WSRC-TR-95-075

Savannah River Site
Environmental Report for 1994

Environmental Monitoring Section
Environmental Protection Department

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

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Savannah River Site Environmental Report for 1994

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Preface

Savannah River Site (SRS) conducts effluent monitoring and environmental surveillance to ensure the safety of the public and the well-being of the environment. DOE Order 5400.1, "General Environmental Protection Program," requires SRS to submit an environmental report that documents the impact of facility operations on the environment and on public health.

SRS has had an extensive environmental surveillance program in place since 1951 (before site startup). At that time, data generated by the onsite surveillance program were reported in site documents. Beginning in 1959, data from offsite environmental monitoring activities were presented in reports issued for public dissemination. SRS reported onsite and offsite environmental monitoring activities separately until 1985, when data from both surveillance programs were merged into one public document.

The *Savannah River Site Environmental Report for 1994* is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 1994.[a] It is prepared by the Environmental Monitoring Section (EMS) of the Westinghouse Savannah River Company (WSRC). The "SRS Environmental Monitoring Plan" (WSRC–3Q1–2–1000) provides complete program descriptions and documents the rationale and design criteria for the monitoring program, the frequency of monitoring and analysis, the specific analytical and sampling procedures, and the quality assurance requirements.

Variations in the report's content from year to year reflect changes in the routine program or difficulties encountered in obtaining or analyzing some samples. Examples of such problems include adverse environmental conditions (such as flooding or drought), sampling or analytical equipment malfunctions, and the samples compromised in the preparation laboratories or counting room.

Unless otherwise indicated, the figures and tables in this report are generated using information about the routine monitoring program. No attempt has been made to include all data from environmental research programs. A more complete listing of data can be found in *Savannah River Site Environmental Data for 1994* (WSRC–TR–95–077).

The following information should aid the reader in interpreting data in this report:

- Analytical results and their corresponding uncertainty terms are reported with up to three significant figures. The last significant figure of a result is determined by the quantification of the uncertainty term. EMS attempts to report the appropriate confidence in the result with the correct number of significant figures.
- The reported uncertainty reflects only the counting error—not other components of random and systematic error present in the measurement process. For this reason, some results may imply a greater confidence than the determination would suggest.
- Uncertainties quoted with means represent the deviation of measurements about the mean value. This number is calculated from the results themselves and is not weighted by the uncertainties of the individual results.
- For gamma-emitting radionuclides, lower limit of detection (LLD) values are not reported or considered in the averages. Detection limits based on typical sample parameters are not reported.
- A value is reported for all other analyses, although it may be below the LLD value. Negative values also are reported. Averages are calculated using both positive and negative results.
- The generic term "dose," as used in the report, refers to the committed effective dose equivalent (50-year committed dose) from internal deposition of radionuclides and to the effective dose equivalent attributable to penetrating radiation from sources external to the body.

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a The reader should note that the purpose of this report is to document effluent monitoring and environmental surveillance for a calendar year; no attempt has been made to produce a comprehensive report of all environmental activities conducted at SRS.

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Acronyms and Abbreviations

A

ALARA – As low as reasonably achievable.

ANSP – Academy of Natural Sciences of Philadelphia.

B

BTU – British thermal unit.

C

CAA – Clean Air Act.

CAAA – Clean Air Act Amendments of 1990.

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (Superfund).

CFC – Chlorofluorocarbon.

CFR – Code of Federal Regulations.

CI – Curie.

CIF – Consolidated Incineration Facility.

CSRA – Central Savannah River Area.

CWA – Clean Water Act.

CX – Categorical exclusion.

D

D&D – Decontamination and decommissioning.

DCG – Derived concentration guide.

DNC – Department National Environmental Policy Act Coordinator.

DOE – U.S. Department of Energy.

DOE–HQ – U.S. Department of Energy–Headquarters.

DOE–SR – U.S. Department of Energy–Savannah River Operations Office.

DWPF – Defense Waste Processing Facility.

DWS – Drinking water standards.

E

EA – Environmental Assessment.

EIS – Environmental Impact Statement.

EMCAP – Environmental Monitoring Computer Automation Project.

EMS – Environmental Monitoring Section of the Environmental Protection Department (of Westinghouse Savannah River Company).

EPA – U.S. Environmental Protection Agency.

EPCRA – Emergency Planning and Community Right-to-Know Act.

EPD – Environmental Protection Department (of Westinghouse Savannah River Company).

ERDA – Education, Research and Development Association of Georgia Universities.

ETF – Effluent Treatment Facility.

F

FDA – U.S. Food and Drug Administration.

FFA – Federal Facility Agreement. Agreement.

FFCA – Federal Facility Compliance Agreement.

FFCAct – Federal Facility Compliance Act.

FONSI – Finding of No Significant Impact.

G

GDNR – Georgia Department of Natural Resources.

GOCO – Government-owned, contractor-operated.

Gy – Gray; unit of absorbed dose.

H

HCFC – Hydrochlorofluorocarbon.

I

ICRP – International Commission on Radiological Protection.

L

LDR – Land disposal restrictions.

LETF – Liquid Effluent Treatment Facility.

LLD – Lower limit of detection.

LLRWDF – Low-Level Radioactive Waste Disposal Facility.

M

MAP – Mitigation Action Plan.

mR – Milliroentgen.

MRD – Mean relative difference.

mrem – Dose equivalent that is one-thousandth of a rem.

MWMF – Mixed Waste Management Facility.

N

NCRP – National Council on Radiation Protection and Measurements.

NEPA – National Environmental Policy Act.

NESHAP – National Emission Standards for Hazardous Air Pollutants.

NOV – Notice of Violation.

NPDES – National Pollutant Discharge Elimination System.

NRC – U.S. Nuclear Regulatory Commission.

O

ODS – Ozone-depleting substances.

P

PAR Pond – Pond constructed at Savannah River Site in 1958 to provide cooling water for P-Reactor and R-Reactor (P and R; hence, PAR).

PCB – Polychlorinated biphenyl.

PEIS – Programmatic Environmental Impact Statement.

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.

ppb – Parts per billion.

ppm – Parts per million.

PVC – polyvinyl chloride.

Q

QA – Quality assurance.

QAD – Quality Assurance Division (Environmental Protection Agency).

QAP – Quality Assurance Program (Department of Energy).

QA/QC – Quality assurance/quality control.

QC – Quality control. In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes.

R

RBOF – Receiving Basin for Offsite Fuel.

RCRA – Resource Conservation and Recovery Act.

RFI/RI – RCRA Facility Investigation/Remedial Investigation.

RQ – Reportable quantity.

RTF – Replacement Tritium Facility.

S

SARA – Superfund Amendments and Reauthorization Act.

SCDHEC – South Carolina Department of Health and Environmental Control.

SDWA – Safe Drinking Water Act.

SEA – Special Environmental Analysis.

SEIS – Supplemental Environmental Impact Statement.

SRARP – Savannah River Archaeological Research Program.

SREL – Savannah River Ecology Laboratory (University of Georgia).

SRFS – Savannah River Forest Station (U.S. Forest Station).

SRS – Savannah River Site.

SRTC – Savannah River Technology Center.

Sv – Sievert.

SWDF – Solid Waste Disposal Facility.

T

TLD – Thermoluminescent dosimeter.

TRI – Toxic Release Inventory.

TSCA – Toxic Substances Control Act.

U

USGS – U.S. Geological Survey.

W

WSRC – Westinghouse Savannah River Company.

Executive Summary

Introduction

The mission at the Savannah River Site (SRS) has changed from the production of nuclear weapons materials for national defense to the management of site-generated waste, restoration of the surrounding environment, and the development of industry in and around the site. However, SRS—through its prime operating contractor, Westinghouse Savannah River Company (WSRC)—is expected to continue maintaining a comprehensive environmental monitoring program.

In 1994, effluent monitoring and environmental surveillance were conducted within a 31,000-square-mile area in and around SRS that includes neighboring cities, towns, and counties in Georgia and South Carolina and extends up to 100 miles from the site. Thousands of samples of air, surface water, groundwater, food products, drinking water, wildlife, rainwater, soil, sediment, and vegetation were collected and analyzed for radioactive and nonradioactive contaminants.

Potential Radiation Doses

SRS follows the radiation protection standards outlined in U.S. Department of Energy (DOE) Order 5400.5, "Radiation Protection of the Public and the Environment," which include U.S. Environmental Protection Agency (EPA) regulations on the doses from airborne releases and treated drinking water.

These regulations state that the dose to an individual must not exceed 10 mrem per year from releases of airborne radioactivity, or 4 mrem per year from releases of liquid radioactivity. The limit for all types of exposures to the public from a DOE facility is 100 mrem per year.

Table 1 shows the 1994 potential radiation doses from SRS releases compared with the applicable federal dose standards and with estimated doses from naturally occurring background radiation. All potential radiation doses attributed to SRS in 1994 were below applicable regulatory standards.

Potential Liquid Pathway Dose

The potential dose to the maximally exposed individual from liquid releases of radioactivity to the Savannah River was estimated to be 0.14 mrem (0.0014 mSv). This potential dose was the same as the 1993 maximum potential dose. The dose remained the same—even though the amount of tritium oxide released from SRS during 1994 was about 14 percent less than the amount released during 1993 (10,900 Ci in 1994 versus 12,700 Ci in 1993)—because the Savannah River flow rate was about 16 percent less in 1994 than in 1993, causing less dilution to occur.

Approximately 47 percent of this potential dose resulted from the ingestion of cesium-137 in Savannah River fish, and about 42 percent resulted from the ingestion (via drinking river water) of tritium oxide.

The 1994 collective dose from liquid releases was estimated to be 1.7 person-rem (0.017 person-Sv).

Potential Drinking Water Pathway Dose

Offsite doses were calculated for persons consuming drinking water from two water treatment plants approximately 100 miles downriver of SRS near Beaufort, South Carolina, and Port Wentworth, Georgia. The maximum doses were 0.05 mrem (0.0005 mSv) at Beaufort and 0.06 mrem (0.0006 mSv) at Port Wentworth. These potential doses are based on an individual who consumes 2 liters per day of treated drinking water from the Savannah River. These doses are 1.25 percent and 1.50 percent, respectively, of the drinking water standard of 4 mrem per year (0.04 mSv per year). Tritium oxide releases accounted for approximately 83 percent of the potential offsite doses at Beaufort and Port Wentworth.

Potential Airborne Pathway Dose

For 1994, the potential dose to the maximally exposed individual from airborne releases of radioactive materials was 0.09 mrem (0.0009 mSv). This potential dose is 0.9 percent of the 10-mrem per year (0.1-mSv per year) limit for exposure to airborne releases from a DOE facility. The 1994 dose was approximately 20 percent lower than the 1993 dose of 0.11 mrem (0.0011 mSv) because there was a 20-percent decrease in airborne tritium oxide releases from 1993 to 1994.

The collective dose (population dose) to the 620,100 persons living within 50 miles of the center of the site was estimated to be 6.3 person-rem (0.063 person-Sv), which is less than 0.01 percent of the collective dose received from naturally occurring sources of radiation (about 195,000 person-rem).

Table 1 1994 Potential Radiation Doses from SRS Releases Compared with Applicable Dose Standards and Estimated Doses from Naturally Occurring Radiation

Exposure Pathway	Maximum Potential Dose from 1994 Releases[a]	Applicable Dose Standard[b]	Percent of Standard	Percent of Natural[c]
Maximally Exposed Individual Doses				
Airborne Releases				
Total Airborne	0.09 mrem	10 mrem[d]	0.9	0.03
Liquid Releases				
Total Liquid	0.14 mrem	None[e]	N/A[e]	0.05
All Pathways[f]	**0.23 mrem**	100 mrem	0.23	0.08
Treated Drinking Water				
Beaufort-Jasper	0.05 mrem	4 mrem[g]	1.25	0.02
Port Wentworth	0.06 mrem	4 mrem[g]	1.50	0.02
Special-Case Exposure Scenarios				
Sportsman Dose				
Deer and hog consumption				
Onsite hunter	46.0 mrem	100 mrem	46.0	15
Offsite hunter	20.0 mrem	100 mrem	20.0	7
Fish consumption				
Steel Creek fish	1.3 mrem	100 mrem	1.3	0.4
Goat Milk Consumption Dose				
Max. individual	0.1 mrem	10 mrem	1.0	0.03
Irrigation Pathway Dose				
Max. individual	0.09 mrem	100 mrem	0.09	0.03
Population (Collective) Doses				
Exposure Pathway	**Maximum Potential Dose from 1994 Releases[a]**	**Applicable Dose Standard[b]**	**Percent of Standard**	**Percent of Natural[c]**
Airborne Releases				
Total Airborne	6.3 person-rem	None[e]	N/A[e]	0.01
Liquid Releases				
Total Liquid	1.7 person-rem	None[e]	N/A[e]	0.01

a Committed effective dose equivalent.

b All the standards listed are given in DOE Order 5400.5, February 8, 1990, "Radiation Protection of the Public and the Environment."

c Estimate of average dose received from naturally occurring radiation is 300 mrem per year [NCRP, 1987]. The population (collective) dose due to naturally occurring radiation is estimated to be about 195,000 person-rem.

d The standard for airborne effluents applies to the sum of the doses from all airborne pathways: inhalation, submersion in a plume, exposure to radionuclides deposited on the ground surface, and consumption of foods contaminated as a result of the deposition of radionuclides.

e There is no separate standard for population dose or for all liquid pathways alone; liquid releases are included in the 100-mrem standard for all pathways.

f The total airborne and liquid exposure pathways are added in order to compare maximum calculated doses from SRS releases with the DOE "all pathways" standard. This total includes the maximum airborne pathway dose of 0.09 mrem (0.0009 mSv) and the maximum liquid pathway dose of 0.14 mrem (0.0014 mSv).

g The drinking water standard applies to public drinking water systems and to drinking water supplies operated by DOE or DOE contractors.

Tritium comprised approximately 88 percent of the estimated doses from SRS airborne releases.

Potential All-Pathway Dose

To demonstrate compliance with 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.

For 1994, the potential maximally exposed individual all-pathway dose was 0.23 mrem (0.0023 mSv) (0.09 mrem from airborne pathway plus 0.14 mrem from liquid pathway). This dose is 8 percent lower than the 1993 all-pathway dose of 0.25 mrem (0.0025 mSv), mainly because of the decrease in atmospheric tritium oxide releases during 1994.

Figure 1 shows a 10-year history of SRS's all-pathway doses (airborne pathway plus liquid pathway doses to the maximally exposed individual). Figure 2 shows a comparison of the 1994 potential all-pathway dose to the DOE dose standard of 100 mrem per year (1.0 mSv per year), to the average annual naturally occurring background dose of 300 mrem (3.0 mSv), and to the average annual dose from all sources of radiation (natural occurring plus manmade) of 360 mrem (3.6 mSv). Figure 3 shows that the 1994 maximum potential all-pathway dose attributable to SRS operations (0.23 mrem) contributed less than 0.1 percent of the average annual radiation dose received by a typical Central Savannah River Area (CSRA) resident.

Potential Sportsman Dose

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 relatively low-probability scenarios, such as consumption of fish caught exclusively from the mouths of SRS streams, or to unique scenarios, such as volunteer deer hunts.

In 1994, the maximum dose to an actual onsite hunter could have been as high as 46 mrem (0.46 mSv), which is 46 percent of DOE's 100-mrem all-pathway dose standard. During the onsite deer hunts, this individual harvested 11 animals—the edible portion totaled about 247 kg (545 pounds)—and was assumed to have eaten all the meat himself.

If a hypothetical offsite hunter living near the site boundary consumed 81 kg (179 pounds) of meat—the annual maximum adult consumption rate for meat—taken from deer living on site prior to being harvested, the individual's maximum dose could have been 20 mrem (0.20 mSv). This dose was based on the average concentration of cesium-137 (6.0 pCi/g) measured in animals harvested at SRS during 1994.

The potential maximum dose for a fisherman was based on the consumption of 19 kg (42 pounds)—the maximum adult consumption rate for fish—of Savannah River fish having the highest measured

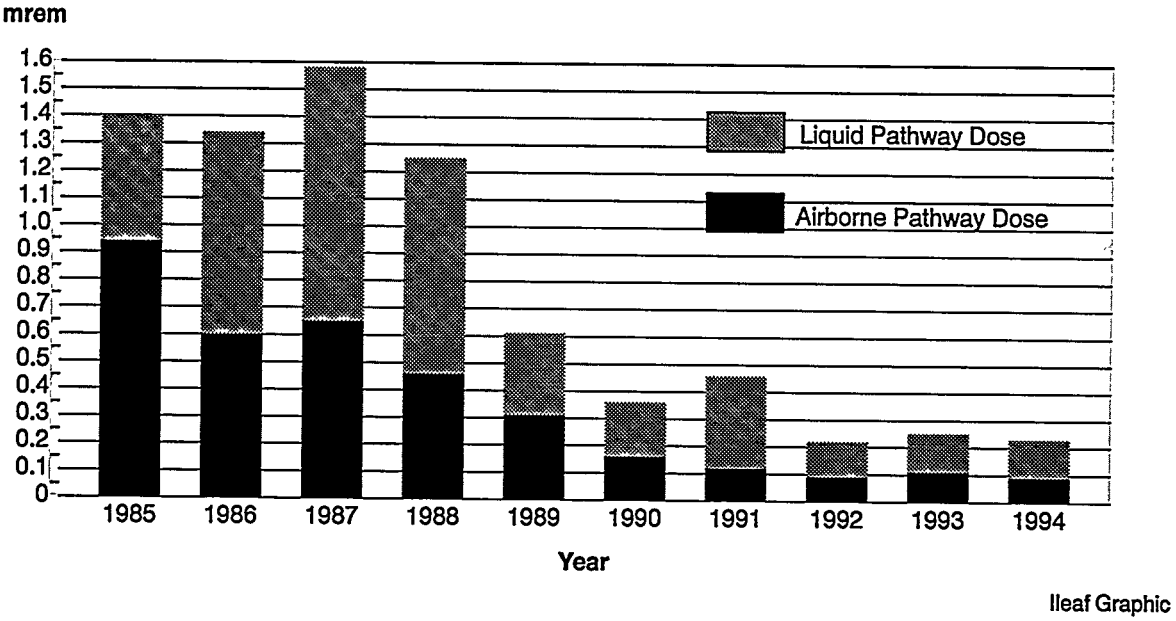

Figure 1 SRS Maximum Potential All-Pathway Doses to the Maximally Exposed Individual (Airborne plus Liquid Pathways) Since 1985

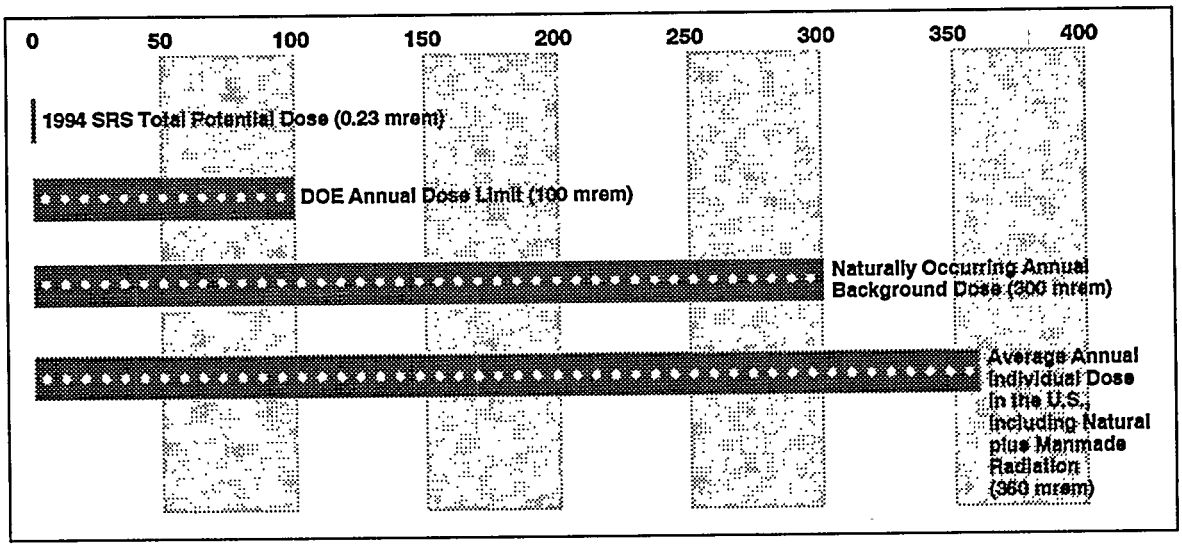

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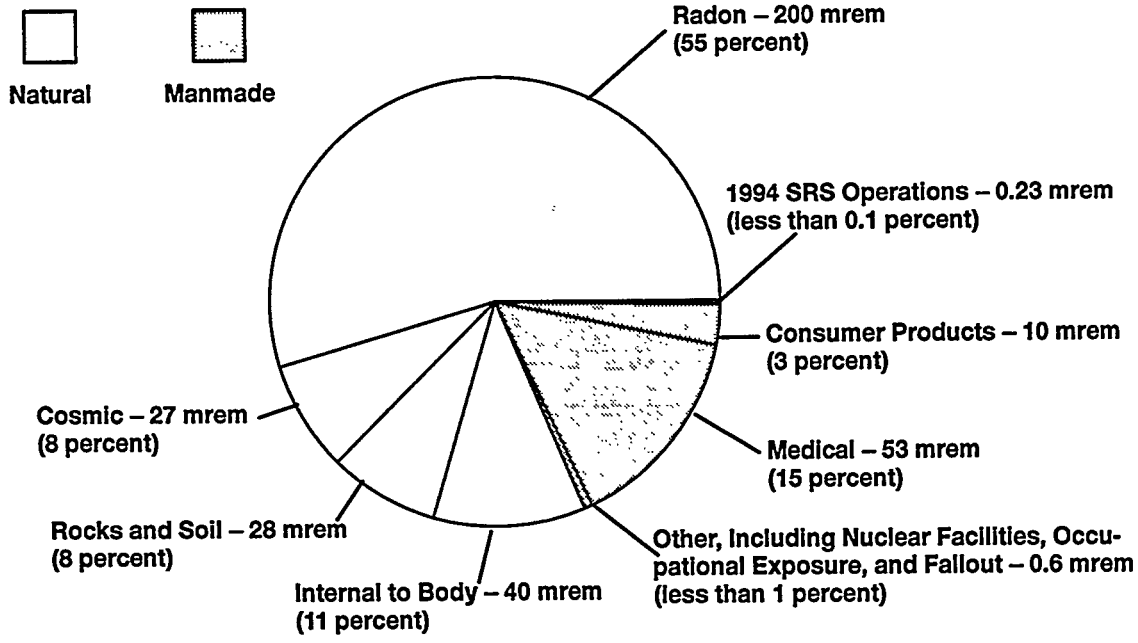
Figure 2 Comparison of Doses from SRS to Background and Federal Standards
SRS's 1994 potential all-pathway dose of 0.23 mrem was 0.23 percent of the 100-mrem federal limit, 0.08 percent of the 300-mrem average annual dose from naturally occurring background radiation, and 0.06 percent of the 360-mrem total annual average dose from natural plus manmade sources of radiation [NCRP, 1987].



Ileaf Graphic

Figure 3 Contributions to the Average Individual Dose
The major contributor to the average individual dose in the United States, including residents of the CSRA, is naturally occurring radiation (about 300 mrem) [NCRP, 1987]. During 1994, SRS operations potentially contributed a maximum individual dose of 0.23 mrem, which is less than 0.1 percent of the 360-mrem total annual average dose (natural plus manmade sources of radiation).

concentrations of radionuclides. In 1994, bass caught at the mouth of Steel Creek had the highest concentrations. Consumption of these bass could have resulted in a dose of 1.3 mrem (0.013 mSv).

Radiological Effluent Monitoring

During 1994, SRS collected and analyzed more than 7,000 effluent samples to quantify radiological releases to the environment from site operations. Tritium was the major contributor to air and liquid releases. In fact, it accounted for more than 99 percent of the total radioactivity released in 1994.

Airborne Emissions

Tritium was the primary radionuclide released to the atmosphere in 1994 with 160,000 Ci (5.9E+15 Bq); this compares with 191,000 Ci (7.1E+15 Bq) released in 1993. This 16 percent decrease in tritium released in 1994 is attributed to the shutdown and layup of all reactor facilities and the mid-year startup of the Replacement Tritium Facility.

Liquid Discharges

Tritium constitutes more than 99 percent of the radioactivity released to the Savannah River from direct, seepage basin, and Solid Waste Disposal Facility migration discharges. In 1994, about 8,800 Ci (3.3E+14 Bq) of tritium were released in liquid discharges from SRS, compared to 11,300 Ci (4.2E+14 Bq) of tritium in 1993. The total amount of tritium released directly from process areas (i.e., reactor, separations, heavy water rework) to site streams during 1994 was 1,210 Ci (4.5E+13 Bq), which was more than 28 percent less than the 1,670 Ci (6.2E+13 Bq) released in 1993.

Radiological Environmental Surveillance

The radiological environmental surveillance program at SRS surveys and quantifies any effects routine and nonroutine operations may have had on the site, the surrounding area, and those populations living in or near the site. Sampled media include air, seepage basins, site streams, the Savannah River, drinking water, rainwater, sediment, soil, vegetation, food products, fish, deer, hogs, turkeys, and beavers.

In 1994, approximately 105,000 radiological analyses were performed on 27,000 samples, and measurements of gamma radiation levels were made at 392 locations on and off site. Activity levels generally were consistent with 1993 levels, except for tritium-in-air concentrations. It was determined that a program change implemented in late 1993 caused analytical calculations of the tritium-in-air concentrations to produce artificially high results. The problem—which meant that 1994 results had to be expressed as tritium in atmospheric moisture rather than tritium in air—has been corrected.

Radionuclide activity levels, such as tritium, cesium, and strontium, were at or slightly above their limits of detection and were consistent with observed historical levels in sampled media. In air and surface water, some onsite activity levels were, as expected, slightly higher than observed in offsite media. Because of production slowdown, most tritium transport in site streams, which has been decreasing in recent years, was attributed to outcropping from retired seepage basins. No samples collected exceeded EPA drinking water standards.

Nonradiological Effluent Monitoring

Nonradioactive airborne emissions of sulfur dioxide, oxides of nitrogen, carbon monoxide, and total particulate matter less than 10 microns released from SRS stacks were within applicable South Carolina Department of Health and Environmental Control (SCDHEC) standards.

SRS maintained its National Pollutant Discharge Elimination System (NPDES) compliance rating above 99 percent for liquid releases. Of the 7,568 analyses performed in 1994, nine exceeded permit limits.

Nonradiological Environmental Surveillance

The nonradiological environmental surveillance program at SRS involves sampling and analyzing surface waters (site streams and the Savannah River), drinking water, sediment, groundwater, and fish.

In 1994, more than 16,000 analyses for specific chemicals and metals were performed on more than 5,600 samples, not including groundwater. All results were below regulatory detection limits, except in S-Area, where results exceeded the SCDHEC action level of 15 parts per billion for lead. A corrective action plan was implemented to elevate the pH, and subsequent sampling confirmed the lead concentrations fell below the SCDHEC action level.

Groundwater

SRS monitors groundwater for radioactive and nonradioactive constituents to identify contamination that may have occurred because of site operations. Groundwater beneath 5 to 10 percent of the site has been contaminated by industrial solvents, tritium,

metals, or other constituents used or generated by SRS operations. This report describes groundwater monitoring results for approximately 1,400 wells in 94 locations within designated areas at SRS. Approximately 76,000 radiological analyses and 700,000 nonradiological analyses were performed on groundwater samples.

During 1994, most analytical results were similar to those of recent years. For the first time, wells at the F-Area tank farm were analyzed for specific volatile organic compounds. Trichlorofluoromethane (Freon 11, which may have been used as a refrigerant, coolant, or degreaser in the past) was reported at elevated levels in two wells.

Nonroutine Occurrences

The SRS environmental monitoring program extends beyond routine effluent monitoring and environmental surveillance activities. Upon notification by area operations personnel, the Environmental Protection Department's Environmental Monitoring Section (EMS) is prepared to respond to unplanned environmental releases—both radiological and nonradiological—as required.

If EMS is notified of a suspected unplanned environmental release, personnel are dispatched to collect appropriate samples. These samples are given priority in preparation and, if radiological in nature, priority in analysis. The data are validated, and a determination is made as to whether there was an actual release. If there was, then consequences to the public and the environment are determined.

In 1994, there were a number of unplanned environmental releases, but none that required the sampling and analysis services of EMS.

Special Surveys

Lower Three Runs Creek

A survey of the Lower Three Runs Creek corridor was conducted during the fall of 1993 to characterize the corridor following the PAR Pond drawdown of 1991 and prior to refilling the pond. A detailed explanation of the drawdown appears on page xxiv. The 1993 survey, results of which were not available until 1994, is the latest in a series of Lower Three Runs surveys dating to 1971—and the first conducted since 1988. Eleven sampling trails were established during previous Lower Three Runs surveys to monitor the stream system.

During the survey, ambient gamma exposure rates were determined, and samples of soil and vegetation were collected for laboratory analysis.

Soil samples were analyzed for gamma-emitting radionuclides, total strontium, and plutonium-238,239. Vegetation samples were analyzed for gross alpha, gross beta, gamma-emitting radionuclides, and tritium.

Savannah River Swamp

In the 1960s, a portion of the Savannah River Swamp was contaminated with approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60. The contamination resulted from failed fuel elements that leaked radioactivity into the P-Area storage basin; occasionally, this water was discharged to Steel Creek.

The most recent comprehensive survey to characterize the contaminated area was conducted in 1990. Cursory surveys, which consist of gamma radiation measurements and sampling at selected locations, have been conducted annually to provide interim monitoring of the swamp.

The 1994 survey—a cursory survey—followed the program changes implemented in 1990. Thermoluminescent dosimeters (TLDs) were placed at each of the 54 sampling locations to provide an integrated exposure measurement, and samples of soil and vegetation were collected from one location on each of 10 trails. These 10 locations, a subset of the 54 established historical locations, were designated in 1990 as the points to be used for comparative purposes during cursory surveys. Each location corresponds to the area on its trail that historically has exhibited the highest activity levels.

Academy of Natural Sciences of Philadelphia

The Environmental Research Division of the Academy of Natural Sciences of Philadelphia (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.

The 1994 ANSP studies on the Savannah River included biweekly diatometer monitoring throughout the year, cursory surveys in the vicinity of the SRS (algae, aquatic macrophytes, insects, and fish), and sampling near Vogtle Electric Generating Plant in September (algae, protozoa, noninsect macroinvertebrates, insects and fish).

Education, Research and Development Association of Georgia Universities

SRS contracted with the Education, Research and Development Association of Georgia Universities (ERDA) to conduct a study in 1993 and 1994 that compares pollutants released from the site with those that have entered the environment from other sources [ERDA, 1995]. The levels of these pollutants then could be considered in terms of impact on the health of the environment and of the public.

Information was gathered by researchers at the Georgia Institute of Technology in Atlanta and evaluated on three topics pertinent to preparation of the annual *Savannah River Site Environmental Report*—Savannah River water quality, foodstuffs, and general surveillance data. The study is expected to be published in 1995.

Compliance Activities

SRS continued operations in 1994 that involved many processes and chemicals subject to regulatory compliance with a growing number of environmental statutes, regulations, and policies. Compliance is required to ensure that SRS, the public, and the surrounding environment are protected from any adverse effects generated by site operations. This section addresses some environmental compliance issues involving the site during 1994.

Federal Facility Agreement

In accordance with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE, EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), and SCDHEC entered into a Federal Facility Agreement (FFA), which became effective August 16, 1993. Declaration of the effective date results in the FFA being an enforceable agreement. The FFA, which sets the milestones for environmental remediation at SRS, coordinates site cleanup activities into one comprehensive strategy. Disputes related to schedule commitments in Appendix E of the FFA were resolved June 27, 1994, when agreement was reached among all involved parties.

Releases or potential releases from Resource Conservation and Recovery Act (RCRA)/CERCLA waste management units are evaluated under the FFA. Work plans detailing the proposed investigations for the RCRA/CERCLA units must be approved by both EPA and SCDHEC prior to implementation. During 1994, nine field starts were initiated according to approved work plans and the schedule in Appendix D of the FFA.

Federal Facility Compliance Act

The Federal Facility Compliance Act (FFCAct) was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act to clarify provisions concerning the application of certain requirements and sanctions to federal facilities. With respect to DOE and other federal agencies, the FFCAct waives sovereign immunity from all civil and administrative penalties and fines to include both coercive and punitive sanctions for violations of the Solid Waste Disposal Act. The FFCAct provides a 3-year window of protection (until October 1995) from fines and penalties so that DOE sites can develop site treatment plans with their state and federal regulatory agencies. By October 1995, DOE's Savannah River Operations Office (DOE–SR) must have prepared a plan for developing capacities and technologies for treating mixed wastes according to the land disposal restrictions (LDRs). Upon the State of South Carolina's approval of the SRS plan, SCDHEC must issue an order requiring compliance with the approved plan.

DOE–SR is developing a site-specific plan—with State of South Carolina involvement—that addresses SRS mixed wastes, as required by the FFCAct. DOE–SR submitted the first phase of the site treatment plan to the state on October 28, 1993. This phase, known as the conceptual site treatment plan, was followed by submittal of the draft site treatment plan in August 1994. The proposed site treatment plan is scheduled to be submitted in March 1995.

National Pollutant Discharge Elimination System

The Clean Water Act (CWA) of 1972 created the NPDES program, which is regulated by SCDHEC under EPA authority. The program is designed to protect surface waters by limiting all nonradiological releases of effluents into streams, reservoirs, and other wetlands. (Radiological effluents are covered under other acts.) Discharge limits are set for each facility to ensure that SRS operations do not impact aquatic life adversely or degrade water quality.

NPDES permit compliance at SRS has improved steadily during the past 10 years. In October 1994, SCDHEC personnel conducted a 2-week audit of SRS wastewater facilities and found one exceedance. As it was in 1993, the 1994 compliance rate was 99.9 percent, based on a permit-required minimum—for calculation purposes—of 8,000 analyses. The total number of analyses performed during 1994 was 7,568 (fewer than 8,000 because of 12 inactive outfalls). Nine of these exceeded NPDES permit limits.

NESHAP Radionuclide Program

The SRS National Emission Standards for Hazardous Air Pollutants (NESHAP) radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. Work is proceeding on schedule under the radionuclide Federal Facility Compliance Agreement (FFCA) signed October 31, 1991.

The first amendment to the FFCA for radionuclide NESHAP was signed by EPA Region IV August 16, 1993. The amendment will provide SRS an extension of the original FFCA through February 10, 1995, to accomplish monitoring upgrades to several additional sources.

NESHAP Asbestos Removal Program

The site implemented an asbestos removal program in 1988.

Asbestos is removed during maintenance and renovations of equipment and buildings. During 1994, SRS removed 115,323 square feet of transite panel, which contains asbestos. Also removed were 18,558 linear feet and 7,566 square feet of asbestos pipe and surface insulation. Estimates of the percentage of total friable asbestos (a form that can be crumbled or pulverized with hand pressure when dry) removed from SRS cannot be accurately determined because it is not known exactly how much exists on site. SRS will continue to identify and remove such asbestos according to state (SCDHEC R.61–86.1) and federal (40 CFR 61, Subpart M) regulations and "best management practices."

PAR Pond Repair/Refill

PAR Pond, a 2,640-acre reservoir constructed in 1958 on Lower Three Runs Creek, served as a recirculating cooling reservoir for P-Reactor and R-Reactor. In March 1991, an inspection of the PAR Pond dam revealed a depression on the downstream face. The reservoir was drawn down, reducing the original volume by about two-thirds. The drawdown exposed about 1,300 acres of sediments containing both radiological and nonradiological contaminants. In March 1992, the exposed sediment area of the pond was declared a unit to be addressed under CERCLA. WSRC's Site Services Engineering and Environmental Protection departments recommended repairing the dam and refilling the pond. Repairs were completed in August 1994; the PAR Pond Interim Action Proposed Plan was approved in November; and a 30-day public review and comment period was initiated in December. The Interim Action PAR Pond Record of Decision, which supports refilling the pond, is expected to be issued in January 1995. The refill, set to begin in February 1995, should require 2 to 3 months to complete.

Chapter 1

Site and Operations Overview

Diane Spitzer
Technical Publications

In this chapter...

