP); in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA—also known as the Superfund); in the Resource Conservation and Recovery Act (RCRA); in the Clean Water Act (i.e., NPDES); and in the National Environmental Policy Act (NEPA). Compliance with environmental requirements is assessed by the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Environmental Protection Agency (EPA).

The SRS environmental monitoring program's objectives incorporate recommendations of the International Commission on Radiological Protection (*"Principles of Monitoring for the Radiation Protection of the Public,"* ICRP Publication 43), of DOE Order 5400.1, and of DOE/EH–0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance."

More specific information about certain media is presented in the following paragraphs.

## Air

DOE Order 5400.5 also establishes Derived Concentration Guides (DCGs) for radionuclides in air. DCGs, calculated by DOE using methodologies consistent with recommendations found in International Commission on Radiological Protection (ICRP) publications 26 and 30, are used as reference concentrations for conducting environmental protection programs at DOE sites and for making dose comparisons. DCGs are not considered release limits. DCGs are discussed in more detail on page 187.

In addition, radiological airborne releases are subject to EPA regulations cited in 40 CFR 61, Subpart H, NESHAP.

SCDHEC regulates nonradioactive air emissions—both criteria pollutants and toxic air pollutants—from SRS sources. Each source is permitted by SCDHEC, with specific limitations identified, as outlined in various South Carolina air pollution control regulations and standards. The applicable standards are source dependent; however, the primary standards that govern criteria air pollutants and ambient air quality are identified in SCDHEC Air Pollution Control Regulation 61–62.5, Standard No. 2, which lists eight criteria air pollutants commonly used as indices of air quality (e.g., sulfur dioxide, nitrogen dioxide, and lead) and provides an allowable site boundary concentration for each pollutant. The standards for toxic air pollutants are identified in Regulation 61–62.5, Standard No. 8, which identifies 257 toxic air pollutants and their respective allowable site boundary concentrations. Specific permits for operating facilities are listed in appendix B, "SRS Environmental Permits."

SCDHEC airborne emission standards for each SRS permitted source may differ, based on size and type of facility, type and amount of expected emissions, and the year the facility was placed into operation. For example, for powerhouse boilers constructed before February 11, 1971, the particulate emission limit is 0.6 pounds per million BTU (British thermal unit) of boiler fuel heat input. Boilers constructed after 1971 must meet more stringent standards identified in 40 CFR 60, "New Source Performance Standards." For process and diesel engine stacks in existence prior to January 1, 1986, and powerhouse stacks built before February 11, 1971, the opacity standard is 40 percent. For new sources placed into operation after these dates, the opacity standard typically is 20 percent.

Compliance with the various standards is determined in several ways. At the SRS powerhouses, stack compliance tests are performed every 2 years for each boiler by airborne emission specialists under contract to SRS. The tests include

- sampling of the boiler exhaust gases to determine particulate emission rates and carbon dioxide and oxygen concentrations
- laboratory analysis of coal for sulfur content, ash content, moisture content, and BTU output

Sulfur content and BTU output are used to calculate sulfur dioxide emissions. SCDHEC also conducts visible-emissions observations during the tests to verify compliance with opacity standards. The day-to-day control of particulate matter smaller than 10 microns is demonstrated by opacity meters in all SRS powerhouse stacks.

For the package steam generating boilers in K-Area and P-Area, compliance with sulfur dioxide standards is determined by analysis of the fuel oil being purchased from the offsite vendor. The percent of sulfur in the fuel oil must be below 0.5. Compliance with particulate emission standards was determined with mass-balance calculations.

Compliance by SRS diesel engines and other process stacks is determined during annual compliance inspections by the local SCDHEC district air manager. These inspections include a review of operating parameters, an examination of continuous-emission monitors (where required for process stacks), and a visible-emissions observation for opacity.

Compliance by all toxic air pollutant and criteria pollutant sources is also determined by using EPA-approved air dispersion models. Air dispersion modeling is extremely conservative unless refined models are used. The Industrial Source Complex Version No. 2 model was used to predict maximum ground-level concentrations occurring at or beyond the site boundary for new sources permitted during 1996.

## Liquid

DOE Order 5400.5 also establishes DCGs for radionuclides in water. DCGs were calculated by DOE using methodologies consistent with recommendations found in ICRP Publications 26 and 30 and are used

- as reference concentrations for conducting environmental protection programs at DOE sites
- as screening values for considering best available technology for treatment of liquid effluents
- for making dose comparisons

DCGs are discussed in more detail on page 187.

DOE Order 5400.5 exempts aqueous tritium releases from best available technology requirements but not from ALARA considerations.

EPA drinking water standards (40 CFR 141) for radionuclides apply at the water treatment plants serving Beaufort and Jasper counties in South Carolina and Port Wentworth in Georgia. Drinking water standards for specific radionuclides are listed in appendix D, "Drinking Water Standards."

DOE Order 5400.5, chapter II, section 3a(4), requires that settleable solids in process waste streams be tested to ensure that no buildup of radionuclides occurs in the sediments of the receiving streams.

From January 1, 1996, through September 30, 1996, SRS discharged water into site streams and the Savannah River under four NPDES permits: two for industrial wastewater (SC0000175 and SC0044903) and two for stormwater runoff—SCR000000 for industrial discharge and SCR100000 for construction discharge. A fifth NPDES permit—a no-discharge permit (ND0072125)—was issued to cover land application of sludge generated at onsite sanitary waste treatment plants. Industrial permit SC0000175 expired in 1988 and industrial permit SC0044903 expired in 1995. Because SRS had applied for a new permit, discharges were allowed to continue under the expired permits until October 1, 1996, when the new NPDES permit, SC0000175, was put into effect. Discharge points covered under the two old industrial wastewater permits, SC000175 and SC0044903, were included in the new SC0000175 permit, which remains in effect until September 30, 2001.

Stormwater industrial permit SCR000000 covers 48 discharge locations sorted into 11 groups. A representative site from each group was sampled, as required by the permit. Construction permit SCR100000 does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site. SCDHEC did not request any such sampling in 1996.

**Chart 1**
**South Carolina Water Quality Standards for Freshwaters**

Note: This is a partial list only of water quality standards for freshwaters.

| Parameters | Standards |
|---|---|
| **a. Fecal coliform** | Not to exceed a geometric mean of 200/100 mL, based on five consecutive samples during any 30-day period; nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 mL. |
| **b. pH** | Range between 6.0 and 8.5. |
| **c. Temperature** | Generally, shall not be increased more than 5 °F (2.8 °C) above natural temperature conditions or be permitted to exceed a maximum of 90 °F (32.2 °C) as a result of the discharge of heated liquids. For exceptions, see E–6, Regulation 61–68, State of South Carolina Water Classifications and Standards (May 28, 1993). |
| **d. Dissolved oxygen** | Daily average not less than 5.0 mg/L, with a low of 4.0 mg/L. |
| **e. Garbage, cinders, ashes, sludge, or other refuse** | None allowed. |
| **f. Treated wastes, toxic wastes, deleterious substances, colored or other wastes, except those in (e) above.** | None alone or in combination with other substances or wastes in sufficient amounts to make the waters unsafe or unsuitable for primary-contact recreation or to impair the waters for any other best usage as determined for the specific waters assigned to this class. |
| **g. Ammonia, chlorine, and toxic pollutants listed in the federal Clean Water Act (307) and for which EPA has developed national criteria (to protect aquatic life).** | See E–7 (list of water quality standards based on organoleptic data) and E–8 (water quality criteria for protection of human health), Regulation 61–68, State of South Carolina Water Classifications and Standards (May 28, 1993). |

SOURCE: [SCDHEC, 1993]

## Site Streams

SRS streams are classified as "Freshwaters" by the South Carolina Pollution Control Act. Freshwaters are defined as surface water suitable for

- primary- and secondary-contact recreation and as a drinking water source after conventional treatment in accordance with SCDHEC requirements
- fishing and survival and propagation of a balanced indigenous aquatic community of fauna and flora
- industrial and agricultural uses

Chart 1 provides some of the specific guides used in water quality surveillance, but because some of these guides are not quantifiable, they are not tracked in response form (i.e., amount of garbage found)

## Savannah River

Because the Savannah River is defined under the South Carolina Pollution Control Act as a Freshwater system, the river is regulated in the same manner as are site streams (chart 1).

## Drinking Water

SRS drinking water systems must meet the water quality criteria mandated by SCDHEC State Primary Drinking Water Regulations, R.61–68. Drinking water standards for specific contaminants are provided in appendix D, "Drinking Water Standards."

All 27 systems are monitored routinely for compliance with SCDHEC bacteriological water quality limits. The sampling frequency depends on the population served. All systems are monitored semiannually for chlorocarbon concentrations. SRS also monitors the 13 larger systems for lead and copper concentrations according to SCDHEC requirements. SCDHEC periodically collects samples from the 13 larger systems to determine compliance with chemical, synthetic organic, and volatile organic water quality limits.

## Groundwater

The analytical results of samples taken from SRS monitoring wells that exceed various standards are discussed in this report. Constituents discussed are compared to final federal primary drinking water standards (DWS), or other standards if DWS do not exist, because groundwater aquifers are defined as potential drinking water sources by the South Carolina Pollution Control Act. [SCDHEC, 1985]. The DWS can be found in appendix D, "Drinking Water Standards." DWS are not always the standards applied by regulatory agencies to the SRS waste units under their jurisdiction. For instance, standards under RCRA are DWS, groundwater protection standards, background levels, and alternate concentration limits.

Two constituents having DWS, dichloromethane and bis(2-ethylhexyl) phthalate, are not discussed in this report. Both are common laboratory contaminants and are reported in groundwater samples with little or no reproducibility. Both are reported, with appropriate flags and qualifiers, in the data tables of the quarterly reports cited in chapter 10, "Groundwater."

The standard used for lead is the SCDHEC DWS. The federal standard of 15 µg/L is a treatment standard for drinking water at the consumer's tap; thus, it is inappropriate for use as a groundwater standard.

Of the radionuclides discussed, only gross alpha, strontium-90, and tritium are compared to true primary DWS. The regulatory standards for radionuclide discharges from industrial and governmental facilities are set under the Clean Water Act, RCRA, and Nuclear Regulatory Commission and DOE regulations. The proposed drinking water maximum contaminant levels discussed in this report are only an adjunct to these release restrictions and are not used to regulate SRS groundwater.

The standard used for gross beta is a screening standard; when public drinking water exceeds this standard, the supplier is expected to analyze for individual beta and gamma emitters. A gross beta result above the standard is an indication that one or more radioisotopes are present in quantities that would exceed the EPA annual dose equivalent for persons consuming 2 liters daily. Thus, for the individual beta and gamma radioisotopes (other than strontium-90 and tritium), the standard discussed in this report is the activity per liter that would, if only that isotope were present, exceed the dose equivalent. Similarly, the standards for alpha emitters discussed in this report are calculated to present the same risk at the same rate of ingestion.

Although radium has a DWS of 5 pCi/L for the sum of radium-226 and radium-228, the standards discussed in this report are the proposed standards of 20 pCi/L for each isotope separately. Radium-226, an alpha emitter, and radium-228, a beta emitter, cannot be analyzed by a single method. Analyses for total alpha-emitting radium, which consists of radium-223, radium-224, and radium-226, are compared to the standard for radium-226. During 1997, EPA-proposed standards of 20 pCi/L for radium-226 and 20 pCi/L for radium-228 are expected to replace the 5 pCi/L interim standard.

Four other constituents without DWS are discussed in this report when their values exceed specified levels. These constituents are specific conductance at values equal to or greater than 100 µS/cm, alkalinity (as $CaCO_3$) at values equal to or greater than 100 mg/L, total dissolved solids (TDS) at values equal to or greater than 200 mg/L, and pH at

values equal to or less than 4.0 or equal to or greater than 8.5. The selection of these values as standards for comparison is somewhat arbitrary; however, these values exceed levels usually found in background wells at SRS. The occurrence of elevated alkalinity (as $CaCO_3$), specific conductance, pH, and TDS within a single well may indicate leaching of the grouting material used in well construction, rather than degradation of the groundwater.

## Potential Dose

The radiation protection standards followed by SRS are outlined in DOE Order 5400.5 and include U.S. Environmental protection Agency (EPA) regulations on the potential doses from airborne releases and treated drinking water.

The following radiation dose standards for protection of the public in the SRS vicinity are specified in DOE Order 5400.5.

Drinking Water Pathway .... 4 mrem per year
Airborne Pathway ........ 10 mrem per year
All Pathways ........... 100 mrem per year

The EPA annual dose standard of 10 mrem (0.1 mSv) for the atmospheric pathway, which is contained in "National Emission Standards for Hazardous Air Pollutants–Radionuclides (NESHAP)," 40 CFR Part 61, Subpart H, is adopted in DOE Order 5400.5.

These dose standards are based on recommendations of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP).

The DOE dose standard enforced at SRS for drinking water consumed from site drinking water systems, community drinking water systems, and downriver water treatment plants is consistent with the criteria contained in "National Interim Primary Drinking Water Regulations, 40 CFR Part 141." Under these regulations, persons consuming drinking water shall not receive an annual whole body dose—DOE Order 5400.5 interprets this dose as committed effective dose equivalent —of more than 4 mrem (0.04 mSv). Both of these dose standards are based on a consumption of 2 liters of water per day. However, some radionuclide dose conversion factors (including tritium) differ between EPA and DOE. Because SRS must use DOE-provided, ICRP-based dose conversion factors, a direct comparison of the estimated drinking water doses in chapter 7, "Potential Radiation Doses," to the EPA drinking water dose standard cannot be made. However, radionuclide concentrations found in drinking water are directly compared to the EPA drinking water concentration standards in chapter 6, "Radiological Environmental Surveillance."

### Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides

Average concentrations of radionuclides in airborne emissions are calculated by dividing the yearly release total of each radionuclide from each stack by the yearly stack flow quantities. These average concentrations then can be compared to the DOE derived concentration guides (DCGs), which are found in DOE Order 5400.5 for each radionuclide.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs, which are based on a 100-mrem exposure, are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure (assumed to be an average inhalation rate of 8,400 cubic meters per year). This means that the DOE DCGs are based on the highly conservative assumption that a member of the public has direct access to and continuously breathes (or is immersed in) the actual air effluent 24 hours a day, 365 days a year. However, because of the large distance between most SRS operating facilities and the site boundary, and because the wind rose at SRS shows no strong prevalence (chapter 7, "Potential Radiation Doses"), this scenario is improbable.

Average annual radionuclide concentrations in SRS air effluent can be referenced to DOE DCGs as a screening method to determine if existing effluent treatment systems are proper and effective.

### Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Guides

In addition to dose standards, DOE Order 5400.5 imposes other control considerations on liquid releases. These considerations are applicable to direct discharges but not to seepage basin and Solid Waste Disposal Facility (SWDF) migration discharges. The DOE order lists DCG values for most radionuclides. DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. These DCG values are not release limits but screening values for best available technology investigations and for

determining whether existing effluent treatment systems are proper and effective.

Per DOE Order 5400.5, exceedance of the DCGs at any discharge point may require an investigation of best available technology waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from best available technology requirements; however, it is not excluded from other as-low-as-reasonably-achievable (ALARA) considerations. DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month average concentrations.

DCGs, based on a 100-mrem exposure, are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). They are based on the highly conservative assumption that a member of the public has continuous direct access to the actual liquid effluents and consumes 2 liters of the effluents every day, 365 days a year. However, because of security controls and the large distance between most SRS operating facilities and the site boundary, this scenario is highly improbable, if not impossible.

For each site facility that releases radioactivity, EMS compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs.

## Environmental Restoration and Waste Management

SRS began its cleanup program in 1981. Two major federal statutes drive the site's environmental restoration and waste management activities: the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). RCRA addresses the management of regulated hazardous waste and requires that permits be obtained for facilities that treat, store, or dispose of hazardous or mixed waste. It also requires that DOE facilities perform appropriate corrective action to address contaminants in the environment. CERCLA (also known as Superfund) addresses the uncontrolled release of hazardous substances and the cleanup of inactive waste sites. This act establishes a National Priority List of sites targeted for assessment and, if necessary, restoration. SRS was placed on this list December 21, 1989 [Fact Sheet, 1995]. SRS entered into an agreement with EPA and SCDHEC as to how SRS would be cleaned up. The agreement became effective in August 1993.

## Quality Assurance/Quality Control

DOE Order 5700.6C, "Quality Assurance," sets requirements and guidelines for departmental quality assurance (QA) practices. WSRC developed an implementation plan to address the order, entitled "Revised Implementation Plan: DOE Order 5700.6C." To ensure compliance with regulations and to provide overall quality requirements for site programs, WSRC developed the *Westinghouse Savannah River Company Quality Assurance Management Plan* (WSRC–RP–92–225). The requirements of WSRC–RP–92–225 are implemented by the *Westinghouse Savannah River Company Quality Assurance Manual* (WSRC 1Q).

The *Environmental Monitoring Section Quality Assurance Plan*, Volume III (WSRC–3Q1–2), part of the EMS WSRC–3Q1 procedure series, was written to apply the QA requirements of WSRC 1Q to the environmental monitoring and surveillance program. The EMS WSRC–3Q1 procedure series includes procedures on sampling, radiochemistry, and water quality that emphasize the quality control requirements for EMS.

NESHAP defines specific QA requirements for monitoring radiological air emissions [EPA, 1989]. The EMS QA program's plan to comply with these requirements is found in WSRC–3Q1–2, Volume I, Attachment 3–1, "NESHAP QA Plan" (WSRC–IM–91–60).

To ensure valid and defensible monitoring data, the records and data generated by the monitoring program are maintained according to the requirements of DOE Order 1324.2A, "Records Disposition," and of WSRC 1Q. QA records include sampling and analytical procedure manuals, logbooks, chain-of-custody forms, calibration and training records, analytical notebooks, control charts, validated laboratory data, and environmental reports. These records are maintained and stored per the requirements of WSRC–1M–93–0060, *WSRC Sitewide Records Inventory and Disposition Schedule*.