Introduction

The Savannah River Site (SRS) covers some 310 square miles along the Savannah River in South Carolina (figure 1–1). In 1994, it was South Carolina's largest private employer, with a work force of approximately 21,000. Ninety percent of the site's employees live in six South Carolina and Georgia counties (Aiken, Barnwell, Bamberg, and Allendale counties in South Carolina and Richmond and Columbia counties in Georgia).

For more than 40 years, SRS produced materials to support the nation's nuclear weapons stockpile and various nondefense programs. In doing so, the site became an integral financial and cultural part of the surrounding area and the state of South Carolina.

When the Cold War ended in 1991, world conditions and national policies changed. The U.S. Department of Energy (DOE) responded to these changes by refocusing its missions, which included defining the following new roles for SRS:

- to protect and improve environmental quality
- to support a secure national defense and reduce nuclear danger
- to enhance industrial competitiveness and economic development

In 1994, SRS achieved major goals in the transition to its new mission, led by successful test runs at the Defense Waste Processing Facility (DWPF)—a facility designed to mix high-level waste with glass—for safe storage.

This chapter examines SRS—its history, its geographic features, its impact on the local community, and its changing mission.

Site Facts

Nearby Population and Economic Activity

The average population density in the counties surrounding SRS is 85 people per square mile, with the largest concentration in the Augusta, Georgia, metropolitan area. Based on 1990 U.S. Census Bureau data, the population within a 50-mile radius of SRS is 620,100.

Various industrial, manufacturing, medical, and farming operations are conducted near the site. Major industrial and manufacturing facilities in the area include textile mills, polystyrene foam and paper products plants, chemical processing facilities, and a commercial nuclear power plant. Farming is diversified and includes crops such as cotton, soybeans, corn, and small grains.

Climate

SRS has a relatively mild climate, with an average frost-free season of approximately 246 days. The average annual rainfall, about 48 inches, is fairly evenly distributed throughout the year. There is no strong prevailing wind direction; however, there is a relatively high frequency of east-through-northeast winds during the summer and fall and of south-through-northwest winds during the late fall, winter, and spring [Hunter, 1990]. No unusual topographic features significantly influence the general climate, except for the Savannah River.

Water Resources

SRS, bounded on its southwestern border for about 35 river miles (as measured from the upriver boundary of the site, near Jackson, South Carolina, to the Lower Three Runs Creek corridor) by the Savannah River, is approximately 160 river miles from the Atlantic Ocean. Five major SRS streams feed into the river: Upper Three Runs Creek, Four Mile Creek (also referred to as Fourmile Branch), Pen Branch, Steel

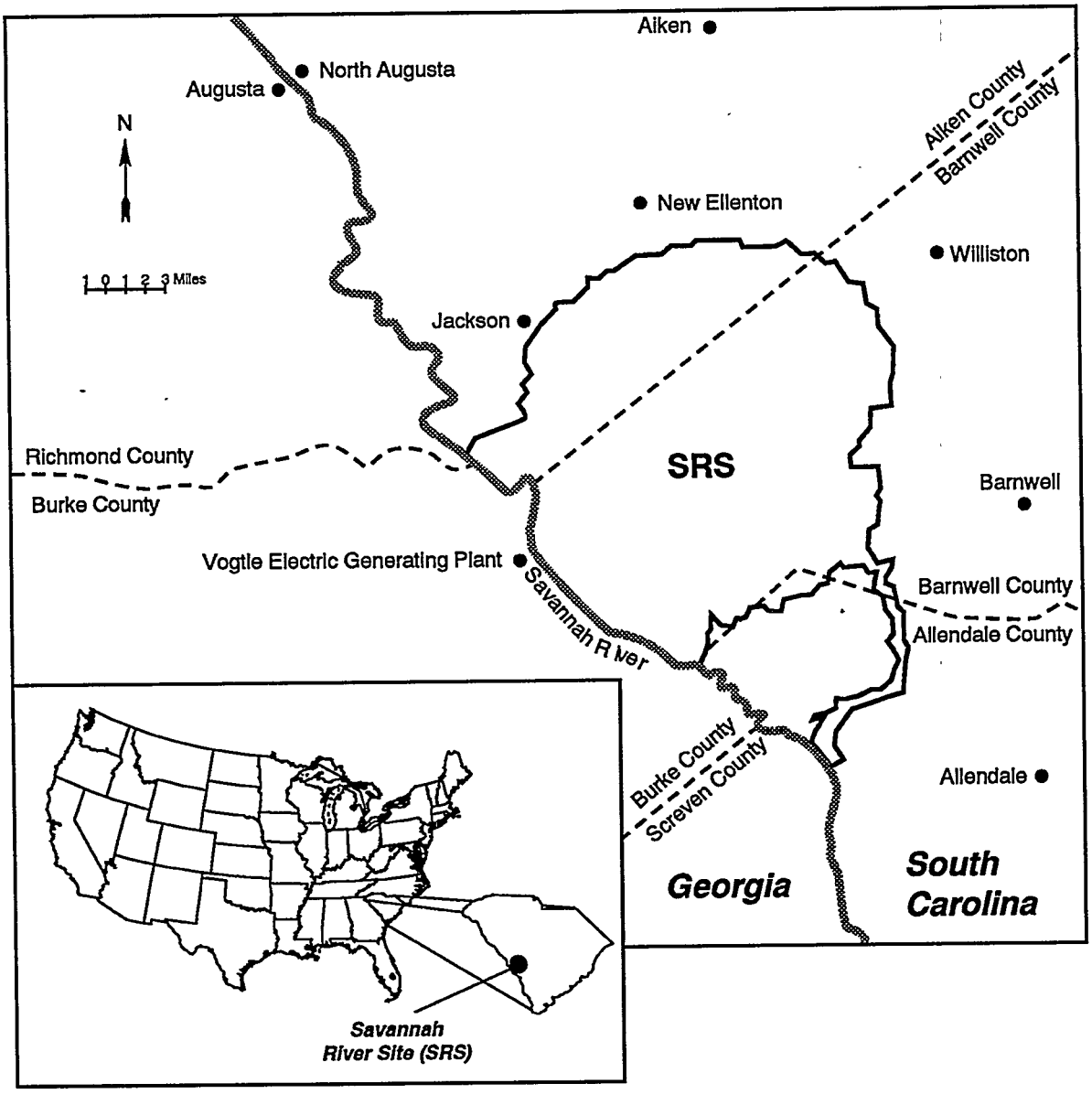


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Figure 1–1 Regional Location of SRS
SRS is about 25 miles southeast of Augusta, Georgia, and 12 miles south of Aiken, South Carolina. The site, approximately 310 square miles in area, covers about 1 percent of the state of South Carolina.

Creek, and Lower Three Runs Creek. These streams, which receive effluents from various onsite operations, are not commercial water sources.

The two main bodies of water on site, PAR Pond and L-Lake, are manmade. PAR Pond was constructed in 1958 to provide cooling water for P-Reactor and R-Reactor (hence the name PAR Pond). It covers 2,640 acres and is approximately 60 feet deep. The 1,000-acre L-Lake was constructed in 1985 to receive heated cooling water from L-Reactor.

The Savannah River is used as a drinking water supply for approximately 56,000 residents downriver of SRS in Port Wentworth, Georgia, and near Beaufort, South Carolina (Beaufort and Jasper counties) [Fledderman, 1994]. The City of Savannah Industrial and Domestic Water Supply Plant (formerly Cherokee Hill Water Treatment Plant) intake, at Port Wentworth, is approximately 130 river miles from SRS; the Beaufort-Jasper Water Treatment Plant intake, near Beaufort, is approximately 120 river miles from SRS. The Savannah River also is used for commercial and

sport fishing, boating, and other recreational activities. There is no known use of the river for irrigation by farming operations downriver of the site [Hamby, 1991]. SRS uses water from the river for some of its operations.

Geology and Hydrology

SRS is on the Upper Coastal Plain of South Carolina. Coastal Plain deposits at SRS consists of 500 to 1,400 feet of sands, clays, and limestones of Tertiary and Cretaceous age. These sediments are underlain by sandstones of Triassic age and by older metamorphic and igneous rocks.

The sandy sediments of the Coastal Plain contain several productive aquifers, separated by clay-rich units, that drain into the Savannah River, its tributaries, and the Savannah River Swamp. The older, underlying rocks are nearly impermeable and are not a major water source.

Land Resources

The SRS region is part of the Southern Bottomland Hardwood Swamp region, which extends south from Virginia to Florida and west along the Gulf of Mexico to the Mississippi River drainage basin. The main features are river swamps, rarely more than five miles wide.

Plant and Animal Life

The area of the site not used for production and production-related activities—about 175,000 acres—has been managed for several decades. In 1951, the U.S. Forest Service was asked to establish a reforestation and forest management plan, which was written in 1952. In 1953, SRS had the largest mechanized planting in the United States, with 28 planting machines capable of planting 400,000 seedlings a day [SRFS, 1991]. During that year, 10 million trees were planted; by 1968, 100 million trees had been planted [SRFS, 1982]. In all, the Forest Service has planted more than 300 million trees, mainly pines, which cover almost 80 percent of the site. SRS maintains a forest management program to contribute to environmental protection and research.

In 1972, SRS was designated as the first National Environmental Research Park. These parks are used as outdoor laboratories to study the impact of human activity on the environment. This designation has created a unique environment for preserving and studying vegetation and wildlife.

To help maintain the site as a National Environmental Research Park, several areas have been designated as set-aside areas. Thirty areas, covering 14,288 acres, have been set aside to protect rare, threatened, and endangered biota, as well as unique habitats. Chapter 3, "Environmental Program Information," contains additional information about these set-aside areas.

Vegetation

Most of the site's environs are rural. Approximately 40 percent of the countryside is forested with longleaf and loblolly pines and sweet gum, maple, birch, and various oak-hickory hardwood trees.

Major plant communities at SRS include cypress-gum and lowland hardwood swamps, sandhills, and old agricultural fields, as well as aquatic and semiaquatic areas. These habitats range from very sandy, dry hilltops to continually flooded swamps.

Wildlife

SRS is populated with more than 50 species of mammals, including deer, feral hogs, beavers, rabbits, foxes, raccoons, bobcats, river otters, and opossums. In 1952, there were fewer than three dozen white-tailed deer on site. Since that time, the population has increased dramatically, and the site now is home to several thousand white-tailed deer [SRFS, 1982]. In 1965, managed public deer hunts were initiated to reduce the increasing number of deer-vehicle accidents and to maintain the health of the herd.

More than 100 species of reptiles and amphibians—including turtles, alligators, lizards, snakes, frogs, and salamanders—and more than 200 species of birds inhabit the site.

The area provides refuge for endangered and threatened species: the red-cockaded woodpecker, the American alligator, the southern bald eagle, the wood stork, the shortnose sturgeon, and two species of the purple coneflower. Many site research projects are designed to protect and increase the populations of these species.

Site History

President Harry S. Truman personally asked E.I. du Pont de Nemours and Company to locate, build, and operate a facility that would produce tritium and plutonium for the nation's nuclear weapons stockpile. The project, which President Truman considered of "highest urgency," was part of U.S. plans in 1950 to develop a hydrogen bomb. At that time, the Soviet Union had begun nuclear weapons testing—a factor in the decision to establish the site.

Wood Storks at SRS

Even before construction of the Savannah River Site in the early 1950s, wood storks had been reported in the area. It is believed that wood storks foraging in the Savannah River Swamp are from the Birdsville Colony, located near Millen, Georgia. The colony is about 28 miles from SRS, a distance well within the storks' 37-to-43-mile daily feeding flight range.

Wood storks are sighted in the Savannah River Swamp mostly during July and August. In July of 1973 and 1974, flocks of 200–400 wood storks were observed on site in the Steel Creek delta. Between 1983 and 1992, more than 800 aerial surveys were conducted to determine the number of wood storks foraging or roosting in the Savannah River Swamp. Individual aerial surveys resulted in the observation of as many as 30 wood storks.

In 1985, foraging ponds were constructed on the Silver Bluff Plantation Sanctuary (Kathwood Lake), located west of SRS, because preliminary data indicated that the increased flow from the restart of L-Reactor could damage the foraging area for the wood storks. During the summers of 1986–1992, wood storks—mostly juvenile and banded storks from the Birdsville Colony—were observed foraging extensively at Kathwood Lake.

Construction

Site surveys began July 15, 1950, and on November 22, the Atomic Energy Commission announced it would buy about 200,000 acres of land for approximately $19 million to build what newspaper accounts called an H-Bomb plant. The South Carolina location was chosen from 114 possible sites because it was an isolated land mass, it was close to relatively pure water, and it had easy access to adequate transportation. [DOE, 1993]

By February 1, 1951, work had begun on the Savannah River Plant (SRP), which was the largest single construction job ever undertaken in the United States at the time. In less than five years all major facilities—five reactors, two chemical separations facilities, a heavy water extraction plant, a nuclear fuel and target fabrication facility, and waste management facilities—were completed.

About 6,000 people living in the area had to relocate. The peak work force reached 38,500 in 1952. The first facility to begin operating, the heavy water plant, started up August 17, 1952; the first production reactor achieved criticality December 28, 1953. All five reactors had achieved criticality by March 1955 [Bebbington, 1990]. Figure 1–2 is a map of the site and various area locations.

By the time the basic site was completed, the project cost, including land, was $1.1 billion. Several other facilities necessary to support operations have been constructed since 1955, including test reactors, uranium fuel processing facilities, and a process development laboratory [WSRC, 1990b].

Du Pont operated the plant until March 31, 1989. On April 1, 1989, Westinghouse Savannah River Company (WSRC) became the prime operating contractor, and SRP became SRS.

Reactors

The five reactors—C, K, L, P, and R—are located in separate areas on site. They produced plutonium and tritium for national defense until 1988. Over time, the reactors aged, and each was shut down briefly for maintenance and repair or because of reduced production demands. By 1988, all five reactors had been shut down and placed under review to determine their future status. By 1991, C-Reactor had been shut down permanently; P-Reactor had been placed on cold standby to be used for spare parts for L-Reactor and K-Reactor; L-Reactor had been placed on warm standby to be used as a backup to K-Reactor; and plans had been made to restart K-Reactor.

Initial steps were taken to restart K-Reactor in December 1991. After power ascension testing was completed successfully in July 1992, the reactor was taken offline for tie-in to a new cooling tower. The operating permit for this project was issued in December 1992, and the cooling tower was tested in 1993. However, K-Reactor was never restarted and remains on cold standby. The other four reactors have been shut down permanently.

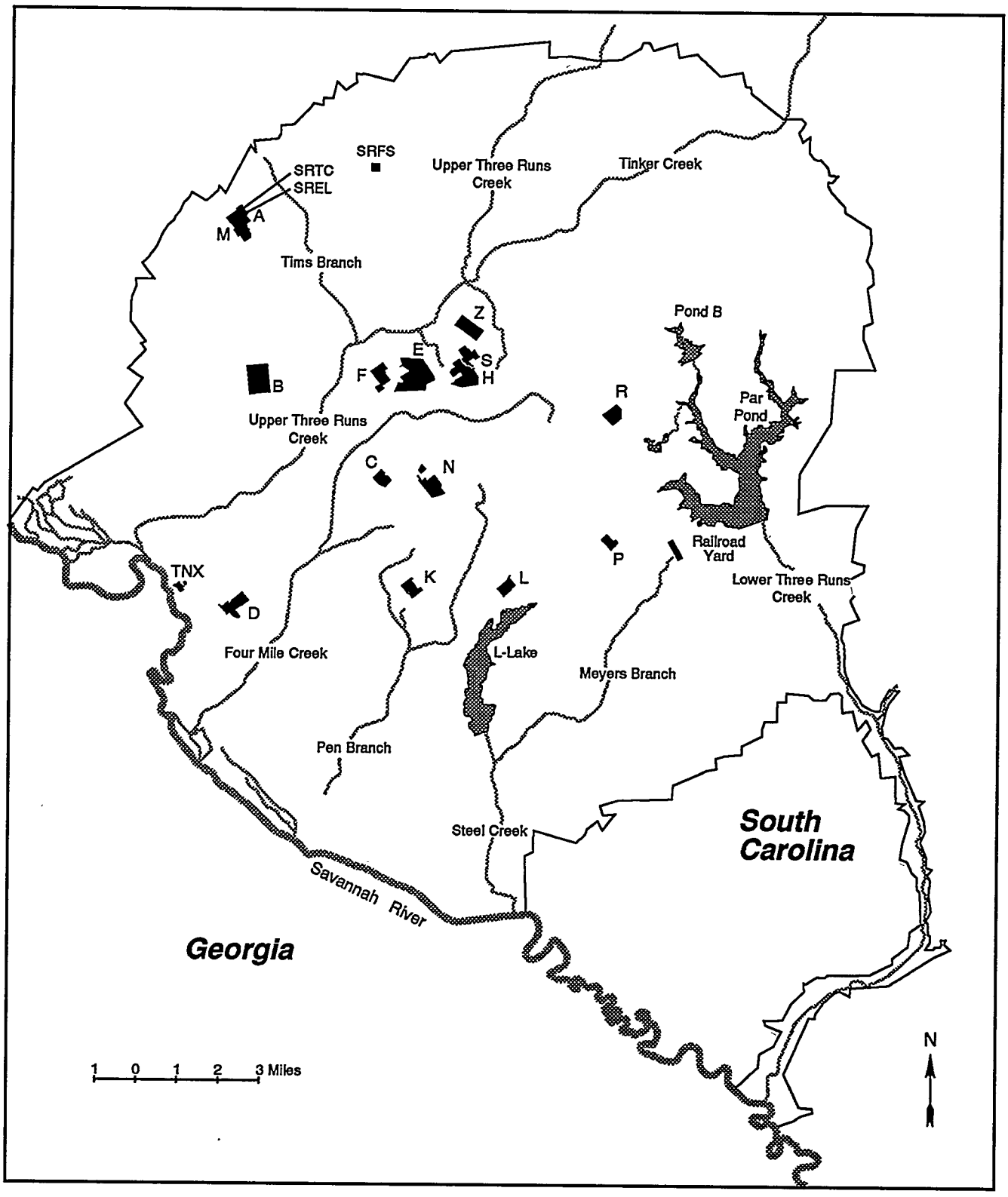

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Figure 1–2 The Savannah River Site

SRS includes several operating areas plus the Savannah River Ecology Laboratory (SREL), the Savannah River Forest Station (SRFS), and the Savannah River Technology Center (SRTC). Production areas are primarily in the interior of the site.

K-Reactor was not restarted because the end of the Cold War brought about a change in the nation's policy toward continued production of a large and diverse nuclear weapons stockpile. Thus, DOE began changing its mission for SRS.

Changing Mission

SRS has undergone significant mission and operational changes during the past few years.

In 1994, WSRC and DOE developed strategic plans outlining the site's role in strengthening the economy, improving the environment, and supporting national security—the main objectives of the new mission [WSRC, 1994].

Now, for the first time, DOE's complexwide budget for environmental management, which includes waste management and environmental restoration programs, is larger than that for defense programs. At SRS, the budget is equally split between these two areas, with a significant decrease projected for the defense programs portion. Plutonium operations are being phased out, and spent fuel processing eventually will be terminated [DOE, 1993].

However, the site has not stopped production activities altogether. The HB-Line in the H-Area canyon building is being used for plutonium-238 separation. In 1994, more than 23,000 g of flight-grade plutonium-238 was produced at SRS and shipped to Los Alamos National Laboratory, Los Alamos, New Mexico, for encapsulation into fuel for the U.S. space mission Cassini.

The site continues a commitment to improve its tritium-handling capabilities by developing new technologies, including the Replacement Tritium Facility (RTF), which replaces facilities that have processed tritium for 35 years. RTF offers a safer, more cost-effective method of storing, separating, purifying, pumping, and compressing hydrogen isotopes [Elgert, 1992]. In 1994, the site completed the isotopic separations test at RTF—the first successful production demonstration of the process in the DOE complex. The site's primary defense production activities will continue to be unloading, recycling, and storing tritium.

In 1994, SRS continued cold standby activities at K-Reactor and shutdown activities at the other reactors.

Also, the site received 153 spent fuel rods from foreign countries in September 1994 as part of DOE's commitment to control nuclear materials around the world.

But the site's priorities are shifting toward waste management, environmental restoration, technology transfer, and educational outreach programs as it moves toward implementing its new mission and achieving new goals.

Waste Management

In 1994, the biggest news in waste management at SRS was the progress made at DWPF, where a high-level radioactive waste and glass frit mixture will be fed into a melter and heated until it becomes molten glass. The mixture then will be poured into stainless steel canisters and allowed to cool and form a solid inert glass suitable for disposal in offsite geologic repositories.

Twelve canisters of simulated glass waste were produced during cold chemical runs in 1994. These runs used nonradioactive chemicals in order to simulate the chemical and physical properties of radioactive liquid waste to test the facility's ability to receive and process liquid waste. Cold chemical runs began in March 1993 but were suspended in April, after 1,300 gallons of water were unintentionally transferred into the melter and melter cell. The runs were resumed in July 1993. Radioactive runs are scheduled for late 1995.

In 1994, the site's solid waste management program began moving from older waste burial methods toward new technologies that treat and dispose of waste more safely [SRS, 1994].

Previously, SRS buried low-level radioactive waste in trenches at the Solid Waste Disposal Facility (SWDF). In 1994, the site began to use engineered disposal vaults to dispose of the metal boxes used to package low-level waste, including the waste already buried in trenches. These vaults represent the most advanced low-level radioactive waste disposal systems in the United States [SRS, 1994].

Vaults also are used to dispose of intermediate-level waste, with tritium-contaminated waste disposed of separately [Fact Sheet, 1992a].

Work continued in 1994 on the construction of the Consolidated Incineration Facility (CIF), near the center of H-Area. CIF is scheduled to begin operation in 1996. In 1994, SRS officials revised the facility's startup plan and worked with environmental regulators on the strategy for a trial burn. CIF will safely treat hazardous and radioactive waste streams for which no treatment capabilities previously existed. It is expected to reduce the volume of specific combustible, hazardous, mixed, and low-level waste by 90 percent. Examples of waste to be treated include sludges, oils, paint solids, solvents, rags, and protective clothing [SRS, 1994].

More information about SRS's waste management program can be found in chapter 4, "Environmental Restoration and Waste Management."

Environmental Restoration

SRS reached an environmental restoration milestone in September 1994, when two air strippers pumping and treating contaminated groundwater in A-Area and M-Area reached the 2-billion-gallon mark. Since 1985, the site has extracted more than 327,000 pounds of organic solvents from a 1,200-acre contaminant plume under the two areas. This project is one of the three largest pump-and-treat projects in the nation.

In 1994, environmental restoration activities at SRS grew by a factor of 10, primarily because of a closer working relationship with regulators that resulted in faster work approvals [SRS, 1994]. In 1992 and 1993, intrusive sampling and/or construction was conducted at an average of five sites per year. In 1994, dirt was turned, samples were taken, or work was performed at 48 sites—24 field projects and 24 site evaluations. The main emphasis continues to be on the top 100 wastes sites in the 420-inactive-waste-site program [SRS, 1994].

Some environmental remediation techniques developed through the Integrated Demonstration projects were transferred from field technology demonstrations to environmental restoration programs in 1994. In 1989, DOE commissioned SRS to establish the demonstration projects to develop new methods for investigating and remediating soil and groundwater contamination. Key technologies developed by the end of 1994 include horizontal drilling and bioremediation.

Chapter 4 contains additional information on these expanding programs.

Technology Transfer

Scientists and engineers at SRS have developed and applied technologies to solve practical problems in achieving the site's national defense mission. Because that mission is changing, these technologies represent a major resource for improving the industrial competitiveness of U.S. industry while enhancing economic diversification of local communities. Thus, SRS has developed an aggressive program to use the expansive technology base already on site to help create a regional economic development plan that will attract high-technology, high-paying jobs to the area.

The Savannah River Technology Center (SRTC), the site's applied research and development section, has developed numerous technologies that can be used commercially or at other DOE sites. One example is SIMON (Semi-Intelligent Mobile Observing Navigator), a robot SRTC developed to conduct waste drum inspections that humans cannot conduct because of the threat of exposure to hazards. This technology will be used across the DOE complex.

SRS is aggressively encouraging its scientists and engineers to record technological successes through patent disclosures. Since 1989, the number of site patent disclosures has reached 1,700, with more than 50 license applications pending. In 1994, DOE received its first royalty check for a site-licensed technology (used by an industry consortium to clean up a Superfund site in Minnesota).

In 1993, DOE authorized SRS's entrance into cooperative research and development agreements with private industry. In 1994, 20 such agreements were put into place; seven others are under negotiation. DOE also authorized SRS to be part of two DOE cooperative agreements—one with the American textile partnership known as Amtex and the other with a consortium of manufacturing companies known as the National Center for Manufacturing Sciences.

In June 1994, ground was broken for the Savannah River Research Campus. In October 1994, Environmental Conversion Industries announced it would locate on the research campus—the first private company to do so.

The site continues to work with state and federal agencies, as well as with private industries and universities, to expand the technology transfer program.

Educational Outreach

SRS has established partnerships with Georgia and South Carolina universities through the Education, Research and Development Association of Georgia Universities (ERDA) and the South Carolina Universities Research and Education Foundation (SCUREF). These partnerships pair the site with universities to conduct site studies and develop new technologies.

SRS continued its educational outreach in 1994, initiating

- an environmental educational program to support wetlands projects involving rural and urban elementary schools
- a summer research mentorship program pairing site scientists with South Carolina Governor's School for Science and Mathematics students for an 8-week project
- a school-to-work program that provides alternative education opportunities to high school students seeking a technical career, such as electronic maintenance repair

Chapter 2

Environmental Compliance

Compiled by Mary Dodgen
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Environmental Protection Department

In this chapter...

Introduction

Savannah River Site (SRS) continued operations in 1994 that involved many processes and chemicals subject to regulatory compliance with a growing number of environmental statutes, regulations, and policies. Compliance is required to ensure that SRS, the public, and the surrounding environment are protected from any adverse effects generated by site operations. This chapter addresses environmental compliance issues involving the site during 1994.

The goal of the site and the U.S. Department of Energy (DOE) is good environmental stewardship and full regulatory compliance, with zero violations. SRS employees maintained progress toward achievement of that goal in 1994. A systematic effort is in place to identify and address all evolving regulatory responsibilities. As part of this process, communications were maintained with all the regulatory agencies concerned to underscore the commitment of the site to environmental compliance. The vast majority of SRS compliance efforts were successful in 1994; however, the site received three Notices of Violation (NOVs) and two consent decrees during the year from the South Carolina Department of Health and Environmental Control (SCDHEC). One NOV involved exceeding permitted discharge levels for a single chemical at one outfall. Another involved failure to provide notification about the demolition of several site buildings, while the last was for unpermitted air emission sources and a failed stack test at a steam boiler. Additional information about these NOVs is provided later in this chapter.

Compliance Activities

Compliance with environmental regulations and with DOE orders related to environmental protection is a critical part of the operations at SRS. Assurance that onsite processes do not impact the environment adversely is a top priority, and management of the environmental programs at SRS is a major initiative. All site activities are overseen by one or more regulatory bodies, including the U.S. Environmental Protection Agency (EPA) and SCDHEC. In recent years, the number of regulations affecting site operations has increased dramatically, and significant effort and budget allocations have been devoted to ensuring that site facilities and operations comply with all requirements.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) was passed in 1976 to address the problem of solid and hazardous waste management. The law requires that EPA regulate spent solvents, batteries, and many other discarded substances deemed potentially harmful to human health and the environment. Amendments to RCRA regulate nonhazardous solid waste, biohazardous medical waste, and some underground storage tanks.

Under RCRA, SRS is responsible for controlling every aspect of the generation, treatment, storage, and disposal of hazardous waste; this is referred to as "cradle-to-grave control." Hazardous waste generators, including SRS, must follow specific requirements for handling these wastes. For many waste management activities, RCRA requires that owners and operators of operating or post-closure-care hazardous waste management facilities have a permit.

EPA is responsible for all hazardous waste regulations. However, EPA can delegate this authority to a state when the state passes laws and regulations that meet or exceed EPA regulations and the state plan is approved by EPA. SCDHEC has authority for all aspects of RCRA except some of the rules associated with the 1984 Hazardous and Solid Waste Amendments to RCRA. Also, SCDHEC has been authorized by Congress to play a key role in the implementation of Federal Facility Compliance Act (FFCAct) statutes and will be the lead regulatory agency for development of the Savannah River Site Treatment Plan, which addresses storage and treatment of mixed waste. More information on waste management at SRS can be found

in chapter 4, "Environmental Restoration and Waste Management."

Federal Facility Compliance Act

The FFCAct was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act to clarify provisions concerning the application of certain requirements and sanctions to federal facilities. With respect to federal agencies, the FFCAct waives sovereign immunity from all civil and administrative penalties and fines to include both coercive and punitive sanctions for violations of the Solid Waste Disposal Act. For mixed waste, the FFCAct provides a 3-year window of protection (until October 1995) from fines and penalties so that DOE sites can develop site treatment plans with their state and federal regulatory agencies. By October 1995, DOE's Savannah River Operations Office (DOE–SR) must have prepared a plan for developing capacities and technologies for treating mixed wastes according to the land disposal restrictions (LDRs). Upon the State of South Carolina's approval of the SRS plan, SCDHEC shall issue an order requiring compliance with the approved plan. A more detailed explanation of LDRs appears below.

DOE–SR is developing a site-specific plan—with State of South Carolina involvement—that addresses SRS mixed wastes, as required by the FFCAct. DOE–SR submitted the first phase of the Site Treatment Plan to the state on October 28, 1993. This phase, known as the conceptual Site Treatment Plan, was followed by submittal of the draft Site Treatment Plan in August 1994. The proposed Site Treatment Plan is scheduled to be submitted in March 1995.

Also in association with the FFCAct, Westinghouse Savannah River Company (WSRC) submitted a mixed waste inventory report January 13, 1993, and DOE Headquarters (DOE–HQ) issued a complexwide report—*U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities, and Technologies*—April 21, 1993, to state governors and to regulatory agencies in states that host DOE sites. This was followed by a comment period for the regulators and states. DOE–HQ provided an update to the mixed waste inventory report in April 1994.

Land Disposal Restrictions

The 1984 RCRA amendments established LDRs, often referred to as "land ban." LDRs allow storage of restricted hazardous wastes solely for the purpose of accumulating such quantities as are necessary to facilitate proper recovery, treatment, or disposal. The amendments require that, prior to land disposal, all wastes meet treatment standards based on the "best demonstrated available technology."

The same restrictions apply to mixed wastes, which are composed of a mixture of radioactive and hazardous wastes. Because LDRs apply to mixed wastes and SRS does not have adequate mixed waste treatment capacity, regulatory agreements are required to achieve compliance. Therefore, a Federal Facility Compliance Agreement (FFCA) was signed in March 1991 between DOE–SR and EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) to address SRS mixed waste compliance with LDRs. The LDR FFCA has been amended twice—in April 1992 to include additional mixed wastes and in April 1993 to modify schedules associated with the "Hazardous Waste/Mixed Waste Disposal Facility Treatment Building" project.

The full impact of the FFCAct was realized during 1993, and further modifications to the LDR FFCA were discussed beginning in August 1993 to provide alignment with the FFCAct. Negotiations were completed, and the LDR FFCA Bridging Amendment was executed June 20, 1994. The revised agreement allows for alignment with the Site Treatment Plan and establishes commitments in the interim until execution of a Site Treatment Plan order with the State of South Carolina, which is expected in or before October 1995.

Treatability variances are an option available to facilities for particular waste streams that either cannot be treated at the level specified in the regulations or for which the treatment technology is inappropriate for the waste. SRS has identified some mixed waste streams that are potential candidates for a treatability variance. One variance—for in-tank precipitation filters—was granted in October 1993 by EPA Region IV. No new variances were requested during 1994.

Underground Storage Tanks

Underground storage tanks at SRS house petroleum products, such as gasoline and diesel fuel, and hazardous substances (as defined by the Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA). All the tanks are regulated under Subtitle I of RCRA.

Underground storage tank regulations require that all regulated existing tanks be closed or upgraded to meet or comply with new tank standards by 1998. In 1994, WSRC closed 11 tanks by removal and performed tightness tests on 15 tanks. Every tank that was tested passed.

The regulations set standards for upgrading existing tanks based on their age. Existing tanks must be monitored for leaks, and records must be kept for inventory control. In areas where underground tanks are still needed, WSRC will replace single-walled tanks with double-walled tanks that have leak detection

Some of the Key Regulations SRS Must Follow

Legislation	What it Regulates/SRS Compliance Status
RCRA Resource Conservation and Recovery Act	♦ Requires that hazardous, nonhazardous, and medical wastes and underground storage tanks containing hazardous substances and petroleum products be managed—in compliance
FFCAct Federal Facility Compliance Act	♦ Requires that DOE develop schedules for mixed waste treatment to avoid waiver of sovereign immunity and to meet LDR requirements—in compliance
CERCLA; SARA Comprehensive Environmental Response, Compensation, and Liability Act; Superfund Amendments and Reauthorization Act	♦ Establishes liability, compensation, cleanup, and emergency response for hazardous substances released to the environment—SRS placed on National Priority List in December 1989
CERCLA (TITLE III); EPCRA Emergency Planning and Community Right-to-Know Act	♦ Requires that hazardous substances used on site be reported to EPA, state, and local planning units and that releases be reported—in compliance
NEPA National Environmental Policy Act	♦ Evaluates potential environmental impact of federal activities and alternatives; in 1994, WSRC conducted 182 reviews for proposed activities—in compliance
SDWA Safe Drinking Water Act	♦ Protects public drinking water systems; enacted in 1974, amended in 1980, 1986—in compliance
CWA; NPDES Clean Water Act; National Pollutant Discharge Elimination System	♦ Regulates liquid discharges at the outfall (e.g., drain or pipe) that carries effluents to streams—in compliance
CAA; NESHAP Clean Air Act; National Emission Standards for Hazardous Air Pollutants	♦ Sets air quality standards for hazardous air emissions, such as radionuclides and benzene—in compliance
TSCA Toxic Substances Control Act	♦ Regulates use and disposal of PCBs—nation has inadequate disposal capacity for radioactive PCBs generated and stored at SRS

systems. During 1994, of the 38 petroleum storage tanks at SRS, 14 met the new tank standards and 11 old tanks were removed or replaced. The 13 remaining tanks are to be upgraded, replaced, or abandoned to meet the December 22, 1998, deadline.

RCRA 3004(u) Program

The hazardous waste permit issued to SRS in September 1987 requires that the site institute a program for investigating and, if necessary, performing corrective action at solid waste management units under RCRA 3004(u). The RCRA 3004(u) requirements have been integrated with the CERCLA requirements because SRS is on the National Priority List—also known as the Superfund List. The integration of RCRA and CERCLA regulatory requirements will provide a more cost-effective and focused investigation and remediation process. The RCRA/CERCLA program status is detailed under the CERCLA section of this chapter (page 12).

Waste Minimization Program

The SRS Waste Minimization Program, a comprehensive plan to minimize waste from all SRS operations, is designed to meet the requirements of RCRA, of DOE orders, and of applicable executive orders. The program focuses mainly on source reduction, on recycling, and on increasing employee awareness of and participation in waste minimization. Total solid waste volumes have declined by more than 50 percent since 1991 [PPG, 1995]. For more information on this program, refer to chapter 3, "Environmental Program Information," and chapter 4.

Notice of Violation (RCRA)

SCDHEC issued an NOV to SRS on October 14, 1993, alleging storage and disposal of mixed waste without a RCRA permit. The NOV was based on information reported to SCDHEC by SRS in September 1993. The issue still had not been resolved as of December 31, 1994, but negotiations were continuing toward a settlement agreement between DOE and SCDHEC.

Comprehensive Environmental Response, Compensation, and Liability Act

SRS was placed on the National Priority List in December 1989, thereby making the site subject to CERCLA (Public Law 96–510), as amended by the Superfund Amendments and Reauthorization Act (SARA, Public Law 99–499). CERCLA assigns liability and provides for compensation, cleanup, and emergency response for hazardous substances released to the environment.

In accordance with Section 120 of CERCLA, DOE, EPA Region IV, and SCDHEC entered into a Federal Facility Agreement (FFA), which became effective August 16, 1993. Declaration of the effective date results in the FFA being an enforceable agreement. The FFA, which sets the milestones for environmental remediation at SRS, coordinates site cleanup activities into one comprehensive strategy. Disputes related to schedule commitments in Appendix E of the FFA were resolved June 27, 1994, when agreement was reached among all involved parties.

Remediation under CERCLA imposes requirements in addition to existing RCRA requirements. SRS complies with all applicable or relevant and appropriate requirements when performing CERCLA activities. CERCLA requires remedial decisions to be based on the results of the Baseline Risk Assessment, which examines present and future risk to human health and the environment from the waste unit, using conservative, EPA-approved exposure scenarios.

CERCLA also requires public participation in the selection of remediation alternatives. A significant step in this process is the development of a Proposed Plan, which highlights key aspects of the remedial investigation and feasibility study. The plan also provides a brief analysis of remedial alternatives under consideration, identifies the preferred alternative, and tells the public how it can participate in the remedy selection process. After public comment is received, a Record of Decision is issued that presents the selected remedy and provides the rationale for that selection. Also included in this process is the establishment of an administrative record file that documents the remediation alternatives and provides for public review of them. The SRS Public Involvement Plan addresses the requirements of CERCLA, RCRA, and the National Environmental Policy Act (NEPA) of 1969.

Releases or potential releases from RCRA/CERCLA waste management units are evaluated under the FFA. Work plans detailing the proposed investigations for the RCRA/CERCLA units must be approved by both EPA and SCDHEC prior to implementation. During 1994, nine investigations were initiated according to approved work plans and the schedule in Appendix D of the FFA.

Proposed Plans and Records of Decision issued in 1994 documented the RCRA closure of Tank 105–C and the Mixed Waste Management Facility (MWMF). An Interim Action Proposed Plan and a Record of Decision were issued for the TNX Groundwater Operable Unit in 1994, and the PAR Pond Interim Action Proposed Plan was approved. The PAR Pond Interim Action Record of Decision, which will support refill of the pond, is expected to be issued in 1995.

The FFA also identifies more than 300 site evaluation units for which investigation is required. Site evaluation reports for 28 areas were submitted to EPA and SCDHEC during 1994.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 was enacted as a provision to SARA. EPCRA requires facilities to notify state and local emergency planning units about their hazardous chemical inventories and to report releases of hazardous chemicals.

Under Section 312 of EPCRA, SRS completes an annual Tier II Inventory Report for all hazardous chemicals present at the site in excess of specified quantities during the calendar year. Hazardous chemical storage information is submitted to state and local authorities by March 1 for the previous calendar year.

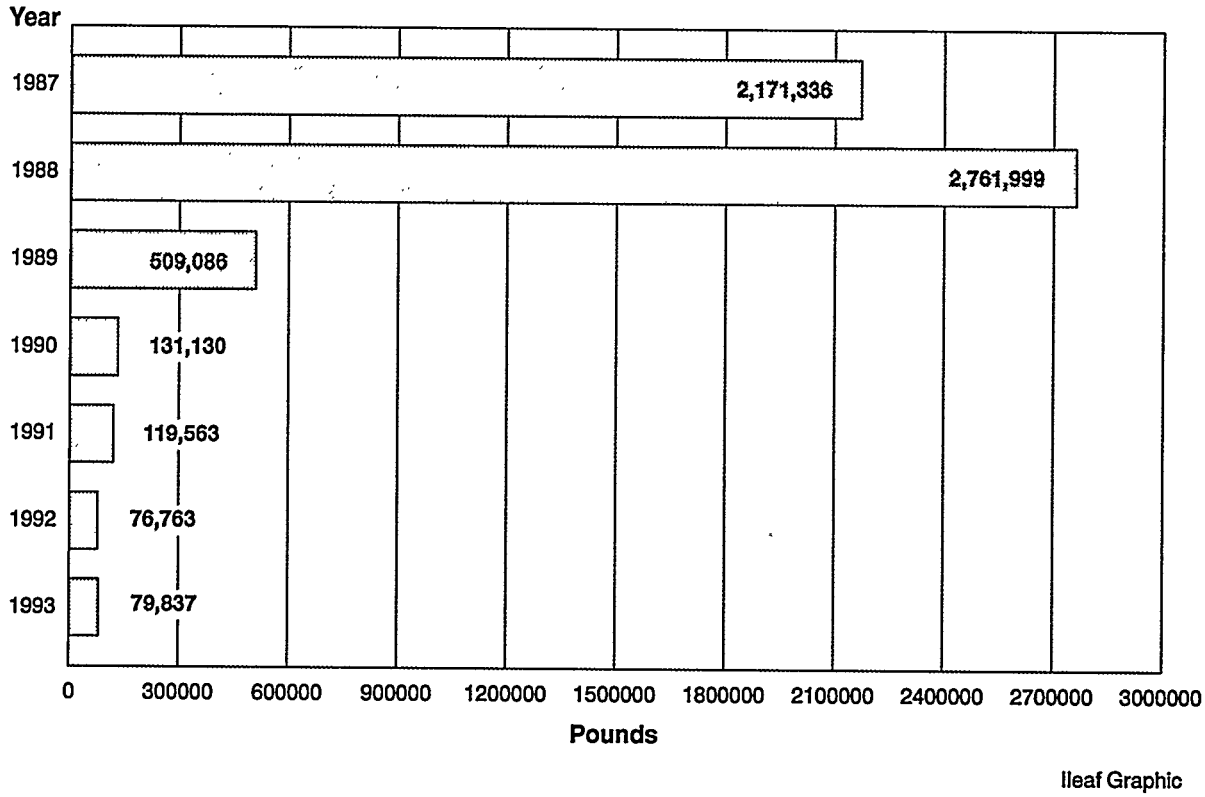


Figure 2–1 Total Toxic Chemical Releases at SRS, 1987–1993
A downward trend in toxic chemical releases occurred at SRS between 1987 and 1993, with the sharpest drop occurring between 1988 and 1989.

Under Section 313 of EPCRA, SRS must file an annual Toxic Chemical Release Inventory report by July 1. SRS calculates chemical releases to the environment and reports aggregate quantities for each regulated chemical that exceeds established threshold amounts. The Pollution Prevention Act of 1990 expanded the Toxic Chemical Release Inventory reports to include source reduction and recycling activities. Pollution prevention information has been reported annually since 1991.

Form R of the Toxic Chemical Release Inventory report for 1993 was submitted to EPA in June 1994. Ten chemicals, with releases totaling 79,837 pounds, were reported to EPA for 1993. This compares—following revisions to the original release estimates—with 76,763 pounds of eight chemicals released during 1992, 119,563 pounds of nine chemicals released during 1991, and 131,130 pounds of 11 chemicals released during 1990. A breakdown of the comparison from 1991 through 1993 is presented in table 2–1. Figure 2–1 shows the overall reduction in total toxic chemical releases at SRS from the period 1987–1993.

33/50 Pollution Prevention Program

In September 1992, DOE formally became the first federal agency to agree to participate in EPA's 33/50 Pollution Prevention Program. Under the agreement, DOE voluntarily adopted the program goals that are expected to reduce the use and release of 17 priority chemicals. The first goal, which calls for a 50-percent reduction by the end of 1995, applies to SRS and other contractor-operated facilities that already were reporting the releases under EPCRA in 1992. The second goal, which calls for a 33-percent reduction by the end of 1997, applies to the other contractor-operated facilities that met the reporting criteria in 1992 but had not previously reported the releases under EPCRA.

Since 1988, SRS has been submitting annual release reports in July—for the previous calendar year. The site's Toxic Chemical Release Inventory reports indicate that releases of six of the 17 priority chemicals have exceeded a reporting threshold at least once since 1988. In the July 1994 report, four such chemicals—lead, toluene, xylene, and methyl ethyl ketone (accounting for 28,312 pounds released to the environment or transferred off site)—were listed as

Table 2–1 Releases of Toxic Chemicals (in Pounds) by SRS During 1991, 1992, 1993 Reporting Years (Reported Under EPCRA Section 313)

1991 Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Ammonia	14,500	894	89	0
Chlorine	0	211	0	0
Freon 113	36,600	0	3	0
Freon 114	15,000	0	0	0
Halon 1301	11,064	0	0	0
Nitric acid	3,601	0	0	333
Sulfuric acid	4	0	0	9,009
Toluene	2,863	0	18	10,100
Xylene	5,530	0	44	9,700
Totals	**89,162**	**1,105**	**154**	**29,142**

1992 Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Ammonia	8,300	654	32	110
Chlorine	1	16	0	0
Freon 113	22,500	960	6	611
Lead	29	1	10,000	18
Nitric acid	790	0	0	643
Sulfuric acid	0	0	0	720
Toluene	3,560	0	4	5,403
Xylene	15,370	0	26	7,009
Totals	**50,550**	**1,631**	**10,068**	**14,514**

1993 Chemical	Air Emissions	Water Discharges	Land Disposal	Offsite Transfers
Ammonia	11,550	977	0	150
Chlorine	0	15	0	0
Lead	76	9	8,500	66
Manganese compounds	42	0	1,250	0
Methyl ethyl ketone	9,735	0	41	0
Methyl tert-butyl ether	540	0	0	0
Nitric acid	37,000	0	0	0
Sulfuric acid	0	0	0	1
Toluene	2,401	0	4	0
Xylene	7,428	0	52	0
Totals	**68,772**	**1,001**	**9,847**	**217**

Table 2–2 Summary of 33/50 Chemicals Exceeding Reporting Threshold (in Pounds) at SRS for Reporting Year (1993), Prior Year (1992), and Base Year (1988)

	Lead and Compounds	Toluene	Xylene	Methyl Ethel Ketone	Total
Amount (MPOU[a])					
Reporting Year	78,082	34,278	47,763	10,423	170,546
Prior Year	11,306	11,651	30,520	9,473	62,950
Total Air Releases	76	2,401	7,428	9,735	19,640
Total Water Releases	9	0	0	0	9
Total Land Releases	8,500	4	52	41	8,597
Total Releases	8,585	2,405	7,480	9,776	28,246
POTW[b]	0	0	0	0	0
Offsite Transfers	66	0	0	0	66
Summary Total					
Reporting Year	8,651	2,405	7,480	9,776	28,312
Base Year	14,763	[c]	1,782	[c]	16,545
Percent Change	–41	[c]	+320	[c]	+71

a Manufactured, processed, or otherwise used
b Publicly owned treatment works
c Reporting threshold not exceeded

exceeding the threshold during 1993. This compares to three chemicals—lead, toluene, and xylene—that exceeded the threshold during 1992, accounting for 41,420 pounds released to the environment or transferred off site. A breakdown of these chemicals and their associated releases in 1993 is presented in table 2–2.

Executive Order 12856

Executive Order 12856, enacted in August 1993, requires that all federal facilities comply with right-to-know laws and pollution prevention requirements. Prior to establishment of the executive order, only private industries in Standard Industrial Classification codes 20–39 were required to comply with EPCRA. The executive order requires that federal facilities meet EPCRA reporting requirements and develop voluntary goals to reduce releases of toxic chemicals 50 percent on a DOE-wide basis by the end of 1999. SRS is meeting compliance requirements for EPCRA.

Executive Order 12856 impacts the site in terms of pollution prevention. Requirements for the reduction in toxic chemical releases go beyond the voluntary 33/50 program and mean that SRS must incorporate into its pollution prevention efforts all the toxic chemicals on the Toxic Chemical Release Inventory report.

National Environmental Policy Act

NEPA provides a means to evaluate the potential environmental impact of proposed federal action and to examine alternatives to those actions. Although implemented on site by the Energy Research and Development Administration during the 1970s, a formal maintenance and operations NEPA compliance group was not established at SRS until 1982. The ongoing mission of this group is to make recommendations regarding the level of NEPA review of a site-proposed action and to prepare documentation in support of DOE compliance with NEPA at SRS. In 1994, 182 reviews of new proposed actions were conducted at SRS and formally documented through Categorical Exclusions (CXs), Notices of NEPA Approval, or Environmental Assessments (EAs). WSRC also provided technical support to DOE–SR for the preparation of Environmental Impact Statements (EISs) and in the implementation of a new DOE NEPA secretarial policy at SRS (page 18).

The types and numbers of NEPA activities conducted at SRS during 1994 are presented in table 2–3. Among the specific activities were the following:

- The final EA and Finding of No Significant Impact (FONSI) on the new sanitary sludge land application sites at SRS were issued and approved in February. The EA assesses the impacts associated with the selection and utilization of new onsite locations for the ongoing activity of spreading site-generated sanitary sludge in forested habitat at SRS.
- A programmatic EA on the urgent-relief acceptance of foreign research reactor spent nuclear fuel was finalized in April. The final FONSI for the proposed federal action also was approved and issued in April. The EA analyzed the impacts and alternatives associated with the acceptance, overseas shipment, and subsequent transport to SRS, by truck, of spent fuel elements from eight foreign research reactors in Europe.
- A final EA and FONSI on the proposed upgrading and consolidation of the domestic water supply system at SRS were approved and issued in June. This project will enable the site to improve the SRS domestic water facilities and modify the existing drinking water supply lines into two consolidated systems.
- An EA on the vendor treatment of M-Area mixed waste at SRS was finalized in June and a final FONSI issued in August. This proposed action will provide DOE with an SRS facility constructed and operated by a subcontractor to stabilize M-Area mixed waste by utilizing a thermal vitrification process.
- The final EA for the transport and disposal of SRS sanitary waste at an offsite facility was issued in August and the final FONSI was approved and issued in September. The purpose of this proposed action is to contract a vendor to collect municipal solid waste from SRS and transport it to an offsite municipal solid-waste landfill for disposal. This action would further enable DOE to curtail operations at the existing site sanitary landfill.
- The final EA and FONSI for the offsite commercial cleaning of controlled and routine laundry from SRS were issued in December 1994. This action enables SRS to establish a coordinated effort with a contracted vendor to provide offsite services for the commercial cleaning of laundry generated at SRS.
- A Supplement Analysis (SA) for the deactivation and transition of SRS reactors was in review at DOE–HQ from June through December. The SA documents the need for preparation of a Supplemental Environmental Impact Statement (SEIS) for these facilities. The proposed action also would encompass the SRS secondary cooling water system, PAR Pond, and L-Lake.
- The final SEIS for the Defense Waste Processing Facility (DWPF) was issued in November. This SEIS assessed the potential environmental impacts of completing and operating the DWPF with the modified process design changes implemented since the completion of the DWPF EIS in 1982. The Record of Decision is expected to be issued in February 1995.
- A final EIS for processing the F-Canyon plutonium solutions at SRS was issued in December. The Record of Decision is expected to be issued early in 1995. This EIS evaluated the potential impacts, during the next 10 years, of alternatives for stabilization of plutonium solutions stored in F-Canyon. Because of safety concerns, DOE proposes to take expedited action to stabilize these solutions.
- A draft EIS on waste management at SRS is being prepared for the site. This EIS will assess the environmental consequences associated with the generation, management, and minimization of low-level, liquid high-level, nonradioactive hazardous, mixed, and transuranic wastes at SRS. This draft is expected to be issued for public review and comment in late January 1995.

Table 2–3 Types of NEPA Activities at SRS During 1994

Activity	Number
Categorical Exclusion Recommendation	4
Sitewide Categorical Exclusion/ Routine Insignificant Actions	174
Environmental Assessment	15
Special Environmental Analysis	1
Programmatic Environmental Assessment	1
Supplement Analysis	2
Environmental Impact Statement	4
Supplemental Environmental Impact Statement	1
Programmatic Environmental Impact Statement	4
Total	206

Table 2–4 contains a complete list of NEPA documentation activities at SRS during 1994.

The sitewide procedure (Environmental Compliance Manual 3Q, Procedure 5.1, "Implementation of the

Table 2–4 SRS Project NEPA Documentation Activities During 1994

Project Name	Level of NEPA Documentation
Domestic Spent Nuclear Fuel/INEL[a] Environmental Restoration and Waste Management	PEIS
Environmental Management	PEIS
Foreign Research Reactor Spent Nuclear Fuel	PEIS
Nuclear Weapons Complex Reconfiguration	PEIS
F-Canyon Plutonium Solutions	EIS
F/H-Canyon Exhaust System	EIS
Interim Management of Nuclear Materials	EIS
SRS Waste Management	EIS
Defense Waste Processing Facility	SEIS
SRS Reactor Transition and Decommissioning	SA
Waste Management Activities for Groundwater Protection	SA
Urgent-Relief Acceptance of Foreign Research Reactor Spent Nuclear Fuel	PEA
PAR Pond Repair and Maintenance Activities	SEA
D-Area Powerhouse Upgrades	EA
DOE Permission for Off-loading Activities to Support the Movement of Commercial Low-Level Nuclear Waste Across SRS	EA
Domestic Water Upgrades and Consolidation	EA
Environmental Monitoring Laboratory	EA
HB-Line Phases I and III	EA
Health Physics Site Support Facility	EA
M-Area Vendor Treatment Process	EA
New Sanitary Sludge Land Application Site	EA
Offsite Commercial Cleaning of Controlled and Routine Laundry	EA
Radiological Equipment Maintenance Facility	EA
SED[b] I & II Facility Decommissioning and Decontamination	EA
Storage of Offsite Plutonium in Building 247–F Vault	EA
Transportation and Disposal of Savannah River Site-Generated Municipal Solid Waste at an Offsite Disposal Facility	EA
Upgrade Site Road Infrastructure	EA
Uranium Solidification Facility in Building 221–H	EA

Key: *EA — Environmental Assessment*
EIS — Environmental Impact Statement
PEA — Programmatic Environmental Assessment
PEIS —Programmatic Environmental Impact Statement
SA — Supplement Analysis
SEA — Special Environmental Analysis
SEIS — Supplemental Environmental Impact Statement

a Idaho National Engineering Laboratory
b Separations Equipment Development

National Environmental Policy Act") for implementation of the revised DOE regulations (10 CFR 1021) concerning NEPA compliance within the DOE complex was revised and improved during 1994. The SRS department NEPA coordinator certification program trained 12 new department NEPA coordinators during 1994. The site had 26 certified department NEPA coordinators within its various contractor organizations as of December 31, 1994. In 1993, DOE–HQ approved the use of 47 CXs for sitewide routine insignificant actions at SRS. These CXs require approval only at the DNC level in the field prior to project implementation. SRS was the first site in the DOE complex to be granted such authority within the NEPA compliance process. The site developed, for reporting and analysis purposes, a computerized database/tracking system for both completed and ongoing SRS NEPA documentation. The SRS NEPA program was reviewed and evaluated during a DOE Level 1 Audit conducted during June and July 1994. The assessment evaluated the site's policies, programs, procedures, and methods for achieving compliance with NEPA at the earliest possible time in the decision-making process for actions that might affect the environment. This assessment identified two proficiencies and six deficiencies concerning these aspects of the NEPA implementation at SRS. An action plan has been developed for correcting the deficiencies, and the plan is being implemented.

The 1994 DOE NEPA compliance officer annual meeting was hosted by SRS in Augusta, Georgia, February 15–17. At this meeting, a new DOE NEPA secretarial policy was reviewed by the DOE Assistant Secretary for Environment, Safety and Health. The policy's primary objective is to streamline the NEPA process so that it works better and costs less, and SRS took several actions to support the new policy during 1994. Of these actions, the following two should result in substantial time and cost savings for the site's NEPA process:

- The EIS process period was reduced, from its original requirement of 3–5 years, to 15 months or less for the issuance of a final EIS.
- SRS was granted site manager approval authority for EAs. In support of this effort, the site prepared an EA quality assurance plan and a public participation plan to improve the EA process.

Safe Drinking Water Act

The federal Safe Drinking Water Act (SDWA) was enacted in 1974 to protect public drinking water systems; it was amended in 1980 and 1986. The SRS drinking water supply is from groundwater sources. Thirteen of the 27 domestic water systems on site each regularly serve more than 25 people and meet the requirements for nontransient, noncommunity systems, which are regulated by SCDHEC. The remaining 15 systems, each of which serves fewer than 25 people, are classified as state systems by SCDHEC and receive a lesser degree of regulatory oversight.

SRS provides drinking water to the majority of its employees through the 13 nontransient, noncommunity systems, which the site continues to work toward upgrading. Approval of the SRS Domestic Water Consolidation Preliminary Engineering Report was issued by SCDHEC May 24, 1993. The report recommended consolidation of 11 of the major site drinking water systems into three systems through the installation of

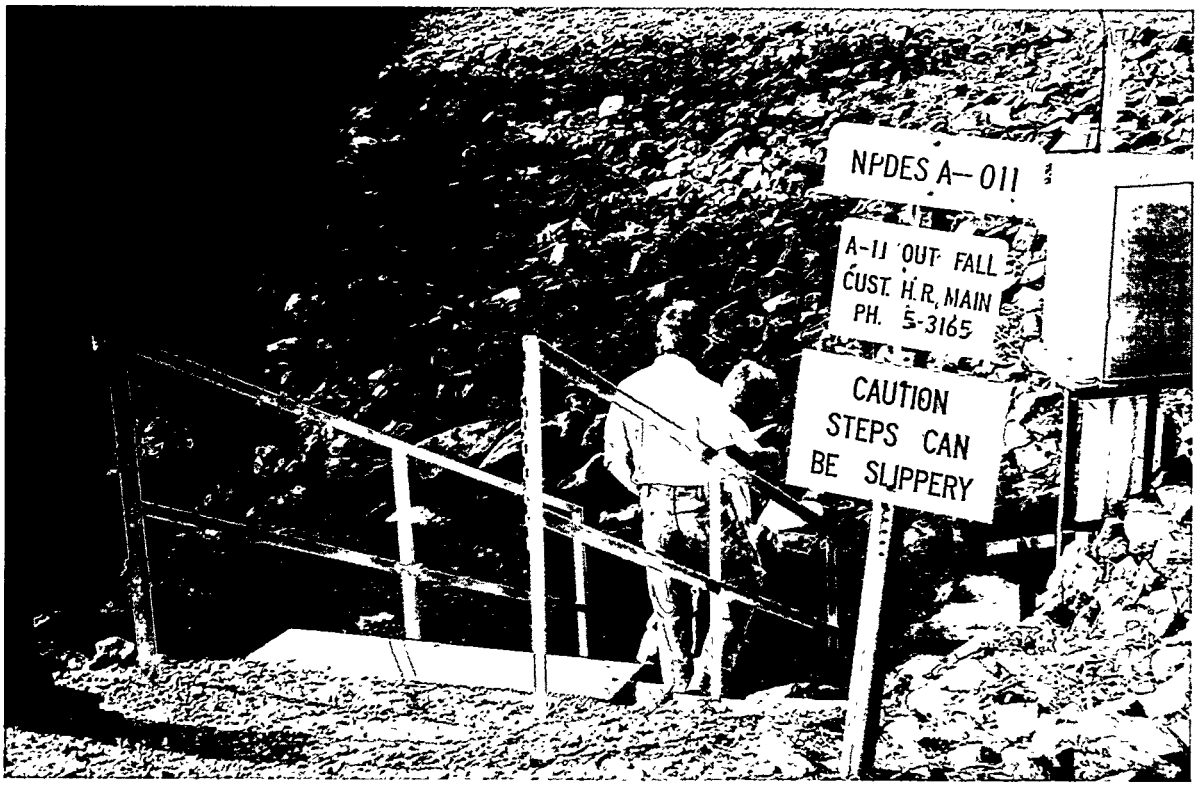
- three elevated storage tanks
- looped distribution piping
- a centralized water treatment facility

Plans had been to consolidate all 13 of the systems, but it subsequently was decided to reclassify the systems in L-Area and P-Area as small systems by 1997. Drinking water system consolidation, scheduled for completion by September 1997, replaces the upgrade plan submitted to SCDHEC in October 1991.

The installation of a 250,000-gallon elevated storage tank in A-Area was completed in 1994. An operating permit was issued by SCDHEC on May 25, and the tank was placed in service. This project will support the consolidated water system project, scheduled to be completed in 1997.

On November 15, 1993, WSRC received analysis results indicating that lead and copper concentrations in the domestic water system at the Savannah River Forest Station (SRFS) exceeded SDWA regulatory action levels. As a result of this exceedance and in accordance with Lead and Copper Rule requirements, WSRC

- notified the system's users of the increased lead and copper levels within 60 days. (Removing the drinking water system from service was not required by the regulations. Bottled water had been made available and was being consumed in this area prior to the exccedance.)
- submitted a corrective action plan to SCDHEC within 6 months. The use of soda ash (pH adjustment) as a corrosion control measure was approved by SCDHEC September 7, 1994. The application to construct a soda ash feed system for the SRFS water system was approved by SCDHEC October 4, 1994. As required by the Lead and Copper Rule, this feed system must be installed by September 7, 1996.



NFN

SCDHEC officials inspect outfall A–011 for compliance with NPDES permit requirements.

During April 1994, lead and copper testing results in S-Area indicated a lead action level exceedance, which triggered the SCDHEC requirements for public notification, for development of an acceptable corrective action plan, and for retesting by a certified laboratory. Corrective actions were completed according to the Lead and Copper Rule requirements. The distribution and source site sampling results, public education materials, and optimal corrosion control treatment recommendation were submitted to SCDHEC October 25.

Clean Water Act

National Pollutant Discharge Elimination System (NPDES)

The Clean Water Act (CWA) of 1972 created the National Pollutant Discharge Elimination System (NPDES) program, which is regulated by SCDHEC under EPA authority. The program is designed to protect surface waters by limiting all nonradiological releases of effluents into streams, reservoirs, and other wetlands. Radiological effluents are covered under other acts. Discharge limits are set for each facility to ensure that SRS operations do not impact aquatic life adversely or decrease water quality.

SRS has five NPDES permits—two for industrial wastewater discharge (SC0000175 and SC0044903), two for general stormwater discharge (SCR000000 and SCR100000), and one for land application (ND0072125). Permit SC0000175 regulated 76 active NPDES outfalls at SRS during 1994. Seven additional NPDES outfalls were regulated under permit SC0044903. Of these 83 industrial wastewater outfalls, 71 discharged (operated) during 1994, six did not discharge, and six were not in service. All the operational outfalls were sampled, while the six that did not discharge continued to be monitored [SRS Data, 1995]. All analytical results, including those that indicated zero discharges at the six nondischarging outfalls, were reported to SCDHEC in the monthly discharge monitoring reports, according to the NPDES permit requirements.

NPDES permit compliance at SRS has steadily improved during the past 10 years. In October 1994, SCDHEC personnel conducted a two-week audit of SRS wastewater facilities and found one exceedance. As it was in 1993, the 1994 compliance rate was 99.9 percent, based on a permit-required minimum—for calculation purposes—of 8,000 analyses. The total number of analyses performed during 1994 was 7,568 (fewer than 8,000 because of the 16 inactive outfalls).

Nine of these exceeded NPDES permit limits. A list of exceedances, including the outfall locations, probable causes, and corrective actions, can be found in chapter 8, "Nonradiological Effluent Monitoring."

Forty-eight stormwater-only point sources are covered under permit SCR000000 for stormwater discharges associated with industrial activity, excluding construction activity. The permit requires that the stormwater discharges be monitored, the samples evaluated, and the data collected. Of the 48 point sources, 11 representative outfalls were monitored. The outfalls represent a wide range of SRS activities, including

- storage, use, or disposal of EPCRA Section 313 chemicals
- land disposal units
- steam electric generation
- chemical and allied product manufacturing

As required by the general permit, a pollution prevention plan was developed and implemented in 1993 for the identified stormwater outfalls. The plan identifies facility areas where "best management practices" and/or "best available technology" should be implemented to prevent or mitigate the release of pollutants with stormwater runoff.

All construction activity that would result in a land disturbance of 5 or more acres must be permitted. Currently, the six land areas associated with industrial activity from construction activity are permitted as required under Permit SCR100000. The pollution prevention plan for this permit also requires a sediment reduction and erosion control plan.

SCDHEC issued SRS a "no discharge" permit (ND0072125) November 15, 1993, allowing land application of sanitary treatment plant biosolids to SRS pine forests on two plots of land along Road F. SCDHEC completed review of the EA under NEPA, and a FONSI was issued in February 1994. After site preparation by the U.S. Forest Service, biosolids were land-applied in July 1994.

Under the federal Oil Pollution Prevention regulation (40 CFR 112), SRS must report petroleum product discharges of 1,000 gallons or more into or upon the navigable waters of the United States, or petroleum product discharges in harmful quantities that result in oil sheens. No such incidents occurred at the site during 1994.

SRS has an agreement with SCDHEC to report petroleum product discharges of 25 gallons or more to the environment. No such incidents occurred at the site during 1994.

On May 31, 1994, SCDHEC sent a proposed draft NPDES permit to SRS for review and comment by September 1, 1994. The original application for renewing the permit was made in 1988 and updated in 1993. SRS comments on the proposed draft NPDES permit were submitted to SCDHEC in September 1994. Among the changes proposed were

- a reduction in the number of outfalls
- consolidation of the five existing NPDES permits into a single site permit

SCDHEC is expected to issue a formal draft NPDES permit to SRS for review and comment in 1995.

Notice of Violation – CWA

SRS received an NOV from SCDHEC in September 1994 for past exceedances of the trichloroethylene effluent limitations at Outfall A–005. Based on self-reporting and the corrective actions taken by SRS, no show-cause hearing was required. In October 1994, SRS submitted a plan to prevent recurrence of the violation, as requested by SCDHEC. The activity that caused the trichloroethylene exceedance was the flushing of a well, which was discontinued. No fine was levied.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act restricts the application of pesticides through a state-administered certification program. SRS's pesticide procedure provides guidelines for pesticide use and requires that applicators be state certified. A pesticide-use task group evaluates planned pesticide programs to ensure that they are acceptable and that appropriate pesticides are used so that any impact on the environment is minimal. The task group also

- maintains records of pest control activities
- assists in communicating information about pesticide use to other site contractors
- contacts offsite utility companies to determine the pesticide applications they plan for right-of-way maintenance on SRS property

SRS pesticide programs typically include such activities as the maintenance of roadways and fence lines through the use of herbicides.

Clean Air Act

Regulation, Delegation, and Permits

The Clean Air Act (CAA) provides the basis for protecting and maintaining air quality. Except for radioactive sources, which are regulated by EPA,

regulation of air emissions under the CAA has been delegated to SCDHEC. Under the CAA, SRS is classified as a "major source" and, as such, is assigned one permit number (0080–0041) by SCDHEC. In this permit, each emission source is identified by the area designation, by a point identification number, and by a source description. SRS holds operating and construction permits from SCDHEC's Bureau of Air Quality Control, which regulates nonradioactive toxic and criteria pollutant emissions from approximately 183 point sources, several of which have specific emission limits. As of May 1994, SCDHEC had completed renewal of all SRS operating permits, which are valid for 5 years. Of the 183 sources, 54 are diesel generators, which are exempt from regulator requirements for operations of less than 250 hours per year.

During 1994, SCDHEC conducted 72 source compliance inspections at SRS including biennial stack tests, initial operation inspections following completion of construction, and annual compliance inspections.

National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAP) is a CAA-implementing regulation that sets air quality standards for air emissions containing hazardous air pollutants, such as radionuclides (40 CFR 61, Subpart H), benzene, and asbestos. Regulation of hazardous air pollutants, except radionuclides, has been delegated to SCDHEC.

SRS, like most South Carolina industrial complexes, uses a number of chemicals identified by SCDHEC as toxic air pollutants and by EPA as hazardous air pollutants. These include many common consumer products—e.g., off-the-shelf bug sprays, correction fluids, paints, sealers, janitorial cleaning supplies, gasoline for vehicles—as well as a number of typical industrial chemicals, such as degreasers, solvents, metals, batteries, and diesel fuel. But SRS has at least one category, radionuclides, not found in typical industrial settings. During the course of normal operations, some radionuclides are released to the air. These air emissions are regulated by SCDHEC and EPA Region IV.

NESHAP Radionuclide Program The SRS NESHAP radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. Work is proceeding on schedule under the radionuclide FFCA signed October 31, 1991.

The first amendment to the FFCA for radionuclide NESHAP was signed by EPA Region IV August 16, 1993. The amendment will provide SRS an extension of the original FFCA through February 10, 1995, to accomplish monitoring upgrades to several additional sources.

A comprehensive analysis of all SRS radionuclide emission sources, both point and nonpoint, was completed in late 1991. Because of modifications in the dose modeling, the analysis was repeated in 1992. Results of the 1992 analysis indicated that four of 260 point sources would require monitoring equipment upgrades—not because they emit significant doses, but because of their proximity to the site boundary. The upgrades were added to the FFCA, which requires that monthly progress reports be submitted to EPA. During 1994, the maximally exposed individual effective dose equivalent, calculated using the NESHAP-required CAP88 computer code, was estimated to be 0.15 mrem (0.0015 mSv), which is 1.5 percent of the 10-mrem-per-year (0.10-mSv-per-year) EPA standard (chapter 7, "Potential Radiation Doses").

NESHAP Nonradionuclide Program As previously indicated, SRS uses many chemicals identified as toxic or hazardous air pollutants. As required by SCDHEC Air Pollution Control Regulation 62.5, Standard No. 8 (toxic air pollutants), SRS completed and submitted an air emission inventory (discussed in the following paragraph) and air dispersion modeling data for all site sources by June 28, 1993. The submitted data demonstrated compliance by computer modeling the accumulated ambient concentration of individual toxic air pollutants at the boundary line and comparing them to the Standard No. 8 maximum allowable concentrations. Under Title III of the federal Clean Air Act Amendments (CAAA) of 1990, EPA will publish a list of hazardous air pollutant-emitting source categories potentially subject to maximum achievable control technology standards. The list includes all radionuclides as a single item, along with 188 toxic air pollutants.

Air Emissions Inventory The CAAA of 1990 also include, under Title V, a major new permitting section expected to have a significant impact on the site. Title V will require that SRS submit new application packages for some new air sources and for some already-permitted sources. The full impact on the site is not yet known, however, because the implementation plan submitted to EPA by the State of South Carolina has not been approved.

To meet these standards, SRS personnel conducted a comprehensive air emissions inventory of all site facilities in 1993 to demonstrate compliance with Standard No. 8, to ensure that all radiological and nonradiological sources had been accounted for, and to better characterize emission points from site processes.

Guidelines and procedures were written to ensure documentation of all vents and stacks for each building and to calculate emissions based on design capacity, maximum potential emissions, and actual emissions for a selected period of time.

The inventory identified approximately 5,300 radiological and nonradiological air emissions sources. Air emissions data from 1990 established the SRS baseline emissions. Calculations from the 1990 data demonstrated that SRS complied with Standard No. 8. Inventory data must be *recorded* annually and *reported* every other year. Data from 1993 were *reported* in March 1994, and 1994 data have been *recorded* as required.

Ozone-Depleting Substances The CAAA of 1990 contained a chapter under Title VI addressing stratospheric ozone protection. This new law requires that EPA establish a number of regulations to phase out the production and consumption of ozone-depleting substances (ODS). The substances commonly are used as refrigerants in air conditioning and cooling systems (Freon); degreasers and cleaners; spray can propellants; fire suppressants (Halon); and many other common consumer products.

Several sections of Title VI of the CAAA of 1990, along with recently established EPA regulations, apply to the site. The ODSs are regulated in two general categories: Class I substances—or chlorofluorocarbons (CFCs), halon, carbon tetrachloride, and methyl chloroform—and Class II substances, or hydrochlorofluorocarbons (HCFCs). Class I ODSs are about 10 times more ozone-depleting than HCFCs and thus are more strictly regulated. As required by the CAAA of 1990, most Class I Halons were phased out of production by January 1, 1994, and other Class I ODSs will be phased out by January 1, 1996. This means that several very important refrigerants (Freon 11, 12, 114, and 502) used on site essentially will be unavailable for purchase after 1995. Many of the large chillers on site that use these refrigerants are being scheduled for total replacement or for retrofits that will use chemical substitutes. The site also is scheduling fire suppression (Halon) system replacements. Many common degreasers are Class I ODSs and have been targeted for replacement. Most major degreasing applications already have been eliminated or replaced with HCFCs or non-ODS. Smaller ODS degreasing applications, such as those in maintenance and electrical shops, are being targeted for phaseout.

The SRS CAAA of 1990 Title V air permit application will include ODS emission sources. All large (greater than or equal to 50-pound charge) HVAC/chiller systems and fire suppression systems for which there are recordkeeping requirements will be included as fugitive emission sources.

The site has formed a CFC steering committee of participants from all the major users of these substances. A number of technical subcommittees also were initiated to address particular applications, such as refrigeration, fire suppression, degreasers, laboratory applications, and environmental compliance. The "Savannah River Site Refrigerant Management Plan," completed and issued in September 1994, provides guidance to assist SRS and DOE in the phaseout of CFC refrigerants and equipment.

The site has

- purchased certified recycling equipment
- trained and certified technicians where required
- begun recordkeeping and leak-tracking for large cooling systems
- implemented proper labeling and other recordkeeping requirements

In 1994, SRS completed an initial draft of a subcontract for the offsite reclamation of used refrigerants. Initial drafts of the reclamation subcontract are under review.