*Appendix B*

# SRS Environmental Permits

*Listed below are the construction and operating permits held by Savannah River Site. The permits are divided by type of permit; for each type, the permit number, permit title, and permitted source are provided.*

**Air Permits**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–A–CA | VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; A–014 OUTFALL (GROUNDWATER REMEDIATION), 782–3M |
| A0080–0041–A–CB | 320-GPM AIR STRIPPER, A–002; CATALYTIC OXIDATION UNIT (A–001A OUTFALL); SRTC |
| 0080–0041–A–CC | A-AREA POWERHOUSE EFFLUENT TREATMENT AND REROUTING SYSTEM, 784–A (BAGHOUSE) |
| 0080–0041–F–CL | TWO 20,000-GALLON UNDERGROUND STORAGE FUEL TANKS, 254–5F |
| 0080–0041–G–CK | 500-KW PORTABLE DIESEL-GENERATOR SET, #E–82643, ALL AREAS |
| 0080–0041–G–CL | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #7776, ALL AREAS |
| 0080–0041–H–CG | 350-KW EMERGENCY POWER DIESEL GENERATOR (254–11H) TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261–H |
| 0080–0041–H–CG | 350-KW EMERGENCY POWER DIESEL GENERATOR (254–12H) TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261–H |
| 0080–0041–H–CG–R1 | CONSOLIDATED INCINERATION FACILITY (CIF) FOR NONRADIOACTIVE HAZARDOUS WASTE, 261–H |
| 0080–0041–H–CH | MODIFICATION TO 0080–0041–S13; LATE-WASH FACILITY, 241–10H |
| 0080–0041–H–CI | CONSOLIDATED INCINERATION FACILITY (CIF) ASHCRETE PROCESS |
| 0080–0041–H–CK | NEW SOLVENT STORAGE TANK FACILITY (FOUR 30,000-GALLON UNDERGROUND TANKS, NEAR CIF, 261–H) |
| 0080–0041–H–CL | TWO 20,000-GALLON UNDERGROUND STORAGE FUEL TANKS, 254–5H |
| 0080–0041–M–CA | VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SEWER (GROUNDWATER REMEDIATION), 782–5M |
| 0080–0041–M–CB | VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA BASIN (GROUNDWATER REMEDIATION), 782–4M |
| 0080–0041–M–CC | VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SOLVENT STORAGE (GROUNDWATER REMEDIATION), 782–6M |
| 0080–0041–M–CD | SOIL VAPOR EXTRACTION/CATALYTIC OXIDATION UNIT, 782–7M |
| 0080–0041–M–CE | MIXED-WASTE VITRIFICATION PROCESS, M-AREA |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–M–CF–R1 | CATALYTIC OXIDATION UNIT TO REDUCE VOC EMISSIONS FROM 610-GPM M–1 AIR STRIPPER, M-AREA |
| 0080–0041–M–CG | MODIFICATION TO MIXED-WASTE VITRIFICATION PROCESS (NOx CONTROL STRATEGIES), M-AREA |
| 0080–0041–M–CH | SOIL VAPOR EXTRACTION/CATALYTIC OXIDATION UNIT, 782–8M |
| 0080–0041–PORT–CB | 15,000-LB/HR PORTABLE PACKAGE STEAM GENERATOR #1, GENERAL SITE |
| 0080–0042–CN | OFF-GAS COMPONENTS TEST FACILITY, 678–T |
| 0080–0045–CI | NAVAL FUEL MATERIALS FACILITY (FMF) CEMENT AND FLY-ASH SILOS AND BAGHOUSE, 247–F |
| 0080–0045–CK | NEW SPECIAL RECOVERY PROCESS WITH CYCLONE, SCRUBBERS, AND HEPA FILTERS, 221–F |
| 0080–0046–CE | 150-KW EMERGENCY POWER DIESEL GENERATOR, 241–96H |
| 0080–0046–CH | FUEL PROCESSING FACILITY (FPF) WITH HEPA FILTERS |
| 0080–0048–CB | 800-KW EMERGENCY POWER DIESEL GENERATOR–A, 107–3P |
| 0080–0048–CC | 800-KW EMERGENCY POWER DIESEL GENERATOR–B, 107–2P |
| 0080–0049–CB | 800-KW EMERGENCY POWER DIESEL GENERATOR–A, 107–L |
| 0080–0049–CC | 800-KW EMERGENCY POWER DIESEL GENERATOR–B, 107–L |
| EXEMPTED | 12,000-GALLON JET FUEL STORAGE TANK TO SERVE AVIATION OPERATIONS DEPARTMENT FACILITY, B-AREA |
| 0080–0041–A01 | 71.7-MMBTU/HR COAL BOILER #1; CYCLONES, 784–A |
| 0080–0041–A02 | 71.7-MMBTU/HR COAL BOILER #2; CYCLONES, 784–A |
| 0080–0041–A03 | 600-KW EMERGENCY POWER DIESEL GENERATOR, 794–A |
| 0080–0041–A04 | 400-KW EMERGENCY POWER DIESEL GENERATOR, 773–A |
| 0080–0041–A05 | 150-KW EMERGENCY POWER DIESEL GENERATOR, 751–2A |
| 0080–0041–A06 | 400-KW EMERGENCY POWER DIESEL GENERATOR (503–2A) TO SERVE 735–A, 735–11A, 774–A, AND 773–A FEEDERS |
| 0080–0041–A07 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 703–A (C–WING) |
| 0080–0041–A08 | 250-KW EMERGENCY POWER DIESEL GENERATOR, 754–4A |
| 0080–0041–A09 | 455-KW EMERGENCY POWER DIESEL GENERATOR, 720–2A |
| 0080–0041–A10 | 1250-KW EMERGENCY POWER DIESEL GENERATOR #1, 754–5A (TO SERVE 703–44A) |
| 0080–0041–A11 | 1250-KW EMERGENCY POWER DIESEL GENERATOR #2, 754–5A (TO SERVE 703–44A) |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–A12 | 70-GPM AIR STRIPPING COLUMN, A–001; CATALYTIC OXIDATION UNIT (A–001A OUTFALL), SRTC |
| 0080–0041–A14 | 155-KW EMERGENCY POWER DIESEL GENERATOR, 737–2A (TO SERVE SREL) |
| 0080–0041–C06 | 365-KW EMERGENCY POWER DIESEL GENERATOR, 183–3C |
| 0080–0041–D05 | 150-KW EMERGENCY POWER DIESEL GENERATOR, 501–D |
| 0080–0041–F05 | URANIUM DISSOLUTION, 221–F |
| 0080–0041–F06 | 200-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254–5F #1 |
| 0080–0041–F07 | 200-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254–5F #2 |
| 0080–0041–F08 | 175-KW EMERGENCY POWER DIESEL GENERATOR, 772–F #1 |
| 0080–0041–F09 | 175-KW EMERGENCY POWER DIESEL GENERATOR, 772–F #2 |
| 0080–0041–F10 | 350-KW EMERGENCY POWER DIESEL GENERATOR, 241–19F |
| 0080–0041–F11 | 350-KW EMERGENCY POWER DIESEL GENERATOR, 235–F |
| 0080–0041–F12 | 350-KW EMERGENCY POWER DIESEL GENERATOR, 254–4F |
| 0080–0041–F13 | 250-KW EMERGENCY POWER DIESEL GENERATOR, 254–1F |
| 0080–0041–F14 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 241–74F |
| 0080–0041–F15 | 600-KW EMERGENCY POWER DIESEL GENERATOR, 292–F |
| 0080–0041–F16 | 600-KW EMERGENCY POWER DIESEL GENERATOR, 247–1F NAVAL FUEL (FMF) |
| 0080–0041–F17 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 254–7F |
| 0080–0041–F18 | 415-KW EMERGENCY POWER DIESEL GENERATOR, 772–1F |
| 0080–0041–F19 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 292–2F |
| 0080–0041–F20 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 254–9F |
| 0080–0041–F21 | 1000-KW EMERGENCY POWER DIESEL GENERATOR, 221–F |
| 0080–0041–F22 | 600-KW EMERGENCY POWER DIESEL GENERATOR, 254–10F |
| 0080–0041–F23 | 350-KW EMERGENCY POWER DIESEL GENERATOR, 254–8F |
| 0080–0041–F24 | NAVAL FUEL MATERIALS FACILITY (FMF) STACK; SCRUBBERS AND HEPA FILTERS, 247–F |
| 0080–0041–F25 | NAVAL FUEL MATERIALS FACILITY (FMF) WASTEWATER TREATMENT FACILITY; DEMISTER, 247–F |
| 0080–0041–F26 | NINE FINISHING VENTS, NINE SCRUBBERS, AND NINE HEPA FILTERS FOR NAVAL FUEL MATERIALS FACILITY (FMF), 247–F |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–F27 | 455-KW EMERGENCY POWER DIESEL GENERATOR, 720–F |
| 0080–0041–G01 | WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #1; CARBON SCRUBBER, ALL AREAS |
| 0080–0041–G02 | WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #2; CARBON SCRUBBER, ALL AREAS |
| 0080–0041–G03 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–112; ALL AREAS |
| 0080–0041–G04 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–113; ALL AREAS |
| 0080–0041–G05 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–114; ALL AREAS |
| 0080–0041–G06 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–115; ALL AREAS |
| 0080–0041–G07 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–116; ALL AREAS |
| 0080–0041–G08 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–128; ALL AREAS |
| 0080–0041–G09 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–129; ALL AREAS |
| 0080–0041–G10 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–130; ALL AREAS |
| 0080–0041–G11 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–131; ALL AREAS |
| 0080–0041–G12 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SME 52–132; ALL AREAS |
| 0080–0041–G13 | 200-KW MOBILE EMERGENCY GENERATOR, SME 60–171; ALL AREAS |
| 0080–0041–G14 | 15,000-LB/HR PORTABLE PACKAGE STEAM GENERATING BOILER #2 (NSPS), ALL AREAS |
| 0080–0041–G15 | PORTABLE NORKOT MAXIGRIND 9100 DIESEL-POWERED CHIPPER UNIT, SME 36–25; ALL AREAS |
| 0080–0041–G16 | 190-KW MOBILE EMERGENCY GENERATOR, SRO #0391; ALL AREAS |
| 0080–0041–G17 | 250-KW MOBILE EMERGENCY GENERATOR, SRO #7835; ALL AREAS |
| 0080–0041–G18 | PORTABLE SOIL VAPOR EXTRACTION UNIT, SRO #5957; ALL AREAS |
| 0080–0041–G19 | 600-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #5422 |
| 0080–0041–G20 | 300-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #5430 |
| 0080–0041–G21 | 300-KW MOBILE EMERGENCY DIESEL GENERATOR, SRO #6455 |
| 0080–0041–G22 | 260-KW MOBILE EMERGENCY GENERATOR, SRO #7850; ALL AREAS |
| 0080–0041–G23 | 250-KW MOBILE EMERGENCY GENERATOR, SRO #7858; ALL AREAS |
| 0080–0041–G24 | WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #3; CARBON SCRUBBER, ALL AREAS |
| 0080–0041–G25 | WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #4; CARBON SCRUBBER, ALL AREAS |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–G26 | WASTE PAINT SOLVENTS DISTILLATION AND CONDENSATION UNIT #5; CARBON SCRUBBER, ALL AREAS |
| 0080–0041–G27 | 1000-KW EMERGENCY POWER DIESEL GENERATOR TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), 654–G |
| 0080–0041–G28 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5233; ALL AREAS |
| 0080–0041–G29 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5248; ALL AREAS |
| 0080–0041–G30 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #5278; ALL AREAS |
| 0080–0041–G31 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6940; ALL AREAS |
| 0080–0041–G32 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6941; ALL AREAS |
| 0080–0041–G33 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6943; ALL AREAS |
| 0080–0041–G34 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6944; ALL AREAS |
| 0080–0041–G35 | PORTABLE DIESEL-POWERED AIR COMPRESSOR, SRO #6945; ALL AREAS |
| 0080–0041–H01 | 71.7-MMBTU/HR COAL BOILER #1; 2 CYCLONES, 784–H |
| 0080–0041–H02 | 71.7-MMBTU/HR COAL BOILER #2; 2 CYCLONES, 784–H |
| 0080–0041–H03 | 71.7-MMBTU/HR COAL BOILER #3; 2 CYCLONES, 784–H |
| 0080–0041–H04 | 400-LB/HR TYPE "O" WASTE INCINERATOR, BAGHOUSE AND HEPA FILTERS (BETA-GAMMA INCINERATOR), 230–H |
| 0080–0041–H05 | SEPARATION PROCESS, 221–H |
| 0080–0041–H06 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 234–4H |
| 0080–0041–H07 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 299–1H |
| 0080–0041–H08 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 241–74H |
| 0080–0041–H09 | 250-KW EMERGENCY POWER DIESEL GENERATOR, 254–1H |
| 0080–0041–H10 | 275-KW EMERGENCY POWER DIESEL GENERATOR, 254–3H |
| 0080–0041–H11 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 221–HB |
| 0080–0041–H12 | 300-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254–5H, #1 |
| 0080–0041–H13 | 300-KW CONTINUOUSLY RUNNING DIESEL GENERATOR, 254–5H, #2 |
| 0080–0041–H14 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 232–H |
| 0080–0041–H15 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 234–H |
| 0080–0041–H16 | 500-KW EMERGENCY POWER DIESEL GENERATOR, 232–H, #2 |
| 0080–0041–H17 | 500-KW EMERGENCY POWER DIESEL GENERATOR, 254–H |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–H18 | 600-KW EMERGENCY POWER DIESEL GENERATOR, 292–H |
| 0080–0041–H19 | 1000-KW EMERGENCY POWER DIESEL GENERATOR, 221–H |
| 0080–0041–H20 | 500-KW EMERGENCY POWER DIESEL GENERATOR, 254–8H |
| 0080–0041–H21 | 400-KW EMERGENCY POWER DIESEL GENERATOR, 254–9H |
| 0080–0041–H22 | 765-KW EMERGENCY POWER DIESEL GENERATOR (254–10H) TO SERVE 233–H (RTF) |
| 0080–0041–H23 | 2500-GPM EMERGENCY DIESEL FIRE WATER PUMP #1, 241–125H (ITP) |
| 0080–0041–H24 | 2500-GPM EMERGENCY DIESEL FIRE WATER PUMP #2, 241–125H (ITP) |
| 0080–0041–H25 | 455-KW EMERGENCY POWER DIESEL GENERATOR, 720–H |
| 0080–0041–H26 | IN-TANK PRECIPITATION (ITP) TANK #48; 241–948H |
| 0080–0041–H27 | IN-TANK PRECIPITATION (ITP) TANK #49; 241–949H |
| 0080–0041–H28 | IN-TANK PRECIPITATION (ITP) FILTER/STRIPPER BUILDING, 241–96H |
| 0080–0041–H30 | IN-TANK PRECIPITATION (ITP) TANK #50; 241–950H |
| 0080–0041–H31 | IN-TANK PRECIPITATION (ITP) TANK #22; 241–922H |
| 0080–0041–H32 | 12,500-GALLON NO. 2 FUEL OIL STORAGE TANK TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF) |
| 0080–0041–K01 | 194.5-MMBTU/HR COAL BOILER, CYCLONES; UNIT #1 |
| 0080–0041–K03 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–1K |
| 0080–0041–K04 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–2K |
| 0080–0041–K05 | 150-KW EMERGENCY POWER DIESEL GENERATOR #1, 108–4K |
| 0080–0041–K06 | 150-KW EMERGENCY POWER DIESEL GENERATOR #2, 108–4K |
| 0080–0041–K07 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 152–7K |
| 0080–0041–K08 | 365-KW EMERGENCY POWER DIESEL GENERATOR (183–3K ) TO SERVE 183–2K, 905–95K, AND 905–106K |
| 0080–0041–K09 | 520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191–K (SERVING 105–K) |
| 0080–0041–K10 | 800-KW EMERGENCY POWER DIESEL GENERATOR–A, 107–K |
| 0080–0041–K11 | 800-KW EMERGENCY POWER DIESEL GENERATOR–B, 107–K |
| 0080–0041–K12 | 76.8-MMBTU/HR NO. 2 FUEL OIL-FIRED BOILER (NSPS SOURCE), K-AREA |
| 0080–0041–K13 | 38-MMBTU/HR NO. 2 FUEL OIL-FIRED PACKAGE STEAM GENERATOR RATED AT 30,000-LB/HR STEAM PRODUCTION (NSPS SOURCE), K-AREA |
| 0080–0041–K14 | 2500-GPM (375-BHP) EMERGENCY-FIRE WATER PUMP, 192–2K |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–K15 | 30,000-GALLON #2 FUEL OIL STORAGE TANK, 500–02; 184–2K (NSPS SOURCE) |
| 0080–0041–K15 | 30,000-GALLON #2 FUEL OIL STORAGE TANK, 500–03; 184–2K (NSPS SOURCE) |
| 0080–0041–L01 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–1L |
| 0080–0041–L02 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–2L |
| 0080–0041–L03 | 520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191–L |
| 0080–0041–L04 | 150-KW EMERGENCY POWER DIESEL GENERATOR #1, 108–4L |
| 0080–0041–L05 | 150-KW EMERGENCY POWER DIESEL GENERATOR #2, 108–4L |
| 0080–0041–L06 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 152–7L |
| 0080–0041–L07 | 365-KW EMERGENCY POWER DIESEL GENERATOR, 183–3L |
| 0080–0041–M02 | ALUMINUM TUBE CLEANING WITH NITRIC ACID, 321–M |
| 0080–0041–M03 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 320–M (REPLACED 150-KW GENERATOR) |
| 0080–0041–M04 | 610-GPM M–1 AIR STRIPPER, M-AREA |
| 0080–0041–N01 | 2500-GPM (370-BHP) DIESEL FIRE PUMP, CENTRAL SHOPS (MATERIALS MANAGEMENT RECEIVING AND STORAGE) |
| 0080–0041–P02 | 194.5-MMBTU/HR COAL BOILER, CYCLONES, 184–P #2 |
| 0080–0041–P03 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–1P |
| 0080–0041–P04 | 1250-KW EMERGENCY POWER DIESEL GENERATOR, 108–2P |
| 0080–0041–P05 | 150-KW EMERGENCY POWER DIESEL GENERATOR, 108–4P, #1 |
| 0080–0041–P06 | 150-KW EMERGENCY POWER DIESEL GENERATOR, 108–4P, #2 |
| 0080–0041–P07 | 200-KW EMERGENCY POWER DIESEL GENERATOR, 152–7P |
| 0080–0041–P08 | 365-KW EMERGENCY POWER DIESEL GENERATOR, 183–2P |
| 0080–0041–P09 | 520-BHP EMERGENCY DIESEL BOOSTER PUMP, 191–P (SERVING 105–P) |
| 0080–0041–S05 | 2050-KW EMERGENCY POWER DIESEL GENERATOR #1, 292–S |
| 0080–0041–S06 | 2050-KW EMERGENCY POWER DIESEL GENERATOR #2, 292–S |
| 0080–0041–S07 | 261-BHP EMERGENCY FIRE WATER PUMP, 980–S |
| 0080–0041–S08 | DWPF VITRIFICATION BUILDING (PROVIDES VENTILATION FOR PERSONNEL CORRIDOR, LABORATORIES, WELD TEST, AND CHEMICAL STORAGE TANKS – ZONE 2, 221–S); HEPA FILTER |

**Air Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 0080–0041–S09 | DWPF PROCESS STACK (PROVIDES VENTILATION FOR PROCESS CELLS, PROCESS VESSEL VENT, AND MELTER OFF-GAS – ZONE 1, 291–S); SAND FILTER |
| 0080–0041–S10 | DWPF COLD-FEEDS FACILITY (CHEMICAL STORAGE TANKS FOR FORMIC ACID, HYDROXYLAMINE NITRATE, OXALIC ACID, NITRIC ACID, SODIUM HYDROXIDE, AND A GLASS FRIT-HANDLING SYSTEM WITH BAGHOUSE, 422–S) |
| 0080–0041–S11 | DWPF 150,000-GALLON ORGANIC WASTE STORAGE TANK VENT (BENZENE STORAGE, 430–S); INTERNAL FLOATING ROOF WITH PRIMARY AND SECONDARY SEALS, NITROGEN BLANKET, AND HEPA FILTER |
| 0080–0041–S12 | DWPF LOW-POINT PUMP PIT (TRANSFER OF RADIOACTIVE SLURRIES AND SOLUTIONS, 511–S); HEPA FILTERS |
| 0080–0041–T02 | PORTABLE 300-KW EMERGENCY POWER DIESEL GENERATOR, SRO #0392 |
| 0080–0041–T03 | 300-KW EMERGENCY POWER DIESEL GENERATOR, 672–T |
| 0080–0041–T04 | 20-LB/HR SHIRCO INCINERATOR, HEPA FILTERS, 677–T |
| 0080–0041–T05 | PRECIPITATE HYDROLYSIS EXPERIMENTAL FACILITY, 682–T |
| 0080–0041–T06 | 1000-KW EMERGENCY POWER DIESEL GENERATOR, 654–1T |
| 0080–0041–T07 | 300-KW EMERGENCY POWER DIESEL GENERATOR (654–T) TO SERVE 678–T |
| 0080–0041–Z01 | 425-KW EMERGENCY POWER DIESEL GENERATOR, 956–Z |
| 0080–0041–Z02 | SILO TO STORE CEMENT OR SLAG, WITH BAGHOUSE, 205–Z |
| 0080–0041–Z03 | THREE FLY-ASH/CEMENT SILOS WITH BAGHOUSE, 205–Z |
| 0080–0041–Z04 | WEIGH HOPPER WITH BAGHOUSE, 205–Z |
| 0080–0041–Z05 | TWO PREMIX AIR BLENDERS WITH BAGHOUSE, 205–Z |
| 0080–0041–Z06 | PREMIX FEED BIN WITH BAGHOUSE, 210–Z |
| 0080–0041–Z07 | GROUT MIXER WITH BAGHOUSE, SCRUBBER, AND TWO HEPA FILTERS (ONE IN SERVICE, ONE STANDBY) TO INCLUDE VOC EMISSIONS FROM STACK, 210–Z |
| 0080–0041–Z08 | LOW-POINT DRAIN TANK VENT WITH HEPA FILTER, 551–Z |
| EXEMPTED | 2500-GPM (370-BHP) DIESEL FIRE PUMP, 902–5B |
| EXEMPTED | 2500-GPM (266-BHP) DIESEL FIRE PUMP #1, 902–3F |
| EXEMPTED | 2500-GPM (266-BHP) DIESEL FIRE PUMP #2, 902–3F |
| EXEMPTED | 250-KW EMERGENCY DIESEL GENERATOR, TELEPHONE SWITCH STATION, 702–A |

## U.S. Army Corps of Engineers Nationwide Permits

| Permit Number | Permit Title |
|---|---|
| NWP #3 | REPLACEMENT OF BRIDGES 603–2G AND 603–3G ACROSS UPPER THREE RUNS CREEK, AIKEN COUNTY, SC |
| NWP #3 | REPLACEMENT OF BRIDGES AT ROAD 8–1 AND ROAD 2–1 ON UPPER THREE RUNS CREEK, AIKEN COUNTY, SC |
| NWP #3 | REPLACEMENT OF BRIDGE, 603–72G, ON ROAD B OVER LOWER THREE RUNS CREEK, BARNWELL COUNTY, SC |
| NWP #3 | REPLACEMENT OF BRIDGE ON ROAD 4 OVER FOURMILE BRANCH, AIKEN COUNTY, SC |
| NWP #12 | PIPE BRIDGE INSTALLATION FOR POTABLE WATER LINE ACROSS UPPER THREE RUNS CREEK AND SITE WETLANDS CROSSING, AIKEN COUNTY, SC |
| NWP #26 | EROSION CONTROL PROJECT IN THE Z CHANNEL BETWEEN Z-AREA AND UPPER THREE RUNS CREEK |
| NWP #26 | EROSION CONTROL PROJECT IN THE F–2 OUTFALL CHANNEL TO UPPER THREE RUNS CREEK |
| NWP #26 | EROSION CONTROL PROJECT IN THE F–1 OUTFALL CHANNEL TO UPPER THREE RUNS CREEK |

## Domestic Water Permits

The South Carolina Department of Health and Environmental Control (SCDHEC) has granted Westinghouse Savannah River Company's Environmental Protection Department the authority—now under the General Construction Permit Program (GCP), formerly under the Modified Permitting Program (MPP)—to review domestic water construction permit application packages and to issue domestic water construction and operating permits on behalf of SCDHEC. Several South Carolina municipalities have similar agreements with SCDHEC. All domestic water permits listed in this report that begin with "G" fall under the GCP; those that begin with "M" fall under the MPP.

| Permit Number | Permit Title |
|---|---|
| 210966 | DOMESTIC WATER SYSTEM UPGRADE, PHASE II, ZONE 5 (A-AREA CENTRAL TREATMENT PLANT) |
| 306376 | 500,000-GALLON DOMESTIC WATER ELEVATED STORAGE TANK TO SERVE A-AREA AND B-AREA (DOMESTIC WATER SYSTEM UPGRADE, PHASE II, ZONE 4) |
| 411337 | SODIUM HYPOCHLORITE SYSTEM, 780–1A |
| 200092 | DOMESTIC WATER DEEP WELLS, 905–104L AND 904–105L, TO SERVE L-AREA |
| 200279 | DOMESTIC WATER DEEP WELL, 905–120P, TO SERVE P-AREA |
| 201715 | DOMESTIC WATER DEEP WELL, 905–107G, TO SERVE RAILROAD CLASSIFICATION YARD |
| 202822 | DOMESTIC WATER SYSTEM (TEST WELL #1, "DIVISION A") TO SERVE D-AREA |
| 202822A1 | DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE D-AREA |
| 202915 | DOMESTIC WATER WELL AND DISTRIBUTION SYSTEM TO SERVE CONSTRUCTION SUPPORT AREA, S-AREA |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 203427 | SODIUM HYPOCHLORITE SYSTEM, 280–F |
| 203467 | SODIUM HYPOCHLORITE SYSTEM, 280–H |
| 203590 | DOMESTIC WATER WELL, 905–126G, TO SERVE 100-AREA FIRE STATION, 709–1G (INTERSECTION OF ROAD C AND ROAD 7) |
| 203628 | DOMESTIC WATER WELL, 905–118G, TO SERVE PISTOL RANGE (REPLACED WELL 905–11G) |
| 203638 | DOMESTIC WATER WELL, 905–117G, TO SERVE ALLENDALE BARRICADE (REPLACED WELL 905–6G) |
| 203786 | DOMESTIC WATER WELL, 905–114G, TO SERVE RIVER WATER PUMPING STATION, 681–3G (REPLACED WELL 905–4G) |
| 204138 | DOMESTIC WATER DEEP WELL, 905–106K, TO SERVE K-AREA (REPLACED WELL 905–94K) |
| 204198 | DOMESTIC WATER DEEP WELL, 905–119H, TO SERVE H-AREA (REPLACED WELL 905–66H) |
| 205142 | POLYPHOSPHATE SYSTEMS, 200–F-AREA |
| 205217 | UPGRADE INSTRUMENTATION 280–1H (CAUSTIC FEED SYSTEM); (F-Area also covered under this permit) |
| 205217 | UPGRADE INSTRUMENTATION 280–1F (CAUSTIC FEED SYSTEM); (H-Area also covered under this permit) |
| 205702 | POLYPHOSPHATE SYSTEMS, 200–H-AREA |
| 205877 | DOMESTIC WATER WELL, 905–116G, PIPING AND STORAGE TANK TO SERVE AUGUSTA BARRICADE, 701–6G (REPLACED WELL 905–10G) |
| 206474 | DOMESTIC WATER TEST WELL, 905–136G, TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF) |
| 206474A1 | DOMESTIC WATER SYSTEM (PUMP, WELLHEAD PIPING, TREATMENT, TANK AND DISTRIBUTION SYSTEM) TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF) |
| 206501 | DOMESTIC WATER DEEP WELL, 905–125B (TEST WELL) TO SERVE B-AREA (REPLACES WELL 905–59B) |
| 206501A1 | DOMESTIC WATER DEEP WELL, 905–125B, (PUMP/PIPING/TREATMENT) TO SERVE B-AREA |
| 206575 | DOMESTIC WATER DEEP WELLS, 905–112G AND 905–113G, TO SERVE A-AREA AND M-AREA |
| 207853 | DOMESTIC WATER SYSTEM (BACKUP TEST WELL) TO SERVE D-AREA |
| 207853A1 | DOMESTIC WATER SYSTEM (BACKUP PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE D-AREA |
| 208425 | DOMESTIC WATER TEST WELL, 905–108G, TO SERVE ADVANCED TACTICAL TRAINING ACADEMY (ATTA), 617–G |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 208425A1 | DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, TANK) TO SERVE ADVANCED TACTICAL TRAINING ACADEMY (ATTA), 617–G |
| 208434 | DOMESTIC WATER SYSTEMS (WELLS/PIPING/TREATMENT) TO SERVE ROAD 2 BARRICADE 701–8G (WELL 905–111G), ROAD 3 BARRICADE 701–12G (WELL 905–110G), AND ROAD 6 BARRICADE 701–13G (WELL 905–109G) |
| 208866 | DOMESTIC WATER WELL, 905–115G, TO SERVE AIKEN BARRICADE, 701–5G (REPLACED WELL 905–69G) |
| 209191 | DOMESTIC WATER TEST WELL, 905–131G, TO SERVE SREL PAR POND LABORATORY, 737–G |
| 209191A1 | DOMESTIC WATER SYSTEM (PUMP, PIPING, TREATMENT, STORAGE TANK) TO SERVE SREL PAR POND LABORATORY, 737–G |
| 209454 | DOMESTIC WATER WELLS, 905–96G AND 905–97G, TO SERVE TNX-AREA |
| 210657 | DOMESTIC WATER DEEP WELL, 905–103F, AND DISTRIBUTION SYSTEM TO SERVE F-AREA (REPLACED WELL 905–39F) |
| 212745 | DOMESTIC WATER DEEP WELLS, 905–1 AND 905–2, TO SERVE S-AREA |
| 304134 | TNX-AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS |
| 306386 | 650,000-GALLON DOMESTIC WATER ELEVATED STORAGE TANK TO SERVE C-AREA AND N-AREA (DOMESTIC WATER UPGRADE, PHASE II, ZONE 4) |
| 400203 | TNX-AREA HYDROPNEUMATIC DOMESTIC WATER STORAGE TANK |
| 400347 | DOMESTIC WATER HEADERS, TNX-AREA |
| 400737 | DOMESTIC WATER SYSTEM (PUMP, PIPING, STORAGE TANK) TO SERVE, Z-AREA |
| 401118 | DOMESTIC WATER LINE TO SERVE NEW WASTE TRANSFER FACILITY (NWTF), 241–102H |
| 401354 | 250,000-GALLON DOMESTIC WATER STORAGE TANK, A-AREA |
| 401446 | DOMESTIC WATER LINE TO SERVE PRODUCTION CONTROL FACILITY, 772–1F |
| 401654 | B-AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS |
| 402186 | DOMESTIC WATER LINES TO SERVE S-AREA |
| 402343 | H-AREA BACKUP BOOSTER PUMP (“AS BUILT”) |
| 402874 | SEGREGATED DOMESTIC WATER SUPPLY, 300/700 AREA, PHASE I |
| 402925–RI | DOMESTIC WATER LINES TO SERVE TEMPORARY CONSTRUCTION BUILDINGS, S-AREA |
| 403434 | SEGREGATED DOMESTIC WATER SUPPLY, 300/700 AREA, PHASE II |
| 404608 | DOMESTIC WATER LINE TO SERVE 717–K |
| 404618 | DOMESTIC WATER LINE TO SERVE 705–C |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 405184 | DOMESTIC WATER LINE TO SERVE 773–41A AND 773–42A |
| 405556 | DOMESTIC WATER LINES TO SERVE H-AREA |
| 405566 | UPGRADE DOMESTIC WATER SYSTEM, 200–F |
| 406137 | DOMESTIC WATER LINE TO SERVE INTERIM STORAGE AND REDRUMMING FACILITY, 645–1N AND 645–2N (FORMERLY 709–1G AND 709–2G) |
| 406871E1 | DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING CENTER, 730–B |
| 407705M | DOMESTIC WATER LINE TO SERVE C-AREA COMBINED DOMESTIC/FIRE SYSTEM |
| 407830 | DOMESTIC WATER LINE TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING AND STORAGE FACILITIES (MMRSF), 731–N THROUGH 731–4N |
| 408035M | DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING AND OPERATIONS SUPPORT FACILITY |
| 408221 | K-AREA DOMESTIC WATER TREATMENT AND DISTRIBUTION SYSTEM UPGRADE |
| 408285 | DOMESTIC WATER LINE TO SERVE TNX-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–41T |
| 408505M | DOMESTIC WATER SYSTEM UPGRADE – PHASE 1 (D-AREA) |
| 408552 | K-AREA FILTER BACKWASH SYSTEM |
| 408595 | DOMESTIC WATER LINE TO SERVE CONSTRUCTION OFFICE BUILDING, 305–1M |
| 409115M | DOMESTIC WATER SYSTEM UPGRADE – PHASE I (B-AREA) |
| 409125M | DOMESTIC WATER SYSTEM UPGRADE – PHASE I (A-AREA) |
| 409484 | DOMESTIC WATER LINE TO SERVE REACTOR SIMULATOR FACILITY, 707–C |
| 409955 | DOMESTIC WATER AND FIRE PROTECTION LINES TO SERVE HELICOPTER FACILITY, 703–5G AND 703–6G |
| 410155M | DOMESTIC WATER SYSTEM UPGRADE – PHASE 1 (N-AREA) |
| 410406 | DOMESTIC WATER LINE TO SERVE VEHICLE PROTECTION SHELTER SAFETY SHOWER AND EYE-WASH STATION, 777–A |
| 410956 | DOMESTIC WATER UPGRADE, PHASE II, ZONE 5 (B-AREA BOOSTER PUMP AND WATER TREATMENT PLANT MODIFICATIONS) |
| 411357 | DOMESTIC WATER LINE TO SERVE THREE SAFETY SHOWERS AT ETF–H LIFT STATION |
| 411995 | DOMESTIC WATER LINE TO SERVE 340–M AND 341–M |
| 412255 | DOMESTIC WATER LINE FROM DOMESTIC WATER DEEP WELLS (905–112G AND 905–113G) TO SERVE A-AREA AND M-AREA |
| 412917 | DOMESTIC WATER LINE TO SERVE F/H ETF CONTROL BUILDING, 241–84H AND F/H ETF TREATMENT BUILDING, 241–81H |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 510255 | MODIFICATION TO D-AREA DOMESTIC WATER SYSTEM (SODIUM ALUMINATE FEED SYSTEM) |
| 603505 | FORESTRY AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS (SODA ASH FEED SYSTEM) |
| LS–1–W | DOMESTIC WATER LINE TO SERVE TRITIUM FACILITIES SUPPORT BUILDING, 235–H |
| LS–106–W | DOMESTIC WATER LINE TO SERVE CONSTRUCTION SUPPORT FACILITIES AT DWPF AUXILIARY PUMP PIT, S-AREA |
| LS–11–W | DOMESTIC WATER LINE TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 247–F |
| LS–115–W | DOMESTIC WATER LINE TO SERVE CENTRAL SHOPS ADMINISTRATION BUILDING (CSAB), 704–3N |
| LS–118–W | DOMESTIC WATER LINE TO SERVE 719–4A |
| LS–119–W | DOMESTIC WATER LINE TO SERVE 730–M |
| LS–139–W | DOMESTIC WATER LINE TO SERVE REPLACEMENT TRITIUM FACILITY (RTF), 233–H AND 249–H |
| LS–168–W | DOMESTIC WATER LINE TO SERVE SUPPORT SERVICES BUILDING, 716–2A |
| LS–178–W | DOMESTIC WATER LINE TO SERVE COMPUTER REPAIR BUILDING, 722–5A |
| LS–185–W | DOMESTIC WATER LINE TO SERVE 703–41A |
| LS–187–W | DOMESTIC WATER LINE TO SERVE THREE SAFETY SHOWERS AT THE ETF–F LIFT STATION |
| LS–232–W | TEMPORARY DOMESTIC WATER LINE TO SERVE TOILET TRAILER 704–47S AND OFFICES 704–44S, 704–45S, AND 704–46S (Formerly FPF Construction Engineers' Offices 225–1H, 225–2H, and 225–3H) AND TOILET TRAILER 704–47H AND OFFICES 704–27H, 704–32H, 704–37H, AND 704–42H |
| LS–233–W | TEMPORARY DOMESTIC WATER LINE TO SERVE F/H ETF TOILET TRAILER, 704–46H |
| LS–238–W | DOMESTIC WATER LINE TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701–3H, AND CENTRAL ALARM STATION (CAS), 720–H |
| LS–25–W | DOMESTIC WATER LINE TO SERVE C-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–9C |
| LS–264–W | DOMESTIC WATER LINE TO SERVE CONSTRUCTION QUALITY ASSURANCE OFFICE BUILDING, 704–1N |
| LS–265–W | DOMESTIC WATER LINE TO SERVE EQUIPMENT STORAGE AND HEALTH PROTECTION (HP) FACILITY, 221–25F |
| LS–4–W | DOMESTIC WATER LINE TO SERVE OFFICE BUILDING, 703–41A |
| LS–43–W | "AS BUILT" DOMESTIC WATER LINE TO SERVE 773–A, 773–41A, AND 773–42A |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| LS–55–W | DOMESTIC WATER LINE TO SERVE N-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–38N |
| LS–56–W | DOMESTIC WATER LINE TO SERVE H-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–20H |
| LS–57–W | DOMESTIC WATER LINE TO SERVE RADIOLOGICAL AND ENVIRONMENTAL SUPPORT FACILITY, 735–11A |
| LS–60–W | DOMESTIC WATER LINE TO SERVE ADMINISTRATION BUILDING, 704–S |
| LS–61–W | DOMESTIC WATER LINE TO SERVE S-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 980–S |
| LS–7–W | DOMESTIC WATER LINE TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 221–17F, AND 221–18F |
| LS–8–W | DOMESTIC WATER LINE TO SERVE 703–4A, 703–6A, AND 703–34A |
| LS–81–W | DOMESTIC WATER LINE TO SERVE CONSTRUCTION ADMINISTRATION OFFICE BUILDING, 704–6C |
| LS–82–W | DOMESTIC WATER LINE TO SERVE B-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–2B |
| LS–91009 | DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 245–F THROUGH 245–12F |
| LS89002 | DOMESTIC WATER AND FIRE PROTECTION LINES TO SERVE TEMPORARY MODULAR OFFICES 706–8C THROUGH 706–19C AND 703–1C THROUGH 703–28C |
| LS89008 | EXPANSION OF DOMESTIC WATER AND FIRE PROTECTION TO SERVE MODULAR OFFICES, B-AREA |
| LS89016 | RELOCATION OF DOMESTIC WATER LINE AT L-AREA SANITARY FLOW EQUALIZATION BASIN |
| LS89017 | DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 707–7K THROUGH 707–19K |
| LS89020 | INSTALL BLOCK VALVE ON 200–F AREA DOMESTIC WATER WELL HEADER |
| LS89028 | DOMESTIC WATER LINE TO SERVE GENERAL PHYSICS OFFICE, 777–18A |
| LS89029 | DOMESTIC WATER LINE TO SERVE MATERIAL MANAGEMENT, RECEIVING, AND STORAGE FACILITIES (MMRSF) FIRE WATER STORAGE TANK MAKEUP WATER SYSTEM, 681–17N, AND 681–18N |
| LS91001 | DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 773–62A THROUGH 773–70A |
| LS91005 | DOMESTIC WATER LINE TO FILL IN-TANK PRECIPITATION (ITP) FIRE TANK, 241–20H |
| LS91006 | DOMESTIC WATER LINE TO FILL IN-TANK PRECIPITATION (ITP) FIRE TANK, 241–21H |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| LS91007 | DOMESTIC WATER LINE REROUTE TO SERVE SAFETY SHOWER/EYE-WASH STATIONS AT THE REPLACEMENT HIGH-LEVEL EVAPORATOR, H-AREA |
| LS91010 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, B-AREA |
| LS91011 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, 3/700 AREA |
| LS91012 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, C-AREA |
| LS91013 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, N-AREA |
| LS91014 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, D-AREA |
| LS91015 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, FORESTRY AREA |
| LS91016 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, L-AREA |
| LS91017 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, P-AREA |
| LS91018 | UPGRADE DOMESTIC WATER SYSTEMS INSTRUMENTS, RAILROAD YARD |
| G0017 | DOMESTIC WATER LINE TO SERVE SREL DISTANT LEARNING CENTER, 737–27A |
| G0027 | DOMESTIC WATER UPGRADE, PHASE III (K-AREA TO L-AREA CONNECTOR) |
| G0076 | DOMESTIC WATER LINE TO SERVE SOLID WASTE MANAGEMENT FACILITIES ACCESS |
| G0016 | DOMESTIC WATER UPGRADE, PHASE II, ZONE 1 (B-AREA, A-AREA , AND FORESTRY AREA CONNECTOR) |
| G0026 | DOMESTIC WATER UPGRADE, PHASE II, ZONE 2 (B-AREA, F-AREA, C-AREA, N-AREA, H-AREA, S-AREA, Z-AREA, AND FORESTRY AREA CONNECTOR) |
| G0036 | DOMESTIC WATER UPGRADE, PHASE II, ZONE 3 (D-AREA AND TNX-AREA CONNECTOR) |
| G0046 | DOMESTIC WATER LINE TO SERVE DWPF LATE-WASH FACILITY RESTROOM UNIT, 512–8S |
| G0056 | DOMESTIC WATER LINE TO SERVE H-AREA MEDICAL FACILITY, 719–H |
| G0066 | DOMESTIC WATER LINE TO SERVE SMALL-ANIMAL CARE FACILITY, 737–24A |
| M0075 | DOMESTIC WATER LINE TO SERVE WASTE MANAGEMENT OFFICE AND STORAGE BUILDING, 241–102H |
| G0086 | T & T RESTROOM TRAILER, 704–46H |
| M0012E2 | DOMESTIC WATER LINE TO SERVE B-AREA FIRE PROTECTION SUPPLY SYSTEM |
| M0013 | DOMESTIC WATER LINE TO SERVE NITRIC TANK SAFETY SHOWER/EYE-WASH STATION, 221–S |
| M0014E1 | DOMESTIC WATER LINE TO SERVE TRAINING CENTER, 766–H (FORMERLY 225–H) |
| M0016 | DOMESTIC WATER UPGRADE – PHASE I (TNX-AREA) |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| M0022 | DOMESTIC WATER LINE TO SERVE PORTABLE BOILER INSTALLATION, 183–2P, |
| M0023E1 | DOMESTIC WATER LINE TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261–H |
| M0024 | DOMESTIC WATER LINE REROUTE TO SERVE ESSENTIAL-MATERIALS WAREHOUSE, 315–M |
| M0025R2 | DOMESTIC WATER LINE TO SERVE DWPF LATE-WASH FACILITY |
| M0032 | DOMESTIC WATER LINE TO SERVE PORTABLE BOILER INSTALLATION, 183–2K |
| M0033E1 | DOMESTIC WATER LINE TO SERVE F-AREA AND E ROAD FIRE PROTECTION SUPPLY |
| M0034 | DOMESTIC WATER LINE TO SERVE FORESTRY AREA RESTROOM TRAILER, 760–21G |
| M0035 | DOMESTIC WATER SYSTEM UPGRADE – PHASE I (FORESTRY AREA) |
| M0042E1 | DOMESTIC WATER LINE TO SERVE LUNCHROOM TRAILER, 773–72A |
| M0043 | DOMESTIC WATER LINE TO SERVE OPERATION SUPPORT BUILDING, 704–2H |
| M0044 | DOMESTIC WATER LINE TO SERVE ASBESTOS ABATEMENT SHOWERS, 412–D AND 413–D |
| M0045 | DOMESTIC WATER LINE TO SERVE 704–8T |
| M0052 | DOMESTIC WATER LINE TO SERVE LUNCHROOM TRAILER, 740–16A |
| M0053 | DOMESTIC WATER LINE TO SERVE 221–S LAB TRAILERS SAFETY SHOWER/EYE-WASH STATION |
| M0054E1 | DOMESTIC WATER LINE TO SERVE B-AREA UTILITIES UPGRADE; 735–4B AND 735–2B |
| M0055 | DOMESTIC WATER LINE TO SERVE SRFS EDUCATION TRAILER RESTROOMS, 760–22G |
| M0063R1 | DOMESTIC WATER LINE TO SERVE ADMINISTRATIVE SUPPORT BUILDING, 708–1B |
| M0064E1 | DOMESTIC WATER LINE TO SERVE COMPRESSED-GAS STORAGE FACILITY, 731–6N |
| M0065 | K-AREA DOMESTIC WATER LOOP COMPLETION |
| M0072E2 | DOMESTIC WATER LINE TO SERVE FLAMMABLE-STORAGE FACILITY, 731–5N |
| M0073E1 | DOMESTIC WATER LINE TO SERVE SAFEGUARDS AND HEALTH PROTECTION SHOP, 228–H |
| M0074R1 | DOMESTIC WATER LINE TO SERVE SAFETY SHOWER/EYE-WASH STATION, 421–6D |
| M0082 | DOMESTIC WATER LINE TO SERVE CENTRAL SERVICES WORKS ENGINEERING (CSWE) FACILITY, 717–11A |