NESHAP Asbestos Removal Program Asbestos insulation, considered one of the best boiler and piping insulators, can be found in older buildings throughout SRS. This is because people were unaware of the danger of airborne asbestos fibers in the early 1950s, when SRS was constructed. Today, however, it is known that asbestos can cause cancer in humans. The site implemented an asbestos removal program in 1988.

Asbestos is removed during maintenance and renovations of equipment and buildings. During 1994, SRS removed 115,323 square feet of transite panel, which contains asbestos. Also removed were 18,558 linear feet and 7,566 square feet of asbestos pipe and surface insulation. This compares with 79,548 square feet of transite panel and 12,372 linear feet and 4,384 square feet of asbestos pipe and surface insulation removed during 1993. Estimates of the percentage of total friable asbestos (a form that can be crumbled or pulverized with hand pressure when dry) removed from SRS cannot be accurately determined because it is not known exactly how much exists on site. SRS will continue to identify and remove such asbestos according to state (SCDHEC R.61–86.1) and federal (40 CFR 61, Subpart M) regulations and "best management practices."

Notice of Violation – CAA

Two inspections involving stack tests resulted in an NOV being issued October 20, 1993, to SRS by

SCDHEC under the CAA. The NOV was the result of failed biennial source compliance tests for two coal-fired boilers in H-Area. The particulate matter emission rates for the two boilers, calculated from stack test results, exceeded the maximum permitted limit. The excess emissions, which occurred during regulatory compliance testing in January and June 1993, did not pose a threat to public health or to the environment, and corrective actions were taken. One of the two boilers passed a compliance retest in September 1993; the other, in December 1993. An enforcement conference for this NOV was conducted November 30, 1993. On March 4, 1994, SCDHEC signed Settlement Agreement 94–24–A, which included a civil penalty related to H-Area powerhouse air emissions.

On July 5, 1994, SRS formally notified SCDHEC that demolition of several buildings had occurred at B-Area. On July 6, to verify the demolition operation, SCDHEC asbestos personnel inspected B-Area and found that three buildings at the Heavy Water Components Test Reactor facility had been demolished without the proper regulatory notification for building demolition projects. SCDHEC must be notified of demolition of site buildings so that it can check for asbestos materials and ensure proper asbestos management/removal. An NOV was received from SCDHEC August 19 for lack of notification to the state for small demolition projects; an enforcement conference was held September 8. A proposed settlement agreement, received from SCDHEC December 2 for lack of notification to the state for small demolition projects, is being reviewed.

An NOV was received from SCDHEC on July 27, 1994, for unpermitted sources identified during annual inspections and for failed sulfur dioxide emissions from a D-Area boiler stack test. SRS undertook an inventory and review of all SRS storage tanks for applicability of the permitting requirements. Permit applications were submitted for the unpermitted sources. The sulfur dioxide emission rate was calculated based on the laboratory analysis of the sulfur content from coal samples. High sulfur coal supply was corrected. SRS submitted test results from a blend of high sulfur and low sulfur coal that resulted in satisfactory sulfur dioxide emissions below the permitted level. On December 5, 1994, SCDHEC signed Settlement Agreement 94–133–A, which included a civil penalty related to unpermitted sources and failed sulfur dioxide emissions.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) gives EPA comprehensive authority to identify and control chemical substances manufactured, imported, processed, or used in the United States. Reporting and recordkeeping are mandated for new chemicals and for any chemical that may present a substantial risk of injury to human health or the environment. The site's Environmental Protection Department (EPD) and Industrial Hygiene Section coordinate reporting and recordkeeping requirements under TSCA.

Polychlorinated biphenyls (PCBs), which are chemicals specifically regulated under 40 CFR 761 of TSCA, have been used in the past in various SRS processes. PCBs on site are in pre-1979 electrical equipment in the form of transformers, small capacitors, and fluorescent light ballasts. The site has a well-structured PCB program that complies with TSCA regulation 40 CFR 761, with DOE orders, and with WSRC policies. The 1993 PCB Annual Document Log was completed prior to the July 1, 1994, deadline in full compliance with the regulations. Disposal of PCBs from SRS is conducted at EPA-approved disposal facilities within the regulatory time frame.

In August 1993, PCBs were confirmed to be present as a component of dense nonaqueous phase liquids in samples from two groundwater monitoring wells around the M-Area hazardous waste management facility. Regulators were notified and a modification to the RCRA Part B Permit Application to address the discovery of PCBs was submitted to SCDHEC. Any waste generated was handled according to the appropriate TSCA and RCRA requirements. Savannah River Technology Center (SRTC) continues to study ways to remediate the dense nonaqueous phase liquids. SRS plans to submit a request to EPA for approval to conduct research and development field activities on this material.

SRS has some PCBs—radioactively contaminated during a spill—that have been stored on site since 1978. TSCA regulations call for annual disposal of PCB waste, but there is insufficient capacity for disposal of radioactive PCB waste off site. These radioactive PCB materials are stored on site in a facility that meets storage requirements under 40 CFR 761.65 (b) (1). SRS continues to seek disposal technologies and facilities that can handle radioactive PCB waste. A task team is pursuing the possibility of treating the waste with a dechlorination process. A request to conduct a treatability study was submitted to EPA in July 1994. SRS plans to ship the waste to a vendor for characterization during 1995. Following EPA approval, SRS will perform the treatability study using the vendor's process.

During 1994, SRS flushed and refilled 20 site electrical transformers containing PCB-contaminated oil. This

action was taken in an effort to reduce the PCB concentration in the transformer oil below regulatory limits. Successful conclusion of a regulatory-prescribed period of use and testing will allow the transformers to be reclassified as non-PCB in 1995. Also during 1994, PCBs at regulated levels were discovered in the 105–R disassembly basin sludge and water. Testing in the other reactor facilities has identified trace levels of PCBs in a few locations in other buildings. The source of the PCBs is under investigation.

Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of wildlife, fish, and plants in danger of becoming extinct. The act also protects and conserves the ecosystems on which such species depend.

Several endangered species exist at SRS. The site conducts research on the wood stork, the red-cockaded woodpecker, the bald eagle, the shortnose sturgeon (figure 2–2), and the smooth purple coneflower. Studies of the bald eagle on PAR Pond are being formulated to comply with the Endangered Species Act, as requested by the U.S. Fish and Wildlife Service. Programs designed to enhance the habitat of such species also are in place. NEPA reviews of new projects at SRS in 1994 found no activities of significant impact.

Smooth Purple Coneflower

Sometimes, the rarest things are stumbled upon by chance. That is what happened at the Savannah River Site (SRS) in June 1994, when a second colony of an endangered plant was discovered growing near an electrical power line.

A University of South Carolina at Aiken botanist, contracted by the Savannah River Forest Station, spotted the new colony of smooth purple coneflowers a mile southeast of L-Area. At least 400 of the "alien-looking" plants, which bloom for only 3 to 4 weeks in the summer, were found growing in the colony; however, a subsequent, more intensive survey indicated the presence of approximately 1,000 plants in the new colony.

The colony is being protected by controlled mowing until a formal management plan can be approved for it.

An initial colony of 219 smooth purple coneflowers, discovered at SRS in 1966, is being preserved by prescribed burning and tree thinnings, which allow more sunlight to reach the plants.

Ecologists say it is important to protect these colonies to comply with federal law and to maintain plant diversity at SRS. Since the smooth purple coneflower was placed on the endangered list in October 1992—it is the only federally endangered plant on site—approximately 60 different colonies have been located across the nation.

National Historic Preservation Act

The National Historic Preservation Act of 1966, Section 106, governs the protection and preservation of archaeological and historical resources. SRS ensures that the site is in compliance with this act through the site-use process. All sites being considered for activities such as construction are evaluated by the University of South Carolina's archaeology group to ensure that archaeological or historic sites are not impacted. NEPA reviews of new projects at SRS in 1994 found no activities of significant impact.

Floodplains and Wetlands

Under DOE General Provisions, 10 CFR, Part 1022 ("Compliance with Floodplains/Wetlands Environmental Review Requirements"), establishes policies and procedures for implementing DOE's responsibilities in terms of compliance with Executive Orders 11988 ("Floodplain Management") and 11990 ("Protection of Wetlands"). Part 1022 includes DOE policies regarding the consideration of floodplains/wetlands factors in planning and decision making. It also includes DOE procedures for identifying proposed actions involving floodplains/wetlands, providing early public reviews of such proposed actions, preparing floodplains/wetlands assessments, and issuing statements of findings for actions in floodplains.

Executive Order 11988, "Floodplain Management"

Executive Order 11988, "Floodplain Management," was established to avoid long- and short-term impacts associated with the occupancy and modification of floodplains. Evaluation of impacts to SRS floodplains is ensured through the NEPA Evaluation Checklist and the site-use system. Site-use applications are reviewed for potential impacts by WSRC, DOE-SR, SRFS, and Savannah River Ecology Laboratory (SREL), as well as by professionals from other organizations. NEPA reviews of new projects at SRS in 1994 found no activities of significant impact.

Executive Order 11990, "Protection of Wetlands"

Executive Order 11990, "Protection of Wetlands," was established to mitigate adverse impacts to wetlands

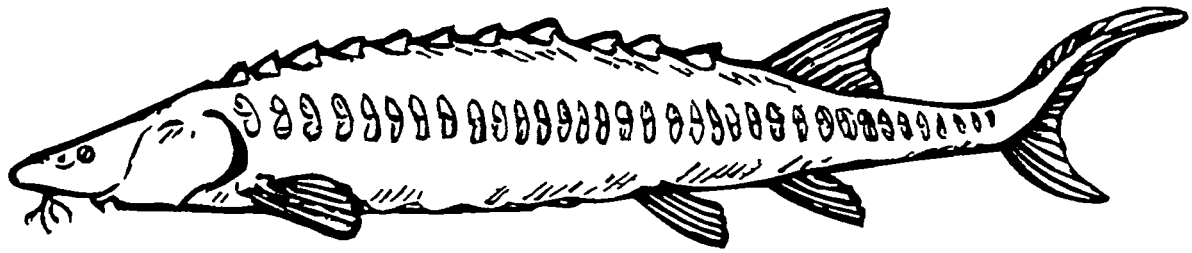


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Figure 2–2 Shortnose Sturgeon
The shortnose sturgeon is one of several endangered species at SRS. The anadromous fish historically has been found in the middle reaches of the Savannah River; its larvae have been reported in the Upper Three Runs Creek area of SRS.

caused by destruction and modification of wetlands and to avoid new construction in wetlands wherever possible. Avoidance of impact to SRS wetlands is ensured through the site-use process, various departmental procedures and checklists, and project reviews by the SRS Wetlands Task Group. Many groups and individuals, including scientists at SRTC, SREL, and EPD, review site-use applications to ensure that proposed projects do not impact wetlands. NEPA reviews of new projects at SRS in 1994 found no activities of significant impact.

Environmental Release Response and Reporting

Response to Unplanned Releases

The SRS environmental monitoring program extends beyond routine effluent monitoring and environmental surveillance activities. Upon notification by area operations personnel, the Environmental Monitoring Section (EMS) is prepared to respond to unplanned environmental releases—both radiological and nonradiological—as required.

If an unplanned environmental release is suspected, EMS personnel are dispatched—upon request—to collect appropriate samples. These samples are given priority in preparation and, if radiological in nature, priority in the count room. The data are validated and a determination is made as to whether there was an actual release. If there was, then consequences to the public and the environment are determined.

In 1994, there were a number of unplanned environmental releases, but none that required the sampling and analysis services of EMS.

Occurrences Reported to Regulatory Agencies

CERCLA requires notification of the National Response Center if a nonpermitted release of a reportable quantity (RQ) or more of a hazardous substance (including radionuclides) is released to the environment. The CWA requires that the National Response Center be notified if an oil spill causes a "sheen" on navigable waters of the United States, such as rivers, lakes, or streams. Reporting of oil spills was reinforced with liability provisions in CERCLA's National Contingency Plan.

Other CERCLA provisions allow exemptions from reporting a release of an RQ or more of a hazardous substance if the release is covered by a continuous-release notification or if it is "federally permitted." A continuous-release notification provides an exemption from reporting each release of a specific hazardous substance greater than an RQ. SRS was not required to submit any continuous-release notifications in 1994.

The three CERCLA releases reported to regulatory agencies during 1994 are described in Table 2–5. This compares with zero CERCLA releases reported during 1993, three during 1992, and four during 1991. Of the three releases reported during 1994, two were of a CERCLA RQ.

EPCRA (40 CFR 355.40) requires that reportable releases of extremely hazardous substances or

Table 2–5
CERCLA Releases Reported to Regulatory Agencies in 1994

Date	Applicable Regulation/ Reason for Notification	Agencies Notified	Description
March 5	Exceeded CERCLA RQ of 10 pounds	SCDHEC/ EPA	Approximately 10 pounds of sodium chromate leaked to the ground because of a line failure.
June 20	Exceeded CERCLA RQ of 10 pounds	SCDHEC/ EPA	Approximately 125 gallons of chromium water leaked to the ground because of a valve failure.

CERCLA hazardous substances be reported to any local emergency planning committees and state emergency response commissions likely to be affected by the release. There were no EPCRA reportable releases in 1994.

Federally permitted releases comply with a legally enforceable license, permit, regulation, or order. Under the Atomic Energy Act, for example, releases of SRS radionuclides are federally permitted as long as public dose standards in DOE orders are not exceeded.

Other regulations and agreements require that SCDHEC be notified when regulatory thresholds are exceeded. In 1994, four notifications, based on agreement with the state, were made—one for a sewage release of about 100 gallons and three for petroleum spills of more than 25 gallons. Also, it is SRS policy to notify SCDHEC and the Georgia Department of Natural Resources (GDNR) of any occurrence that may interest state regulatory agencies. Although not required by law, these "courtesy notifications" enhance environmental protection objectives by providing state regulatory agencies the opportunity to review occurrences that may degrade the onsite environment.

Site Item Reportability and Issues Management (SIRIM) Program

The Site Item Reportability and Issues Management (SIRIM) program, mandated by DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information," is designed to "... establish a system for reporting of operations information related to DOE-owned or operated facilities and processing of that information to provide for appropriate corrective action ... ." It is the intent of the order that DOE be "... kept fully and currently informed of all events which could: (1) affect the health and safety of the public; (2) seriously impact the intended purpose of DOE facilities; (3) have a noticeable adverse effect on the environment; or (4) endanger the health and safety of workers."

The SIRIM program at SRS is designed to meet the requirements of DOE Order 5000.3B by ensuring that

- all occurrences specified are identified in a timely manner, categorized, and reported
- proper corrective actions are taken in a timely manner
- all reportable occurrences are reviewed to assess significance and root causes
- occurrence reports to DOE operations are disseminated to prevent the recurrence of similar events

All SIRIM events are classified in one of the following categories: (1) facility condition; (2) environmental; (3) personnel safety; (4) personnel radiation protection; (5) safeguards and security; (6) transportation; (7) value-based reporting; 8) facility status; or 9) cross-group items. The impact—or the anticipated impact—of each event is categorized as follows (based on criteria in site procedures):

- **Emergency** – the most serious event; requires increased alert status for onsite and, in specific cases, offsite authorities
- **Unusual occurrence** – a nonemergency event that has significant impact or potential for impact on safety, environment, health, security, or operations
- **Off-normal occurrence** – an abnormal or unplanned event or condition that deviates from established standards or specifications

In 1994, of the approximately 1,400 SIRIM events reported to DOE–SR, 54 were categorized as primarily environmental. Of these 54 incidents, none were classified as emergencies, 14 were classified as unusual occurrences, and 40 were classified as off-normal occurrences. Table 2–6 lists unusual environmental occurrences reported through SIRIM in 1994.

Appraisals/Surveillances

The SRS environmental program is overseen by a number of organizations, both outside and within the DOE complex. The SRS environmental appraisal/sur-

Table 2–6
Unusual Occurrences Reported Through SIRIM in 1994

Discovery Date	Occurrence	Report No. (SR–WSRC–)	Cause/Explanation[a]
Jan. 24	Spill of approximately 30 gallons of unleaded gasoline at 663–E	SLDHZD–1994–0001	Rust caused hole in man-lift fuel tank; unleaded gasoline leaked to ground, gravel
Feb. 17	Halon discharge from a glove box in 235–F	S235–1994–0003	Heat detector in glove box failed because of age
March 5	Chromate cooling water leak from East Pump House	HTANK–1994–0036	Pipeline failed because of point load imposed on pipe by asphalt chunks in backfill material subjected to heavy vehicle traffic
March 14	Potential deficiencies in Consolidated Incineration Facility (CIF) air pollution control permit application	SLDHZD–1994–0003	Some new air emission sources not adequately identified during preparation of CIF air pollution control permit
March 25	Lead wheel weights discovered in landfill	TD–1994–0002	Environmental requirements for use of site facilities not effectively communicated to General Services Administration Maintenance Shop personnel
April 19	184–K and 484–D fuel storage tank air emissions noncompliance	POD–1994–0015	Because of inadequate site permitting procedures, these above-ground fuel oil storage tanks not recognized as potential air emission sources
June 20	Spill of chromium/water mixture in 400–D Area	HWFAC–1994–0009	Tanker wall corroded to porous condition because of acidic nature of liquid inside tanker, thus allowing passage of the solution
June 21	Air quality permit parameter compliance exceeded in boiler compliance test at 484–D	POD–1994–0029	Boiler compliance test exceeded sulfur dioxide emission limit because of high sulfur content (sulfur >2% contamination) in the coal
July 27	Notice of Violation for unpermitted sources and sulfur dioxide emissions exceedance	POD–1994–0039	Resulted from March 14, April 19, and June 21 occurrences described above.
Aug. 19	Notice of Violation from SCDHEC for failure to notify regarding demolition of asbestos-containing buildings	ERF–1994–0003	Site exclusion to asbestos notification requirements misinterpreted; all seven buildings demolished from Jan. 1 to June 30 contained less asbestos than limit (260 linear feet) for NESHAP asbestos permit
Aug. 19	Fuel oil leak from pipeline at N-Area (Central Shops)	CMD–1994–0007	Pipe deteriorated because of age
Aug. 19	Notice of Violation to A–005 outfall	CSWE–1994–0009	Flushing of Well 53–A produced trichloroethylene plume downstream
Oct. 31	Spill of approximately 45 gallons of diesel fuel from dump truck fuel tank at Burma Road Landfill	CMD–1994–0008	Valve connector on dump truck fuel tank broke when struck by piece of wood thrown up underneath frame by motion of truck
Dec. 15	Detection of benzene in water and soil while installing well at Three Rivers Landfill Site.	ERF–1995–0001	Groundwater contamination (not associated with known plume) discovered

a SRS takes followup corrective actions to minimize impact on environment.

veillance program is designed to monitor environmental performance, ensure regulatory compliance, and promote the improvement of environmental programs at the site. Each year, this involves performance of appraisals/surveillances by DOE and its operating contractors according to DOE Order 5482.1B, "Environment, Safety, and Health Appraisal Program." Appraisals are formal systematic evaluations of an environmental program to determine compliance, performance, and effectiveness of implementation against DOE requirements and expectations. The time period to conduct an appraisal may span several weeks. Surveillances are more narrowly focused assessments of an environmental compliance activity as it relates to specific requirements. The time period to conduct a surveillance may span several hours.

During 1994, 12 appraisals (10 by DOE–SR and two by DOE–HQ) and 200 surveillances (168 by DOE–SR and 32 by WSRC) were conducted. DOE–SR assessed site compliance in a number of areas during 1994, including the following:

- Public Involvement Plan
- Underground Storage Tank Management Program
- Radiological Liquid Effluent Monitoring Program
- CERCLA Baseline Risk Assessments Program
- NEPA
- Radiological NESHAP Compliance (Subpart H)
- Solid (Nonhazardous) Waste Management Program

In addition to the SRS appraisal/surveillance program, SCDHEC inspects the SRS environmental program for regulatory compliance. SCDHEC representatives performed three comprehensive compliance inspections in 1994, as follows:

- During the period April 18–21, annual air compliance inspections for 46 of the site's 175 permitted air emission sources were conducted. The air emission sources were in compliance, but two potential sources that had been constructed without proper SCDHEC Bureau of Air Quality Control construction permits were identified. An NOV was issued to SRS for the unpermitted sources.
- During the period April 18–29, the annual comprehensive monitoring evaluation for compliance with hazardous waste management regulations at SRS was conducted. The evaluation generated a satisfactory rating for the site.
- During the period October 10–21, annual operation and maintenance inspections were performed at SRS wastewater treatment facilities, and grab and composite samples were collected at site NPDES discharge points. The NPDES comprehensive compliance inspection resulted in eight of nine categories receiving satisfactory ratings. Although one unsatisfactory rating was received, SCDHEC reported that the wastewater treatment facilities were found to be well-maintained. SRS received a satisfactory rating.

SCDHEC also performed numerous other routine compliance inspections during the year.

Progress Assessment Team

The DOE Progress Assessment Team conducted an onsite assessment of the Environmental, Safety, and Health programs at SRS during February and March 1993. The assessment represents a follow-up to the March 1990 visit from DOE's Tiger Team. The Progress Assessment Team's final report identified several strengths, concerns, and weaknesses noted during its assessment. Of these findings, one strength, two concerns, and two weaknesses were attributed to WSRC environmental programs.

WSRC prepared response sheets providing corrective action plans to address each of the concerns and weaknesses, and 13 action items were developed to address them. Eight of the 13 action items were completed as scheduled during 1993, and the five remaining items were completed during 1994.

Environmental Permits

SRS has 591 construction and operating permits that specify operating levels for each permitted source. This compares with 550 such permits in 1993, 481 in 1992, and 459 in 1991. Table 2–7 summarizes the permits held by the site during the last four years. Appendix B provides a comprehensive list of the permits, including the permit number, type of permit, and permitted source.

Environmental Training

The site's environmental training program identifies training activities to teach job-specific skills that protect the employee and the environment while satisfying regulatory training requirements. Chapter 3 contains more information about the training program.

Transition and Decontamination and Decommissioning

As the mission for selected facilities at SRS shifts from a national defense initiative to one of cleanup and environmental restoration, efforts and activities are under way to implement a transition of selected site facilities to the environmental division of DOE and to

Table 2–7
SRS Construction and Operating Permits

Type of Permit	Number of Permits			
	1991	1992	1993	1994
Air	133	134	172	189
C.O.E. (Corps of Engineers) 404	1	1	1	1
Domestic Water	111	127	146	152
Industrial Wastewater	79	75	79	83
NPDES–Discharge	2	2	2	2
NPDES–No Discharge	0	0	1	1
NPDES–Stormwater	0	1	2	2
RCRA	1	1	1	1
Sanitary Wastewater	112	119	120	133
SCWRC 401	1	1	1	1
Solid Waste	6	6	6	6
Underground Injection Control	2	3	6	7
Underground Storage Tanks	11	11	13	13
Totals	459	481	550	591

initiate decontamination and decommissioning (D&D) activities. Transition and D&D activities are discussed in detail in chapter 4.

Other Major Environmental Issues and Actions

Key SRS compliance issues addressed during 1994 included

- tritium migration
- PAR Pond repair/refill

Tritium Migration

The Trans-River Flow Project was initiated in 1988 to address Georgia officials' concerns about migration of tritium in groundwater. Development of a U.S. Geological Survey computer model for this Central Savannah River Area (CSRA) regional groundwater study was completed in 1994. The model is being used to quantitatively relate the groundwater flows of the area's aquifers to each other and to surface discharge into the area's streams. (The CSRA is an 18-county area in Georgia and South Carolina that surrounds Augusta, Georgia, and includes SRS.) The study, which covers 10 Georgia and South Carolina counties around the site, is believed to be one of the largest and most detailed modeling studies ever conducted on both sides of a major river. The database includes 3,829 wells, 51,258 water level measurements dating to the 1800s, and 560 hydrologic property measurements. The model divides the vertical section into six aquifers to a depth in excess of 1,000 feet. Aquifer thickness and potentiometric maps already have been produced for pre-1953 conditions. Drilling for stratigraphic, hydrologic, and geochemical information is continuing in Georgia, and four locations are scheduled for pump tests through the summer of 1995 to determine aquifer characteristics. The research phase is scheduled to end in mid-1996, and the final report is due in 1997.

PAR Pond Repair/Refill

PAR Pond, a 2,640-acre reservoir constructed in 1958 on Lower Three Runs Creek, served as a recirculating cooling reservoir for P-Reactor and R-Reactor. In March 1991, an inspection of the PAR Pond dam revealed a depression on the downstream face. The reservoir was drawn down, reducing the original volume by about two-thirds. The drawdown exposed about 1,300 acres of sediments containing both radioactive and nonradioactive contaminants. In March 1992, the exposed sediment area of the pond was declared a unit to be addressed under CERCLA. WSRC's Site Services Engineering and Environmental Protection departments recommended repairing the dam and refilling the pond. Repairs were completed in

August 1994; the PAR Pond Interim Action Proposed Plan was approved in November; and a 30-day public review and comment period was initiated in December. The Interim Action PAR Pond Record of Decision, which supports refilling the pond, is expected to be issued in January 1995. The refill, set to begin in February 1995, should require 2 to 3 months to complete.

Chapter 3

Environmental Program Information

Compiled by Mary Dodgen and Greg Peterson
Environmental Protection Department

In this chapter...

Introduction

Environmental monitoring programs at Savannah River Site (SRS) are discussed in this chapter, as are other environmental activities—such as pollution prevention awareness, waste minimization, training, and some special studies. The Environmental Protection Department's Environmental Monitoring Section (EMS) conducts most environmental monitoring at and around SRS. Other site operating groups—including Radiological Control Operations (RCO), Savannah River Technology Center (SRTC), Savannah River Ecology Laboratory (SREL), Savannah River Forest Station (SRFS), and Savannah River Archaeological Research Program (SRARP)—conduct environmental programs and public outreach activities. Also, the Division of Environmental Research of the Academy of Natural Sciences of Philadelphia has conducted biological and water quality surveys of the Savannah River since 1951.

Environmental restoration and waste management activities are discussed in chapter 1, "Site and Operations Overview," and chapter 4, "Environmental Restoration and Waste Management."

Environmental Monitoring

Environmental monitoring, discussed more extensively in later chapters of this report, includes radiological effluent monitoring (chapter 5), radiological environmental surveillance (chapter 6), nonradiological effluent monitoring (chapter 8), nonradiological environmental surveillance (chapter 9) and groundwater monitoring (chapter 10).

Environmental monitoring serves two main purposes at SRS:

- to show compliance with federal, state, and local regulations, as well as with U.S. Department of Energy (DOE) orders
- to monitor any effects of site operations on onsite and offsite natural resources and on human health

Radioactive airborne and liquid release monitoring, performed at or near points of discharge to the environment, serves compliance purposes and provides source terms for offsite dose calculations made by SRTC. More information about dose calculations appears in chapter 7, "Potential Radiation Doses." Environmental surveillance—conducted by collecting and analyzing onsite and offsite samples at various distances from points of discharge—verifies dose

Effluent Monitoring versus Environmental Surveillance

Per DOE Order 5400.5, "Radiation Protection of the Public and the Environment":

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposure to members of the public, and demonstrating compliance with applicable standards.

Environmental surveillance is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE 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.

Monitoring occurs at the point of discharge, such as an air stack or drainage pipe; surveillance involves looking for contaminants in the environment.

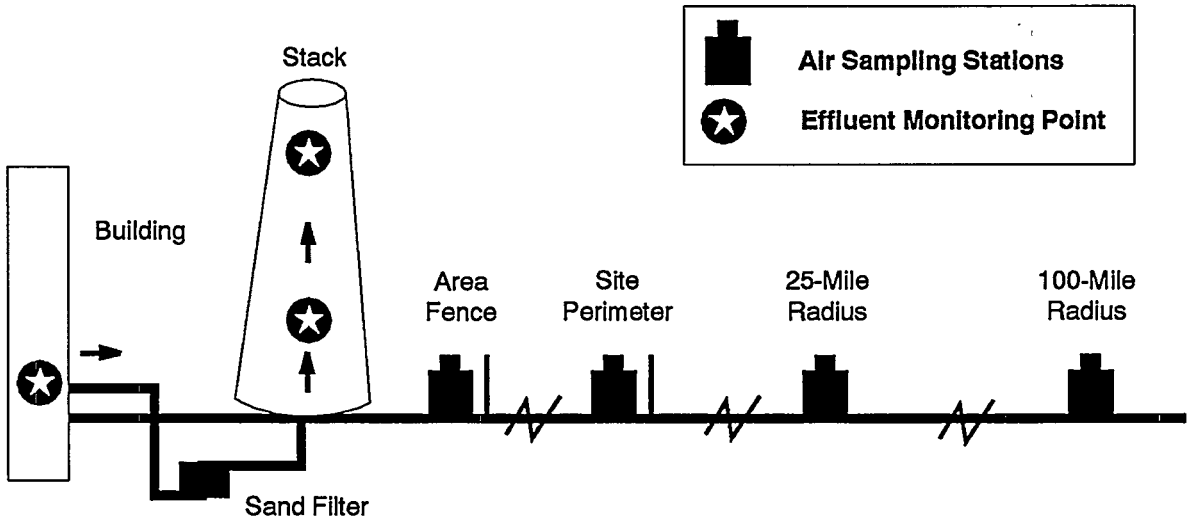

Figure 3–1 Typical Airborne Effluent Monitoring and Environmental Surveillance
Radioactive materials are monitored at the point of discharge and tracked in the surrounding environment.

calculations and monitors the effects of SRS releases. RCO and EMS share radiological effluent monitoring responsibilities: RCO collects and screens air and liquid samples from regulated (radiologically controlled) areas and maintains monitoring equipment on stacks and at some liquid effluent discharge points. EMS collects and analyzes most liquid effluent samples. Results of these analyses are compiled and reported in a monthly radioactive releases report and summarized in the annual *Savannah River Site Environmental Data* publication.

SRS handles plutonium, tritium, and other special nuclear materials, so much of the environmental monitoring effort is focused on collecting and analyzing for radioactive materials in samples of airborne and liquid effluents released during routine operations. A typical setup for airborne effluent monitoring is shown in figure 3–1. Radioactive materials are monitored at their points of discharge and tracked as they disperse into the surrounding environment. The data obtained at the point of discharge (e.g., stack, pipe, or outfall)—where the concentration would be higher if a contaminant is present—is used to calculate the estimated contaminant concentration in sampled media, such as water, soil, or vegetation.

Because most radionuclides are released in such small amounts that they cannot be readily measured in the sample media, SRS uses mathematical models to estimate the transport and dispersion of radionuclides into the environment. More information can be found in chapter 7.

Models may be used to improve a radiological monitoring program. For example, modeling predictions may be used to identify locations for measuring devices or to prioritize pathways and contaminants. Modeling can contribute to the best use of available resources for sampling and analysis and can be used to verify that a sampling network performs according to requirements.

SRS also has a monitoring program for nonradioactive contaminants. The nonradiological monitoring program is designed to ensure that the physical and chemical properties of airborne and liquid releases comply with federal and state standards.

Monitoring for nonradioactive contaminants in SRS airborne releases is designed to ensure compliance with permits issued by the South Carolina Department of Health and Environmental Control (SCDHEC). The major nonradiological airborne emissions of concern from SRS stacks include sulfur dioxide, oxides of nitrogen, and total particulate matter. Ambient air quality near SRS is monitored by South Carolina and Georgia as part of a network associated with the federal Clean Air Act. Clean Air Act Amendments, implemented in 1990, require federal facilities, such as SRS, to comply with provisions of the act.

Nonradioactive liquid effluents generally are sampled at National Pollutant Discharge Elimination System (NPDES) outfalls (points of discharge) and reported to SCDHEC in a monthly discharge monitoring report, as required by the Clean Water Act. Monitoring requirements for liquids may vary at each outfall, depending on the type of facility and the known

characteristics of the wastewater. In addition to the monitoring conducted at outfalls, surveillances are conducted through the collection and analysis of samples from site streams and the Savannah River to verify the outfall sampling data and to ensure the detection and characterization of materials that could adversely affect the environment. Adverse conditions resulting from the presence of such materials are identified and evaluated to provide a basis for corrective action. A typical setup for liquid effluent monitoring is shown in figure 3–2.

Policy

The SRS policy for environmental monitoring is to

- design and operate a program to aid in dose assessments
- determine trends in environmental radioactivity concentrations
- identify and quantify potential problems and provide a basis for corrective action
- address government and public concerns about site operations

Objectives

The purpose of many environmental regulations is to protect human health and the environment. The SRS program 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 ("General Environmental Protection Program"), and of DOE/EH–0173T ("Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance"). These objectives are

- to assess actual or potential exposures of radioactive and nonradioactive materials to critical groups and populations from normal site operations or from accidents
- to comply with authorized limits and regulatory requirements
- to verify the adequacy of each facility in containing radioactivity and controlling effluents
- to notify proper officials of unusual or unforeseen conditions and, where appropriate, to activate a special environmental monitoring program
- to communicate accurate and effective EMS monitoring results to DOE, to other government agencies, and to the general public
- to maintain an accurate and continuous record of the effects of SRS operations on the environment
- to determine radioactive concentrations and nonradioactive contaminants in environmental media for the purpose of assessing the immediate and long-term consequences of normal and accidental releases

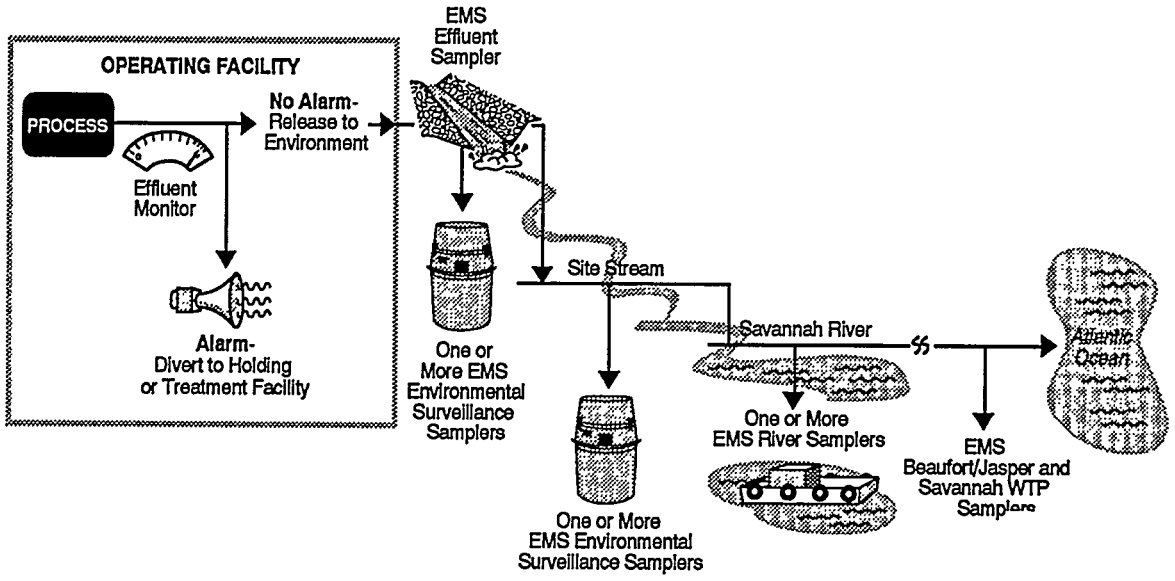

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Figure 3–2 Typical Liquid Effluent Monitoring and Environmental Surveillance
Radioactive materials are monitored at the point of discharge and tracked in the surrounding environment.

- to distinguish between environmental contamination and effects from SRS operations and those from other sources
- to evaluate and revise the environmental monitoring program in response to changing conditions in transfer pathways
- to provide site-specific data for risk assessment for human populations near SRS
- to conduct scientific studies on the transfer pathways of radioactive and nonradioactive contaminants in the environment
- to assess the validity and effectiveness of models used to predict the concentration of pollutants in the environment
- to determine the long-term buildup and prediction of environmental trends from site-released contaminants
- to establish baselines of environmental quality so that trends in the physical, chemical, and biological condition of environmental media can be characterized
- to identify and quantify new or existing environmental quality problems and to evaluate the need for remedial actions or mitigation measures
- to pinpoint exposure pathways in which contaminants are accumulated and transmitted to the public

To meet these objectives, approximately 50,000 samples are collected and 1,000,000 analyses performed annually for radioactive and nonradioactive contaminants.

Rationale

The justification for sampling locations, sample media, sampling frequencies, and analyses is called the rationale for monitoring. Monitoring program design also considers environmental regulations, critical pathways analysis, public concerns, and measurement capabilities. SRS environmental monitoring activities are documented in sections 1101–1111 (SRS EM Program) of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1, which is scheduled to be issued in 1995.