**Domestic Water Permits, continued**

| Permit Number | Permit Title |
|---|---|
| M0083 | DOMESTIC WATER LINE TO SERVE RESTROOM TRAILER, 704–11K |
| M0084E1 | DOMESTIC WATER LINE TO SERVE TYPE III TANK SALT REMOVAL CONTROL BUILDING, 241–2H |
| M0085 | DOMESTIC WATER LINE TO SERVE FORESTRY SERVICE BUILDING, 760–15G |
| M0092 | DOMESTIC WATER LINE TO SERVE ENGINEERING SUPPORT BUILDING, 707–7F |
| M0093 | D-AREA BACKUP WELL CONNECTOR |
| M0102 | DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICES, 233–20H AND 233–21H |
| M0103E1 | DOMESTIC WATER LINE TO SERVE DRINKING WATER FOUNTAIN, 740–4A |
| M0112 | DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICES, 742–G AND 742–1G THROUGH 742–14G |
| M0113 | DOMESTIC WATER LINE TO SERVE 704–11K, 704–12K, AND 705–K |
| M0122 | DOMESTIC WATER LINE TO SERVE SRTC MODULAR RESTROOM UNIT, 773–71A |
| M0123E1 | DOMESTIC WATER LINE TO SERVE SAFETY SHOWER/EYE-WASH STATIONS, 673–T, 678–T, AND 679–8T |

**Industrial Wastewater Permits**

| Permit Number | Permit Title |
|---|---|
| 12888 | METALLURGICAL LABORATORY NEUTRALIZATION FACILITY, 723–A |
| 16119 | F/H ETF PERMANENT pH ADJUSTMENT SYSTEM |
| 17911–IW | F-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (EXTRACTION/INJECTION PIPING NETWORK) |
| 17912–IW | H-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (EXTRACTION/INJECTION PIPING NETWORK) |
| 17998–IW | A-AREA POWERHOUSE EFFLUENT REROUTE SYSTEM, 784–A |
| 18052–IW | F-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (WASTEWATER TREATMENT UNIT) |
| 18053 | H-AREA SEEPAGE BASINS GROUNDWATER REMEDIATION (WASTEWATER TREATMENT UNIT) |
| 18078–IW | 483–6D SURGE BASIN LINER REPLACEMENT |
| 10253 | M-AREA 610-GPM AIR STRIPPER |
| 10287 | LIQUID EFFLUENT TREATMENT FACILITIES (LETF), 300–M |
| 10349 | 672–T TNX-AREA PROCESS SEWER TO OUTFALL X–008 |
| 10358 | S-AREA OIL/WATER SEPARATOR |

**Industrial Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 10389 | M-AREA DRAIN LINE |
| 10475 | NONCONTACT COOLING WATER DIVERSION, 300–M AREA |
| 10696 | INTERIM SLUDGE STORAGE TANK, M-AREA |
| 10765 | WASTEWATER NEUTRALIZATION FACILITY, 704–B |
| 10949 | TRADE WASTE-FLOW EQUALIZATION TANK, 607–18A, FOR SILVER RECOVERY, 703–43A |
| 11406 | FIRE BRIGADE TRAINING FACILITIES OIL/WATER SEPARATOR, 411–D |
| 11411 | DWPF TREATED EFFLUENT LINE, S-AREA |
| 11413 | DWPF CHEMICAL TREATMENT FACILITY, S-AREA |
| 11497 | PRODUCTION CONTROL FACILITY SANITARY/PROCESS SEWER, 772–1F |
| 11498 | FLOW-MONITORING STATION FOR NPDES OUTFALL L–007 |
| 11588 | POWERHOUSE EFFLUENT DIVERSION TO ASH BASIN; 400–D (H-Area also covered under this permit) |
| 11588 | POWERHOUSE EFFLUENT DIVERSION TO ASH BASIN; 200–H (D-Area also covered under this permit) |
| 11589 | POWERHOUSE EFFLUENT DIVERSION TO ASH BASIN, 184–P |
| 12622 | ORGANICS REMOVAL FACILITY (ORF), TNX-AREA |
| 12633 | TNX-AREA EFFLUENT TREATMENT PLANT (ETP) |
| 12683 | INDUSTRIAL WASTEWATER TREATMENT FACILITY TO SERVE Z-AREA SALTSTONE MANUFACTURING FACILITY |
| 12782 | REPLACEMENT TRITIUM FACILITY (RTF) PROCESS SEWER |
| 12870 | F/H EFFLUENT TREATMENT FACILITY (ETF), 241–81H |
| 12894 | FILTRATE HOLD-TANK COVERS, M-AREA |
| 12973 | P-AREA NEUTRALIZATION FACILITY, 183–2P |
| 13105 | F/H ETF PROCESS SEWER LINES, F-AREA (H-Area also included under this permit) |
| 13105 | F/H ETF PROCESS SEWER LINES, H-AREA (F-Area also included under this permit) |
| 13154 | FLOW MEASUREMENT DEVICE, L-AREA |
| 13354 | D-AREA NEUTRALIZATION FACILITY, 483–1D |
| 13355 | F-AREA NEUTRALIZATION FACILITY, 280–1F |
| 13356 | H-AREA NEUTRALIZATION FACILITY, 280–H |
| 13357 | K-AREA NEUTRALIZATION FACILITY, 183–2K |

**Industrial Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 13431 | FLUME AT M–004 OUTFALL |
| 13735 | INDUSTRIAL WASTEWATER pH CONTROL SYSTEM, 211–F |
| 13978 | TNX-AREA ION-EXCHANGE FACILITY |
| 14020 | MERCURY AND ORGANIC REMOVAL FACILITY FOR F/H ETF |
| 14100 | REPAIR ASH BASIN DIKE 488–1D |
| 14218 | NPDES OUTFALL STRUCTURES F–012 AND F–013 (FLOW-MONITORING WEIR BOX STRUCTURES) |
| 14219 | NPDES OUTFALL STRUCTURES H–017 AND H–018 (MONITORING WEIR BOX STRUCTURES) |
| 14338 | "AS BUILT" H–Z INTERAREA SALT SOLUTION TRANSFER LINE |
| 14379 | UPPER THREE RUNS CREEK DIFFUSER FOR F/H ETF OUTFALL, H–016 |
| 14520 | "AS BUILT" F/H ETF TANK 50 |
| 14624 | EXISTING F/H ETF AREA PROCESS SEWER LINES, F-AREA (H-Area also included under this permit) |
| 14624 | EXISTING F/H ETF AREA PROCESS SEWER LINES, H-AREA (F-Area also included under this permit) |
| 14832 | MODIFICATION TO M-AREA LIQUID EFFLUENT TREATMENT FACILITIES (LETF); SUPERNATANT TRANSFER AND POLYMER ADDITION SYSTEMS |
| 15256 | EVAPORATOR RECYCLE LINE FOR F/H ETF |
| 15467 | UPGRADE PROCESS SEWERS, 211–F/H ETF, F-AREA (H-Area also included under this permit) |
| 15467 | UPGRADE PROCESS SEWERS, 211–F/H ETF, H–AREA (F-Area also included under this permit) |
| 15892 | F/H ETF INTERIM pH ADJUSTMENT SYSTEM (CAUSTIC AND ACID SUPPLY) |
| 16449 | K-REACTOR EMERGENCY RETENTION BASIN PERCOLATION DRAIN FIELD |
| 16478 | FOUNDATIONS AND SUPPORTING STRUCTURE SURROUNDING CWST; K-AREA RETENTION BASIN |
| 16614 | K-REACTOR EMERGENCY RETENTION BASIN LINER AND COVER |
| 16783 | "AS BUILT" DWPF INDUSTRIAL WASTEWATER TREATMENT FACILITY, S-AREA |
| 16785 | K-AREA NATURAL-DRAFT COOLING TOWER THERMAL MITIGATION |
| 16797 | (70-GPM AIR STRIPPER) PROTOTYPE AIR STRIPPER COLUMN RELOCATION AND RECOVERY WELL INSTALLATION |
| 16938 | K-REACTOR RETENTION BASIN UMBRELLA TOP STRUCTURE |
| 17022 | UPGRADE D-AREA NEUTRALIZATION FACILITY, 483–1D |

**Industrial Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 17424–IW | "AS BUILT" F-AREA HIGH-LEVEL RADIOACTIVE WASTE TANK FARM (H-Area also covered under this permit) |
| 17424–IW | "AS BUILT" H-AREA HIGH-LEVEL RADIOACTIVE WASTE TANK FARM (F-Area also covered under this permit) |
| 17434–IW | TNX-AREA TRICKLE-FLOW BIOREACTOR UNIT |
| 17588–IW | MOBILE TRICKLE-FLOW BIOREACTOR SYSTEM |
| 17596–IW | DWPF PRECIPITATE-FEED LATE-WASH FACILITY |
| 17614–IW | 250-GPM AIR STRIPPER (A–002), SRTC |
| 17765–IW | INVESTIGATION-DERIVED WASTE (IDW) TRANSFER STATION AT F/H EFFLUENT TREATMENT FACILITY (ETF) |
| 17816–IW | MODIFICATION TO 735–11A LAB BUILDING PROCESS SEWER SYSTEM NEUTRALIZATION FACILITY, 607–17A |
| 17903–IW | TEMPORARY BOILER BLOWDOWN TRANSFER SYSTEM, 784–A |
| 17938–IW | GROUNDWATER OPERABLE UNIT (GWOU) AIR STRIPPER, TNX-AREA |
| 17980–IW | "AS BUILT" 299–H MAINTENANCE AND DECONTAMINATION FACILITY WASTE COLLECTION TANK AND CONVEYANCE SYSTEM |
| 7289 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, A-AREA (M-Area also covered under this permit) |
| 7289 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, M-AREA (A-Area also covered under this permit) |
| 7290 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, F-AREA |
| 7291 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, H-AREA |
| 7292 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, P-AREA |
| 7293 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, K-AREA |
| 7294 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, C-AREA |
| 7295 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, D-AREA |
| 7296 | "AS BUILT" WASTEWATER TREATMENT FACILITIES, N-AREA |
| LS–112–S | FIRE-TRAINING FACILITY PROCESS SEWER, 904–D |
| LS–42–S | INERT L-FACILITY LOADING DOCK SEWER RELOCATION, 234–H |
| LOA–7/10/95 | M-AREA PROCESS WASTE INTERIM TREATMENT/STORAGE FACILITY (PWIT/SF) SLUDGE VENDOR TREATMENT PROCESS; MODIFICATION TO M-AREA LIQUID EFFLUENT TREATMENT FACILITY (LETF) |

## NPDES – Discharge Permits

| Permit Number | Permit Title |
|---|---|
| SC0000175 | 76 OUTFALLS AT SAVANNAH RIVER SITE |
| SC0044903 | SEVEN OUTFALLS AT SAVANNAH RIVER SITE |

These permits were in effect until October 1, 1996, when a new NPDES permit (also numbered SC0000175) was issued. The new permit combined the previous permits into one and decreased the number of outfalls to 37.