Environmental Regulations

The SRS environmental monitoring program is designed to reflect environmental stewardship and to meet state and federal regulatory requirements for radiological and nonradiological programs. These requirements are stated in DOE orders 5400.1 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 these requirements is audited by regulators, including SCDHEC and the U.S. Environmental Protection Agency (EPA), and by DOE. A review of the site's compliance activities can be found in chapter 2, "Environmental Compliance."

Critical Pathways Analysis

Airborne and liquid releases of radioactive materials can reach people in a variety of ways. The routes that radioactive materials follow to get from an SRS facility to the environment and then to people are known as exposure pathways. Figure 3–3 illustrates some of the pathways by which radioactivity can move through the environment to people.

Fewer than 10 of the radionuclides released from SRS facilities each year are significant contributors to offsite doses; that is, they each represent more than 1 percent of the total dose. These radionuclides are tritium, strontium-90, iodine-129, iodine-131, cesium-137, uranium-235,238, plutonium-238, and plutonium-239. Information from the 1986–1993 SRS environmental reports was examined to determine which radionuclides and exposure pathways are most important in terms of the quantity of radionuclides released, the dose to the maximally exposed individual, and the collective dose to the population. This type of analysis, called a critical pathways analysis, provides an indication of the important radionuclides and pathways for a particular site. More information on the results of a critical pathways analysis of SRS operations is documented in the SRS EM Program. Information from the critical pathways analysis is used in the site's environmental monitoring program to determine additional sampling locations and analyses.

Public Concerns

Public concerns influence the environmental monitoring program; the public wants to know about releases and their effects. While the actual amount of a material released may cause concern, the potential effect of a release on the environment and on public health can cause even greater concern. One aspect of the environmental monitoring program that addresses these concerns is the placement of thermoluminescent dosimeters (TLDs) in offsite locations within an 8,000-square-mile area of SRS. These dosimeters provide a quick, reliable method to determine the dose

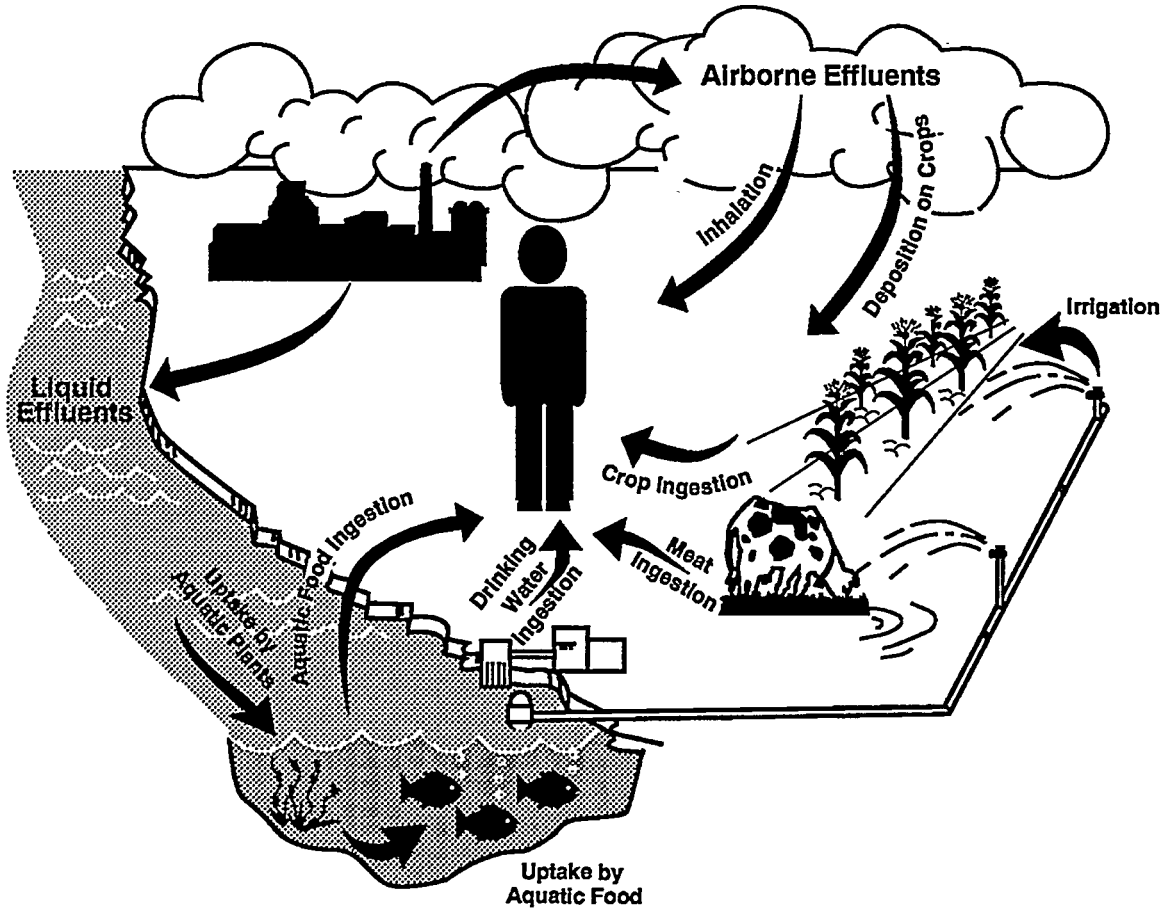

Figure 3–3 Exposure Pathways

Airborne and liquid releases of radioactive materials from SRS operations can reach people in a variety of ways. These ways, or routes, are called exposure pathways.

from gamma-emitting radionuclides in the event of an unplanned release of radioactive material.

Measurement Capabilities

Many materials released from SRS exist in such low concentrations in the environment that they cannot be readily measured. Thus, measurement capabilities become factors in the rationale for monitoring certain materials. In these cases, modeling is used to estimate concentration levels. More information can be found in chapter 7.

1994 Program Changes

The types, frequencies, and locations of environmental measurements are reviewed annually to determine if a need for monitoring still exists. If a clear rationale for a measurement no longer exists, it is deleted from the program. Likewise, the program is modified as new methods and needs evolve. No major program changes occurred in 1994.

The SRS EM Program contains detailed descriptions of existing SRS environmental monitoring activities and document the procedures, practices, and programs that implement the criteria and requirements set forth in the *Savannah River Site Environmental Monitoring Plan* (SRS EM Plan), WSRC–3Q1–2, Volume 1, Section 1000 Addendum. A complete revision (Rev. 3) of the SRS EM Plan, which is required by DOE Order 5400.1, was approved by DOE's Savannah River Operations (DOE–SR) in 1994.

Beginning in 1994—following a critical pathways analysis—seepage basin migration samples were analyzed for iodine-129 and technetium-99, which are somewhat mobile in the environment and have long half-lives (15,700,000 and 213,000 years, respective-

ly). The data obtained were used in the dose calculations documented in chapter 7.

Other Environmental Activities

Pollution Prevention/ Waste Minimization

Pollution prevention at SRS includes

- source reduction activities
- recycling of wastes and pollutants
- reduction in the use of materials, energy, water, and other resource
- protection of natural resources and human health through conservation or more efficient use
- waste disposal in an environmentally safe and cost-effective manner

Pollution prevention programs permeate many activities, organizations, and implementation teams. Improvements in the coordination and communication between these program areas are ongoing, and employee awareness of—and management emphasis on—pollution prevention is increasing. Chapter 4 highlights results of noteworthy pollution prevention activities implemented during 1994. The *SRS Waste Minimization and Pollution Prevention Awareness Plan* (WSRC–RP–93–1494, Rev. 1) provides program details.

An aggressive waste minimization program has reduced various wastes that require costly treatment, storage, and disposal. Total solid waste volumes have declined by more than 50 percent, or 840,000 cubic feet, since 1991 [PPG, 1995]. This is attributable to waste minimization, volume reduction, and changing site missions. Documented source reduction and recycling initiatives alone have saved more than 980,000 cubic feet of disposal space since 1991. The use of Pollution Prevention Activity Forms since 1993 has helped quantify disposal space savings activities.

Reducing site demand for energy in turn reduces emissions and conserves resources associated with energy production. A comprehensive energy conservation program and site mission changes helped drive down energy consumption, per facility square footage, by more than 50 percent from 1988 to 1994.

Reduction of Chemical Releases

Under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA), SRS has filed Toxic Chemical Release Inventory reports annually since 1987. The site calculates chemical releases to the environment and reports aggregate quantities for each regulated chemical that exceeds threshold amounts. Between 1987 and 1993, reportable release quantities have declined by 96 percent. More about Toxic Chemical Release Inventory reports can be found on page 13 in chapter 2.

Affirmative Procurement of Recycled Products

The SRS Affirmative Procurement Plan promotes the purchase of products in EPA-designated recycled product categories to conserve natural resources. The plan follows federal guidance for implementing affirmative procurement requirements at DOE sites. In November 1994, SRS contractors submitted affirmative procurement reports that describe the yearly site purchases of products in the EPA-designated recycled product categories. The reports are an annual requirement of Executive Order 12873 and RCRA Section 6002. In 1994, SRS contractors purchased more than $1.14 million worth of products containing recovered or recycled material. Recycled-product purchases included paper and paper products, toner cartridges, construction materials, and other office products and supplies.

Excess Chemical Management

The Chemical Commodity Management Center was created and staffed in 1994. The center's purpose is to ensure environmentally sound, safe, and cost-effective acquisition, distribution, and reuse of chemicals for the site.

Ozone-Depleting Substances

The Clean Air Act Amendments of 1990 require that EPA publish a number of regulations to phase out the production and consumption of ozone-depleting substances. The *Savannah River Site Refrigerant Management Plan*, issued in September 1994, provides guidance to assist SRS in meeting the requirements of these regulations. More information about this program can be found in chapter 2.

Employee Awareness and Training

SRS environmental awareness and training programs help to achieve environmental goals at the site. SRS is committed, as a matter of policy, to maintaining its facilities and conducting its operations in full compliance with all applicable laws and regulations for the protection of the environment and of the health and safety of its employees and the general public. The awareness program is designed to communicate SRS environmental philosophy and policy to the employees. The training program identifies training

Environmental Awareness and Earth Day

The first Earth Day was celebrated April 22, 1970, by 10,000 schools, 2,000 colleges and universities, and many communities. Since 1970, Earth Day and the environmental awareness movement have grown and taken on international importance. In a 1989 speech addressing a global scientific conference on holes in the ozone layer, Prince Charles, heir to the British throne, was frank: "Human beings can be rightly proud of their inventiveness. We thought the world belonged to us. Now we are beginning to realize that we belong to the world. We are responsible to it, and to each other. Our creativity is a blessing, but unless we control it, it will be our destruction" [Earth Day, 1989].

The first Environmental Awareness Day at SRS (1988) focused on the theme "Savannah River Plant: Protecting the Future." Since then, Earth Day has been an annual site observance.

The Earth Day emphasis in 1994 was on employee action, as reflected by the slogan "You Can Make a World of Difference." Employees were encouraged to submit their ideas on pollution prevention, waste minimization, and general environmental protection. More than 1,200 ideas were submitted by employees. These ideas and their implementation status were shared with all site employees to increase overall environmental awareness. One example is the Green Building Program, which includes a signed contract by the employees in a specific building to commit to making pollution prevention and waste minimization a daily habit and part of the SRS culture. The program incorporates such practices as recycling paper, cardboard, and aluminum; replacing plastic foam cups with paper cups or ceramic coffee mugs; encouraging double-sided copying; and outfitting the building for water and energy conservation.

The 1994 SRS Earth Day Logo

activities to teach job-specific skills that protect the environment and satisfy regulatory requirements.

Awareness

SRS strives to educate employees about environmental protection. The awareness program was enhanced in 1988, when the site held its first Environmental Awareness Day—a sitewide event at SRS that has been observed each April in connection with Earth Day activities. The event's purpose is to increase awareness of the environment, of waste minimization, and of pollution prevention.

The awareness program has grown to include other activities that educate employees about environmental issues. Environmental information is distributed to all site personnel via the *SRS News*, a newspaper published for employees, their families, and retirees, and the site's monthly video magazine, *Spectrum*.

Training

The *SRS Environmental Training Plan*, WSRC–RP–92–282, issued in February 1992, is a documented framework for implementing and managing an integrated environmental training system at the site. The plan addresses federal and state environmental regulations. The focus is on required training and recommended education courses for employees (based on responsibility) involved with environmental oversight, hazardous materials, and waste management at SRS. The training program includes formal delivery (classroom, self-paced, computer-based, etc.) as well as documented, supervised on-the-job experience, when appropriate. All training activities are documented, and programmatic and individual records are maintained. The *SRS Environmental Training Plan* represents a centralized, total-quality approach to environmental training, with a primary objective of training and developing employees as "partners in environmental excellence."

A number of achievements were made in environmental training during 1994, including the following:

- *SRS Environmental Training Plan* Hazardous Waste Operations (HAZWOPER) courses (29 CFR 1910.120), implemented in 1992, provided employee health and safety training in 1994 for those involved in hazardous-waste cleanup activities and in working at RCRA treatment, storage, and disposal facilities.

- The Consolidated Annual Training program, which meets general training requirements for all employees, was implemented.
- SRS procured environmental courses from offsite locations for onsite delivery and to cost-effectively provide up-to-date information on environmental regulations.
- The Environment, Safety, Health & Quality Assurance Division's training program maintained and enhanced relations with other government-owned, contractor-operated (GOCO) organizations to facilitate the exchange of environmental training courses and programs that can be adapted to meet SRS needs.
- SRS provided instructors and students for the DOE/Westinghouse School for Environmental Excellence, which was hosted by SRS in January 1994.
- The Central Environmental Committee Executive Committee implemented core and advance training for SRS environmental coordinators.

Information Exchange

To improve and update its environmental monitoring and research programs, SRS has opened several avenues of exchange with state and federal regulators, other GOCO facilities, and scientists.

DOE–SR representatives attend DOE Headquarters (DOE–HQ)-sponsored technical information exchange workshops, which provide a way to enhance the exchange of technical information between DOE sites.

Environmental awareness and information exchange tours are conducted for many special-interest groups, including environmental activists and representatives of other GOCOs, of DOE–HQ, of Westinghouse Corporate, of EPA, and of SCDHEC. Tours are designed to meet the needs of a particular group. For example, EPA and SCDHEC tours might focus on regulatory issues, while visitors from other GOCOs might be interested in activities applicable to their own programs.

The Environmental Advisory Committee, which is comprised of nationally recognized consultants from the fields of biology, ecology, hydrogeology, health physics, environmental restoration, and economics, meets quarterly to review site environmental programs and make recommendations. The committee has reviewed the 1993 and 1994 site environmental reports.

Representatives of SCDHEC, the Georgia Department of Natural Resources, Georgia Power Company, Chem-Nuclear Systems, DOE, and Westinghouse Savannah River Company (WSRC) have met semiannually since 1987 in a data exchange program designed to promote the sharing of technical environmental program information and data. These meetings provide an open forum in which to review and possibly improve each organization's monitoring program. The data exchange program is known as the Central Savannah River Area Radiological Environmental Monitoring Program.

Environmental Research

DOE designated SRS as the first National Environmental Research Park in 1972. Since then, scientists from universities and other organizations have used the site as an outdoor laboratory to study the impact of human activities on the environment. The protected boundaries of the site provide land suitable for long-term research projects. Thirty areas covering 14,288 acres have been set aside to protect rare, threatened, and endangered biota, as well as unique habitats. These set-aside areas provide undisturbed land for comparison with areas affected by SRS operations and forest management. As a result of the research park program, scientists have compiled detailed information on many aspects of the SRS environment, including soil development and inventories of plant and animal species. National Environmental Research Park activities are conducted by and coordinated through SRTC, SREL, SRFS, and SRARP.

Savannah River Technology Center

SRTC, a research and development facility at SRS, provides support to many onsite operations. Numerous research and development activities conducted by SRTC are designed to meet environmental and other compliance requirements. Projects include the radiation assessment program, the calculation of dose uncertainties, the meteorological monitoring program, and the development and testing of new equipment.

Savannah River Ecology Laboratory

SREL is operated by The University of Georgia at Athens under contract with DOE. SREL has conducted independent environmental studies of SRS, surrounding streams and ponds, and the Savannah River since 1951. Studies focus on research activities involving freshwater and terrestrial ecosystems in natural and disturbed habitats, as well as on biological inventories, competition in plant and animal communities, and the use of radioactive tracers to determine food chains. More information can be obtained by contacting SREL at 803–725–2472.

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The population of red-cockaded woodpeckers at SRS increased from 11 in 1986 to 77 in 1994, demonstrating the success of SRFS in managing this endangered species.

Savannah River Forest Station

SRFS was formed in 1952, when the Atomic Energy Commission and the U.S. Department of Agriculture's Forest Service formed an interagency agreement to create a forest management organization at SRS. SRFS has expanded its management from that of timber to that of all site natural resources. This expansion includes wildlife, fish, and botany studies; management for threatened, endangered, or sensitive wildlife and plant species; protection of soil and watershed quality; and efforts to maintain a healthy forest for environmental research. The steady onsite population increase of the red-cockaded woodpecker represents an example of successful management for endangered species. More information can be obtained by contacting SRFS at 803–725–2441.

Savannah River Archaeological Research Program

SRARP began in 1973 under a cooperative agreement with DOE and the South Carolina Institute of Archaeology and Anthropology, University of South Carolina. The primary function of SRARP is to provide DOE with recommendations concerning archaeological matters to facilitate the management of archaeological resources at SRS. Other functions of SRARP include cultural resource management, research, and public education, as well as compliance activities involving reconnaissance surveys, general intensive watershed surveys, specific intensive surveys, data recovery, and coordination with major land users.

More than 5,000 acres of SRS land came under cultural resources review in 1994. This review entailed 47 field surveys resulting in the recording of 64 new sites. Twenty-four existing sites within survey tract boundaries were revisited to update site file records. Research conducted by SRARP was reported in eight journal articles/book chapters and five monographs/reports published during 1994. SRARP employees also presented research results in 13 papers at professional meetings and organized three symposia. More information can be obtained by contacting SRARP at 803–725–3623.

Public Outreach

SRS public outreach activities, such as public meetings, the Visitors Program, the Speakers Bureau, and the Traveling Lecturers Program, provide communication channels between the site and the public. Local newspaper, television, and radio advertisements also inform the public about environmental activities. More information can be obtained by contacting the WSRC Public Relations Department at 1–800–603–0970.

When topics involve unusually complex issues, DOE may conduct workshops that give special-interest groups or citizens the chance to meet with site representatives.

Various regulations require that SRS notify the public of environmental plans and activities. RCRA, CERCLA, NEPA, and the Clean Water Act mandate regulatory public notice requirements. SRS meets these requirements by using various community involvement tools, including notices to contiguous landowners, to media, to local and state government agencies, and to any other interested stakeholders. Such notices typically are sent in a newsletter called the *Environmental Bulletin.*

The most significant public outreach activity of 1994 was the establishment of a Citizens Advisory Board in response to public suggestions on the SRS Federal Facility Agreement in 1992.

SRFS also has community outreach programs that include Smokey Bear, Woodsy Owl, Earth Day, and the Senior Community Service Program. SRFS environmental awareness programs are shared with visitors. Also, a Natural Resources Environmental Education Program provides onsite science and mathematics education for students in third through eighth grades. The program, which aims to increase student awareness of the role of science and mathematics in solving natural resource and environmental problems, is a cooperative effort between DOE and the University of South Carolina at Aiken. It is available at SRFS.

Citizens Advisory Board

The Savannah River Site Citizens Advisory Board (CAB) was established in 1994 to increase public participation in decisions made at the site. The 25-member board held its first meeting February 17–18 in Augusta, Georgia.

Chosen by an independent panel from about 250 applications, the CAB's members reflect the broad diversity of the population surrounding the site. The board includes South Carolina and Georgia citizens representing the business sector, academia, local governments, environmental and special-interest groups, and the general public.

The CAB spent most of its first year on organizational activities—writing bylaws, participating in an extensive education process, and forming three issued-based subcommittees: the Environmental Remediation Program subcommittee, the Nuclear Materials subcommittee, and the Risk Management and Future Use subcommittee. These groups plan to focus on health effects and risk.

On October 25, the CAB made its first formal recommendation—that all significant environmental documents, such as the annual *SRS Environmental Report*, receive an appropriate level of independent technical review before publication. The environmental report is reviewed by the Environmental Advisory Committee; the CAB supported continuation of this independent review.

The CAB's goal is to provide timely, high-quality public participation in decisions regarding environmental restoration, waste management, and related activities at SRS.

More information can be obtained by contacting SRFS at 803–725–2441.

SREL's Environmental Outreach and Education Program was shared with 150,000 people during 1994. The program emphasizes the importance of environmental awareness in decision making regarding ecological problems. Environmental awareness is promoted through tours, lectures to students and other groups, teacher workshops, and various exhibits. A new conference center was constructed during 1994 to accommodate program expansion. More information can be obtained by contacting SREL at 803–725–2472.

SRARP intensified its heritage education activities in 1994 with a full schedule of classroom education, public outreach, and onsite tours. Volunteer excavations at the Tinker Creek site at SRS were continued with the Augusta Archaeological Society. Seventy-eight presentations, displays, and tours were provided for schools, historical societies, civic groups, and environmental and historical awareness day celebrations. In addition, the SRARP staff taught three anthropology courses at Augusta College at Augusta, Georgia. More information can be obtained by contacting SRARP at 803–725–3623.

Chapter 4

Environmental Restoration and Waste Management

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Environmental Restoration Department
Laura Bagwell, Solid Waste Department
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In this chapter...

Introduction

The Savannah River Site's (SRS) environmental and waste management programs changed significantly in 1994, with the beginning of more aggressive approaches to achieving results in the field. This chapter presents a brief overview of the programs and describes some of their major accomplishments during the year.

The U.S. Department of Energy (DOE) uses the term "environmental restoration" to refer to the assessment and cleanup of facilities (decontamination and decommissioning) and of inactive waste sites (i.e., "units"), including remediation of contaminated groundwater. "Cleanup" means actions taken to deal with previous releases or to control potential future releases of hazardous substances. This may involve complete removal of a substance; it also may involve stabilizing, containing, or otherwise treating the substance so it does not affect human health or the environment [DOE EM, 1991f]. Determining the most environmentally sound method of cleaning up facilities or waste units is a major component of the SRS environmental restoration program.

DOE uses the term "waste management" to refer to safe and effective management of various kinds of nonhazardous, hazardous, and radioactive waste generated on site. Identifying the need for appropriate waste management facilities and ensuring their availability have been major components of the SRS waste management program.

Two major federal statutes govern the site's environmental restoration and waste management activities, which were begun in 1981: 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. 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, 1992b]. Complete information on SRS compliance activities can be found in chapter 2, "Environmental Compliance."

Environmental Restoration

The mission of the SRS environmental restoration program is to safely and cost-effectively remediate the 420 inactive waste and groundwater units that are present on site while managing risk and protecting human health and the environment (figure 4–1). In 1994, the SRS environmental restoration program achieved significant results in the field under the guidance of the following initiatives:

- addressing risks
- providing a safe work place
- obtaining better managerial and financial control
- creating an outcome-oriented system
- enhancing technology development
- developing stronger external partnerships

SRS's major priority in environmental restoration has been to reduce the possibility of any potential groundwater migration of contaminants off site. In 1994, new technologies further improved the groundwater cleanup program and increased the rate of cleanup. By the end of the year, two air strippers had treated a total (since 1985) of 2.1 billion gallons of groundwater, and more than 327,000 pounds of organic solvents had been removed from a 1200-acre area of groundwater contamination in A-Area and M-Area

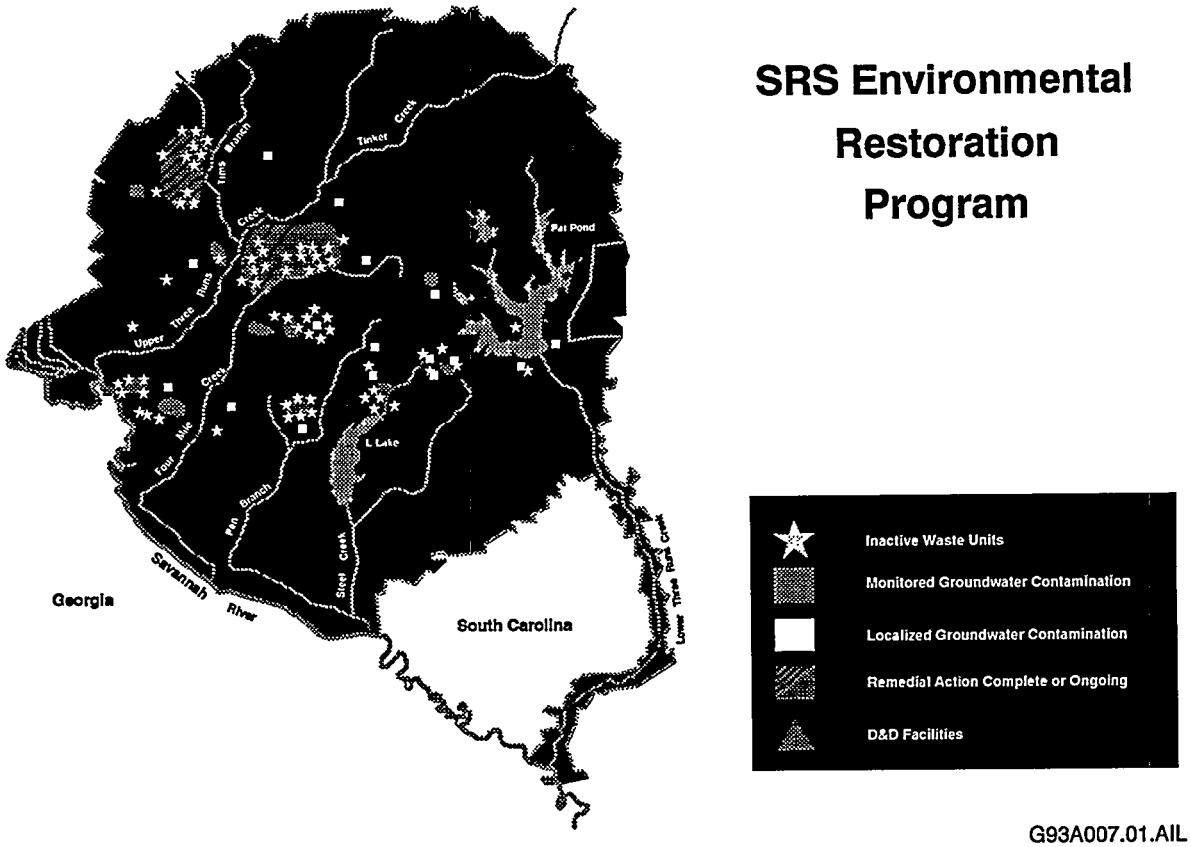


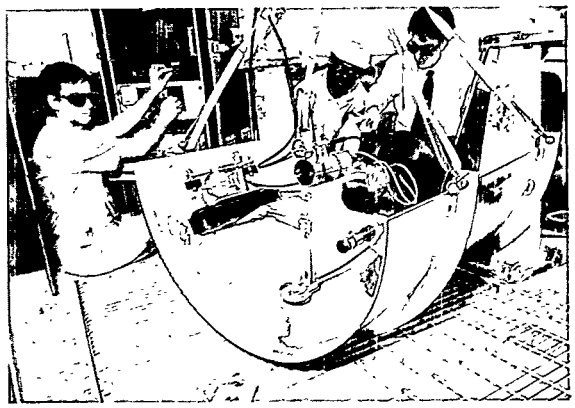
Figure 4–1 Environmental Program Map
The SRS environmental program sites map identifies inactive waste units, monitored groundwater contamination, localized groundwater contamination, complete or ongoing remedial action, and decontamination and decommissioning facilities at SRS.

[WSRC, 1995]. A third air stripper and additional monitoring wells are being added to continue to protect offsite groundwater and surface water supplies.

Demonstrations of innovative remediation strategies continued in 1994. For example, a robotic pipe crawler was used to characterize process sewer lines leading to the old F-Area retention basin. This remote device, originally developed to inspect reactor pipes, was adapted to environmental restoration uses in 1994. Also in 1994, the use of more durable prefabricated radiological containment huts—which limit exposure to radiation—further reduced employee risk, decreased costs, and minimized waste.

The huts are collapsible so they can be easily and safely packaged for disposal.

SRS completed field testing of the Bentonite Mat Demonstration in 1994. The project, which began in 1993, tested the performance of different waste capping techniques. Also, Haliburton NUS/Brown and Root Environmental showcased its SoilSaw™ project at SRS in February 1994. SoilSaw, an adaptation of an existing technology, places a barrier in the soil to stop migration of underground contaminants.



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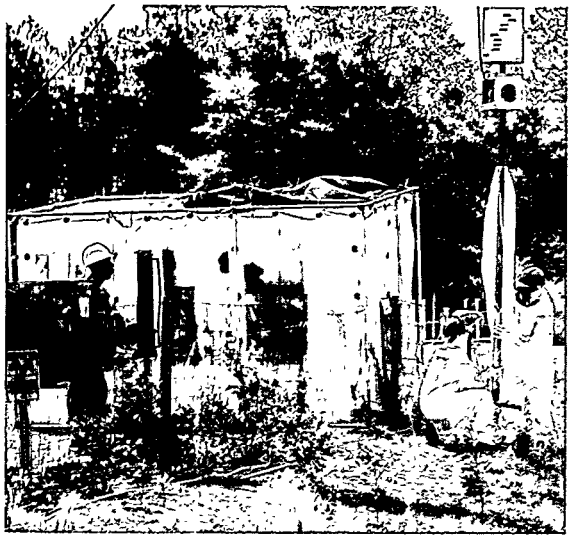
The robotic pipe crawler, a new technology, is designed to improve the SRS environmental restoration program's characterization program.



94-1469-32

Prefabricated radiological containment huts are used in many SRS projects to reduce risk and increase employee safety.

In addition, the U.S. Environmental Protection Agency (EPA), the South Carolina Department of Health and Environment Control (SCDHEC), and Westinghouse Savannah River Company (WSRC) conducted an electron beam demonstration, which determined the effectiveness and cost of operating this new technology to destroy volatile organic compounds (VOCs) in groundwater. In 1994, 14 demonstration tests of this technology were successfully conducted in M-Area.

Once technologies have been tested and demonstrated successfully, they can be used in the field with greater confidence and transferred to other applications. Key technology transfers such as horizontal wells and bioremediation, which started as remediation demonstrations at SRS, have been successfully transferred to offsite applications. For example, John F. Kennedy International Airport in New York City is using one horizontal well technology developed at SRS to remediate jet fuel leakage in soil under airport runways without disturbing the area above.

Waste Management Units and Groundwater

Environmental restoration work at SRS is increasing primarily because of the close working relationship between regulators and the site [SRS, 1994]. A concerted effort focused on the top 100 waste site locations—based on risk—in SRS's environmental restoration program. Two sites were remediated; groundwater cleanup was accelerated in two large areas; 13 remediation projects were moved from the planning stage to field work; and characterization field work began at 14 additional waste sites.

Project management activities were streamlined in 1994; this saved $2 million, which was applied to field remediation. Characterization work began at the F-Area retention basin. Four temporary wells were installed to identify how contaminants affect groundwater. Five background soil samples also were collected from varying depths. The samples, requested by the regulators, were analyzed and used to support the Streamlined Approach for Environmental Restoration process and to verify assumptions made during the conceptual phase of streamlining.

At the H-Area retention basin, results from Phase I sampling confirmed the absence of metallic and organic contamination; however, all samples contained radioactivity. Phase II sampling, which will focus on radioactive contaminants, is scheduled to begin after regulators approve the remedial investigation work plan. Sampling was conducted as part of the Streamlined Approach for Environmental Restoration process, which should lead to faster characterization at a lower cost. A removal action is expected to be scheduled for this site.

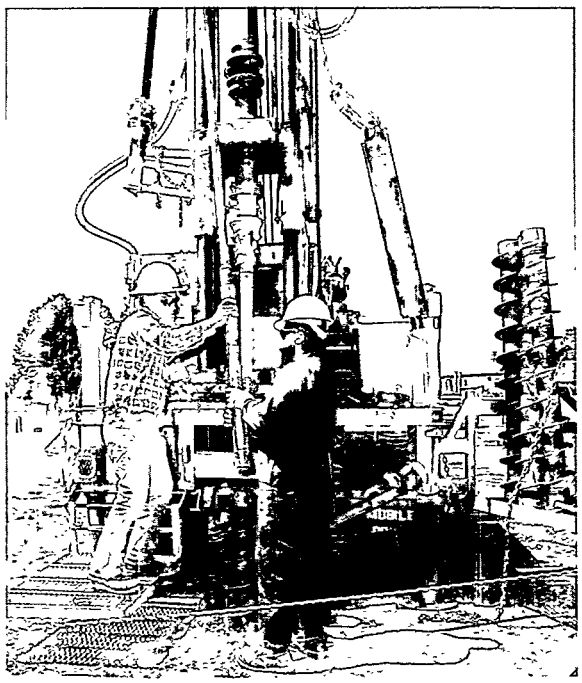
Field achievements for the year included completion of work in such areas as the A-Area burning/rubble pits. All surface sampling, soil borings, and well sampling were completed, and four piezometers (measuring devices) or wells were installed. Major characterization work also was completed.

In the A-Area and M-Area Cretaceous Aquifer Study, a geological investigation was completed with characterization work performed to define the boundaries of the contaminant plume in the deep cretaceous aquifer. In addition, five soil coring locations were completed to a depth of 600 feet, with samples analyzed for VOCs.

Additional remediation units were put in place in 1994 to support the A-Area and M-Area vadose zone groundwater cleanup. At the burial ground complex, regulators accepted a combined groundwater and waste site investigation plan, allowing characterization work to begin in the field.

At the N-Area (formerly Central Shops) burning/rubble pit, characterization work began ahead of schedule. Three piezometers were installed to determine the direction of groundwater flow and the best location for a downgradient monitoring well. Soil sampling from 12 boring locations and six surface locations began in 1994.

Field characterization at the chemical, metals, and pesticide pits began in 1994. Soil borings and sampling outside the pits were completed, as was the installation



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Employees take a soil sample using a split-spoon sampler during the latest characterization work at the N-Area burning/rubble pit.

and removal of seven temporary piezometers and the collection of water samples and water elevations by hydrocone. Surface sampling at four random locations outside the pits, at five sedimentation deposition areas, and at five water and sediment sampling locations in Pen Branch were completed. Also performed were field screening for VOCs at 32 areas outside the pits and geophysical logging of existing groundwater wells. Plans were completed for oil drum removal at the D-Area oil seepage basin, where 100 drums are scheduled for burial pending a record of decision.

At the miscellaneous chemical basin/metals burning pit, field characterization work began ahead of schedule in 1994. All 22 required surface samples, 27 required soil borings, and the soil gas survey were completed, and cone penetrometer work obtained lithologic and groundwater data.

During 1994, major construction was completed at the Mixed Waste Management Facility to improve drainage at the burial ground complex; significant remedial engineering was completed at the old F-Area seepage basin; and preclosure activities were begun to reduce environmental risk at the sanitary landfill. Field investigation work of groundwater at TNX began in 1994.

Risk Management

At SRS, potential for risk exists with

- the treatment, storage, and disposition of legacy nuclear materials
- spent nuclear fuel
- radioactive and hazardous waste
- waste sites
- contaminated groundwater
- facility operations

Risk, therefore, is a factor when performing environmental activities and requires careful management—in terms of both how and when the activities are performed. An example of an action taken to reduce risk at SRS is groundwater cleanup. Contamination in groundwater migrates from its source over time, and groundwater cleanup activities are managed to ensure that cleanup is accomplished before the contamination reaches unacceptable levels in potential drinking water supplies.

To ensure public and employee safety, risk management at SRS involves

- cleaning up the contamination so it is no longer a risk
- performing cleanup and waste management activities so that releases do not occur as these activities are performed
- ensuring that cleanup is accomplished so that problems, such as spread of groundwater contamination attributable to groundwater movement, do not arise over time
- stabilizing situations so that any unanticipated environment-threatening releases will not occur

Transition, Decontamination, and Decommissioning

Decommissioning, conducted to reduce the potential for negative health and safety impacts of SRS-contaminated facilities, includes stabilization, reduction, or removal of radioactive or hazardous materials or demolition of the facilities (DOE Order 5820.2A,"Radioactive Waste Management").