## NPDES – No-Discharge Permit

| Permit Number | Permit Title |
|---|---|
| ND0072125 | SRS SANITARY SLUDGE LAND APPLICATION SITE, FORESTS (SLUDGE FROM ALL SWTPs) |

## NPDES – Stormwater Permits

| Permit Number | Permit Title |
|---|---|
| SCR000000 | 50 INDUSTRIAL STORMWATER OUTFALLS AT SAVANNAH RIVER SITE |
| SCR100000 | 15 NPDES-PERMITTED CONSTRUCTION STORMWATER SITES AT SAVANNAH RIVER SITE |

## RCRA Permit

| Permit Number | Permit Title |
|---|---|
| SCI80008989 | SEVEN PERMITTED RCRA FACILITIES AT SAVANNAH RIVER SITE |

## Sanitary Wastewater Permits

| Permit Number | Permit Title |
|---|---|
| 17,955–IW | SANITARY SEWER TO SERVE 241–102H |
| 17,956–IW | SANITARY SEWER TO SERVE 703–5B |
| 02–91040041 | SEPTIC TANK AND TILE FIELD TO SERVE OFFICE BUILDING, 704–56H (A.K.A. 5002–H) |
| 02–92080098 | SEPTIC TANK AND TILE FIELD TO SERVE SREL PAR POND LABORATORY, 737–G |
| 10132–P | SEPTIC TANK AND TILE FIELD TO SERVE TOILET TRAILER 704–47S AND OFFICES 704–44S, 704–45S, AND 704–46S (FORMERLY FPF CONSTRUCTION ENGINEERS' OFFICES 225–1H, 225–2H, AND 225–3H) |
| 10236 | SANITARY SEWER SYSTEM (LIFT STATION AND SEWER LINE) TO SERVE CHANGE STATION FACILITY, 241–58H |
| 10314 | DWPF CONSTRUCTION SITE SANITARY SEWER SYSTEM, S-AREA |
| 10499 | SANITARY SEWER TO SERVE DWPF, 200–S |
| 10521 | CHEMICAL FEED FACILITY (607–16A) FOR A-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7–1A, 607–7–2A, AND 607–23A |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 10522 | CHEMICAL FEED FACILITY (607–19F) FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7F AND 607–21F |
| 10523 | CHEMICAL FEED FACILITY (607–20H) FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7H AND 607–21H |
| 10524 | CHEMICAL FEED FACILITY (607–22P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7P AND 607–23P |
| 10525 | CHEMICAL FEED FACILITY (607–38N) FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–18N AND 607–42N |
| 10526 | CHEMICAL FEED FACILITY (607–14D) FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–15D |
| 10530 | TNX-AREA 20,000-GALLON SANITARY WASTEWATER TREATMENT PLANT, 607–40T |
| 10533 | SEPTIC TANK AND TILE FIELD (607–54G) TO SERVE DEER HUNT BUILDING, 760–12G |
| 10825 | SANITARY SEWER LIFT STATION (607–19A) TO SERVE 730–A |
| 11407 | SANITARY SEWER LIFT STATION TO SERVE 321–M CHANGE ROOM |
| 11442 | SANITARY SEWER SYSTEM (LIFT STATION AND SEWER LINE) TO SERVE ECR/ICR CONTROL HOUSE, 241–82H |
| 11687 | SEPTIC TANK AND TILE FIELD TO SERVE WACKENHUT HELICOPTER FACILITY, 703–5B |
| 11755 | SEPTIC TANK AND TILE FIELD TO SERVE 100-AREA FIRE STATION, 709–1G (INTERSECTION OF ROAD C AND ROAD 7) |
| 11847 | EFFLUENT WEIR FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–40T |
| 12386 | SANITARY SEWER TO SERVE 730–M |
| 12695 | SANITARY SEWER TO SERVE REPLACEMENT TRITIUM FACILITY (RTF), 233–H |
| 12725 | 45,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–18F) FOR SANITARY WASTEWATER TREATMENT PLANTS, 607–7F AND 607–21F (PHASE III) |
| 12910 | H-AREA 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–21H |
| 13155 | NAVAL FUEL (FMF) FLOW MEASUREMENT DEVICE; OUTFALL F–003(A) |
| 13156 | SANITARY SEWER TO SERVE 716–2A |
| 13157 | SANITARY SEWER TO SERVE COMPUTER REPAIR BUILDING, 722–5A |
| 13175 | 97,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607–22A) FOR SANITARY WASTEWATER TREATMENT PLANTS, 607–7–1A, 607–7–2A, AND 607–23A |
| 13291 | SEPTIC TANK AND TILE FIELD TO SERVE AUXILIARY PUMP PIT |
| 13430 | F-AREA 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–21F |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 13538 | SEPTIC TANK AND TILE FIELD TO SERVE K-AREA COOLING TOWER CONSTRUCTION TRAILER |
| 13539 | SEPTIC TANK AND TILE FIELD TO SERVE K-AREA COOLING TOWER ECR/ICR BUILDING, 153–1K |
| 13717 | SEPTIC TANK (831–1Z) AND TILE FIELD (831–2Z) TO SERVE Z-AREA |
| 14311 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR C-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–7C |
| 14312 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR K-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–17K |
| 14313 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR L-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–16L |
| 14314 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7P AND 607–23P |
| 14315 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7F AND 607–21F |
| 14316 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7H AND 607–21H |
| 14317 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR S-AREA SANITARY WASTEWATER TREATMENT PLANTS, 831–1S AND 831–2S |
| 14318 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–15D |
| 14320 | INTERIM SODIUM HYPOCHLORITE DISINFECTION SYSTEM (607–8A) FOR A-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7–1A, 607–7–2A, AND 607–23A |
| 14322 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–18N AND 607–42N |
| 14323 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR NAVAL FUEL (FMF) SANITARY WASTEWATER TREATMENT PLANT, 607–17F |
| 14324 | INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–40T |
| 14407 | D-AREA 20,000-GPD SANITARY WASTEWATER TREATMENT PLANT EXPANSION, 607–15D |
| 14443 | SEPTIC TANK AND TILE FIELD TO SERVE 241–102H |
| 15005 | A-AREA 65,000-GPD SANITARY WASTEWATER TREATMENT PLANT EXPANSION, 607–23A |
| 15049 | 35,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–19G) FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–18G AND 607–42G |
| 15416 | 12,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–16K) FOR SANITARY WASTEWATER TREATMENT PLANT, 607–17K |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 15417 | 11,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–24P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7P AND 607–23P |
| 15418 | 17,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607–15L) FOR SANITARY WASTEWATER TREATMENT PLANT, 607–16L |
| 15419 | SANITARY SEWER LIFT STATION TO SERVE REPLACEMENT TRITIUM FACILITY (RTF) |
| 15444 | SANITARY SEWER LIFT STATION TO SERVE 341–M |
| 15506 | 15,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–22F) FOR NAVAL FUEL (FMF) SANITARY WASTEWATER TREATMENT PLANT, 607–17F |
| 15530 | 27,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607–4C) FOR SANITARY WASTEWATER TREATMENT PLANT, 607–7C |
| 15740 | SANITARY SEWER SYSTEM EXPANSION (TWO LIFT STATIONS AND SEWER LINE) TO SERVE C-AREA |
| 16477 | SANITARY SEWER TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING AND STORAGE FACILITIES (MMRSF), 731–N THROUGH 731–4N |
| 16784 | TNX-AREA SANITARY WASTEWATER TREATMENT PLANT (607–40T) EFFLUENT REROUTE FROM OUTFALL X–013 TO X–008A |
| 16961 | SANITARY SEWER LINE FROM MATERIAL MANAGEMENT RECEIVING AND STORAGE FACILITIES (MMRSF) TO N-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17057 | B-AREA 80,000-GPD SANITARY WASTEWATER TREATMENT PLANT UPGRADE, 607–4B (INCLUDES 40,000-GALLON FLOW EQUALIZATION BASIN) |
| 17059 | SANITARY SEWER TO SERVE B-AREA ENGINEERING CENTER, 730–B |
| 17156 | FLOW CONTROL BOXES FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT, 607–40T |
| 17157 | FLOW CONTROL BOXES FOR H-AREA SANITARY WASTEWATER TREATMENT FACILITIES, 607–7H AND 607–21H |
| 17232 | SANITARY SEWER TO SERVE 705–3C |
| 17273–IW | SANITARY SEWER TO SERVE 704–49S OFFICE BUILDING |
| 17278–IW | SANITARY SEWER TO SERVE 730–1M OFFICE BUILDING |
| 17279–IW | SANITARY SEWER TO SERVE 705–K OFFICE BUILDING |
| 17383–IW | SANITARY SEWER TO SERVE REPLACEMENT TRITIUM FACILITY (RTF) TRAILERS, 233–20H AND 233–21H |
| 17419–IW | SANITARY SEWER TO SERVE H-AREA TRAILERS, 742–10G THROUGH 742–12G |
| 17499–IW | SANITARY SEWER AND LIFT STATION TO SERVE 704–2H |
| 17528–IW | SANITARY SEWER TO SERVE ENGINEERING SUPPORT FACILITY, 730–1B, AND OPERATIONS SUPPORT FACILITIES, 730–2B AND 730–4B |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 17604–IW | SANITARY SEWER TO SERVE SITE TRAINING BUILDING, 766–H (FORMERLY 225–H) |
| 17643–IW | COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1A (FROM C ROAD [INCLUDING LS–3000A] TO CSWTF) |
| 17646–IW | COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1A (FROM LS–4000C TO LS–3000A) |
| 17656–IW | SANITARY SEWER TO SERVE HEALTH PROTECTION INSTRUMENT CALIBRATION FACILITY, 735–2B, AND NEW WHOLE BODY COUNTER FACILITY, 735–4B |
| 17676–IW | SANITARY SEWER TO SERVE 241–2H |
| 17679–IW | 1,050,000-GPD CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF) TO SERVE A-AREA, B-AREA, C-AREA, F-AREA, H-AREA, N-AREA, NF-AREA, AND S-AREA |
| 17682–IW | SANITARY SEWER REROUTE TO SERVE SREL LIBRARY ADDITION, 737–A |
| 17683–IW | COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 1B (B-AREA, F-AREA, H-AREA, AND S-AREA) |
| 17690–IW | COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 2 (A-AREA, C-AREA, AND N-AREA) |
| 17715–IW | UV DISINFECTION SYSTEM FOR D-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17719–IW | UV DISINFECTION SYSTEM FOR P-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17721–IW | UV DISINFECTION SYSTEM FOR K-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17722–IW | UV DISINFECTION SYSTEM FOR TNX-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17726–IW | UV DISINFECTION SYSTEM FOR L-AREA SANITARY WASTEWATER TREATMENT PLANT |
| 17842–IW | SANITARY SEWER AND LIFT STATION TO SERVE SREL ANIMAL-HOLDING FACILITIES |
| 17,981–IW | SANITARY SEWER TO SERVE H-AREA MEDICAL FACILITY, 719–H |
| 1995020076 | SEPTIC TANK AND TILE FIELD TO SERVE CENTRAL STAGING AREA, 704–13G |
| 1995020100 | SEPTIC TANK AND TILE FIELD TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF), 261–H |
| 7947 | L-AREA 35,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–16L |
| 8611–P | SEPTIC TANK AND TILE FIELD TO SERVE INTERIM STORAGE AND REDRUMMING FACILITY, 645–1N (FORMERLY 709–1G), N-AREA |
| 8670 | K-AREA 24,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–17K |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| 8928 | NAVAL FUEL (FMF) 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–17F |
| 9256P | SEPTIC TANK AND TILE FIELD TO SERVE LANDFILL MONITORING BUILDING, 642–E |
| 9326 | H-AREA 60,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–7H (F-Area, N-Area, and P-Area also included under this permit) |
| 9326 | P-AREA 10,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–23P (F-Area, H-Area, and N-Area also included under this permit) |
| 9326 | N-AREA 30,000-GPD (607–18G) AND 40,000-GPD (607–42G) SANITARY WASTEWATER TREATMENT PLANTS (F-Area, H-Area, and P-Area also included under this permit) |
| 9326 | F-AREA 60,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–7F (H-Area, N-Area, and P-Area also included under this permit) |
| 9694 | SANITARY SEWER SYSTEM (LIFT STATION AND SEWER LINE) TO SERVE 773–41A and 773–42A |
| 9888 | S-AREA, TWO 12,000-GPD SANITARY WASTEWATER TREATMENT PLANTS, 831–1S AND 831–2S |
| 9940 | SANITARY SEWER TO SERVE REACTOR SIMULATOR FACILITY, 707–C |
| 9983 | C-AREA, 55,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–7C |
| 9998 | SEPTIC TANK AND TILE FIELD TO SERVE F/H ETF CONTROL BUILDING, 241–84H |
| LS–10–S | SANITARY SEWER TO SERVE NAVAL FUEL MATERIAL FACILITY (FMF), 247–F AND 248–F |
| LS–129–S | SANITARY SEWER TO SERVE 719–4A |
| LS–134–S | DWPF SANITARY SEWER LINE MODIFICATION, S-AREA |
| LS–149–S | SANITARY SEWER TO SERVE TNX-AREA EFFLUENT TREATMENT PLANT, 904–T |
| LS–158–S | SANITARY SEWER TO SERVE 3/700 CONSTRUCTION FACILITY |
| LS–2–S | SANITARY SEWER TO SERVE TRITIUM FACILITY SUPPORT BUILDING, 235–H |
| LS–206–S | SEWER PIPE AND MANHOLE, 704–1T |
| LS–227–S | SANITARY SEWER TO SERVE 705–C |
| LS–228–S | SANITARY SEWER TO SERVE 717–K |
| LS–239–S | SANITARY SEWER TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701–4F; AND CENTRAL ALARM STATION (CAS), 720–F |
| LS–240–S | SANITARY SEWER TO SERVE 720–2A (3/700 AREA SECURITY UPGRADE, PACAS FACILITY) |
| LS–244–S | SANITARY SEWER TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701–3H; AND CENTRAL ALARM STATION (CAS), 720–H |

**Sanitary Wastewater Permits, continued**

| Permit Number | Permit Title |
|---|---|
| LS–256–S | MACERATOR FOR F-AREA SANITARY FLOW EQUALIZATION BASIN, 607–18F |
| LS–275–S | SANITARY SEWER TO SERVE EQUIPMENT STORAGE AND HEALTH PROTECTION FACILITY, 221–25F |
| LS–3–S | SANITARY SEWER TO SERVE 703–41A |
| LS–32–S | SANITARY SEWER TO SERVE WACKENHUT BUILDINGS 703–B AND 703–1B |
| LS–335–S | SANITARY SEWER TO SERVE TEMPORARY MODULAR OFFICE TRAILERS 704–7K THROUGH 704–19K |
| LS–336–S | "AS BUILT" OIL/WATER SEPARATOR, 716–A |
| LS–337–S | "AS BUILT" OIL/WATER SEPARATOR, 722–4A |
| LS–35–S | SANITARY SEWER RELOCATION TO SERVE 735–11A |
| LS–351–S | SANITARY SEWER TO SERVE TEMPORARY MODULAR OFFICE TRAILERS, 245–F THROUGH 245–12F |
| LS–352–S | SANITARY SEWER TO SERVE N-AREA NEW EMPLOYEE PROCESSING CENTER |
| LS–354–S | SANITARY SEWER TO SERVE TO SERVE GENERAL PHYSICS OFFICE, 777–18A |
| LS–52–S | SANITARY SEWER TO SERVE 707–H |
| LS–53–S | SANITARY SEWER TO SERVE CONSTRUCTION OFFICE BUILDING, M-AREA |
| LS–62–S | SANITARY SEWER RELOCATION TO SERVE 717–F |
| LS–78–S | SANITARY SEWER TO SERVE CONSTRUCTION ADMINISTRATION BUILDING, C-AREA |
| LS–79–S | SANITARY SEWER TO SERVE N-AREA ELECTRICAL OFFICE BUILDING |
| LS–80–S | SANITARY SEWER TO SERVE N-AREA RECEIVING AND STORES WAREHOUSE |

**SCDHEC 401 (Water Quality) Permit**

| Permit Number | Permit Title |
|---|---|
| SC 88–D–005 | F/H ETF DIFFUSER |

**SCDHEC Navigable Waters Permits**

| Permit Number | Permit Title |
|---|---|
| SC 96–003 | BRIDGE REPLACEMENTS AT ROAD C AND ROAD F AND UTILITY RELOCATION OVER UPPER THREE RUNS CREEK, AIKEN COUNTY, SC |
| SC 96–005 | REPLACEMENT OF BRIDGE, 603–72G, ON ROAD B OVER LOWER THREE RUNS CREEK, BARNWELL COUNTY, SC |

## SCDHEC Navigable Waters Permits, continued

| Permit Number | Permit Title |
|---|---|
| SC 96–009 | PIPE BRIDGE INSTALLATION FOR POTABLE WATER LINE ACROSS UPPER THREE RUNS CREEK, AIKEN COUNTY, SC |
| SC 96–031 | BRIDGE REPLACEMENTS AT ROAD 8–1 AND ROAD 2–1 ON UPPER THREE RUNS CREEK, AIKEN COUNTY, SC |

## Solid Waste Permits

| Permit Number | Permit Title |
|---|---|
| 025500–1120 | SANITARY LANDFILL |
| 025500–1601 | D–F STEAM-LINE INDUSTRIAL SOLID WASTE LANDFILL (ASBESTOS) |
| 025500–1602 | F-AREA INERT-MATERIALS LANDFILL (RAILROAD TIE PILE) |
| 025500–1603 | Z-AREA SALTSTONE DISPOSAL FACILITY |
| 025800–1901 | BURMA ROAD INERT-MATERIALS LANDFILL |
| IWP–211 | H-AREA INERT-MATERIALS LANDFILL |

## Underground Injection Control Permits

| Permit Number | Permit Title |
|---|---|
| 103R | INJECTION/EXTRACTION BIOREMEDIATION PROJECT NEAR THE M-AREA SETTLING BASIN (One Class V.A.–G experimental technology injection well, AMH–1, to remove TCE and PCE using methane solutions) |
| 194 | BIOREMEDIATION OPTIMIZATION TEST AT THE SANITARY LANDFILL, 740–G (Six-Class V.A.–I aquifer remediation injection wells, AIW–1 through AIW–6) |
| 201 | PURGE-WATER MANAGEMENT SYSTEM DEMONSTRATION, TNX-AREA (One Class V.A.–G experimental technology injection well, P–26D; Phase I, demonstrate unit at a "clean" well) |
| 201M | PURGE-WATER MANAGEMENT SYSTEM DEMONSTRATION, M-AREA (One Class V.A.–G experimental technology injection well, MCB–5; Phase II, demonstrate unit at a "contaminated" well) |
| 211 | F-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION (Ten Class V.A.–I aquifer remediation injection wells, FIN–1 through FIN–10) |
| 215 | GROUNDWATER OPERABLE UNIT (GWOU) RECIRCULATION WELL, TNX-AREA (One Class V.A.–I corrective-action injection well, TVR–1) |
| 223 | H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION (Ten Class V.A.–I aquifer remediation injection wells, HIN–1 through HIN–10) |
| 225 | IN-SITU BIOREMEDIATION AT 108–3C (Eight Class V.A.–I aquifer remediation injection wells) |
| 237 | IN-SITU BIOREMEDIATION AT 108–3L (Eleven Class V.A.–I aquifer remediation injection wells, 104 through 114) |

## Underground Injection Control Permits, continued

| Permit Number | Permit Title |
|---|---|
| 244 | H-AREA RETENTION BASIN PILOT INJECTION TEST (Twenty Class V.A.–G experimental technology injection wells for Viscous Barrier Demonstration Project) |
| 245 | H-AREA COLLOID STUDY INJECTION TEST; SERIES I (One Class V.A.–G experimental technology injection well, HIW–IID) |
| 245II | H-AREA COLLOID STUDY INJECTION TEST; SERIES II (One Class V.A.–G experimental technology injection well, HIW–IID) |
| 245III | H-AREA COLLOID STUDY INJECTION TEST; SERIES III (One Class V.A.–G experimental technology injection well, HIW–IID) |
| 246 | INJECTION/EXTRACTION TEST AT THE M-AREA SETTLING BASIN (Six Class V.A.–I aquifer remediation injection wells—MSB–22, 3D, 11F, 15D, 9C, and MHT–9D—to locate DNAPL using alcohol solutions) |
| 256 | D-AREA OIL SEEPAGE BASIN SOIL BIOVENTING REMEDIATION SYSTEM (Two Class V.A.–I aquifer remediation horizontal injection wells, DOB–1HW and DOB–2HW) |
| 257 | SANITARY LANDFILL IN-SITU BIOREMEDIATION (Two Class V.A.–G experimental technology horizontal injection wells, SLH–1 and SLH–2) |
| 258 | A/M SOUTHERN SECTOR GROUNDWATER REMEDIATION (Twelve Class V.A.–I aquifer remediation vertical recirculation wells, SSW–1 through SSW–12) |
| 267 | GEOCLEANSE PROCESS DEMONSTRATION NEAR THE M-AREA SEEPAGE BASIN (Four Class V.A.–G aquifer remediation wells, MOX–1 through MOX–4, to remove pure-phase DNAPL) |

## Underground Storage Tank Permits

| Permit Number | Permit Title |
|---|---|
| N–02–GF–09465 | N-AREA 15,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 728–N |
| N–02–GF–09465 | N-AREA 15,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 728–N |
| N–02–GF–09466 | N-AREA 15,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 716–7N |
| N–02–GF–09466 | N-AREA 15,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 716–7N |
| N–02–GF–09468 | RAILROAD YARD 10,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–1G |
| N–02–GF–09469 | S-AREA 15,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK #1, 200–S |
| N–02–GF–09469 | S-AREA 15,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK #2, 200–S |
| N–02–GF–09473 | H-AREA 13,300-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 619–H |
| N–02–GF–09473 | H-AREA 20,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 254–5H #1 |
| N–02–GF–09473 | H-AREA 20,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 254–5H #2 |

**Underground Storage Tank Permits, continued**

| Permit Number | Permit Title |
|---|---|
| N–02–GF–09473 | F-AREA 13,300-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 619–F |
| N–02–GF–09473 | F-AREA 20,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 254–5F #1 |
| N–02–GF–09473 | F-AREA 20,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 254–5F #2 |
| N–02–GF–09476 | A-AREA 5,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 754–5A |
| N–02–GF–09476 | A-AREA 5,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 703–A |
| N–02–GF–09479 | B-AREA 10,000-GALLON UNDERGROUND AVIATION FUEL STORAGE TANK, 703–5B |
| P–02–GF–09467 | FORESTRY AREA 2000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 620–G (A) |
| P–02–GF–09467 | FORESTRY AREA 2000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 620–G (B) |
| P–02–GF–10838 | H-AREA 10,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–2G (A-Area, C-Area, K-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | L-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–L (A-Area, C-Area, H-Area, K-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | C-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–C (A-Area, H-Area, K-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | K-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–K (A-Area, C-Area, H-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | P-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–P (A-Area, C-Area, H-Area, K-Area, L-Area, and N-Area also included) |
| P–02–GF–10838 | A-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–AA (C-Area, H-Area, K-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | A-AREA 5000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 715–AB (C-Area, H-Area, K-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | A-AREA 5000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–AC (C-Area, H-Area, K-Area, L-Area, N-Area, and P-Area also included) |
| P–02–GF–10838 | N-AREA 10,000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 715–N #1 (A-Area, C-Area, H-Area, K-Area, L-Area, and P-Area also included) |
| P–02–GF–10838 | N-AREA 10,000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 715–N #2 (A-Area, C-Area, H-Area, K-Area, L-Area, and P-Area also included) |
| P–02–GF–12476 | A-AREA 5000-GALLON UNDERGROUND DIESEL FUEL STORAGE TANK, 754–6A |

*Appendix C*

# Radionuclide and Chemical Nomenclature

## Nomenclature and Half-Life for Radionuclides

| Radionuclide | Symbol | Half-Life[a,b] |
|---|---|---|
| Americium-241 | Am-241 | 432.7 y |
| Americium-243 | Am-243 | 7.37E3 y |
| Antimony-125 | Sb-125 | 2.758 y |
| Argon-41 | Ar-41 | 1.82 h |
| Beryllium-7 | Be-7 | 53.28 d |
| Californium-252 | Cf-252 | 2.638 y |
| Carbon-14 | C-14 | 5,730 y |
| Cerium-141 | Ce-141 | 32.50 d |
| Cerium-144 | Ce-144 | 284.6 d |
| Cesium-134 | Cs-134 | 2.065 y |
| Cesium-137 | Cs-137 | 30.17 y |
| Cobalt-58 | Co-58 | 70.88 d |
| Cobalt-60 | Co-60 | 5.271 y |
| Curium-242 | Cm-242 | 162.8 d |
| Curium-244 | Cm-244 | 18.1 y |
| Iodine-129 | I-129 | 1.57E7 y |
| Iodine-131 | I-131 | 8.04 d |
| Krypton-85 | Kr-85 | 10.73 y |
| Krypton-88 | Kr-88 | 2.84 h |
| Manganese-54 | Mn-54 | 312.2 d |
| Niobium-95 | Nb-95 | 34.97 d |
| Osmium-185 | Os-185 | 93.6 d |
| Phosphorus-32 | P-32 | 14.28 d |
| Polonium-210 | Po-210 | 138.38 d |
| Plutonium-238 | Pu-238 | 87.7 y |
| Plutonium-239 | Pu-239 | 2.41E4 y |
| Potassium-40 | K-40 | 1.28E9 y |
| Promethium-147 | Pm-147 | 2.6234 y |
| Ruthenium-103 | Ru-103 | 39.27 d |
| Ruthenium-106 | Ru-106 | 1.020 y |
| Selenium-75 | Se-75 | 119.78 d |
| Strontium-89 | Sr-89 | 50.52 d |
| Strontium-90 | Sr-90 | 29.1 y |
| Technetium-99 | Tc-99 | 2.13E5 y |
| Tritium | H-3 | 12.3 y |
| Uranium-235 | U-235 | 7.04E8 y |
| Uranium-238 | U-238 | 4.47E9 y |
| Xenon-133 | Xe-133 | 5.243 d |
| Xenon-135 | Xe-135 | 9.10 h |
| Yttrium-90 | Y-90 | 64.08 h |
| Zirconium-95 | Zr-95 | 64.02 d |

## Nomenclature for Common Chemical Analyses

| Analysis | Symbol |
|---|---|
| Biochemical Oxygen Demand | BOD |
| Chemical Oxygen Demand | COD |
| Dissolved Oxygen | DO |
| Particulate Matter <10 microns | $PM_{10}$ |
| Polychlorinated Biphenyl | PCB |
| Perchloroethylene | PCE |
| Tetrachloroethylene | TCE |
| Total Dissolved Solids | TDS |
| Total Organic Carbon | TOC |
| Total Organic Halogens | TOH |
| Total Phosphates | $TPO_4$ |
| Total Solids | TS |
| Total Suspended Solids | TSS |
| Volatile Organic Compound | VOC |

a h = hour; d = day; y = year

b Reference: Chart of the Nuclides, 14th edition, revised to April 1988, General Electric Company

**Nomenclature for Elements and Chemical Constituents**

| Constituent | Symbol | Constituent | Symbol |
|---|---|---|---|
| Aluminum | Al | Mercury | Hg |
| Ammonia | $NH_3$ | Nickel | Ni |
| Antimony | Sb | Nitrogen | N |
| Arsenic | As | Nitrate | $NO_3$ |
| Barium | Ba | Nitrite | $NO_2$ |
| Beryllium | Be | Oxygen | O |
| Cadmium | Cd | Ozone | $O_3$ |
| Calcium | Ca | Phosphorus | P |
| Calcium Carbonate | $CaCO_3$ | Phosphate | $PO_4$ |
| Carbon | C | Potassium | K |
| Chlorine | Cl | Radium | Ra |
| Chromium | Cr | Rhenium | Re |
| Cobalt | Co | Selenium | Se |
| Copper | Cu | Silver | Ag |
| Fluorine | F | Sodium | Na |
| Iron | Fe | Sulfate | $SO_4$ |
| Lead | Pb | Sulfur Dioxide | $SO_2$ |
| Lithium | Li | Thallium | Tl |
| Magnesium | Mg | Uranium | U |
| Manganese | Mn | Vanadium | V |
| | | Zinc | Zn |

*Appendix D*

# Drinking Water Standards

| Analyte | Level[a] | Units | Status | Reference[b] |
|---|---|---|---|---|
| Alachlor | 0.002 | mg/L | final | CFR, 1993 |
| Aldicarb | 0.003 | mg/L | final | CFR, 1993 |
| Aldicarb sulfone | 0.002 | mg/L | final | CFR, 1993 |
| Aldicarb sulfoxide | 0.004 | mg/L | final | CFR, 1993 |
| Antimony | 0.006 | mg/L | final | CFR, 1993 |
| Antimony-125 | 3.E+02 | pCi/L | interim final | EPA, 1977 |
| Arsenic | 0.05 | mg/L | final | CFR, 1993 |
| Asbestos | 7,000,000 | fibers/L[c] | final | CFR, 1993 |
| Atrazine | 0.003 | mg/L | final | CFR, 1993 |
| Barium | 2.0 | mg/L | final | CFR, 1993 |
| Barium-140 | 9.E+01 | pCi/L | interim final | EPA, 1977 |
| Benzene | 0.005 | mg/L | final | CFR, 1993 |
| Benzo[a]pyrene | 0.0002 | mg/L | final | SDWA,1992 |
| Beryllium | 0.004 | mg/L | final | CFR, 1993 |
| Beryllium-7 | 6.E+03 | pCi/L | interim final | EPA, 1977 |
| 2-sec–Butyl–4, 6–dinitrophenol (Dinoseb) | 0.007 | mg/L | final | CFR, 1993 |
| Cadmium | 0.005 | mg/L | final | CFR, 1993 |
| Carbofuran | 0.04 | mg/L | final | CFR, 1993 |
| Carbon-14 | 2.E+03 | pCi/L | interim final | EPA, 1977 |
| Carbon tetrachloride | 0.005 | mg/L | final | CFR, 1993 |
| Cerium-141 | 3.E+02 | pCi/L | interim final | EPA, 1977 |
| Cesium-137 | 2.E+02 | pCi/L | interim final | EPA, 1977 |
| Chlordane | 0.002 | mg/L | final | CFR, 1993 |
| Chlorobenzene (monochlorobonzene) | 0.1 | mg/L | final | CFR, 1993 |
| Chloroethene (Vinyl chloride) | 0.002 | mg/L | final | CFR, 1993 |
| Chloroform[d] | 0.1 | mg/L | final | CFR, 1993 |

a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].
b References are found on page 225.
c Longer than 10 µm
d The level for total trihalomethanes is set at 0.1 mg/L. Because bromated methanes are rarely detected in SRS groundwater, the Environmental Protection Department (EPD) presumes that most of the trihalomethanes present in site groundwater are chloroform.

| Analyte | Level[a] | Units | Status | Reference[b] |
|---|---|---|---|---|
| Chromium | 0.1 | mg/L | final | CFR, 1993 |
| Chromium-51 | 6.E+03 | pCi/L | interim final | EPA, 1977 |
| Cobalt-58 | 9.E+03 | pCi/L | interim final | EPA, 1977 |
| Cobalt-60 | 1.E+02 | pCi/L | interim final | EPA, 1977 |
| Cyanide | 0.2 | mg/L | final | CFR, 1993 |
| Dalapon | 0.2 | mg/L | final | CFR, 1993 |
| Dibromochloropropane | 0.0002 | mg/L | final | CFR, 1993 |
| Di (2–ethylhexyl) adipate (Deha) | 0.4 | mg/L | final | CFR, 1993 |
| Di (2–ethylhexyl) phthalate | 0.006 | mg/L | final | SDWA,1992 |
| 1,2-Dichlorobenzene | 0.6 | mg/L | final | CFR, 1993 |
| 1,4-Dichlorobenzene (p-Dichlorobenzene) | 0.075 | mg/L | final | CFR, 1993 |
| 1,2-Dichloroethane | 0.005 | mg/L | final | CFR, 1993 |
| cis-1,2-Dichloroethylene | 0.07 | mg/L | final | CFR, 1993 |
| trans-1,2-Dichloroethylene | 0.1 | mg/L | final | CFR, 1993 |
| 1,1-Dichloroethylene | 0.007 | mg/L | final | CFR, 1993 |
| Dichloromethane (Methylene chloride) | 0.005 | mg/L | final | CFR, 1993 |
| 2,4-Dichlorophenoxyacetic acid (2,4–D) | 0.07 | mg/L | final | CFR, 1993 |
| 1,2-Dichloropropane | 0.005 | mg/L | final | CFR, 1993 |
| Dioxin (2,3,7,8–TCDD) | 3.00E–08 | mg/L | final | CFR, 1993 |
| Diquat | 0.02 | mg/L | final | CFR, 1993 |
| Endrin | 0.002 | mg/L | final | CFR, 1993 |
| Endothall | 0.1 | mg/L | final | CFR, 1993 |
| Ethylbenzene | 0.7 | mg/L | final | CFR, 1993 |
| Ethylene dibromide | 0.00005 | mg/L | final | CFR, 1993 |
| Europium-154 | 2.E+02 | pCi/L | interim final | EPA, 1977 |
| Europium-155 | 6.E+02 | pCi/L | interim final | EPA, 1977 |
| Fluoride | 4 | mg/L | final | CFR, 1993 |
| Glyphosate | 0.7 | mg/L | final | CFR, 1993 |
| Gross alpha | 15 | pCi/L | final | CFR, 1993 |
| Heptachlor | 0.0004 | mg/L | final | CFR, 1993 |
| Heptachlor epoxide | 0.0002 | mg/L | final | CFR, 1993 |
| Hexachlorobenzene | 0.001 | mg/L | final | CFR, 1993 |

a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].
b References are found on page 225.

| Analyte | Level[a] | Units | Status | Reference[b] |
|---|---|---|---|---|
| Hexachlorocyclopentadiene | 0.05 | mg/L | final | CFR, 1993 |
| Iodine-129 | 1.E+00 | pCi/L | interim final | EPA, 1977 |
| Iodine-131 | 3.E+00 | pCi/L | interim final | EPA, 1977 |
| Iron-55 | 2.E+03 | pCi/L | interim final | EPA, 1977 |
| Iron-59 | 2.E+02 | pCi/L | interim final | EPA, 1977 |
| Lanthanum-140 | 6.E+01 | pCi/L | interim final | EPA, 1977 |
| Lindane | 0.0002 | mg/L | final | CFR, 1993 |
| Manganese-54 | 3.E+02 | pCi/L | interim final | EPA, 1977 |
| Mercury | 0.002 | mg/L | final | CFR, 1993 |
| Methoxychlor | 0.04 | mg/L | final | CFR, 1993 |
| Nickel | 0.1 | mg/L | final | CFR, 1993 |
| Nickel-59 | 3.E+02 | pCi/L | interim final | EPA, 1977 |
| Nickel-63 | 5.E+01 | pCi/L | interim final | EPA, 1977 |
| Niobium-95 | 3.E+02 | pCi/L | interim final | EPA, 1977 |
| Nitrate + Nitrite (As N) | 10 | mg/L | final | CFR, 1993 |
| Nitrate (as N) | 10 | mg/L | final | CFR, 1993 |
| Nitrite (as N) | 1 | mg/L | final | CFR, 1993 |
| Nonvolatile beta | 4 | mrem/yr | final | CFR, 1993 |
| Oxamyl (Vydate) | 0.2 | mg/L | final | CFR, 1993 |
| PCBs | 0.0005 | mg/L | final | CFR, 1993 |
| Pentachlorophenol | 0.001 | mg/L | final | CFR, 1993 |
| Picloram | 0.5 | mg/L | final | SDWA,1992 |
| Radium-226/228 (Total) | 5 | pCi/L | final | CFR, 1993 |
| Ruthenium-103 | 2.E+02 | pCi/L | interim final | EPA, 1977 |
| Ruthenium-106 | 3.E+01 | pCi/L | interim final | EPA, 1977 |
| Selenium | 0.05 | mg/L | final | CFR, 1993 |
| Simazine | 0.004 | mg/L | final | CFR, 1993 |
| Strontium-89 | 2.E+01 | pCi/L | interim final | EPA, 1977 |
| Strontium-89/90 | 4.20E+01[c] | pCi/L | final | CFR, 1993 |
| Strontium-90 | 8.E+00 | pCi/L | final | CFR, 1993 |
| Styrene | 0.1 | mg/L | final | CFR, 1993 |
| Technetium-99 | 9.E+02 | pCi/L | interim final | EPA, 1977 |
| Tetrachloroethylene | 0.005 | mg/L | final | CFR, 1993 |
| Thallium | 0.002[d] | mg/L | final | CFR, 1993 |
| Tin-113 | 3.E+02 | pCi/L | interim final | EPA, 1977 |

a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].
b References are found on page 225.
c For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.
d This is the lower of two proposed levels.

| Analyte | Level[a] | Units | Status | Reference[b] |
|---|---|---|---|---|
| Toluene | 1.0 | mg/L | final | CFR, 1993 |
| Total radium | 5 | pCi/L | final | CFR, 1993 |
| Toxaphene | 0.003 | mg/L | final | CFR, 1993 |
| 2,4,5-TP (Silvex) | 0.05 | mg/L | final | CFR, 1993 |
| 1,2,4-Trichlorobenzene | 0.07 | mg/L | final | CFR, 1993 |
| 1,1,1-Trichloroethane | 0.2 | mg/L | final | CFR, 1993 |
| 1,1,2-Trichloroethane | 0.005 | mg/L | final | CFR, 1993 |
| Trichloroethylene | 0.005 | mg/L | final | CFR, 1993 |
| Total trihalomethanes[c] (includes bromodichloromethane, bromoform, chloroform, and dibromochloromethane) | 0.1 | mg/L | final | CFR, 1993 |
| Tritium | 2.E+01 | pCi/mL | final | CFR, 1993 |
| Xylenes | 10 | mg/L | final | CFR, 1993 |
| Zinc-65 | 3.E+02 | pCi/L | interim final | EPA. 1977 |
| Zirconium-95 | 2.E+02 | pCi/L | interim final | EPA. 1977 |
| Zicronium/Niobium-95[d] | 2.E+02 | pCi/L | interim final | EPA. 1977 |

a Standards for beta- and gamma-emitting radionuclides are based on the 4-mrem/yr whole-body dose [EPA, 1991].
b References are found on page 225.
c EMS does not test for total trihalomethanes, but each of these analytes is tested separately.
d For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

## References

CFR (Code of Federal Regulations), 1993. "National Primary Drinking Water Regulations," *40 CFR, Part 141*, pp. 592–731, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1977. *National Interim Primary Drinking Water Regulations*, EPA-570/9-76-003. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986. "Water Pollution Control; National Primary Drinking Water Regulations, Radionuclides (Proposed)," *Federal Register*, September, 1986, pp. 34835-34862. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1990. "National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Proposed Rule," *Federal Register*, July 25, 1990, pp. 30369-30448, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1991. "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," *Federal Register*, July 18, 1991, pp. 33052-33127, Washington, D.C.

SDWA (Safe Drinking Water Act—Phase V Rule, Synthetic Organic Chemicals and Inorganic Chemicals), 1992. "National Primary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Final Rule," *Federal Register*, July 17, 1992, 57:138:31776, Washington, D.C.