More than 600 SRS facilities contain contamination from radioactive materials or from hazardous materials, such as asbestos. These include reactors, chemical separation facilities, metal-forming facilities, office buildings, diesel generator houses, and power substations and transformers.

The Transition, Decontamination, and Decommissioning (TD&D) Department was established in late 1993,

and by 1994, a number of programs either were initiated or accelerated.

One of the key decontamination and decommissioning (D&D) projects completed during 1994 involved the demolition of six R-Reactor auxiliary buildings and a chemical silo.

Another major D&D project involved the demolition of four auxiliary buildings at the Heavy Water Components Test Reactor. This was the first phase of D&D work on a 1950s-vintage heavy water test reactor.

Other significant environmental D&D achievements in 1994 included the following:

- A request for proposal to demolish the old tritium facility (232-F) was issued to 16 vendors, and a $1.6 million contract was awarded. Facility preparation for subcontract demolition activities included establishing unrestricted access to approximately 50 percent of the building, with the remainder having minimum radiological requirements.
- Initial areas of the beta-gamma incinerator were decontaminated in preparation for D&D in the process area. Additional work included
  - –decontamination of the lag-feed storage (area where waste was stored before incinerations) and loading dock areas
  - –removal and recycle of a large amount of equipment and materials
  - –removal of the contaminated-solvent unloading station
  - –remediation of two underground fuel storage tanks
- A request for proposal was prepared to negotiate contracts with outside vendors to remove surplus powerhouses.
- Support was provided for Separations Equipment Development Facility trap removal, assay, and shipment planning and activities.

A contract was awarded to develop a management strategy for storage and disposal of uranium oxide. Uranium oxide inventory, storage, conditions, and disposition are important because the mission at SRS is changing from defense programs to environmental management. In 1994, TD&D worked to support this transition.

Waste Management

SRS's waste management responsibilities include proper handling, storage, and disposal of various wastes generated by site operations, including transuranic, high-level, low-level, hazardous, mixed, and sanitary wastes.

Transuranic Waste

Transuranic waste is radioactive waste contaminated with alpha-emitting isotopes, as well as beta- and gamma-emitting isotopes, that have decay rates and activities exceeding specified levels. It contains manmade elements that are heavier than uranium and that decay slowly, requiring thousands of years of isolation. At SRS, transuranic waste includes equipment, protective clothing, and tools. In 1994, the Solid Waste Management Department accepted 4,807 cubic feet of solid transuranic waste for storage on the Transuranic Waste Storage Pads [COBRA, 1994].

High-Level Waste

High-level waste is highly radioactive waste material resulting primarily from the reprocessing of special nuclear materials; this includes liquid waste produced directly in processing and any solid waste derived from the liquid. It contains both transuranic waste and fission products in concentrations requiring permanent isolation from the environment.

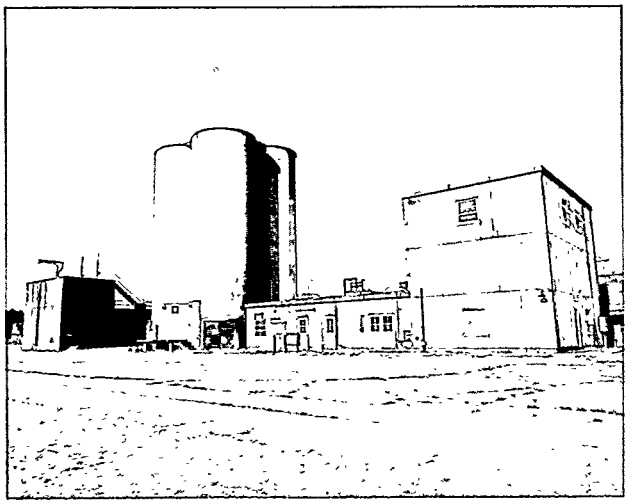
High-level waste is segregated in the F-Area and H-Area canyons according to radionuclide and heat content. High-heat waste primarily is generated during the first extraction cycle in the Separations Canyon and contains a large portion of the radioactivity. Low-heat waste primarily is generated from the second and all subsequent canyon extraction cycles.

SRS manages 51 underground waste storage tanks and two evaporators that safely store and reduce the volume of liquid radioactive waste; 29 tanks are located in the H-Area Tank Farm, and 22 are located in the F-Area Tank Farm. Nearly 90 million gallons of high-level waste have been concentrated by evaporation to the present volume of about 34 million gallons. The 34 million gallons will be pretreated further, concentrating all but a small amount of the radioactivity into a fraction (about 10 percent) of the original volume [DOE EM, 1991a. The remaining high-level waste will be processed in the Defense Waste Processing Facility (DWPF); the low-level waste will be processed in the Saltstone Facility.

The major waste streams into the F-Area and H-Area tank farms include high-heat waste, low-heat waste, receipts from the receiving basin for offsite fuels, and (in the future) the DWPF washwater.

Tank Farm Evaporator Facilities

Each tank farm has one operating evaporator used to concentrate high-level waste following its arrival from



The 183–R Clarification Control Plant, shown here before demolition, was designed to treat the cooling water used by the production reactor facility to reduce sediment and microorganisms growth. The chemical storage silos (tall, cylindrical structures on left) were built to store alum and lime needed in the clarification process. Because of the decision not to restart R-Reactor, this clarification facility was never used.

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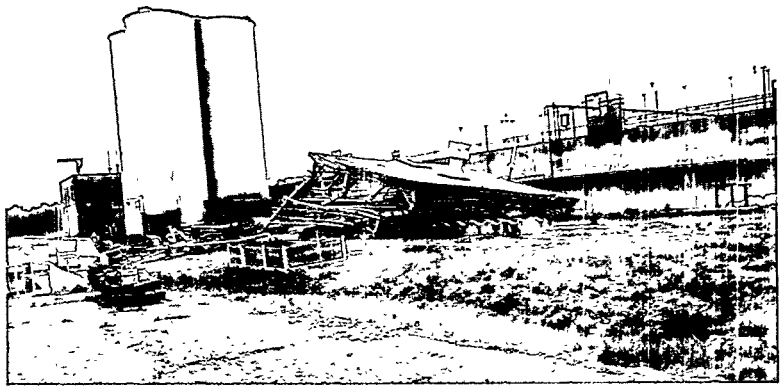
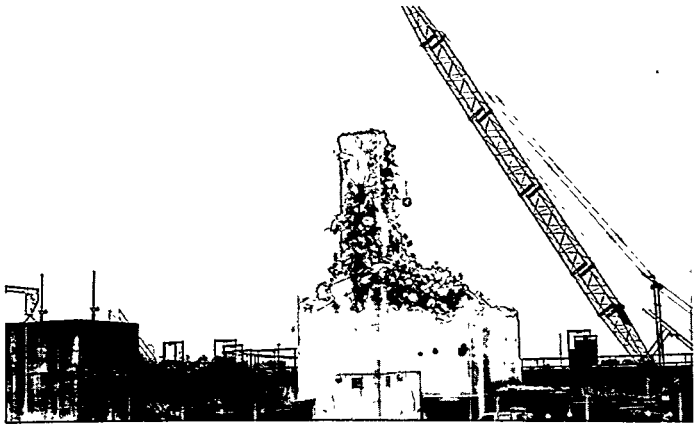
The asbestos-cement siding on the 183–R Clarification Control Plant was stripped from the building. The building frame was pushed down with bulldozers and debris removed to make room for a wrecking-ball crane.

94–1536–65





A wrecking-ball crane demolished the silos of the 183-R Clarification Control Plant

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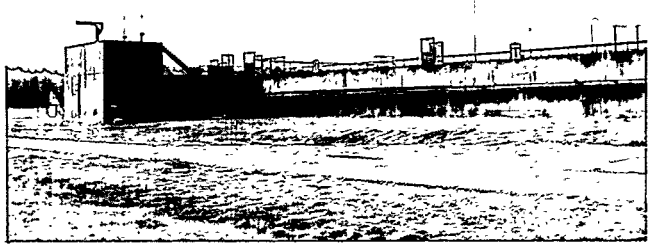
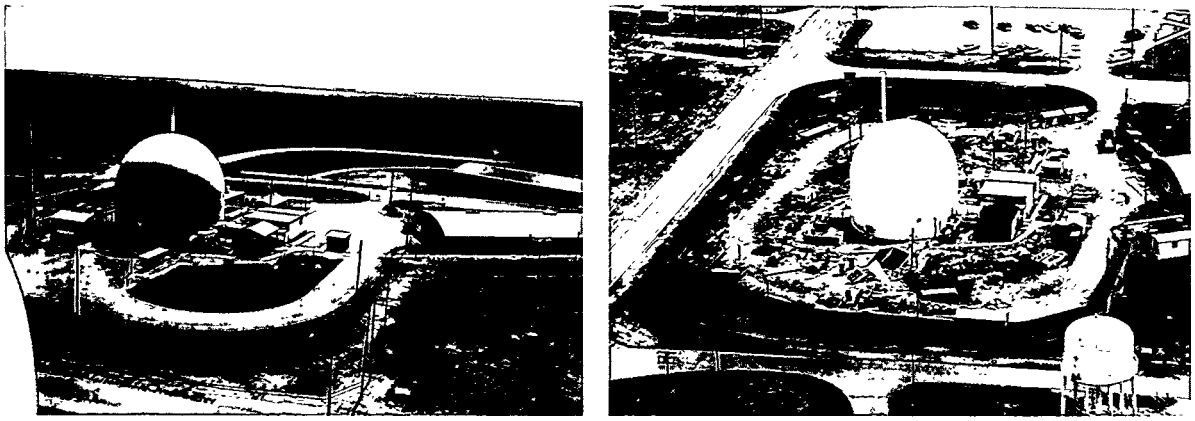
A green field is located where the 183-R Clarification Control Plant once stood.

NFN





10630–1 NFN

The Heavy Water Components Test Reactor and associated auxiliary buildings are shown before (left) and after demolition of four of the auxiliary buildings.

the canyons. Radioactive waste can be reduced to about 25 percent of its original volume and immobilized as crystallized salt by successive evaporation of the liquid supernatant.

SRS has successfully conducted this dewatering operation in its tank farms since the early 1960s. Since the first evaporator facilities began operation in 1960, approximately 105 million gallons of space has been reclaimed.

The 2–F Evaporator processes high-heat and low-heat waste, while the 2–H Evaporator processes low-heat waste only. The other two evaporators, 1–F and 1–H, have been shut down.

A new evaporator—the Replacement High-Level Waste Evaporator—is being built to enable the tank farms to process future waste loads. This new evaporator will have twice the capacity of the 2–H Evaporator and the 2–F Evaporator.

High-Level Waste Accomplishments

Tank Farms The 2–F Evaporator was restarted March 25, after conduct-of-operations improvements were made and the evaporator was converted to high-heat waste service. In 1994, the 2–F Evaporator recovered 489,000 gallons of tank space, thus surpassing its 350,000-gallon goal [Davis, 1994].

The 2–H Evaporator was restarted April 19, 1994, and recovered 1,126,000 gallons of tank space the rest of the year, thus surpassing its 521,000-gallon goal [Davis, 1994].

In-Tank Precipitation startup testing was completed.

Design and construction of Replacement High-Level Waste Evaporator continued on schedule. Steel for the building was erected, and the crane has been installed. However, the projected startup date is being re-evaluated because of the reduced funding for fiscal years 1995–1997.

DWPF/S-Area In 1994, DWPF completed melter heatup and poured 12 canisters of simulated waste glass. The 47,000 pounds of simulated glass poured during this year meet all environmental, design, and operational requirements.

DWPF's ammonia scrubber and hydrogen mitigation modifications outage was successfully completed in December.

DWPF radioactive startup is scheduled for late 1995.

Low-Level Waste

Low-level waste is any radioactive waste not classified as transuranic or high-level waste. High-level waste is discussed below. Low-level radioactive wastes are produced by reactor operations, isotope production, medical procedures, and research and development activities. Examples of SRS's low-level wastes include protective clothing, glove bags, plastic sheeting, equipment, tools, filters, rags, and papers. In 1994, the Solid Waste Management Department accepted 311,694 cubic feet of low-level waste for disposal in the Solid Waste Disposal Facility [COBRA, 1994].

Hazardous Waste

Hazardous waste is defined by RCRA as any toxic, corrosive, reactive, or ignitable material that could damage the environment or negatively affect human health. Environmental laws also list specific materials that are considered hazardous waste and describe specific characteristics that classify a material as a hazardous waste. In 1994, the Solid Waste Manage-

ment Department accepted 3,034 cubic feet of hazardous waste for storage at SRS's hazardous waste storage facilities [PPG, 1995].

Mixed Waste

Mixed waste is both radioactive and hazardous and is governed by both categories of regulations. In 1994, the Solid Waste Management Department accepted 169 cubic feet of mixed waste for storage at SRS's mixed-waste storage buildings [PPG, 1995].

Sanitary Waste

Sanitary waste, which is neither hazardous nor radioactive, includes office waste, food, garbage, refuse, and other solid waste that can be disposed of in landfills. In 1994, 7,009 tons of sanitary waste were disposed of at SRS's Interim Sanitary Landfill, which stopped accepting waste in November when the waste began being shipped to a commercial sanitary landfill [PPG, 1995]. A second category of sanitary waste includes liquid sewage and industrial wastes, which are treated in onsite sewage treatment plants.

Waste Management Programs and Accomplishments

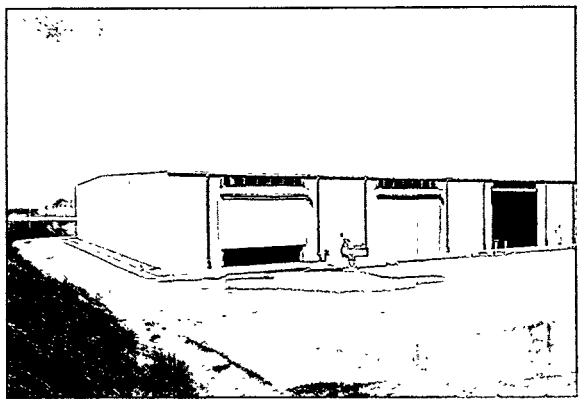
The objectives of new initiatives and ongoing waste management programs at SRS are to minimize environmental impacts, reduce waste generation, and solicit innovative technologies to address various SRS waste streams. Significant accomplishments during 1994 are described in the following paragraphs.

Waste Certification

SRS waste generators must characterize their waste streams with enough accuracy to show compliance with the waste acceptance criteria of the site's various waste management facilities. During 1994, this was accomplished by 28 of the 45 low-level waste generators on site through successful completion of the site's waste certification program. The remaining generators are on schedule to be certified by March 1995.

Waste Minimization

The goal of SRS waste minimization activities is to avoid or reduce waste generation by reducing the source, improving energy usage, and recycling. Such activities include recycling, substituting reusable materials for consumable materials, and reducing the volume and toxicity of hazardous wastes. During 1994, SRS recycled 3,200 tons of materials, reducing by 33 percent the volume of solid, radioactive, hazardous, mixed, and sanitary wastes generated on site. DOE recognized SRS for its source-reduction program [PPG, 1995].



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SRS first placed waste containers in the E-Area Vaults in September 1994.

Startup of E-Area Vaults

During 1994, SRS completed the final stages of a readiness review process to begin operation of the E-Area Vaults. This set of concrete vaults meets strict environmental performance criteria to dispose permanently of certified low- and intermediate-level wastes. SRS placed the first waste containers in the vaults in September.

Sanitary Waste Hauling

SRS has privatized the collection, hauling, and disposal of its sanitary waste (primarily food and office wastes). Recent regulatory changes would have required the site to either upgrade its existing interim sanitary landfill or to build a new landfill to receive a relatively small volume of sanitary waste. Instead, SRS opted to dispose of its sanitary waste at a permitted offsite commercial facility. A 5-year contract was awarded, and sanitary waste was shipped off site beginning in November.

Supplier Environmental and Waste Management Information Exchange

The Supplier Environmental and Waste Management Information Exchange sought innovative treatment technologies from industry in 1994 to address various waste streams and to demonstrate technologies either at vendor facilities or at SRS. Contracts for waste analysis, waste stabilization, volume reduction, decontamination, and destruction of various waste streams were among those awarded during 1994.

Environmental Impact Statement

The *SRS Waste Management Draft Environmental Impact Statement,* DOE/EIS–0217D, was completed in

1994. This document, required by the National Environmental Policy Act (NEPA), provides a broad, integrated look at past, present, and future waste management activities and evaluates the potential environmental impacts of generating, minimizing, treating, storing, and disposing of waste.

Consolidated Incineration Facility

Construction of the Consolidated Incineration Facility (CIF) continued, advancing the project to 95 percent completion in 1994. The CIF will incinerate both solid and liquid forms of low-level radioactive, hazardous, and mixed wastes.

Treatment of Hazardous and Radioactive Material Management Areas Wastes

SRS developed a program to resume shipping certain types of hazardous and radioactive wastes off site for treatment and disposal. The program, which has been approved by DOE, will allow hazardous waste and wastes from radioactive material management areas to be treated at commercial facilities.

Site Treatment Plan for Mixed Wastes

The *Draft Site Treatment Plan for Mixed Wastes* was submitted to EPA and SCDHEC in August 1994. The plan, which is required by the Federal Facility Compliance Act, specifies treatment technologies for SRS mixed waste streams.

Chapter 5

Radiological Effluent Monitoring

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In this chapter...

Introduction

This chapter presents a brief description of the Savannah River Site (SRS) radiological effluent monitoring program and the 1994 effluent monitoring data results. Objectives and rationale for the SRS radiological effluent monitoring program are discussed in chapter 3, "Environmental Program Information."

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards, which can be found in chapter 7, "Potential Radiation Doses," and in appendix A, "Applicable Guidelines, Standards, and Regulations." Also, SRS management philosophy is that potential exposures to members of the public be kept as far below regulatory standards as is reasonably achievable. This philosophy is better known as the "as low as reasonably achievable" (ALARA) concept.

SRS airborne and liquid effluents, which potentially contain radionuclides, are monitored at their points of discharge by a combination of direct measurement and/or sample extraction and analysis. Radiological Control Operations (RCO) and the Environmental Protection Department's Environmental Monitoring Section (EMS) share most of the radiological effluent monitoring responsibilities. RCO personnel collect and screen air and liquid samples from regulated (radiologically controlled) areas and maintain monitoring equipment on stacks and at some liquid effluent discharge points. EMS personnel collect and analyze most liquid effluent samples. Results of these analyses are compiled and reported in monthly radioactive releases reports.

Of the more than 7,000 radiological effluent samples scheduled for collection and analysis during 1994, four were not collected and/or analyzed because of sampling equipment failure or inadvertent loss of or damage to the sample media. However, the radioactive releases attributed to these samples were accounted for in the annual release totals by using either historical process knowledge or less sensitive on-line monitoring results.

A complete description of the EMS sampling and analytical procedures used for radiological effluent monitoring can be found in sections 1102 and 1103 of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1 (SRS EM Program), which is scheduled to be issued in 1995. A summary of data results is presented in this chapter; however, more detailed data can be found in *SRS Environmental Data for 1994* (WSRC–TR–95–077).

Airborne Emissions

Process area discharge stacks that release or have the potential to release radioactive materials are monitored continuously by applicable on-line monitoring (for tritium and noble gases) and/or sampling systems [SRS EM Program, 1995]. Filter paper samples, used to collect radioactive particulates, generally are gathered daily and screened initially for radioactivity by RCO personnel. Charcoal canisters, used to collect radioiodines, are gathered weekly. RCO personnel routinely transfer the charcoal canisters and filter paper samples on a weekly basis to EMS sampling personnel for transport to, and analysis in, the EMS laboratories.

Depending on the processes involved, discharge stacks also may be monitored with "real-time" instrumentation by area operations and/or RCO personnel to determine instantaneous and cumulative atmospheric releases to the environment. Tritium is one of the radionuclides monitored with continuous real-time instrumentation.

Description of Monitoring Program

Sample Collection Systems

Sample collection systems vary from facility to facility, depending on the nature of the radionuclides being discharged. Generally, RCO personnel are responsible for ensuring that the sampling systems are maintained and for collecting the filter papers and charcoal filter samples.

The following effluent sampling and monitoring changes were made during 1994:

- The new 321–M machine room isokinetic sampling system replaced the old 321–M machine room system.
- Sampling systems in the 773–A sand filter discharge, the 773–A B stack, and the 773-A C stack were upgraded to isokinetic sampling systems.
- A new airborne emissions source (728–N) was added to the C-Area monthly radioactive releases report because of changes in operations. Building 728–N, located in N-Area (formerly Central Shops), is a repair facility in which equipment having fixed contamination is cleaned by a process similar to sandblasting.
- Reporting of results from some airborne emission sources (vent, evaporator, vessel vent exhaust, wastewater hold tank stacks in 247–F) was discontinued in the monthly radioactive releases report. These are no longer sources because they were physically capped (closed) when operations were discontinued in building 247–F.

Continuous Monitoring Systems

SRS reactor and tritium facilities use real-time instrumentation to determine instantaneous and cumulative atmospheric releases of tritium and noble gas radioisotopes. All other monitored radionuclides are sampled using filter papers, charcoal filters, or other air effluent sampling media.

Laboratory Analysis

EMS provides most of the necessary radioanalytical laboratory services required to conduct the site airborne effluent monitoring program. However, the Savannah River Technology Center (SRTC) environmental laboratory performs iodine-129 and carbon-14 analyses on certain air effluent samples because of the radioanalytical difficulties associated with these radionuclides.

Effluent Flow Rates

Stack effluent flows generally are determined with hot-wire anemometers, Pitot tubes, or fan capacity calculations. Sample line flow rates usually are determined with in-line rotameters or hot-wire anemometers. Flow rates are used to determine the total quantity of radioactivity released.

Diffuse and Fugitive Sources

An estimate of radionuclide releases from unmonitored diffuse and fugitive sources also is included in the SRS radioactive release totals. These unmonitored sources include ponds, contaminated land areas, and structures without ventilation—or with ventilation but without well-defined release points. The sources were included in the overall SRS source terms for the first time in 1991.

The specific sources and methods used to estimate these emissions are described in *Calculated Release Levels from Phase III Installations*, WSRC–RP–92–542.

Monitoring Results

Data obtained from continuously monitored airborne effluent release points are used in conjunction with calculated release estimates of unmonitored radionuclides (fission product tritium and isotopes of krypton) to quantify the total amount of radioactive material released to the environment. In addition, an estimate of radionuclide releases from unmonitored diffuse and fugitive sources is included in the SRS release totals. Total SRS atmospheric releases for 1994 are shown by source in table 5–1, page 61.

The data shown in table 5–1 are a major component in the determination of offsite dose estimations from SRS operations. The calculated individual and collective doses from atmospheric releases are presented in chapter 7, as is a comparison of these offsite doses to U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) dose standards.

For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and accounted for 56 percent of the total strontium-89,90 reported. Likewise, unidentified alpha emitters were summed with plutonium-239 releases and accounted for nearly 38 percent of the total plutonium-239 releases reported. Strontium-90 and plutonium-239 have the highest dose factors of the common beta- and alpha-emitting radionuclides. Therefore, summing the unidentified beta and alpha emissions this way maintains conservatism of the highest dose being represented. Some of the unidentified beta and alpha activity probably originates from naturally occurring radionuclides, such as potassium-40 and radon-222 progeny. This also adds a degree of conservatism to the dose calculations.

Tritium in elemental and oxide forms accounts for more than 99 percent of the total radioactivity released

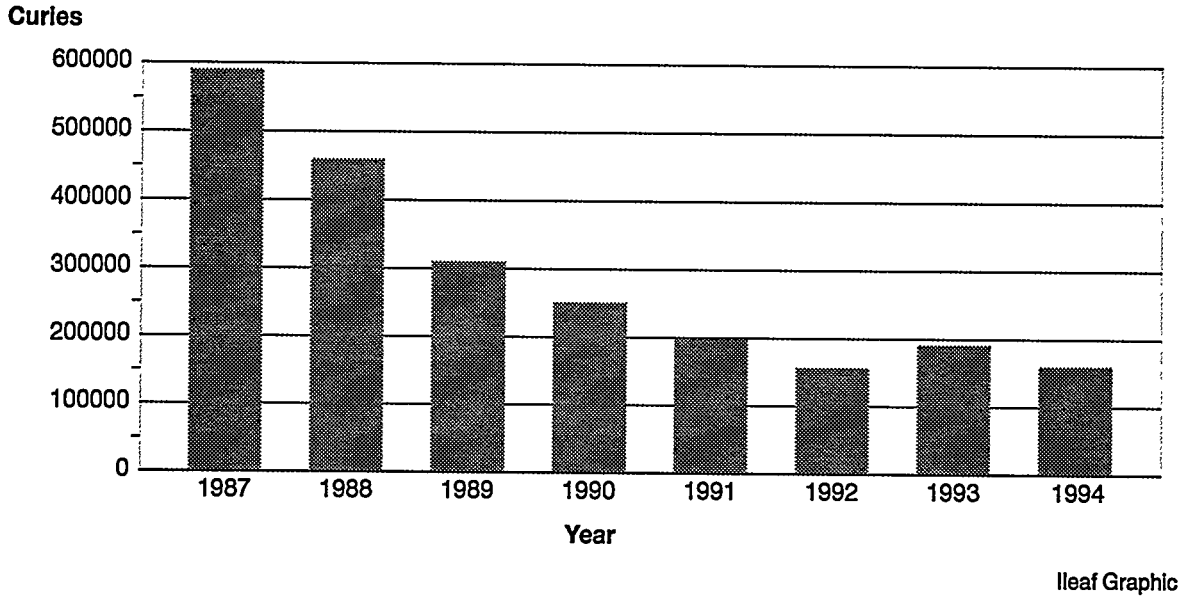

Figure 5–1 SRS Annual Atmospheric Tritium Releases, 1987–1994

to the atmosphere from SRS operations. As an isotope of hydrogen, tritium acts the same as hydrogen chemically and physically and thus is extremely difficult to remove from air effluent streams. During 1994, about 160,000 Ci (5.9E+15 Bq) of tritium was released from SRS, compared to about 191,000 Ci (7.1E+15 Bq) in 1993.

The amount of tritium (and other atmospheric radionuclides) released has been reduced throughout the history of SRS, with changes in the site's mission and improvements in facilities, processes, and operations. During the early years at SRS, large quantities of tritium were discharged to the atmosphere. The maximum yearly release of 2.4 million Ci (8.9E+16 Bq) of tritium occurred during 1958. From 1987 through 1992, the amount of tritium released from SRS decreased approximately 20 percent per year (figure 5–1). In 1993, the increase in tritium released was attributed to increased loading and unloading of tritium reservoirs in the tritium facilities. The 16 percent decrease in the amount of tritium released in 1994 is attributed to: 1) the shutdown and lay-up of all reactor facilities and 2) the midyear startup of the Replacement Tritium Facility (RTF), a tritium processing facility.

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, "Radiation Protection of the Public and the Environment," 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), 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.

Most of the SRS radiological stacks/facilities released small quantities of radionuclides at concentrations below the DOE DCGs [SRS Data, 1995]. However, certain radionuclides—such as tritium (in the oxide form) from the heavy water rework facilities, the reactor facilities, and the tritium facilities, as well as plutonium isotopes from the F-Area and H-Area separations facilities—were emitted at concentration levels above the DCGs. Because of the extreme

difficulty involved in removing tritium and because of current facility designs, site missions, and operational considerations, this situation is unavoidable. However, the dose consequences from all SRS atmospheric releases was considerably less during 1994 than the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv) (chapter 7).

Liquid Discharges

Each process area liquid effluent discharge point that releases or has potential to release radioactive materials is sampled routinely and analyzed for radioactivity [SRS EM Program, 1995]. The locations of the radiological liquid effluent points at SRS are shown, along with the surface water sampling locations, in figure 6–5, page 73.

Site streams also are sampled upgradient and downgradient of seepage basins (chapter 6, "Radiological Environmental Surveillance") to obtain data to calculate the amount of radioactivity migrating from the basins. These results are important in calculating the total amount of radioactivity released to the Savannah River as a result of SRS operations.

Description of Monitoring Program

Sample Collection Systems

Liquid effluents are sampled continuously at or very near their points of discharge to the receiving streams. Three primary systems are used—paddlewheel samplers, Brailsford motor pumps, and Isco samplers. EMS personnel normally collect the liquid effluent samples weekly and transport them to the EMS laboratory for analysis.

The following effluent sampling and monitoring changes were made during 1994:

- The 400–D effluent discharge point became the official discharge point for D-Area, effective March 1.
- P–013A became an official alternate discharge point for P-Area during February. Effluent discharges from P-Area may be diverted through P–019 or P–013A, depending on PAR Pond water level considerations. During December 1993, P-Area liquid effluents were diverted away from P–019 into Steel Creek. EMS subsequently installed a new effluent sampling location (P–013A) at the point of discharge into Steel Creek. During January and February 1994, liquid releases from P-Area were sampled, along with migration releases from the P-Area seepage basin, at the SC–2A environmental surveillance sampling location in Steel Creek. The release totals for these 2 months are included in the site's annual releases totals.
- A new liquid discharge point (105–R sumps) was added to the P-Area monthly radioactive releases report because of a change in operations, i.e., periodic emptying of the 105–R sumps. In 1994, two discharges from 105–R sumps were made.
- Reporting of results from some liquid discharge points—C-Area process sewer, K-Area 107–K heat exchanger cooling water and process sewer, L-Area 107–L heat exchanger cooling water and process sewer, and P-Area 107–P heat exchanger cooling water and process sewer—was discontinued in the monthly radioactive releases report. These effluent monitoring points were consolidated to their respective areas' points of discharge.

Continuous Monitoring Systems

Depending on the processes involved, liquid effluents also may be monitored by area operations and/or RCO personnel with real-time instrumentation to ensure that instantaneous releases stay within established limits. However, because of instrumentation detection capabilities, on-line monitoring systems are not used to quantify liquid radioactive releases from SRS.

Laboratory Analysis

EMS provides most of the necessary radioanalytical laboratory services required to conduct the site liquid effluent monitoring program. However, specific low-level analyses for iodine-129 and technetium-99 are performed by SRTC environmental laboratory personnel.

Flow Rate Measurements

Liquid effluent flows generally are determined by one of four methods: U.S. Geological Survey (USGS) flow stations, stream velocity measurements, Isco sampler flow meters, or pump capacity calculations. Effluent flow rates are used to determine the total radioactivity released.

Settleable Solids

Settleable solids refers to solids that are suspended in wastewater and are determined to be settleable [Method 2540, 1992]. That is, settleable solids are materials settling out of suspension within a defined period.

DOE Order 5400.5 states that liquid process waste streams (liquid discharges) containing radioactive materials in the form of settleable solids may be released to natural waterways (receiving streams) if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (0.2 Bq)/g above background level of settleable solids for

alpha-emitting radionuclides or 50 pCi (2 Bq)/g above background level of settleable solids for beta-emitting radionuclides. The intent of this requirement is to prevent buildup of radionuclide concentrations in sediments.

In 1994—the second year of the settleable solids program—the number of sampling locations was increased from 14 to 24 to provide better coverage of the process effluents. The settleable solids analyses were conducted in the EMS Water Quality Laboratory, and the radionuclide analyses were conducted in the EMS Radiological Laboratory.

Monitoring Results

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. SRS liquid radioactive releases for 1994 are shown by source in table 5–2, page 63.

The data shown in this table are a major component in the determination of offsite dose consequences from SRS operations. The calculated individual and collective doses from site liquid releases are presented in chapter 7, as is a comparison of these offsite doses to EPA and DOE dose standards.

For dose calculation purposes, releases of unidentified beta emitters were summed with strontium-89,90 releases and accounted for nearly 70 percent of the total strontium-89,90 reported. The combined strontium-89,90 and unidentified beta release total for 1994 (3.86E–01 Ci) showed a 19-percent decrease from the 1993 total (4.77E–01 Ci); this is more than a 50-percent decrease from the 1992 (7.90E–01 Ci) total. Also, unidentified alpha emitters were summed with plutonium-239 releases and accounted for more than 99 percent of the total plutonium-239 releases reported.

As with airborne releases, strontium-90 and plutonium-239 have the highest dose factors of the common beta- and alpha-emitting radionuclides found in liquid releases. Therefore, summing the unidentified beta and alpha emissions this way maintains conservatism of the highest dose being represented. In addition, some of the unidentified beta and alpha activity probably originates from naturally occurring radionuclides, such as potassium-40 and radon-222 progeny. This also adds a degree of conservatism to the dose calculations.

Tritium constitutes more than 99 percent of the radioactivity released to the Savannah River from direct, seepage basin, and SWDF migration discharges. In 1994, about 8,800 Ci (3.3E+14 Bq) of tritium were released in liquid discharges from SRS, based on point-of-release concentrations and flow rates, compared to about 11,300 Ci (4.2E+14 Bq) in 1993 [SRS Data, 1995]. SRS tritium transport data for 1960–1994 are summarized in graphic form in figure 6–7 (page 77) in chapter 6. For conservatism, the slightly higher Savannah River transport value (1.09E+04 Ci) was used for dose calculations in chapter 7.

Direct Discharges of Liquid Effluents

As discussed previously, tritium is the major radionuclide released in SRS liquid effluents. The total amount of tritium released directly from process areas (i.e., reactor, separations, heavy water rework) to site streams during 1994 was 1,210 Ci (4.5E+13 Bq), which was more than 28 percent less than the 1993 total of 1,670 Ci (6.2E+13 Bq). The heavy water rework area (400–D) releases decreased 53 percent, from 499 Ci in 1993 to 235 Ci in 1994, and the reactor area (P-Area, L-Area, K-Area, and C-Area) releases decreased 26 percent, from 742 Ci in 1993 to 548 Ci in 1994. There was no change in the separations areas releases (426 Ci in 1993 and in 1994).

Direct releases of tritium to site streams for the years 1988–1994 are shown in figure 5–2.

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 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.

According to 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 ALARA considerations. DOE DCG compliance is demonstrated when the sum of the

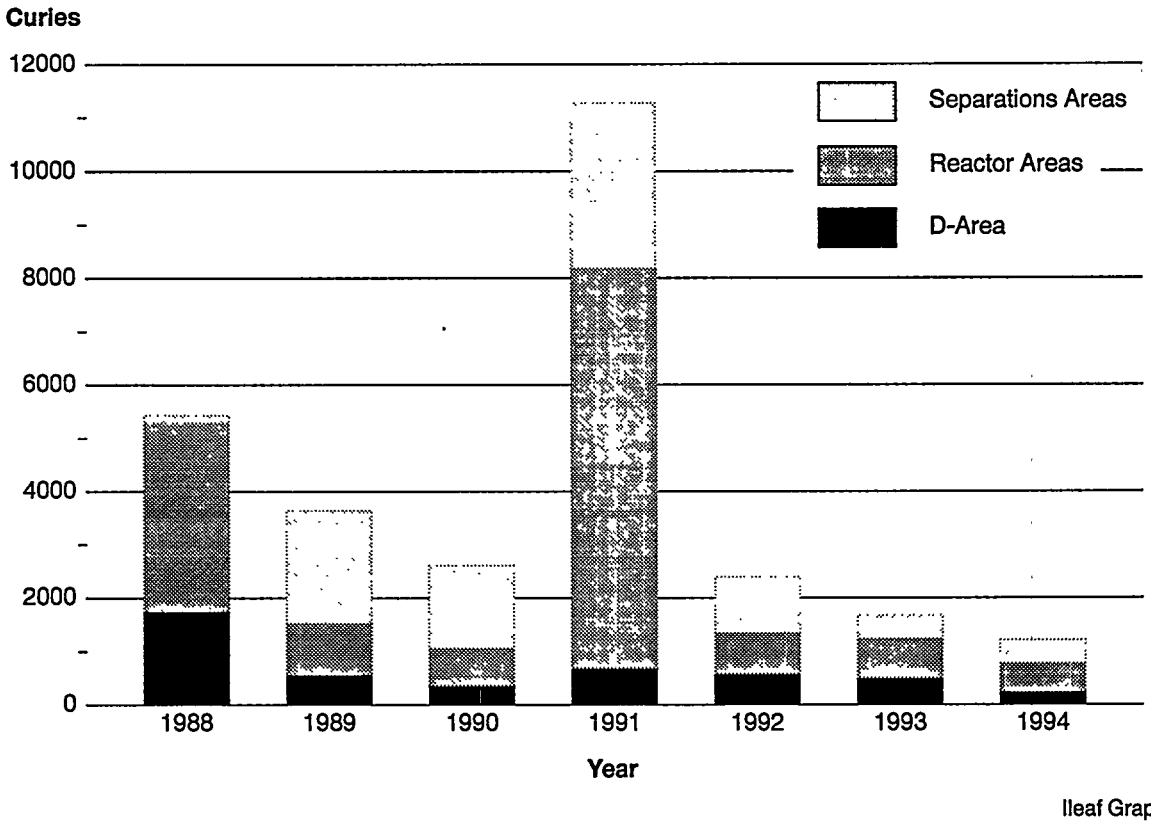

Figure 5–2 Direct Releases of Tritium to SRS Streams, 1988–1994
The 1991 total includes an accidental release in December of 5,700 Ci from K-Reactor.