# Appendix E
# Environmental Monitoring Reports

*Reports of the routine environmental monitoring program at Savannah River Site (SRS) have been prepared periodically since before construction of the site in 1951. The monitoring report numbering system and titles have been changed several times to reflect the evolving progress in the concepts of environmental monitoring. The amount of detailed information contained in the reports also varies from time to time and probably reflects the relative importance and emphasis given to topics by different authors.*

*Except for July–December 1953, reports were issued semiannually from 1951 to 1962, then annually beginning in 1963. Attempts to find a report for July–December 1953 have been unsuccessful. The onsite report was discontinued in 1985, when the onsite and offsite reports were merged into a single publication.*

*Some of the monitoring reports originally contained secret information, primarily radioactive release values that could be related to production rates. The secret information in these reports was deleted in the mid-1970s, and a deleted version (DEL) of the report was issued.*

## Onsite Reports

**Natural Radioactivity Content of the Savannah River Plant**

| | | | |
|---|---|---|---|
| DP27 | Jun 1951–Jan 1953 | | |

**Works Technical Department Data Record, Health Physics Site Survey Data**

| | | | |
|---|---|---|---|
| DPSPU 54–11–12 | Jan–Jul 1953 | No report | Jul–Dec 1953 |

**Radioactivity in the Environment of the Savannah River Plant**

| | | | |
|---|---|---|---|
| DP92 | Jan–Jul 1954 | | |

**Semiannual Progress Report–Regional**

| | | | |
|---|---|---|---|
| DPSP 55–25–34 | Jul–Dec 1954 | DPSP 56–25–13 | Jan–Jun 1955 |

**Health Physics Regional Monitoring**

| | | | |
|---|---|---|---|
| DPSP 56–25–54 (DEL) | Jul–Dec 1955 | DPSPU 60–11–9 | Jul–Dec 1959 |
| DPSP 56–25–4 (DEL) | Jan–Jun 1956 | DPSP 60–25–26 (DEL) | Jan–Jun 1960 |
| DPSP 57–25–15 (DEL) | Jul–Dec 1956 | DPSP 61–25–4 (DEL) | Jul–Dec 1960 |
| DPSP 57–25–43 (DEL) | Jan–Jun 1957 | DPSP 62–25–2 (DEL) | Jan–Jun 1961 |
| DPSP 58–25–17 (DEL) | Jul–Dec 1957 | DPSP 62–25–9 (DEL) | Jul–Dec 1961 |
| DPSP 58–25–38 (DEL) | Jan–Jun 1958 | DPSP 63–25–3 (DEL) | Jan–Jun 1962 |
| DPSPU 59–11–23 | Jul–Dec 1958 | DPSP 63–25–10 (DEL) | Jul–Dec 1962 |
| DPSPU 59–11–30 | Jan–Jun 1959 | | |

**Environmental Monitoring at the Savannah River Plant**

| | | | |
|---|---|---|---|
| DPSPU 64–11–12 | Jan–Dec 1963 | DPST 71–302 | Jan–Dec 1970 |
| DPST 65–302 | Jan–Dec 1964 | DPSPU 72–302 | Jan–Dec 1971 |
| DPST 66–302 | Jan–Dec 1965 | DPSPU 73–302 | Jan–Dec 1972 |
| DPST 67–302 | Jan–Dec 1966 | DPSPU 74–302 | Jan–Dec 1973 |
| DPST 68–302 | Jan–Dec 1967 | DPSPU 75–302 | Jan–Dec 1974 |
| DPST 69–302 | Jan–Dec 1968 | DPSPU 76–302 | Jan–Dec 1975 |
| DPST 70–302 | Jan–Dec 1969 | DPSPU 77–302 | Jan–Dec 1976 |

### Environmental Monitoring at the Savannah River Plant (cont.)

| | | | |
|---|---|---|---|
| DPSPU 78–302 | Jan–Dec 1977 | DPSPU 82–302 | Jan–Dec 1981 |
| DPSPU 79–302 | Jan–Dec 1978 | DPSPU 83–302 | Jan–Dec 1982 |
| DPSPU 80–302 | Jan–Dec 1979 | DPSPU 84–302 | Jan–Dec 1983 |
| DPSPU 81–302 | Jan–Dec 1980 | DPSPU 85–302 | Jan–Dec 1984 |

## Offsite Reports

Results of the environmental monitoring program that affected the offsite environment have been reported to the public since 1959. These reports contained data from the site boundary and beyond. The offsite report was discontinued in 1985, when the on- and offsite reports were merged into a single publication. A listing of the offsite reports follows.

### The Effect of the Savannah River Plant on Environmental Radioactivity

| | | | |
|---|---|---|---|
| No document number | Jan–Mar 1960 | DPST 65–30–2 | Jan–Jun 1965 |
| No document number | Apr–Jun 1960 | DPST 66–30–1 | Jul–Dec 1965 |
| No document number | Jul–Sep 1960 | DPST 66–30–2 | Jan–Jun 1966 |
| No document number | Oct–Dec 1960 | DPST 67–30–1 | Jul–Dec 1966 |
| No document number | Jan–Mar 1961 | DPST 67–30–2 | Jan–Jun 1967 |
| No document number | Apr–Jun 1961 | DPST 68–30–1 | Jul–Dec 1967 |
| No document number | Jul–Sep 1961 | DPST 68–30–2 | Jan–Jun 1968 |
| DPSPU 62–30–11 | Oct–Dec 1961 | DPST 69–30–1 | Jul–Dec 1968 |
| DPSPU 62–30–24 | Jan–Jun 1962 | DPST 69–30–2 | Jan–Jun 1969 |
| DPSPU 63–30–12 | Jul–Dec 1962 | DPST 70–30–1 | Jul–Dec 1969 |
| DPSPU 63–30–1 | Jan–Jun 1963 | DPST 70–30–2 | Jan–Jun 1970 |
| DPSPU 64–30–1 | Jul–Dec 1963 | DPST 71–30–1 | Jul–Dec 1970 |
| DPSPU 64–30–2 | Jan–Jun 1964 | DPST 71–30–16 | Jan–Jun 1971 |
| DPSPU 65–30–1 | Jul–Dec 1964 | | |

### Environmental Monitoring in the Vicinity of the Savannah River Plant

| | | | |
|---|---|---|---|
| DPSPU 72–30–1 | Jan–Dec 1971 | DPSPU 79–30–1 | Jan–Dec 1978 |
| DPSPU 73–30–1 | Jan–Dec 1972 | DPSPU 80–30–1 | Jan–Dec 1979 |
| DPSPU 74–30–1 | Jan–Dec 1973 | DPSPU 81–30–1 | Jan–Dec 1980 |
| DPSPU 75–30–1 | Jan–Dec 1974 | DPSPU 82–30–1 | Jan–Dec 1981 |
| DPSPU 76–30–1 | Jan–Dec 1975 | DPSPU 83–30–1 | Jan–Dec 1982 |
| DPSPU 77–30–1 | Jan–Dec 1976 | DPSPU 84–30–1 | Jan–Dec 1983 |
| DPSPU 78–30–1 | Jan–Dec 1977 | | |

### Savannah River Plant Environmental Report

| | |
|---|---|
| DPSPU 85–30–1 | Jan–Dec 1984 |

## Combined Onsite and Offsite Reports

In 1985, the onsite and offsite environmental monitoring reports were merged into a single publication. A listing of these reports follows.

### Savannah River Site Environmental Report

| | | | |
|---|---|---|---|
| DPSPU 86–30–1 | Jan–Dec 1985 | WSRC–TR–92–186 | Jan–Dec 1991 |
| DPSPU 87–30–1 | Jan–Dec 1986 | WSRC–TR–93–075 | Jan–Dec 1992 |
| DPSPU 88–30–1 | Jan–Dec 1987 | WSRC–TR–94–075 | Jan–Dec 1993 |
| WSRC–RP–89–59–1a | Jan–Dec 1988 | WSRC–TR–95–075 | Jan–Dec 1994 |
| WSRC–IM–90–60 | Jan–Dec 1989 | WSRC–TR–96–0075 | Jan–Dec 1995 |
| WSRC–IM–91–28 | Jan–Dec 1990 | | |

### Savannah River Site Environmental Data

| | | | |
|---|---|---|---|
| WSRC–TR–93–077 | Jan–Dec 1992 | WSRC–TR–95–077 | Jan–Dec 1994 |
| WSRC–TR–94–077 | Jan–Dec 1993 | WSRC–TR–96–0077 | Jan–Dec 1995 |

*Appendix F*

# Errata from 1995 Report

*The following information was reported incorrectly in the* Savannah River Site Environmental Report for 1995 *(WSRC–TR–96–0075):*

**Page 43, right column, second full paragraph:** WSRC–TR–075 should have been WSRC–TR–95–075. *Savannah River Site Environmental Data for 1995* should have been *Savannah River Site Environmental Data for 1994* (WSRC–TR–95–077).

**Page 62, left column, first paragraph, last sentence:** The value 1.7E+13 Bq should have been 1.7E+14 Bq.

**Page 62, right column, first full paragraph, second line:** The value 11 mCi should have been 111 mCi.

**Page 123, map:** The L3R–2 sediment sampling location in figure 9–2, "SRS Stream and Savannah River Nonradiological Sediment Sampling Locations," should have been labeled L3R–3.

**Page 201, right column, last paragraph, last sentence:** Sentence, which ends incorrectly on page 202, should have read as follows: Boilers constructed after 1971 must meet more stringent standards identified in 40 CFR 60, "New Source Performance Standards."

**Page 202, left column, top line on page:** Sentence, which begins incorrectly on page 201, should have read as follows: For process and diesel engine stacks in existence prior to January 1, 1986, and powerhouse stacks built before February 11, 1971, the opacity standard is 40 percent.

**Page 204, left column, first paragraph under "Drinking Water" header:** Reference to appendix D, "Drinking Water Quality Standards," should have been to appendix D, "Drinking Water Standards."

# Glossary

## A

**absorption** – Process by which the number and energy of particles or photons entering a body of matter is reduced by interaction with the matter.

**accuracy** – Closeness of the result of a measurement to the true value of the quantity.

**activity** – See radioactivity.

**adsorption** – Surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid or liquid, as opposed to absorption, the penetration of substances into the bulk of the solid or liquid.

**air flow** – Rate of flow, measured by mass or volume per unit of time.

**air stripping** – Process used to decontaminate groundwater by pumping the water to the surface, "stripping" or evaporating the chemicals in a specially-designed tower, and pumping the cleansed water back to the environment.

**aliquot** – Quantity of sample being used for analysis.

**alkalinity** – Alkalinity is a measure of the buffering capacity of water, and since pH has a direct effect on organisms as well as an indirect effect on the toxicity of certain other pollutants in the water, the buffering capacity is important to water quality.

**alpha particle** – Positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (two protons and two neutrons).

**ambient air** – Surrounding atmosphere as it exists around people, plants, and structures.

**analyte** – Constituent or parameter that is being analyzed.

**analytical detection limit** – Lowest reasonably accurate concentration of an analyte that can be detected; this value varies depending on the method, instrument, and dilution used.

**anion** – Negatively charged ion.

**anomaly** – Deviation beyond normal variations.

**Appendix IX** – List of constituents specified by Appendix IX of the Code of Federal Regulations, Title 40, Part 264. Analyses for Appendix IX constituents are required by the Resource Conservation and Recovery Act under specified conditions.

**aquifer** – Saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.

**aquitard** – Geologic unit that inhibits the flow of water.

**atom** – Smallest particle of an element capable of entering into a chemical reaction.

**Atomic Energy Commission** – Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian application. It was abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration (now part of the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission).

## B

**bailer** – Container lowered into a well to remove water. The bailer is allowed to fill with water and then is removed from the well.

**best available demonstrated technology** – One or more specified treatment technologies or treatment to meet certain concentration limits for hazardous constituents (required by Resource Conservation and Recovery Act Land Disposal Restrictions treatment standards).

**best available technology** – Technology that is the best available at the time to treat waste. See best available demonstrated technology.

**best management practices** – Sound engineering practices that are not, however, required by regulation or by law.

**beta particle** – Negatively charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

**blank** – Control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. In such cases, the measured value or signal for the substance being analyzed is believed to be due to artifacts. Under certain circumstances, that value may be subtracted from the measured value to give a net result reflecting the amount of the substance in the sample. The Environmental Protection Agency does not permit the subtraction of blank results in Environmental Protection Agency-regulated analyses.

**blind blank** – Sample container of deionized water sent to a laboratory under an alias name as a quality control check.

**blind replicate** – In the Environmental Monitoring Section groundwater monitoring program, a second sample taken from the same well at the same time as the primary sample, assigned an alias well name, and sent to a laboratory for analysis (as an unknown to the analyst).

**blind sample** – Control sample of known concentration in which the expected values of the constituent are unknown to the analyst.

**borrow pit** – Excavation dug to provide material such as sand and gravel (borrow) to be used as fill elsewhere.

**Brailsford pump** – Surface water sampling device which is stationed on a stand above a stream. The device, which continuously samples stream water, consists of an all-plastic valveless piston driven by a Brailsford small electric motor. The variable pump speed is set normally at 0.75 gallons/day.

## C

**calibration** – Determination of variance from a standard of accuracy of a measuring instrument to ascertain necessary correction factors.

**Carolina bay** – Type of shallow depression commonly found on the coastal Carolina plains. Carolina bays are typically circular or oval. Some are wet or marshy, while others are dry.

**cation** – Positively charged ion.

**Central Savannah River Area (CSRA)** – Eighteen-county area in Georgia and South Carolina surrounding Augusta, Georgia. The Savannah River Site is included in the Central Savannah River Area. Counties are Richmond, Columbia, McDuffie, Burke, Emanuel, Glascock, Jenkins, Jefferson, Lincoln, Screven, Taliaferro, Warren, and Wilkes in Georgia and Aiken, Edgefield, Allendale, Barnwell, and McCormick in South Carolina.

**chain-of-custody** – Form that documents sample collection, transport, analysis, and disposal.

**chemical oxygen demand** – Indicates the quantity of oxidizable materials present in a water and varies with water composition, concentrations of reagent, temperature, period of contact, and other factors.

**chlorocarbons** – Compounds of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, tetrachloroethylene, etc. They are among the most significant and widespread environmental contaminants. Classified as hazardous wastes, chlorocarbons may have a tendency to cause detrimental effects, such as birth defects.

**cleanup** – Actions taken to deal with release or potential release of hazardous substances. This may mean complete removal of the substance; it also may mean stabilizing, containing, or otherwise treating the substance so that it does not affect human health or the environment.

**closure** – Control of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

**compliance** – Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

**composite** – Blending of more than one portion to make a sample for analysis.

**comprehensive analyses** – Group of analyses that forms the core of the Environmental Monitoring Section groundwater monitoring program each quarter.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** – This act addresses the cleanup of hazardous substances and establishes a National Priorities List of sites targeted for assessment and, if necessary, restoration (commonly known as "Superfund").

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-reportable release** – Release to the environment that exceeds reportable quantities as defined by the Comprehensive Environmental Response, Compensation, and Liability Act.

**concentration** – Amount of a substance contained in a unit volume or mass of a sample.

**conductivity** – Measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in a water and the temperature at which the measurement is made.

**confined aquifer** – Fully saturated aquifer with an aquitard lying above it.

**contamination** – Deposition of unwanted material on the surfaces of structures, areas, objects, or personnel.

**cosmic radiation** – Ionizing radiation with very high energies, originating outside the earth's atmosphere. Cosmic radiation is one source contributing to natural background radiation.

**count** – Signal that announces an ionization event within a counter; a measure of the radiation from an object or device.

**counter** – General designation applied to radiation detection instruments or survey meters that detect and measure radiation.

**counting geometry** – Well-defined sample size and shape for which a counting system has been calibrated.

**criteria pollutant** – any of the pollutants commonly used as indices for air quality that can have a serious effect on human health and the environment, including sulfur dioxide, nitrogen dioxide, total suspended particulates, $PM_{10}$, carbon monoxide, ozone, gaseous fluorides, and lead.

**criticality** – Condition in which a nuclear reactor is just self-sustaining.

**curie** – Unit of radioactivity. One curie is defined as 3.7 x $10^{10}$ (37 billion) disintegrations per second. Several fractions and multiples of the curie are commonly used:

**kilocurie (kCi)** – $10^3$ Ci, one thousand curies; 3.7 x $10^{13}$ disintegrations per second.

**millicurie (mCi)** – $10^{-3}$ Ci, one-thousandth of a curie; 3.7 x $10^7$ disintegrations per second.

**microcurie (µCi)** – $10^{-6}$ Ci, one-millionth of a curie; 3.7 x $10^4$ disintegrations per second.

**picocurie (pCi)** – $10^{-12}$ Ci, one-trillionth of a curie; 0.037 disintegrations per second.

## D

**decay (radioactive)** – Spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same radionuclide.

**decay time** – Time taken by a quantity to decay to a stated fraction of its initial value.

**decontamination and decommissioning** – See environmental restoration.

**derived concentration guide** – Concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air or inhalation), would result in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and lens of the eye. The guides for radionuclides in air and water are given in Department of Energy Order 5400.5.

**desorption** – Process of removing a sorbed substance by the reverse of adsorption or absorption.

**detector** – Material or device (instrument) that is sensitive to radiation and can produce a signal suitable for measurement or analysis.

**diatometer** – Diatom collection equipment consisting of a series of microscope slides in a holder that is used to determine the amount of algae in a water system.

**diatoms** – Unicellular or colonial algae of the class Bacillariophyceae, having siliceous cell walls with two overlapping, symmetrical parts. Diatoms represent the predominant periphyton (attached algae) in most water bodies and have been shown to be reliable indicators of water quality.

**disintegration (nuclear)** – Spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

**dissolved oxygen** – Desirable indicator of satisfactory water quality in terms of low residuals of biologically available organic materials. Dissolved oxygen prevents the chemical reduction and subsequent leaching of iron and manganese from sediments.

**dose** – Energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

**absorbed dose** – Quantity of radiation energy absorbed by an organ, divided by the organ's mass. Absorbed dose is expressed in units of rad (or gray) (1 rad=0.01Gy).

**dose equivalent** – Product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem=0.01 sievert).

**committed dose equivalent** – Calculated total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. Contributions from external dose are not included. Committed dose equivalent is expressed in units of rem (or sievert).

**committed effective dose equivalent** – Sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

**effective dose equivalent** – Sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body.

**collective dose equivalent/collective effective dose equivalent** – Sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within a 50-mile (80-km) radius, and expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or DOE program activities.

**dosimeter** – Portable detection device for measuring the total accumulated exposure to ionizing radiation.

**dosimetry** – Theory and application of principles and techniques involved in the measurement and recording of radiation doses. Its practical aspect is concerned with using various types of radiation instruments to make measurements.

**downgradient** – In the direction of decreasing hydrostatic head.

**downgradient well** – Well that is installed hydraulically downgradient of a site and may be capable of detecting migration of contaminants from a site.

**drinking water standards** – Federal primary drinking water standards, both proposed and final, as set forth by EPA.

**duplicate result** – Result derived by taking a portion of a primary sample and performing the identical analysis on that portion as is performed on the primary sample.

## E

**effluent** – Liquid or gaseous waste discharge to the environment.

**effluent monitoring** – Collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying the release of contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.

**environmental monitoring** – Program at Savannah River Site that includes effluent monitoring and environmental surveillance with dual purpose of (1) showing compliance with federal, state, and local regulations, as well as with U.S. Department of Energy orders, and (2) monitoring any effects of site operations on onsite and offsite natural resources and on human health.

**environmental restoration** – Department of Energy program that directs the assessment and cleanup of its sites (remediation) and facilities (decontamination and decommissioning) contaminated with waste as a result of nuclear-related activities.

**environmental surveillance** – Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from Department of Energy sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

**equipment blank** – Sample container of deionized water that has been pumped through or has filled a sampling device (e.g., well pump bailer). Laboratory analysis of the blank can identify potential contaminants in water, sample container, or analytical equipment.

**exceedance** – Term used by the Environmental Protection Agency and the South Carolina Department of Health and Environmental Control that denotes a report value is more than the upper guide limit. This term is found on the Discharge Monitoring Report forms that are submitted to the Environmental Protection Agency or the South Carolina Department of Health and Environmental Control.

**exposure (radiation)** – Incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is that exposure to ionizing radiation which takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

**exposure pathway** – Route that materials follow to get to the environment and then to people.

**external radiation** – Exposure to ionizing radiation when the radiation source is located outside the body.

## F

**fecal coliform** – Coliform group comprises all of the aerobic, nonspore-forming, rod-shaped bacteria. The test determines the presence or absence of coliform organisms.

**Federal Facility Agreement (FFA)** – Agreement negotiated among the Department of Energy, the Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control, specifying how the Savannah River Site will address contamination or potential contamination to meet regulatory requirements at the Savannah River Site waste units identified for evaluation and, if necessary, cleanup.

**feral hog** – Hog that has reverted to the wild state from domestication.

**field blank** – Sample container of deionized water generated by filling the sample container at the sample location and treated as a groundwater sample.