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 improbable.

For each site facility that releases radioactivity, EMS compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs [Releases, 1994].

The 1994 liquid effluent 12-month average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, in *SRS Environmental Data for 1994* (WSRC–TR–95–077).

The U3R–2A ETF outfall at the Road C discharge point exceeded the DCG guide for 12-month average tritium concentrations during 1993. However, as noted previously, DOE Order 5400.5 specifically exempts tritium from "best available technology" waste treatment investigation requirements. This is because there is no practical technology available for removing tritium from dilute liquid waste streams. In consideration of ALARA principles for tritium discharges, SRS identified several options and alternatives to continuing with these discharges at the U3R–2A ETF outfall [Schwallie, 1992]. None of these alternatives were considered viable on a cost/benefit basis. No other discharge points exceeded the DOE DCGs in 1994.

Seepage Basin and SWDF Migration Results

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, EMS monitors and quantifies the migration of radioactivity from site seepage basins and the SWDF. During 1994, tritium, strontium 89,90, and cesium-137 were detected in migration releases [SRS Data, 1995]. Also, migration releases of iodine-129 and technetium-99 were measured.

Figure 5–3 is a graphical representation of releases of tritium via migration to site streams for the years 1988–1994. During 1994, the total quantity of tritium migrating from the seepage basins and SWDF was 7,600 Ci (2.8E+13 Bq), compared to 9,630 Ci (1.6E+14 Bq) in 1993. Except for 1991, this 21-percent decrease is consistent with the reductions seen since 1988. The reason for the larger than normal increase in migration during 1991 has not been precisely determined. However, it may be attributed to increased rainfall, which could have caused a more rapid migration of contaminants through the seepage basin into the groundwater.

Figure 5–4 shows 1988–1994 total combined tritium releases from direct discharges and seepage basin and SWDF migration. In 1994, direct releases of tritium from process areas accounted for about 14 percent of the total tritium released to the Savannah River.

Migration of Radioactivity from the K-Area Drain Field and Seepage Basin Liquid purges from the K-Area disassembly basin were released to the K-Area seepage basin in 1959 and 1960. Since 1960, purges from the K-Area disassembly basin have been discharged to a percolation field below the K-Area retention basin. A total tritium migration of 878 Ci (3.2E+13 Bq) was calculated from weekly flow measurements and tritium concentrations measured in Indian Grave Branch (a tributary of Pen Branch) during 1994. This migration represents a 20-percent decrease from the 1993 total of 1,100 Ci (4.1E+13 Bq).

Migration of Radioactivity from F-Area and H-Area Seepage Basins Although seepage basins in F-Area and H-Area no longer are used, radioactivity previously deposited in them continues to migrate via the groundwater and to outcrop into Four Mile Creek.

Migration of radioactivity from F-Area and H-Area seepage basins is measured with continuous samplers and flow recorders in Four Mile Creek. Groundwater from the F-Area seepage basins enters Four Mile Creek between sampling locations FMC–3A, FMC–2B, and FMC–A7. Four Mile Creek sampling locations are shown in figure 6–5, page 73.

Most of the outcropping from H-Area seepage basins 1, 2, and 3 occurs between FMC–1C and FMC–2B. Outcropping from H-Area seepage basin 4 and SWDF occurs between FMC–3 and FMC–3A. Radioactivity from H-Area seepage basin 4 and SWDF mixes during groundwater migration to Four Mile

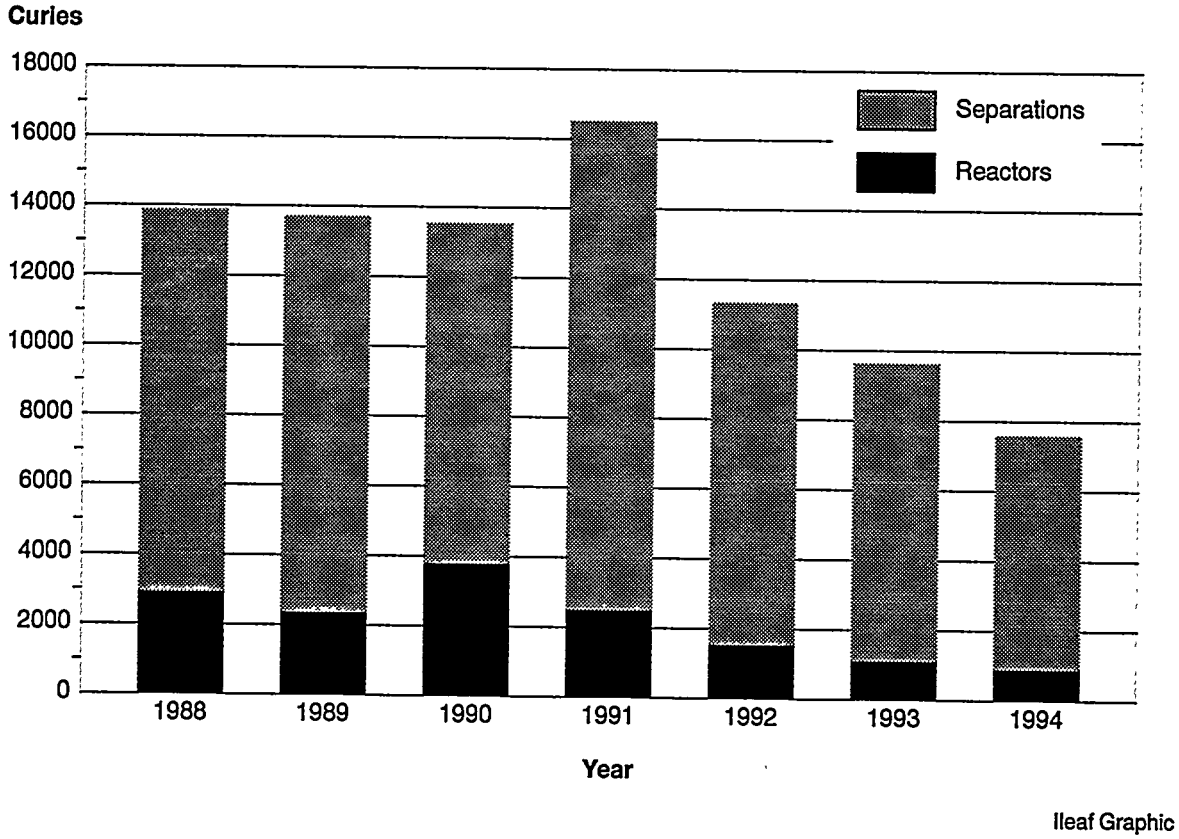

Figure 5–3 Tritium Migration from Seepage Basins and SWDF to SRS Streams, 1988–1994

Creek. Therefore, radioactivity from the two sources cannot be distinguished at the outcrop point.

Measured migration of tritium from F-Area seepage basins was 2,880 Ci (1.1E+14 Bq) in 1994. This is a 32-percent increase over the 1993 total of 2,180 Ci (8.1E+13 Bq); however, it is below the 1992 value of 4,260 Ci (1.6E+14 Bq). The measured migration from H-Area seepage basin 4 and SWDF was 3,090 Ci (1.1E+14 Bq), a 42-percent decrease from the 1993 total of 5,330 Ci (2.0E+14 Bq). The measured migration from H-Area seepage basins 1, 2, and 3 was 739 Ci (2.7E+13 Bq), a 27-percent decrease from the 1993 total of 1,020 Ci (3.8E+13 Bq) [SRS Data, 1995].

Past, current, and computer model-projected tritium migration releases from F-Area and H-Area seepage basins and SWDF are shown in figure 5–5. Generally, and as the data show, tritium migration from the F-Area and H-Area seepage basins, which were closed in 1988, has been declining and is projected to continue to decline. However, tritium migration from SWDF has remained relatively stable during the past 10 years. Furthermore, based on the operational history of SWDF and the geology and hydrology of the site, it is anticipated that, with no corrective actions, SWDF tritium migration to Four Mile Creek is expected to remain at about 4,500 Ci (1.7E+13 Bq) per year for at least the next 10 to 20 years [Looney et al, 1993].

As required by the Resource Conservation and Recovery Act (RCRA), SRS, in conjunction with the South Carolina Department of Health and Environmental Control (SCDHEC), is developing groundwater corrective action plans for SWDF. Portions of SWDF also are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA characterization and assessment also are under way. Reduction of tritium migration releases is one of the factors being considered during the development of these RCRA/CERCLA groundwater corrective action plans. Low-permeability caps, waste form stabilization, groundwater barriers, groundwater pump-treat-reinjection, and other technologies are under consideration as relevant components of SWDF remediation.

The amount of strontium-89,90 entering Four Mile Creek during 1994, was estimated to be 78 mCi (2.9E+09 Bq) from the F-Area seepage basins. This was a 48-percent decrease from the 1993 level of 150 mCi (5.6E+09 Bq). In addition, 35 mCi (1.3E+09 Bq) of strontium-89,90 were estimated to have

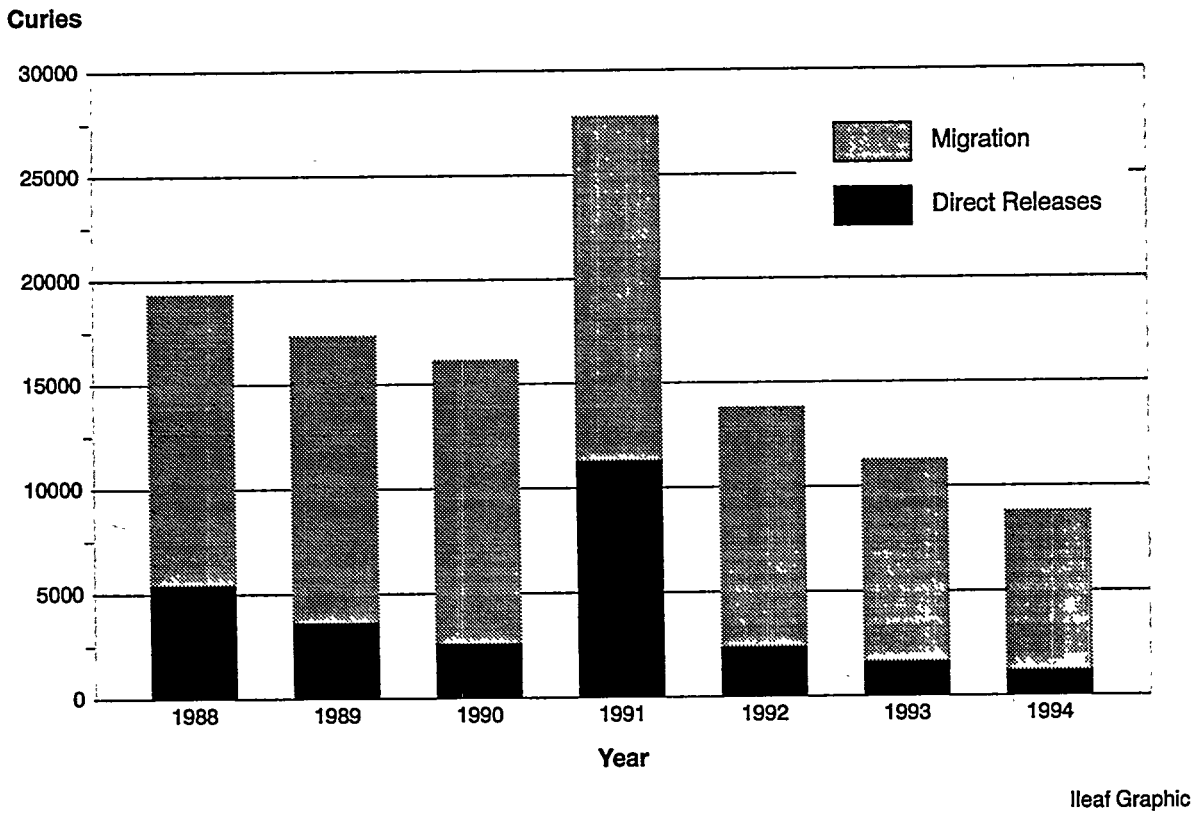

Figure 5–4 Total Tritium Releases to SRS Streams (Direct Discharges and Migration), 1988–1994

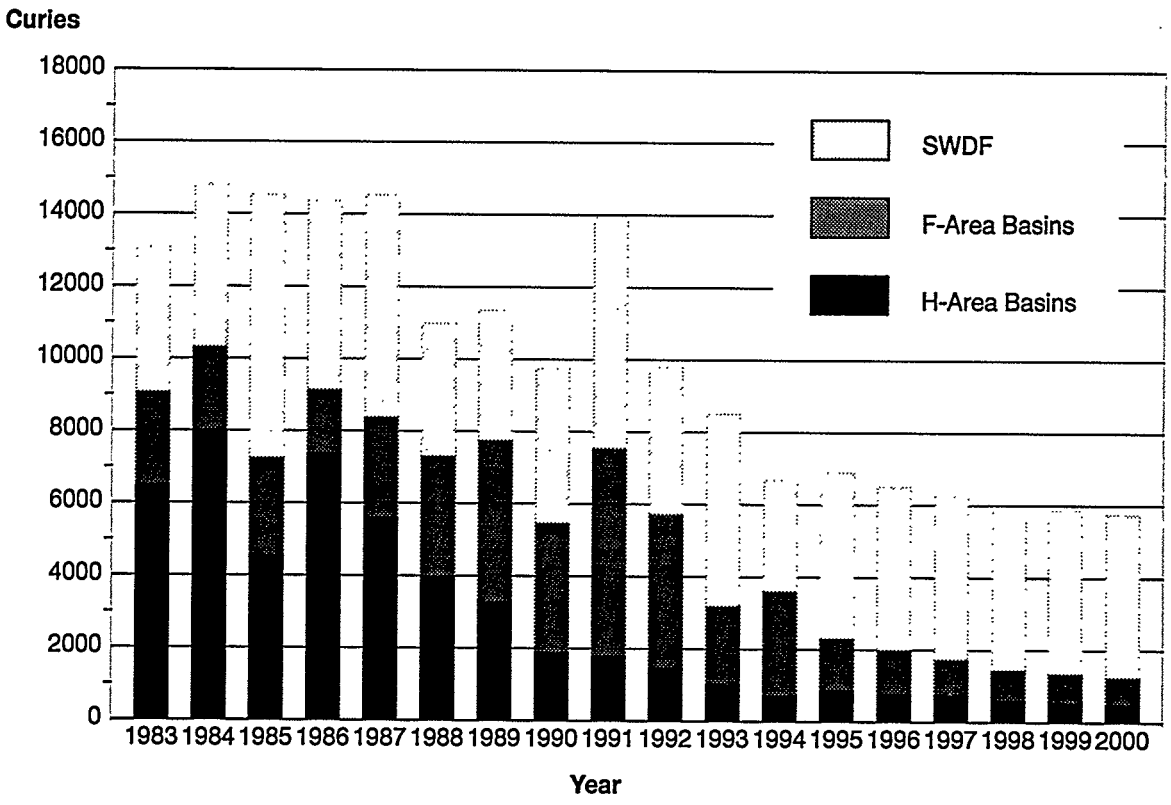

Figure 5–5 Past, Current, and Projected Tritium Migration Releases to Four Mile Creek from the F-Area and H-Area Seepage Basins and SWDF

migrated from the H-Area seepage basins. This was a 46-percent decrease from the 1993 level of 65 mCi (2.4E+09 Bq) [SRS Data, 1995]. Like tritium migration, strontium migration is expected to continue to decline from these closed seepage basins.

In addition, migration of cesium-137, iodine-129, and technetium-99 from the F-Area or H-Area seepage basins and SWDF was detected. About 3 mCi (1.1+08 Bq) of cesium-137, about 74 mCi (2.7E+09 Bq) of iodine-129, and about 9 mCi (3.3E+08 Bq) of technetium-99 were detected. Because of the radioanalytical difficulties associated with iodine-129 and technetium-99, these radionuclides cannot be detected—using common radioanalytical methods—in dilute streams. However, as releases of other radionuclides from SRS continue to decrease, the percentage of the maximum individual offsite dose attributed to iodine-129 (half-life of 1.57E+07 years) and technetium-99 (half-life of 2.15E+05 years) is likely to increase in future years. Therefore, in 1994, the SRTC environmental laboratory, which has the sensitive instrumentation capable of detecting these radionuclides, began analyzing for iodine-129 and technetium-99 in the F-Area and H-Area seepage basins and in SWDF migration samples.

Migration of Radioactivity from P-Area, C-Area, and L-Area Seepage Basins Liquid purges from the P-Area, L-Area, and C-Area disassembly basins have been released periodically to their respective seepage basins since 1978. Purge water is released to the seepage basins to allow a significant part of the tritium to decay before the water outcrops to surface streams and flows into the Savannah River. The delaying action of the basins reduces the dose that users of water from downriver water treatment plants receive from SRS tritium releases. The seepage basins were used for purging the disassembly basins from the 1950s until 1970, but disassembly basin purge water was released directly to SRS streams between 1970 and 1978. The earlier experience with seepage basins indicated that the extent of radioactive decay during the holdup was sufficient to recommend that the basins be used again in P-Area, L-Area, and C-Area. However, no purges to the basins occurred during 1994.

No radionuclide migration was attributed to the C-Area seepage basin in 1994. The failure of the Twin Lakes

Dam in 1991 made the determination of migration more difficult in this area. Results from a sampler installed on Steel Creek above L-Lake indicated that 386 Ci (1.4E+13 Bq) of tritium migrated from the P-Area seepage basin during 1994, about the same level as in 1993 [SRS Data, 1995]. Migration of radionuclides from the L-Area seepage basin has not been detected in site streams.

Settleable Solids

Radionuclide analyses revealed that naturally occurring radionuclides, such as potassium and progeny associated with the uranium and thorium decay chains, were present and identified. Of the 192 samples analyzed in 1994, only four showed the presence of a gamma-emitting radionuclide. All these results were from one location (H–017), as follows:

H–017	3rd Quarter	Cs-137	26,000 pCi/g
H–017(Dup)	3rd Quarter	Cs-137	9,838 pCi/g
H–017	4th Quarter	Cs-137	<MDA
H–017(Dup)	4th Quarter	Cs-137	4,700 pCi/g

Data generated at the other 23 sampling locations indicated that radionuclides were present in the water column but were not associated with the settleable solids. This also is the case with the H–017 result (<MDA) presented in the gamma data table above. Alpha and beta minimum detectable activities (MDAs) were 6.8E–07 μCi per sample and 1.52E–06 μCi per sample, respectively. Evaluation of the data had not been completed by the end of 1994. A "best available technology" investigation will begin in early 1995.

Table 5–1
1994 Radioactive Atmospheric Releases by Source

Radio-nuclide	Half-life	Curies[a]						
		Reactors	Separations[b]	Reactor Materials	Heavy Water	SRTC[c]	Diffuse and Fugitive[d]	Total
Notes: Blank space indicates no quantifiable activity; h = hour, d = day, y = year								
GASES AND VAPORS								
H-3 (oxide)	12.3 y	2.37E+04	8.31E+04		3.01E+02		1.31E+01	1.07E+05
H-3 (elem)	12.3 y		5.29E+04					5.29E+04
H-3 Total	12.3 y	2.37E+04	1.36E+05		3.01E+02		1.31E+01	1.60E+05
C-14	5.7E3 y		3.71E–02				3.50E–13	3.71E–02
Cl-36	3.01E5 y						1.00E–15	1.00E–15
I-129	1.6E7 y		3.80E–03					3.80E–03
I-131	8 d	4.42E–07	2.19E–05			4.77E–05		7.00E–05
I-133	20.8 h					1.98E–03		1.98E–03
I-135	6.57 h					2.96E–01		2.96E–01
Xe-135	9.1 h					2.17E–02		2.17E–02
PARTICULATES								
Be-7	53.28 d						1.50E–13	1.50E–13
Al-26	7.3E5 y						3.50E–14	3.50E–14
S-35	87.2 d						6.85E–12	6.85E–12
Ca-45	162.7 d						1.00E–15	1.00E–15
Ca-47	4.536 d						1.00E–16	1.00E–16
Sc-46	83.81 d						1.00E–16	1.00E–16
Mn–54	312.2 d						1.50E–15	1.50E–15
Co-57	271.8 d						2.50E–14	2.50E–14
Co-60	5.3 y					6.16E–06	1.08E–13	6.16E–06
Ni-63	100 y						2.06E–13	2.06E–13
Zn-65	243.8 d		4.44E–06				2.60E–13	4.44E–06
Se–75	119.78 d						6.00E–16	6.00E–16
Rb–86	18.65 d						2.00E–15	2.00E–15
Sr-85	64.84 d						5.00E–15	5.00E–15
Sr-89,90[e]	29.1 y	1.08E–04	1.58E–03	4.30E–05	1.53E–06	2.34E–06	3.75E–04	2.11E–03
Zr-95	64 d						2.39E–11	2.39E–11

a One curie equals 3.7 E+10 Becquerels.
b Includes separations, waste management, and tritium facilities
c Savannah River Technology Center
d Estimated releases from minor unmonitored diffuse and fugitive sources
e Includes unidentified beta-gamma emissions

Table 5–1
1994 Radioactive Atmospheric Releases by Source

Radio-nuclide	Half-life	Curies[a]						
		Reactors	Separa-tions[b]	Reactor Materials	Heavy Water	SRTC[c]	Diffuse and Fugitive[d]	Total
Ru-106	372.6 d		1.19E-08				4.97E–09	1.69E–08
Cd-109	462.0 d						5.00E–14	5.00E–14
Sb-125	2.8 y						7.27E–12	7.27E–12
Cs-134	2.1 y		8.41E–09				2.01E–13	8.41E–09
Cs-137	30.2 y	6.40E–06	1.49E–04			2.57E–06	1.08E–08	1.58E–04
Ce-144	285 d						1.13E–10	1.13E–10
Eu-154	8.6 y						3.44E–10	3.44E–10
Eu-155	4.7 y						1.63E–10	1.63E–10
Hg-203	46.61 d						2.00E–12	2.00E–12
U-235,238	4.5E9 y		2.22E–03	1.15E–05		3.94E–08	8.12E–06	2.23E–03
Np-237	2.10E6 y						7.40E–15	7.40E–15
Pu–236	2.87 y						1.90E–17	1.90E–17
Pu-238	87.7 y		1.61E–03			7.87E–08	5.18E–07	1.61E–03
Pu-239[e]	2.4E4 y	6.33E–07	7.55E–04	7.82E–07		1.56E–06	6.45E–07	7.59E–04
Am-241,243	7.4E3 y		5.59E–05			2.75E–07	8.86E–10	5.62E–05
Cm-242,244	18.1 y		1.22E–05			3.90E–06	7.32E–09	1.61E–05
Cm-243	29.1 y						1.00E–13	1.00E–13
Cm-248	3.48E5 y						9.20E–18	9.20E–18

a One curie equals 3.7 E+10 Becquerels.
b Includes separations, waste management and tritium facilities
c Savannah River Technology Center
d Estimated releases from minor unmonitored diffuse and fugitive sources
e Includes unidentified alpha emissions

Table 5–2
1994 Radioactive Liquid Releases by Source
(Including Direct and Seepage Basin Migration Releases)

Radio-nuclide	Half-life	Curies[a,b] Reactors	Separations[c]	Reactor Materials	Heavy Water	Savannah River Technology Center/TNX	Total
Note: h = hour, d = day, y = year							
H-3 (oxide)	12.3 y	2.42E+03	7.73E+03		2.62E+02	2.27E–01	1.04E+04[d]
Sr-89,90[e]	29.1 y	2.14E–01	1.59E-01		1.08E–02	1.62E–03	3.86E–01
Tc-99	2.1E5 y		8.80E–03				8.80E–03
I-129	1.6E7 y		7.39E-02				7.39E–02
Cs-137	30.2 y	4.72E–02	9.35E-02				1.41E–01
Pm-147	2.6 y		1.54E-03				1.54E–03
U-235,238	4.5E9 y		1.00E-05				1.00E–05
Pu-239[f]	2.4E4 y	3.51E–04	1.32E–02	1.33E–04	6.52E–04	5.70E–05	1.44E–02

a One curie equals 3.7E+10 Becquerels.
b Blank space indicates no quantifiable activity.
c Includes separations, waste management and tritium facilities
d For conservatism, the slightly higher river transport number (1.09E+04) was used for dose calculations.
e Includes unidentified beta-gamma
f Includes unidentified alpha

Chapter 6

Radiological Environmental Surveillance

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In this chapter...

Introduction

The Savannah River Site (SRS) radiological environmental surveillance program is designed to survey and quantify any effects that routine and nonroutine operations might have on the site and on the surrounding area and population. The program represents an extensive network that covers 31,000 square miles and extends up to 100 miles from the site. In conjunction with the radiological effluent monitoring program (chapter 5, "Radiological Effluent Monitoring"), it enables SRS to monitor ambient radiological conditions and determine site contributions of radioactive materials to the environment.

Radiological surveillance activities are performed by the Environmental Protection Department's Environmental Monitoring Section (EMS) and by the Savannah River Technology Center (SRTC). 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).

As part of the radiological surveillance program, routine surveillance of all radiation exposure pathways (ingestion, inhalation, immersion, and submersion) is performed on all environmental media that may lead to a measurable annual dose at the site boundary. This chapter summarizes surveillance results of the atmosphere (air and rainwater), surface water (seepage basins, site streams, and the Savannah River), drinking water, food products (terrestrial and aquatic), wildlife, soil, sediment, and vegetation. Also summarized are results of extensive monitoring of ambient gamma radiation levels performed on site, at the site boundary, and in population centers (surrounding communities). A description of the surveillance program and 1994 results for groundwater can be found in chapter 10, "Groundwater."

All results discussed in this chapter are based on available samples and/or analyses. Because of sampling and/or analytical difficulties, some sample analyses may be missing. Problems may have arisen with sample collection, such as loss of power to the sampling site or inaccessibility to the sampling site (locked gates, flooding, etc.) Results for collected samples can be rejected after analysis for such reasons as insufficient sample volume, low chemical yield, or equipment failure.

The ± value reported with individual results is a counting uncertainty; the ± value reported with averages (means) is a standard deviation. Also, lower limits of detection (LLD) often vary because of counting times and other factors.

In 1994, approximately 105,000 radiological analyses were performed on 27,000 samples. Details about the number of samples analyzed and the results of those analyses appear in *SRS Environmental Data for 1994* (WSRC–TR–95–077). Information on the rationale for the radiological environmental surveillance program can be found in chapter 3, "Environmental Program Information." Data from earlier years can be found in previous SRS environmental reports and data publications. Document numbers for these can be found in appendix E, "Environmental Monitoring Reports."

A complete description of the SRS radiological environmental surveillance program 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 is scheduled to be issued in 1995.

Air

Description of Surveillance Program

The SRS air surveillance program consists of 35 stations: five on site, 14 along the site perimeter, 12 at approximately a 25-mile radius from the site boundary,

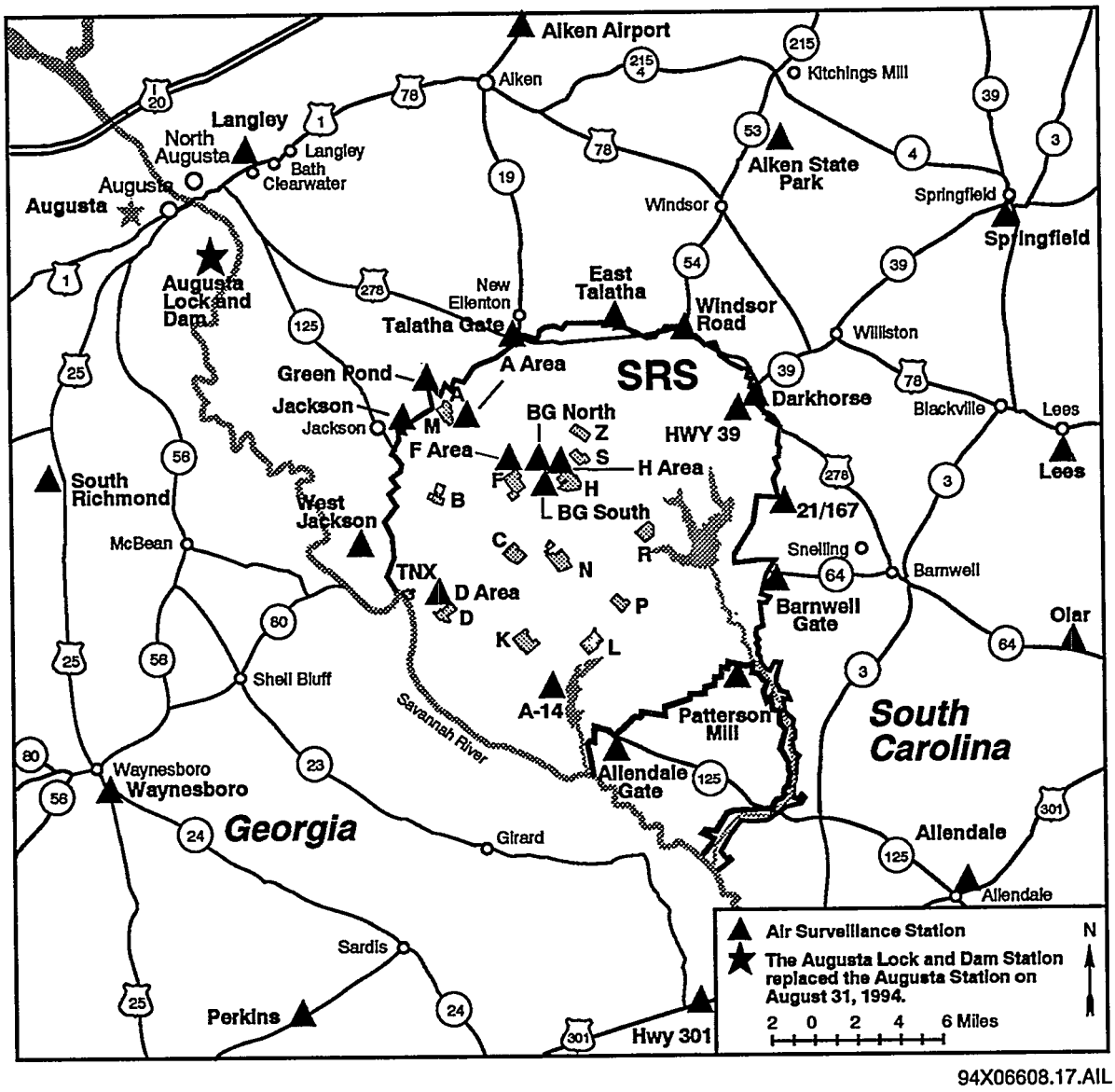

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Figure 6–1 Radiological Air-Surveillance Stations
The SRS air surveillance program consists of 31 stations located within 25 miles of the site and four stations (not shown) approximately 100 miles from the site.

and four at approximately a 100-mile radius from the site boundary. Figure 6–1 shows all the surveillance locations except the 100-mile stations.

In 1994, one program change was implemented. The Augusta, Georgia, station was shut down August 31 and replaced with a new station at the Augusta Lock and Dam on the Savannah River. Access to the existing site had become difficult because of environmental cleanup in the area. Also, the new station is located in an open section of a park and serves as an educational site for the public.

As documented in the *Savannah River Site Environmental Report for 1993*, changes for airborne sampling were implemented in late 1993. During 1994, changes were observed in the variation of tritium-in-air concentrations. It was determined that sampling problems were causing subsequent calculations to produce artificially high tritium-in-air results. The problem has been corrected. Because of the problem, analytical results are presented in pCi/mL of atmospheric moisture, rather than pCi/m^3 of air. To convert the annual average concentration in pCi/mL of atmospheric moisture to pCi/m^3 of air, a Nuclear

Table 6–1
Average Gross Alpha and Gross Beta Measured in Air (μCi/mL), 1989–1994

	Average Gross Alpha					
Locations	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
On site	1.4E–15	1.3E–15	2.5E–15	1.8E–15	1.9E–15	1.4E–15
Site perimeter	1.1E–15	1.1E–15	2.6E–15	1.8E–15	1.8E–15	1.4E–15
25-mile radius	1.1E–15	1.0E–15	2.5E–15	1.7E–15	1.8E–15	1.4E–15
100-mile radius	1.6E–15	1.3E–15	2.6E–15	1.7E–15	2.0E–15	1.8E–15
	Average Gross Beta					
Locations	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
On site	1.8E–14	1.8E–14	1.8E–14	1.9E–14	1.8E–14	1.7E–14
Site perimeter	1.7E–14	1.8E–14	1.8E–14	1.9E–14	1.9E–14	1.8E–14
25-mile radius	1.7E–14	1.8E–14	1.8E–14	1.8E–14	1.8E–14	1.8E–14
100-mile radius	1.7E–14	1.9E–14	1.8E–14	1.7E–14	2.0E–14	1.8E–14

Regulatory Commission (NRC)-approved, generic, absolute humidity of 11 mL of water/m^3 of air may be used. However, because the actual humidity varies greatly throughout the year, use of this figure for a particular week is not valid.

Surveillance Results

Chapter 5 details quantities and types of radionuclides released to the atmosphere in 1994. Except for tritium, these radionuclides were not detectable at the site perimeter. Both onsite and site perimeter/offsite activity concentrations generally were similar to levels observed during previous years.

Gross Alpha and Gross Beta

Gross alpha and gross beta analyses are performed on glass fiber filters used to sample particulates in air. Although these analyses do not provide isotope-specific characterization of activity, they are useful for screening and trending purposes.

A summary of the average gross alpha and gross beta activity analytical results for 1989–1994 appears in table 6–1. As in previous years, these results show no significant difference between onsite locations near operating facilities and those found at the site perimeter and beyond.

The 1994 results show a change in trend. In 1991, an unexplained increase in gross alpha activity from previous years was noticed. This trend continued in 1992 and 1993. The 1994 results show gross alpha concentrations dropping to near the 1989 and 1990 levels (figure 6–2). As indicated in the 1993 annual report, the cause of this spike is unknown, although modifications to the analytical procedure were suspected. In 1994, the only change in EMS analytical procedures was a standardization of the sample hold time prior to analysis to allow for consistent decay of radon-220 and -222 progeny. After implementation of this modification, the analytical results did not show an appreciable change. Based on the this fact and the magnitude of the original fluctuation, it is likely that the observed variance is part of the natural distribution of results.

Gamma-Emitting Radionuclides

Glass fiber filters and activated charcoal canisters are collected weekly and analyzed for gamma-emitting radionuclides. The only manmade radionuclide detected in these samples was cesium-137, which was observed in one sample from F-Area and nine samples from the Barnwell Gate sampling station. The cesium-137 activity in the F-Area sample is attributed to routine operations, while the cause of activity on the Barnwell Gate samples is presumed to be operations at the Chem-Nuclear low-level radioactive waste disposal facility, located adjacent to the Barnwell Gate station.