**food web** – Series of organisms related by predator-prey and consumer-resource interactions; the entirety of interrelated food chains in an ecological community.

**formation** – Mappable unit of consolidated or unconsolidated geologic material of a characteristic lithology or assemblage of lithologies.

**frit** – Fused or partially fused materials used in glassmaking.

## G

**gamma ray** – High-energy, short wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma rays are identical to X-rays except for the source of the emission.

**gamma-emitting radionuclide** – Radionuclide that emits gamma rays.

**gamma spectrometry** – System consisting of a detector, associated electronics, and a multichannel analyzer that is used to analyze samples for gamma-emitting radionuclides.

**gas chromatographic volatile organic analyses (GC VOA)** – Analytical technique detecting and quantifying volatile organic compounds in a sample by gas chromatography.

**Gaussian puff/plume model** – Computer simulated atmospheric dispersion of a release using a Gaussian (normal) statistical distribution to determine concentrations in air.

**Geiger-Mueller counter** – Highly sensitive, gas-filled radiation detector, which operates at voltages sufficiently high to produce ionization. The counter is used primarily in the detection of gamma radiation and beta emission. It is named for Hans Geiger and W. Mueller, who invented it in 1928.

**genotoxicology** – Study of the effects of chemicals or radioactive contaminants on the genetics of individual animals or plants.

**grab sample** – Sample collected instantaneously with a glass or plastic bottle placed below the water surface to collect surface water samples (also called dip samples).

**groundwater (unconfined)** – Groundwater exposed to the unsaturated zone.

## H

**half-life (biological)** – Time required for a biological system, such as that of a human, to eliminate by natural processes half the amount of a substance (such as a radioactive material) that has entered it.

**half-life (radiological)** – Time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

**head reversal** – Hydrologic phenomenon in which a deeper formation has a higher water pressure than a more shallow formation in the same location. This condition results in a tendency for groundwater to flow upward from the deeper media to the more shallow formation.

**heavy water** – Water in which the molecules contain oxygen and deuterium, an isotope of hydrogen that is heavier than ordinary hydrogen.

**herbaceous** – Having little or no woody tissue.

**herbicides/pesticides** – Suite of analyses consisting of 2,4–dichlorophenoxyacetic acid, endrin, lindane, methoxychlor, toxaphene, and 2,4,5–TP (silvex).

**hydraulic gradient** – Difference in hydraulic head over a specified distance.

**hydraulic head** – Elevation of the water in a well or piezometer.

**hydrogeology** – Hydrologic aspects of site geology.

**hydrology** – Science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

## I

**in situ** – In its original place. Field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

**inorganic** – Involving matter other than plant or animal.

**internal dose factor** – Factor used to convert intakes of radionuclides to dose equivalents.

**internal radiation** – Internal radiation occurs when natural radionuclides enter the body by ingestion of foods, milk, and water, and by inhalation. Radon is the major contributor to the annual dose equivalent for internal radionuclides.

**ion** – Atom or compound that carries an electrical charge.

**ion exchange** – Process in which a solution containing soluble ions is passed over a solid ion exchange column that removes the soluble ions by exchanging them with labile ions from the surface of the column. The process is reversible so that the trapped ions are removed (eluted) from the column and the column is regenerated.

**irradiation** – Exposure to radiation.

**Isco sampler** – Portable, microprocessor-controlled water sampler that utilizes a peristaltic pump for sample collection. The sampler may be used with a flowmeter to obtain a flow-proportional sample or without a flowmeter to obtain a time-proportional sample.

**isotopes** – Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons.

**long-lived isotope** – Radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).

**short-lived isotope** – Radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

## L

**laboratory blank** – Deionized water sample generated by the laboratory; a laboratory blank is analyzed with each batch of samples as an in-house check of analytical procedures. Also called an internal blank.

**layup** – To put in condition for possible future use.

**liquid scintillation cocktail** – Solution combined with a radioactive sample which converts the energy of the particle emitted during radioactive decay into light, which is detected by a liquid scintillation counter.

**liquid scintillation counter** – Combination of phosphor, photomultiplier tube, and associated circuits for counting light emissions produced in the phosphors.

**lower limit of detection (LLD)** – Smallest concentration/amount of analyte that can be reliably detected in a sample at a 95 percent confidence level.

## M

**macroinvertebrates** – Size-based classification used for a variety of insects and other small invertebrates; as defined by the Environmental Protection Agency, those organisms that are retained by a No. 30 (590 micron) U.S. Standard Sieve.

**macrophyte** – A plant that can be observed with the naked eye.

**manmade radiation** – Radiation sources such as consumer products, medical procedures, and nuclear industry.

**maximally exposed individual** – Hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

**mean relative difference (MRD)** – Percentage error based on statistical analysis.

**mercury** – Silver-white, liquid metal solidifying at –38.9 °C to form a tin-white, ductile, malleable mass. It is widely distributed in the environment and biologically is a nonessential or nonbeneficial element. Human poisoning due to this highly toxic element has been clinically recognized.

**microbes** – Microscopic organisms.

**migration** – Transfer or movement of a material through the air, soil, or groundwater.

**milliroentgen (mR)** – Measure of X-ray or gamma radiation. The unit is one-thousandth of a roentgen.

**minimum detectable concentration (MDC)** – Smallest amount or concentration of a radionuclide that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level.

**monitoring** – Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically in order to regulate and control potential impacts.

## N

**natural radiation** – Radiation arising from cosmic and other naturally occurring radionuclide (such as radon) sources present in the environment.

**nonpoint source** – any source that does not meet the definition for point source (National Emission Standards for Hazardous Air Pollutants radionuclide program).

**nonroutine radioactive release** – Unplanned or nonscheduled release of radioactivity to the environment.

**nuclide** – Atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

## O

**organic** – Of, relating to, or derived from living organisms (plant or animal).

**outcrop** – Place where groundwater is discharged to the surface. Springs, swamps, and beds of streams and rivers are the outcrops of the water table.

**outfall** – Point of discharge (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

## P

**paddlewheel sampler** – Water sampling device, constructed of a Lexan® wheel, suspended on two pontoons and anchored in streams and rivers.

**parameter** – Analytical constituent; chemical compound(s) or property for which an analytical request may be submitted.

**parts per million (ppm)** – Unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

**percolation** – Slow movement of a liquid through a porous material.

**permeability** – Physical property that describes the ease with which water may move through the pore spaces and cracks in a solid.

**person-rem** – Collective dose to a population group. For example, a dose of one rem to 10 individuals results in a collective dose of 10 person-rem.

**pH** – Measure of the hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH from 0–6, basic solutions have a pH > 7, and neutral solutions have a pH = 7.

**piezometer** – Instrument used to measure the potentiometric surface of the groundwater. Also, a well designed for this purpose.

**plume** – Volume of contaminated air or water originating at a point-source emission (e.g., a smokestack) or a waste source (e.g., a hazardous waste disposal site).

**point of compliance** – Vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.

**point source** – stack or vent (National Emission Standards for Hazardous Air Pollutants radionuclide program).

**population dose commitment** – See collective dose equivalent under dose.

**priority pollutants** – Group of approximately 130 chemicals (about 110 are organics) that appear on an Environmental Protection Agency list because they are toxic and relatively common in industrial discharges.

**process sewer** – Pipe or drain, generally located underground, used to carry off process water and/or waste matter.

**process water** – Water used within a system process.

**purge** – To remove water prior to sampling, generally by pumping or bailing.

**purge water** – Water that has been removed prior to sampling; water that has been released to seepage basins to allow a significant part of tritium to decay before the water outcrops to surface streams and flows to the Savannah River.

## Q

**quality assurance (QA)** – Any action in environmental monitoring to assure the reliability of monitoring and measurement data.

**quality control (QC)** – In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes.

## R

**rad** – Unit of absorbed dose deposited in a volume of material.

**radiation detection instruments** – Devices that detect and record the characteristics of ionizing radiation.

**radioactivity** – Spontaneous emission of radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

**radioisotopes** – Radioactive isotopes.

**radionuclide** – Unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

**real-time instrumentation** – Operation in which programmed responses to an event are essentially simultaneous with the event itself.

**reforestation** – Process of planting new trees on land once forested.

**release** – Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

**rem** – Unit of dose equivalent (absorbed dose in rads × the radiation quality factor). Dose equivalent is frequently reported in units of millirem (mrem) which is one-thousandth of a rem.

**remediation** – Assessment and cleanup of Department of Energy sites contaminated with waste as a result of past activities. See environmental restoration.

**replicate** – In the Environmental Monitoring Section groundwater monitoring program, a second sample from the same well taken at the same time as the primary sample and sent to the same laboratory for analysis.

**replicate result** – Analytical result of a blind replicate sample. See blind replicate.

**Resource Conservation and Recovery Act (RCRA)** – Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes. This act also requires corrective action for releases of hazardous waste at inactive waste units.

**Resource Conservation and Recovery Act (RCRA) closure certification** – Certification prepared within 60 days of closure by the owner or operator of an individual waste disposal unit at a facility or an incinerator, tank, or container storage facility, and a qualified, independent, registered professional engineer. The document certifies that the facility or unit was closed in accordance with the approved facility closure plan.

**Resource Conservation and Recovery Act (RCRA) interim status** – Statutorily conferred authorization for a hazardous waste management unit to operate pending issuance or denial of its Resource Conservation and Recovery Act permit. Interim status provisions, contained in 40 CFR Part 265, allow a facility to operate legally. The facility is considered to be operating under a permit until the Environmental Protection Agency takes final administrative action on that facility's permit application.

**Resource Conservation and Recovery Act (RCRA) site** – Solid waste management unit under Resource Conservation and Recovery Act regulation. See Resource Conservation and Recovery Act.

**retention basin** – Unlined basin used for emergency, temporary storage of potentially contaminated cooling water from chemical separations activities.

**RFI Program** – RCRA Facility Investigation Program; Environmental Protection Agency-regulated investigation of a solid waste management unit with regard to its potential impact on the environment.

**RFI/RI** – RCRA Facility Investigation/Remedial Investigation. See RFI/RI Program.

**RFI/RI Program** – RCRA Facility Investigation/Remedial Investigation Program. At the Savannah River Site, the expansion of the RFI Program to include Comprehensive Environmental Response, Compensation, and Liability Act and hazardous substance regulations.

**roentgen** – Unit of exposure from X- or gamma rays. One roentgen equals $2.58 \times 10^{-4}$ coulombs per kilogram of air.

**routine radioactive release** – Planned or scheduled release of radioactivity to the environment.

## S

**screen zone** – In well construction, the section of a formation that contains the screen, or perforated pipe that allows water to enter the well.

**seep** – Area, generally small, where water percolates slowly to the land surface.

**seepage basin** – Excavation that receives wastewater. Insoluble materials settle out on the floor of the basin and soluble materials seep with the water through the soil column where they are removed partially by ion exchange with the soil. Construction may include dikes to prevent overflow or surface runoff.

**sensitivity** – Capability of methodology or instruments to discriminate between samples with differing concentrations or containing varying amounts of analyte.

**set-aside areas** – Thirty areas covering 14,288 acres set aside to protect rare, threatened, and endangered biota, as well as unique habitats.

**settleable solids** – Material settling out of suspension within a defined period.

**settling basin** – Temporary holding basin (excavation) that receives wastewater which is subsequently discharged.

**sidegradient well** – Well that intercepts groundwater flowing next to a site; a sidegradient well is located neither upgradient nor downgradient to the monitored site.

**Sievert (Sv)** – SI (International System of Units) unit of dose equivalent, 1 Sv=100 rem.

**site stream** – Any natural stream on the Savannah River Site. Surface drainage of the site is via these streams to the Savannah River.

**Solid Waste Disposal Facility** – Place for burying unwanted radioactive material to prevent escape of radioactivity. The surrounding water acts as a shield. Such material is placed in watertight, noncorrosive containers so that it cannot leach out and invade underground water.

**source** – Point or object from which radiation or contamination emanates.

**source check** – Radioactive source with a known amount of radioactivity used to check the performance of the radiation detector instrument.

**source term** – Quantity of radioactivity released in a set period of time that is traceable to the starting point of an effluent stream or migration pathway.

**specific conductance** – Ability of water to conduct electricity; this ability varies in proportion to the amount of ionized minerals in the water.

**spike** – Addition of a known amount of reference material containing the analyte of interest to a blank sample.

**split sample** – Two samples from the same well, taken at the same time, and sent to two different laboratories for analysis.

**stable** – Not radioactive or not easily decomposed or otherwise modified chemically.

**stack** – Vertical pipe or flue designed to exhaust airborne gases and suspended particulate matter.

**standard deviation** – Indication of the dispersion of a set of results around their average.

**stormwater runoff** – Surface streams that appear after precipitation.

**strata** – Beds, layers, or zones of rocks.

**substrate** – Substance, base, surface, or medium in which an organism lives and grows.

**Superfund** – see Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

**supernatant** – Portion of a liquid above settled materials in a tank or other vessel.

**surface water** – All water on the surface of the earth, as distinguished from groundwater.

# T

**tank farm** – Installation of interconnected underground tanks for storage of high-level radioactive liquid wastes.

**temperature** – Thermal state of a body considered with its ability to communicate heat to other bodies.

**terrestrial radiation** – Ionizing radiation emitted from radioactive materials, primarily potassium-40, thorium, and uranium, in the earth's soils. Terrestrial radiation contributes to natural background radiation.

**thermoluminescent dosimeter (TLD)** – Device used to measure external gamma radiation.

**total activity** – Total quantity of radioactive decay particles that are emitted from a sample.

**total dissolved solids** – Dissolved solids and total dissolved solids are terms generally associated with freshwater systems and consist of inorganic salts, small amounts of organic matter and dissolved materials.

**total organic halogens** – Measure of the total concentration of organic compounds that have one or more halogen atoms.

**total phosphorus** – When concentrations exceed 25 mg/L at the time of the spring turnover on a volume-weighted basis in lakes or reservoirs, it may occasionally stimulate excessive or nuisance growths of algae and other aquatic plants.

**total solids** – Sum of total dissolved solids and suspended solids.

**total suspended particulates** – Refers to the concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

**transmissive zone** – Zone of sediments sufficiently porous and permeable to allow the flow of groundwater through the zone.

**transport pathway** – pathway by which a released contaminant physically is transported from its point of discharge to a point of potential exposure to humans. Typical transport pathways include the atmosphere, surface water, and groundwater.

**transuranic waste** – Solid radioactive waste containing primarily alpha-emitting elements heavier than uranium.

**turbidity** – Measure of the concentration of sediment or suspended particles in solution.

# U

**upgradient** – In the direction of increasing hydrostatic head.

# V

**vadose zone** – Soil zone located above the water table.

**vitrification** – Process of changing into glass.

**volatile organic compounds** – Broad range of organic compounds, commonly halogenated, that vaporize at ambient, or relatively low, temperatures (e.g., acetone, benzene, chloroform, and methyl alcohol).

# W

**waste unit** – Inactive area that is known to have received contamination or had a release to the environment.

**water table** – Planar, underground surface beneath which earth materials, as soil or rock, are saturated with water.

**watershed** – Region draining into a river, river system, or body of water.

**weighting factor** – Value used to calculate dose equivalents. It is tissue specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection (Publication 26).

**wetlands** – Lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted for life in saturated soils.

**wind rose** – Diagram in which statistical information concerning direction and speed of the wind at a location is summarized.

**worldwide fallout** – Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

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| Units of Measure | | | |
|---|---|---|---|
| **Symbol** | **Name** | **Symbol** | **Name** |
| *Temperature* | | *Mass* | |
| °C | degrees Centigrade | g | gram |
| °F | degrees Fahrenheit | kg | kilogram |
| | | mg | milligram |
| | | µg | microgram |
| *Time* | | *Area* | |
| d | day | $mi^2$ | square mile |
| h | hour | $ft^2$ | square foot |
| y | year | | |
| *Length* | | *Radioactivity* | |
| cm | centimeter | Ci | curie |
| ft | foot | cpm | counts per minute |
| in. | inch | mCi | millicurie |
| km | kilometer | µCi | microcurie |
| m | meter | pCi | picocurie |
| mm | millimeter | Bq | becquerel |
| µm | micrometer | | |
| *Volume* | | *Radiation Dose* | |
| gal | gallon | mrad | millirad |
| L | liter | mrem | millirem |
| mL | milliliter | Sv | sievert |
| ppb | parts per billion | mSv | millisievert |
| ppm | parts per million | µSv | microsievert |
| | | R | roentgen |
| *Rate* | | mR | milliroentgen |
| cfs | cubic feet per second | µR | microroentgen |
| gpm | gallons per minute | Gy | gray |

| Fractions and Multiples of Units | | | | |
|---|---|---|---|---|
| Multiple | Decimal Equivalent | Prefix | Symbol | Report Format |
| $10^6$ | 1,000,000 | mega- | M | E+06 |
| $10^3$ | 1,000 | kilo- | k | E+03 |
| $10^2$ | 100 | hecto- | h | E+02 |
| 10 | 10 | deka- | da | E+01 |
| $10^{-1}$ | 0.1 | deci- | d | E–01 |
| $10^{-2}$ | 0.01 | centi- | c | E–02 |
| $10^{-3}$ | 0.001 | milli- | m | E–03 |
| $10^{-6}$ | 0.000001 | micro- | µ | E–06 |
| $10^{-9}$ | 0.000000001 | nano- | n | E–09 |
| $10^{-12}$ | 0.000000000001 | pico- | p | E–12 |
| $10^{-15}$ | 0.000000000000001 | femto- | f | E–15 |
| $10^{-18}$ | 0.000000000000000001 | atto- | a | E–18 |

| Conversion Table (Units of Radiation Measure) | | |
|---|---|---|
| Current System | *Systéme International* | Conversion |
| curie (Ci) | becquerel (Bq) | 1 Ci = $3.7 \times 10^{10}$Bq |
| rad (radiation absorbed dose) | gray (Gy) | 1 rad = 0.01 Gy |
| rem (roentgen equivalent man) | sievert (Sv) | 1 rem = 0.01 Sv |

| Conversion Table | | | | | |
|---|---|---|---|---|---|
| Multiply | By | To Obtain | Multiply | By | To Obtain |
| in. | 2.54 | cm | cm | 0.394 | in. |
| ft | 0.305 | m | m | 3.28 | ft |
| mi | 1.61 | km | km | 0.621 | mi |
| lb | 0.4536 | kg | kg | 2.205 | lb |
| liq qt-U.S. | 0.946 | L | L | 1.057 | liq qt-U.S. |
| $ft^2$ | 0.093 | $m^2$ | $m^2$ | 10.764 | $ft^2$ |
| $mi^2$ | 2.59 | $km^2$ | $km^2$ | 0.386 | $mi^2$ |
| $ft^3$ | 0.028 | $m^3$ | $m^3$ | 35.31 | $ft^3$ |
| d/m | 0.450 | pCi | pCi | 2.22 | d/m |
| pCi | $10^{-6}$ | µCi | µCi | $10^6$ | pCi |
| pCi/L (water) | $10^{-9}$ | µCi/mL (water) | µCi/mL (water) | $10^9$ | pCi/L (water) |
| pCi/$m^3$ (air) | $10^{-12}$ | µCi/mL (air) | µCi/mL (air) | $10^{12}$ | pCi/$m^3$ (air) |

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