Plutonium and Strontium

Monthly composite samples are analyzed for plutonium-238 and plutonium-239. These radionuclides are released in small amounts from routine operations at the separations areas, with smaller amounts released from SRTC. The observed surveillance results are consistent with this source term. Airborne concentrations are highest at the separation areas and Burial Ground locations (those sites near the

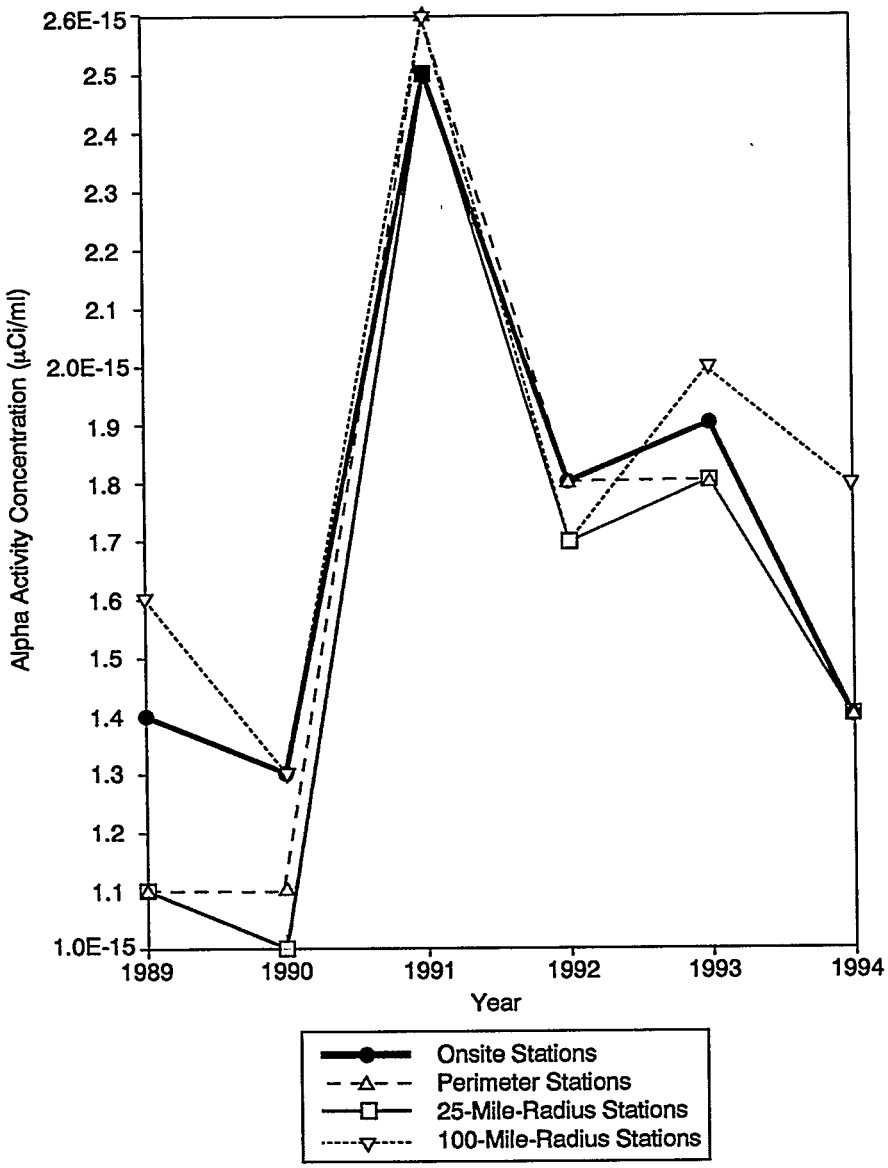

Figure 6–2 Airborne Particulate Alpha Activity
An increase in airborne alpha activity at SRS airborne surveillance stations was observed first in 1991. In 1994, the results dropped to pre-1991 levels. This variance appears to be part of the natural distribution of analytical results.

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point of release) and decrease to background levels at the the site perimeter and off site as the result of dispersion, diffusion, and deposition. The analytical results from these locations are similar, and all plutonium-238 and plutonium-239 results are consistent with previously observed historical levels.

Monthly composite samples also are analyzed for strontium-89,90 activity. In 1994, a small amount of strontium was released from the separations areas. As was the case with the plutonium-238 and plutonium-239 surveillance results, airborne concentrations were highest at those stations at the center of the site (separation areas and Burial Ground), which are near the release point. Strontium-89,90 levels decrease at the site perimeter and at offsite monitoring locations, approaching the detection limit. The analytical results from these locations are similar, and all strontium-89,90 results are consistent with previously observed historical levels.

Tritium

As noted in the air surveillance program description, problems were experienced in the tritium program during 1994. As a result, all analytical results are expressed as pCi/mL of atmospheric moisture rather than pCi/m^3 of air.

Biweekly silica gel samples are analyzed for tritium, which is released from routine operations at the separations areas and, in smaller amounts, from the reactor areas and D-Area. Like other specific radionuclides, the analytical results are consistent with

the source term. The highest tritium levels are observed near H-Area, but they decrease with distance from the release point. Other onsite locations (F-Area and Burial Ground) show concentrations substantially lower than at H-Area but greater than at the site boundary, while site perimeter tritium concentrations are higher than 25-mile-radius concentrations.

Rainwater

SRS maintains a network of rainwater sampling stations to measure deposition from worldwide fallout and emissions from the site. Rainwater can be a source of dose to man through the ingestion pathway (food products and drinking water) and by direct external exposure. Rainwater data are used to assist in the detection and quantification of unplanned releases and as an important indicator of environmental atmospheric trends.

Description of Surveillance Program

Rainwater collection pans are located atop each air surveillance station (figure 6–1). Ion exchange resin columns are placed at four of these stations—H-Area (on site), Barnwell Gate and Darkhorse (site perimeter), and Olar (off site)—to determine radionuclide deposition. Rainwater passes from the pans through the ion exchange columns and into collection bottles. The ion exchange columns, to be analyzed for deposition, and water from the collection bottles are returned to the laboratory. Rainwater at all other 25-mile and site perimeter locations, which do not have ion exchange columns, passes directly from the pans to the collection bottles and also is returned to the laboratory.

Ion exchange and rainwater samples from the previously mentioned four stations were collected monthly. In addition, ion exchange resin columns are located at the four 100-mile locations. Rainwater samples from these four control stations were collected and analyzed quarterly.

In general, ion exchange column samples are analyzed for gross alpha, gross beta, gamma-emitting radionuclides, plutonium-238, plutonium-239, and strontium-89,90. Rainwater samples are analyzed for tritium.

Surveillance Results

The quarterly frequency allows more activity to collect on the 100-mile-radius ion columns; the levels of this activity typically exceed those measured at locations on site, at the site perimeter, and at the 25-mile-radius stations. Therefore, in an attempt to compare the mean concentration, gross alpha and gross beta results from ion exchange columns have been normalized to the units of pCi/m^2 per year [SRS Data, 1995].

Gross Alpha and Gross Beta

The normalized average gross alpha and gross beta measurements represented a typical numerical distribution of measurements seen at each station and did not reflect contributions from SRS operations. As expected, the longer sampling interval at the 100-mile-radius stations resulted in increased gross alpha and gross beta measurements, which can be observed in the minimum and maximum concentrations.

Plutonium

No detectable levels of plutonium-238 or plutonium-239 were observed.

Strontium

Measurements of strontium-89,90 in rain were below detectable levels.

Tritium

Biweekly rainfall samples from all atmospheric surveillance stations were analyzed for tritium. As expected, the highest concentration of rainwater tritium, located in H-Area and averaging (5.55 ± 4.81)E–05 μCi/mL, is collected at the station nearest the tritium facilities, which routinely release tritium in their atmospheric effluent (figure 6–3).

Gamma Radiation

Description of Surveillance Program

The ambient gamma exposure rates in and around SRS are monitored by an extensive environmental thermoluminescent dosimeter (TLD) program. TLDs provide a reliable and relatively inexpensive method of accurately quantifying the gamma exposure environment. TLDs have been used by SRS since 1965 to measure environmental gamma exposure rates.

The gamma radiation surveillance program consists of 394 monitoring locations in and around SRS. The majority of the monitoring sites are located within a 50-mile radius of the site, although some stations are up to 100 miles from the site boundary. The information provided by this program is used to determine the impact, if any, of site operations on the gamma exposure environment; to evaluate trends in environmental exposure levels; to support routine and emergency dose calculation models; and to assist in determining protective actions in the event of an unplanned release of gamma-emitting radionuclides.

The routine TLD surveillance network is divided into five areas: onsite locations, site perimeter locations, air

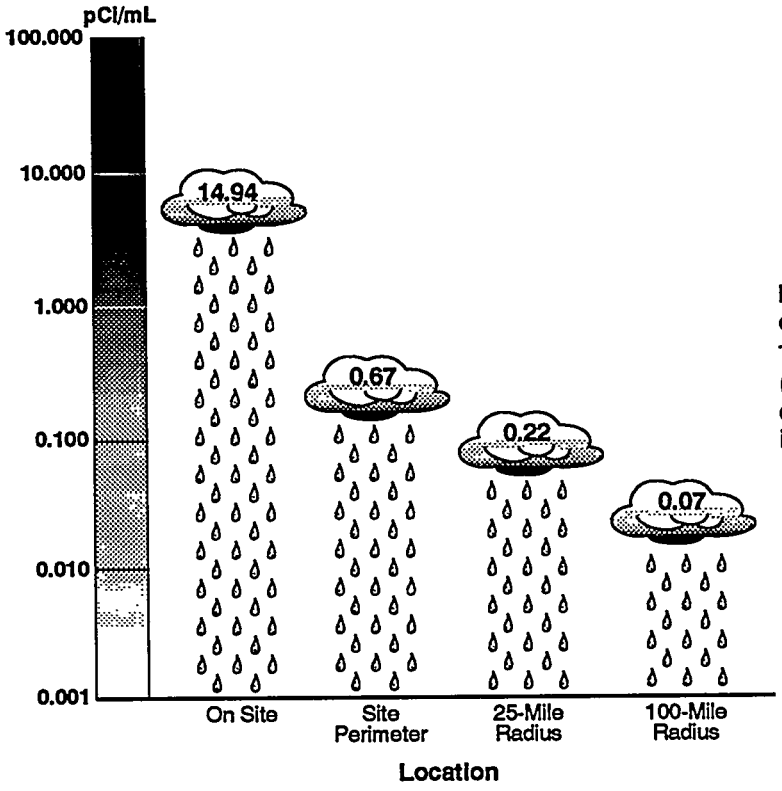

Figure 6–3 Average Concentration of Tritium in Rainwater

Tritium concentrations in rainwater (shown here in pCi/mL), generally decrease as the distance from the site increases.

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monitoring locations (designated as "614" buildings), population centers, and NRC/Vogtle Electric Generating Plant stations. The monitored population centers are within approximately a 50-mile radius of the site boundary (figure 6–4). The surveillance locations in each program are as follows:

- on site, 96 locations
- site perimeter, 179 locations
- air monitoring stations, 39 locations
- population centers, 62 locations
- NRC/Vogtle, 18 locations

Every three months, the TLDs are collected for analysis and replaced.

No major changes to the TLD program were implemented in 1994, but two additional locations around the Burial Ground (643–26E #1 and 643–26E #2) were added.

Surveillance Results

The surveillance results indicate gamma exposure levels consistent with those measured in 1993. Table 6–2 summarizes the maximum exposure rates observed in each surveillance network.

Most onsite measurements were no greater than levels observed on the site perimeter or at offsite locations. However, several onsite measurements were elevated, including those at F-Area, H-Area, E-Area, and N-Area (formerly Central Shops). As in previous years, the maximum exposure rate observed was on site. In 1994, the maximum annual integrated exposure was 315.4 mrem, which was measured on the E-Area perimeter at 643-G, site 3. This is substantially lower than the 1993 maximum of 460.4 mrem, measured at N-Area, site 5. As indicated in the quarterly data, routine operations at N-Area in 1994 resulted in an exposure rate reduction during the first two quarters of the year.

Exposure rates along the site perimeter and at offsite locations are consistent with historical levels. The measured rates show a high variability from location to location, but generally remain constant throughout the year at a particular site. The gamma radiation levels may vary significantly between two locations because of differences in the terrestrial, cosmic, and manmade components of natural background radiation. The U.S. Environmental Protection Agency (EPA) estimates an average outdoor exposure in Augusta of 84 mrem per year from cosmic and terrestrial radiation [Oakley, 1972]; the 1994 surveillance results are consistent with this figure.

E-Basin South. Seepage basin surveillance locations are shown in figure 6–5.

Seepage basin water is analyzed for gross alpha, gross beta, and tritium content. Analyses for specific radionuclides are determined by the makeup of previous releases to the basins.

Surveillance Results

Sampling results from 1994 for seepage basin water were similar to those from 1993, largely because liquid effluents no longer introduce new activity to the basins. The C-Area basin contained the highest beta activity, the majority of which was identified as cesium-137.

Site Streams

Continuous surveillance is used on several SRS streams, including Tims Branch, Upper Three Runs Creek, Four Mile Creek (also known as Fourmile Branch), Pen Branch, Steel Creek, and Lower Three Runs Creek. Stream water sampling locations that monitor below process areas serve to detect and quantify levels of radioactivity in liquid effluents that are being transported to the Savannah River. In 1994, 23 samplers on SRS streams served as environmental surveillance points. Stream surveillance locations are shown in figure 6–5.

Description of Surveillance Program

Stream samples are collected every week and analyzed as either weekly, biweekly, or monthly composites. Frequency and types of analyses performed on each sample are based on the potential quantity and type of radionuclides likely to be present in the water at the surveillance station. Generally, tritium determinations, gamma spectroscopy, and gross alpha and gross beta screening are performed on stream water. Monthly composites also are analyzed for strontium-89,90, another likely byproduct of SRS operations. Analytical schemes for particular stream locations are documented in the SRS EM Program.

Surveillance Results

The average gross alpha, gross beta, and tritium concentrations at downstream locations near the creek mouths are presented in table 6–3. A graph showing the average concentration over a 7-year period is presented in figure 6–6. The locations of these stations, well below all points at which radioactivity is introduced into the respective streams, ensure that adequate mixing has taken place and that a representative sample is being analyzed. Concentrations at surveillance station U3R-1A (above process effluents and runoff locations on Upper Three Runs Creek) and at an Edisto River surveillance station in the Aiken State Park above SRS are listed for comparison purposes in table 6–3. The following sections contain discussions of surveillance results from each of the major SRS creeks.

Tims Branch

A tributary of Upper Three Runs Creek, Tims Branch receives effluents from M-Area and SRTC. A surveillance point on Tims Branch, TB-5, is located downstream of all release points and before entry into Upper Three Runs Creek. Tritium was not above the lower limit of detection in Tims Branch in 1994, and gross alpha and beta measurements, while above the detection limits, are comparable to levels seen above SRS at the U3R-1A and the Edisto sampling locations.

Upper Three Runs Creek

Upper Three Runs Creek receives discharges from the Effluent Treatment Facility (ETF), flow from Tims Branch, effluent from the Naval Fuels Facility, and stormwater runoff from F-Area and H-Area. Tritium, the predominant radionuclide detected in Upper Three Runs Creek, is discharged primarily from the ETF. The average concentration of tritium in 1994 at U3R-4, located on SRS Road A, was (3.57 ± 2.31)E–06 µCi/mL, which was 18 percent of the 2.00E–05-µCi/

Table 6–2
TLD Surveillance Results Summary for 1994

Surveillance Network	Maximum Exposure (mrem per year)	Location
On site	315.4	643–G #3
Site perimeter	94.7	Location 49
Population centers	131.2	Saluda, S.C.
Air monitoring sites	116.8	Burial Ground North
NRC/Vogtle	80.3	NRC Site 5

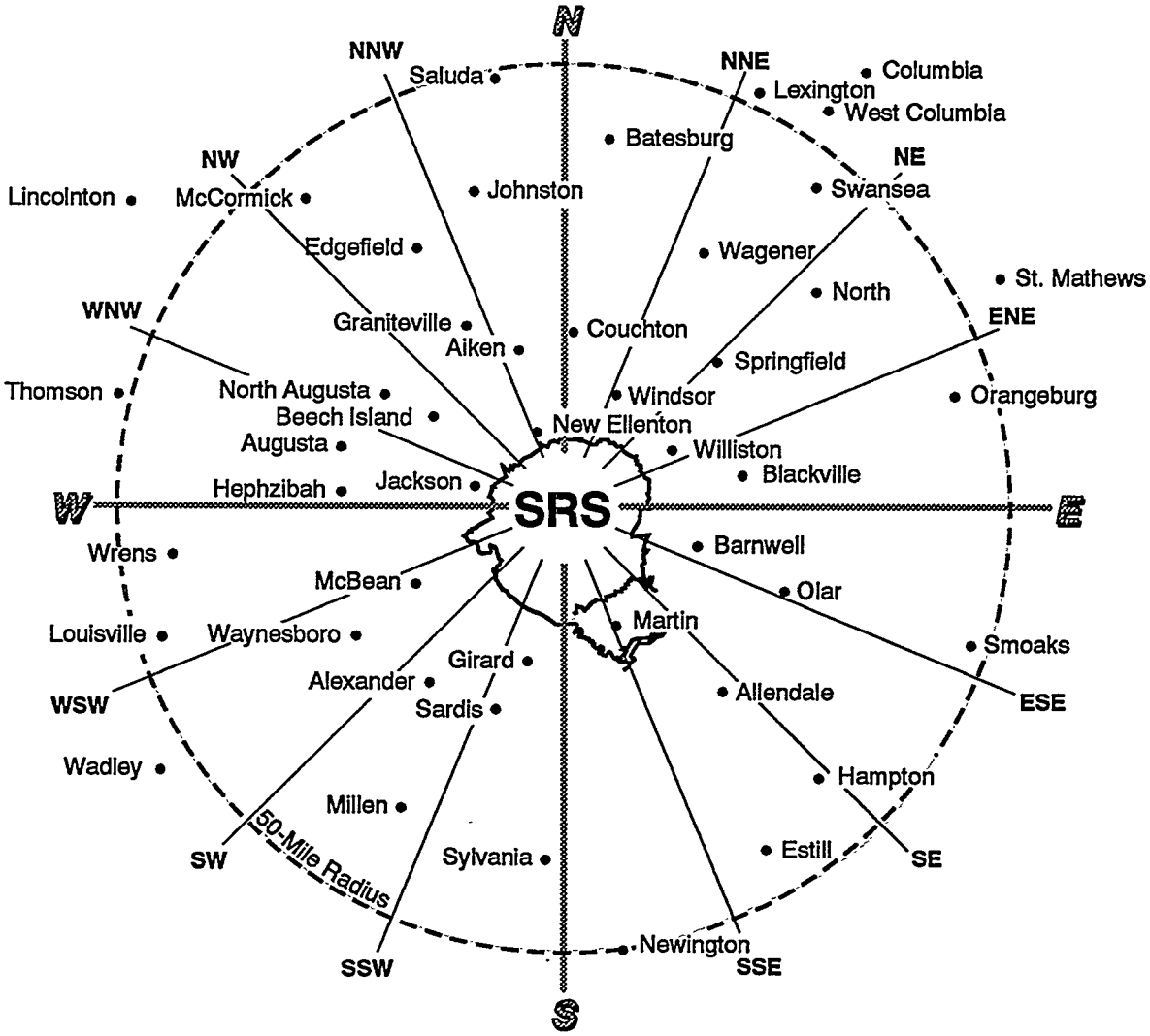

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Figure 6–4 Offsite TLD Surveillance Locations
Ambient gamma exposure rates are monitored in cities and towns within a 50-mile radius of SRS.

Seepage Basins

During previous years of operation, SRS discharged liquid effluent to seepage basins to allow for the decay and natural removal of radioactivity in the water before it reached onsite streams. The practice of discharging water to the seepage basins was discontinued in 1988, but water accumulating in the basins from other sources continues to be monitored by EMS because of potential contamination from the basin soil.

Description of Surveillance Program

In 1994, aqueous samples were scheduled to be collected monthly from the Solid Waste Disposal Facility (SWDF) and TNX seepage basins and quarterly from the C-Area, L-Area, and P-Area seepage basins. Because of dry conditions, no samples were collected from the A-Area and P-Area seepage basins in 1994. As part of the E-Area expansion plan, EMS also monitors two basins, E-Basin North and

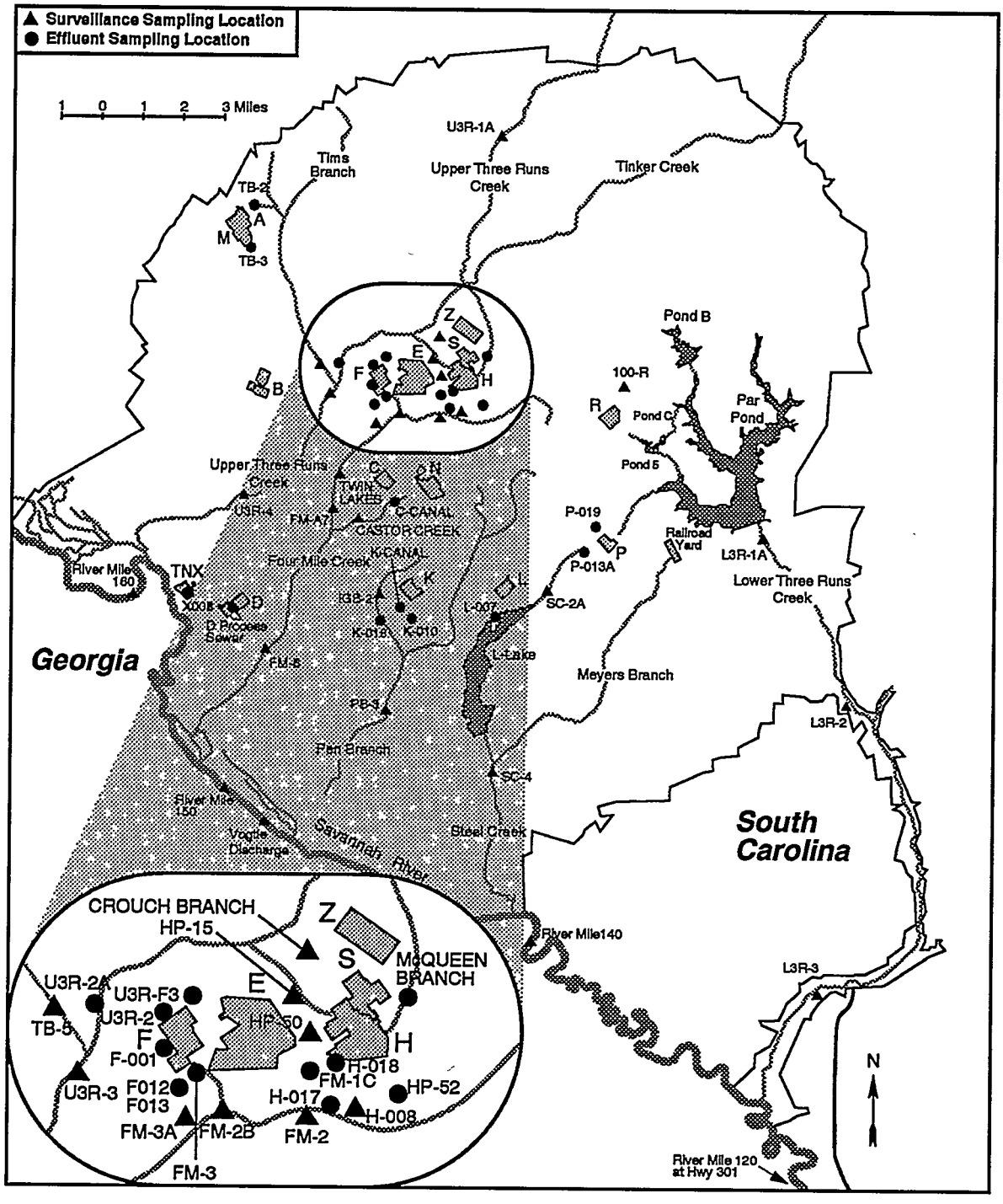

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Figure 6–5 Radiological Surface-Water Sampling Locations
Surveillance and effluent sampling points are located on SRS seepage basins and streams and on the Savannah River.

mL EPA drinking water standard for tritium. Gross alpha concentrations in Upper Three Runs Creek were slightly above those observed at the Edisto River station. The highest concentrations are believed to be caused by naturally occurring radium, thorium, and/or uranium from heavy mineral deposits common to waters in these sampling areas.

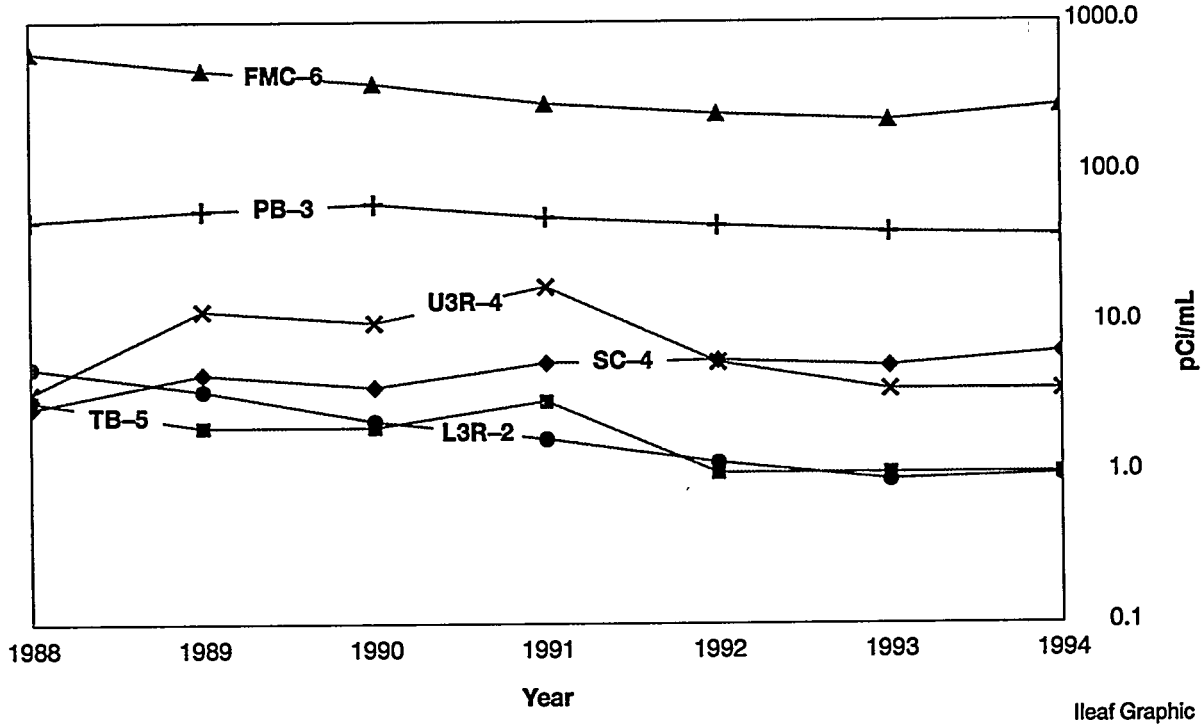

Figure 6–6 Average Tritium Concentration in SRS Streams, 1988–1994
Stream water analysis shows a fairly steady decrease in the concentration of tritium in SRS streams.

Four Mile Creek

Four Mile Creek receives effluents from F-Area, H-Area, and C-Area, as well as from water that has migrated from seepage basins and is outcropping into the stream. Four Mile Creek transported the majority of radioactivity present in SRS streams in 1994, mostly in the form of gross beta-gamma activity and tritium. The gross beta-gamma is made up of strontium-89,90 (outcropping from retired seepage basins) and cesium-137 (from direct releases and resuspension of activity deposited in the streambed). The amount of tritium transported in Four Mile Creek was approximately 64 percent of the total amount reaching the Savannah River in 1994. Because the highest tritium concentrations are present at surveillance points along Four Mile Creek, and not at the stations monitoring direct releases, most of the tritium transport is due to outcropping activity from retired seepage basins and from the SWDF. This activity is expected to decrease as a result of the closure of the F-Area and H-Area seepage basins in 1988.

Pen Branch

Pen Branch receives discharges from K-Area and flow from a tributary, Indian Grave Branch. Because K-Reactor did not operate in 1994, tritium detected in Pen Branch was due to water entering from Indian Grave Branch, which carries tritium outcropping from the K-Area percolation field and seepage basins. The average tritium concentration at PB-3 was (3.83 ± 0.34)E–05 µCi/mL in 1994, or virtually unchanged from the level observed in 1993.

Steel Creek

Steel Creek receives releases from L-Area effluents and tritium migration from P-Area seepage basins. When P-Area diverts water away from PAR Pond to Steel Creek, the area's discharges are transported to the stream. All releases enter L-Lake, water from which overflows into Steel Creek and is monitored at SC-4. Gross alpha and gross beta concentrations at SC-4 were below detection limits, with tritium being detected at an average concentration of (6.35 ± 0.59)E–06 µCi/mL. Because the highest tritium concentration, (9.49 ± 0.14)E–05 µCi/mL, is measured at the surveillance station at SC-2A, and not at the direct-release monitoring stations in L-Area and P-Area, activity being transported in Steel Creek is attributed to outcropping from the P-Area seepage basins.

Lower Three Runs Creek

Lower Three Runs Creek receives overflow from PAR Pond, a manmade pond that receives discharges from P-Area. Gross beta concentrations in PAR Pond and

Lower Three Runs Creek are above detection limits; this is attributable to low concentrations of cesium-137 from previous releases during P-Area and R-Area operations. Tritium concentrations in Lower Three Runs Creek are at background levels.

Savannah River

Continuous surveillance is performed along the Savannah River at points above and below SRS and below the point at which Plant Vogtle liquid discharges enter the Savannah River. In 1994, five locations along the river served as environmental surveillance points. River sampling locations are shown in figure 6–5.

Description of Surveillance Program

The Savannah River, which provides SRS its western boundary for a 35-mile stretch, is analyzed to determine what effect the site's effluents have on the river water. Gross screening for alpha and beta emitters, along with determinations of specific radionuclides, such as tritium, strontium-89,90, and gamma emitters, is performed on weekly, biweekly, and monthly composites.

Surveillance Results

Gross Alpha, Gross Beta, and Tritium

The average concentrations of gross alpha, gross beta, and tritium at river locations are presented in table 6–4. The order of the locations begins at RM–160, above the site, and ends at RM–120, after all site streams enter the Savannah River. Samplers situated between RM–160 and RM–120 are located at regular intervals along the SRS boundary and where Plant Vogtle discharges feed into the river.

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The highest average concentration in 1994, (2.09 ± 1.09)E–06 μCi/mL, was measured at RM–150. The average concentration above SRS, measured at RM–160, was (1.44 ± 1.83)E–07 μCi/mL. The average concentration at RM–120, located on U.S. Highway 301 below SRS, was (1.27 ± 0.47)E–06 μCi/mL. The RM–120 concentration was 6 percent of the 2.00E–05-μCi/mL drinking water standard set by EPA for tritium in drinking water.

Tritium Transport in Streams and River

Tritium is introduced into SRS streams and the Savannah River via production areas on site. Because

Table 6–3
Average 1994 Concentration of Radioactivity in SRS and Surveillance Station Waters (μCi/mL)

Location[a]	Gross Alpha	Gross Beta	Tritium
Lower Limits of Detection	6.23E–10	1.55E–09	1.30E–06[b]
Onsite			
Tims Branch (TB–5)	(1.71 ± 0.79)E–09	(2.13 ± 0.87)E–09	(1.18 ± 0.55)E–06
Upper Three Runs (U3R–4)	(1.57 ± 0.79)E–09	(1.19 ± 0.52)E–09	(3.57 ± 2.31)E–06
Four Mile Creek (FMC–6)	(3.02 ± 2.92)E–10	(1.21 ± 0.21)E–08	(2.75 ± 0.37)E–04
Pen Branch (PB–3)	(1.59 ± 2.34)E–10	(1.23 ± 0.67)E–09	(3.83 ± 0.34)E–05
Steel Creek (SC–4)	(0.37 ± 1.80)E–10	(1.35 ± 0.58)E–09	(6.35 ± 0.59)E–06
Lower Three Runs (L3R–2)	(1.84 ± 2.81)E–10	(1.79 ± 0.83)E–09	(9.75 ± 3.46)E–07
Surveillance Station			
Upper Three Runs (U3R–1A)	(1.49 ± 0.85)E–09	(9.40 ± 5.78)E–10	(4.58 ± 3.08)E–07
			Tritium
Lower Limit of Detection			4.07E–07[c]
Offsite Surveillance Station			
Edisto River	(9.00 ± 5.73)E–10	(1.21 ± 0.57)E–09	(1.61 ± 1.85)E–07

a Site surveillance locations are near mouths of streams.
b Lower limit of detection for tritium by short count
c Lower limit of detection for tritium by long count

Table 6–4
Average 1994 Concentration of Radioactivity in the Savannah River (μCi/mL)

Location Lower Limits of Detection	Alpha 6.23E–10	Gross Beta 1.55E–09	Tritium 4.07E–07
RM–120	(1.08 ± 2.40)E–10	(1.65 ± 0.65)E–09	(1.27 ± 0.47)E–06
RM–140	(1.40 ± 2.85)E–10	(1.66 ± 0.67)E–09	(1.60 ± 0.59)E–06
RM–150	(1.80 ± 2.25)E–10	(1.66 ± 0.71)E–09	(2.09 ± 1.09)E–06
Vogtle discharge	(1.57 ± 2.84)E–10	(1.62 ± 0.67)E–09	(1.22 ± 1.16)E–06
RM–160	(1.04 ± 2.34)E–10	(1.59 ± 0.66)E–09	(1.44 ± 1.83)E–07

of the mobility of tritium in water and the quantity of the radionuclide released during the years of SRS operations, a tritium balance has been performed annually since 1960. The balance is evaluated among the following alternative methods of calculation:

- tritium releases from effluent release points and calculated seepage basin migration (direct releases)
- tritium transport in SRS streams and the last sampling point before entry into the Savannah River (stream transport)
- tritium transport in the Savannah River downriver of SRS after subtraction of any measured contribution above the site (river transport)

Figure 6–7 shows graphic and numeric summaries of the last 35 years of direct releases, stream transport, and river transport determined by EMS.

In 1994, tritium transport continued a downward trend from the highs registered in the mid-1960s. The decrease is attributed to a slowdown in production activities on site.

General agreement between the three calculational methods of annual tritium transport—measurements at the source, stream transport, and river transport—serves to validate SRS sampling schemes and counting results. Differences between the various methods can be attributed to uncertainties arising in the collection and analytical processes, including determinations of water flows and varying transport times. Because of the close agreement, and because it can be independently verified by offsite agencies, the river transport value has been chosen for use in annual environmental dose calculations.

Drinking Water

EMS collects drinking water samples from locations at SRS, in surrounding towns and communities, and at water treatment facilities that use Savannah River water. Potable water from surrounding communities is analyzed to ensure that SRS operations are not adversely affecting the water supply and to provide voluntary assurance that drinking water is below EPA drinking water standards for radionuclides.

Description of Surveillance Program

Sampling on site consists of monthly grab samples at production areas and quarterly grab samples at nonproduction and perimeter stations. Semiannual collection is performed at towns within a 30-mile radius of the site. Collected monthly are samples from

- two water treatment plants downriver of SRS that supply treated Savannah River water to Beaufort and Jasper counties in South Carolina and to Port Wentworth, Georgia
- the North Augusta (South Carolina) Water Treatment Plant
- the D-Area treatment facility on site

At all these facilities, raw and finished water samples are collected daily and composited for analysis by EMS. All drinking water samples are screened for alpha and beta emitters and analyzed specifically for tritium. Drinking water samples also are analyzed at least once a year for strontium-89,90. Offsite drinking water sampling locations are shown in figure 6–8.

Surveillance Results

Gross Alpha and Gross Beta

All drinking water samples collected by EMS are screened for gross alpha and gross beta concentrations to determine if activity levels warrant further analysis. No samples collected in 1994 exceeded EPA's 1.50E–08-μCi/mL alpha activity limits or 5.00E–08-μCi/mL beta activity limits. The highest average alpha concentration—(8.15 ± 1.39)E–09 μCi/mL at the 701-5G Aiken Barricade (Talatha

Gate)—has been characterized for specific alpha activity, with at least a partial source of activity due to radium-226. One TNX sample average exceeded 8.00E–09 μCi/mL of beta activity. This concentration is the EPA limit for strontium-90, which is the most restrictive beta-emitting radionuclide. However, specific analysis of the sample for strontium-89,90 did not show detectable activity. [SRS Data, 1995].

Strontium

No drinking water samples collected and analyzed by EMS for strontium-89,90 exceeded the 1.90E–09-μCi/mL detection limit of the EMS laboratories. This limit is approximately 25 percent of the EPA drinking water standard for strontium-90.

Tritium

No drinking water samples collected and analyzed by EMS exceeded the 2.00E–05-μCi/mL EPA tritium limit. Detectable levels of tritium were present in the drinking water samples collected monthly from the Beaufort-Jasper and Port Wentworth water treatment facilities. These levels reflect the introduction of tritium from SRS operations into the Savannah River. The average tritium concentration in finished water at Beaufort-Jasper in 1994, (7.84 ± 4.25)E–07 μCi/mL, was 4 percent of the EPA drinking water limit, as was the average tritium concentration at Port Wentworth, (8.03 ± 4.24)E–07 μCi/mL.

Terrestrial Food Products

Description of Surveillance Program

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically found in the Central Savannah River Area (CSRA). Because radioactive materials can be transported to man through the consumption of milk and other food products containing radioactivity, food product samples are analyzed to determine what effects, if any, SRS operations have on them. Data from the food product surveillance program are not used to

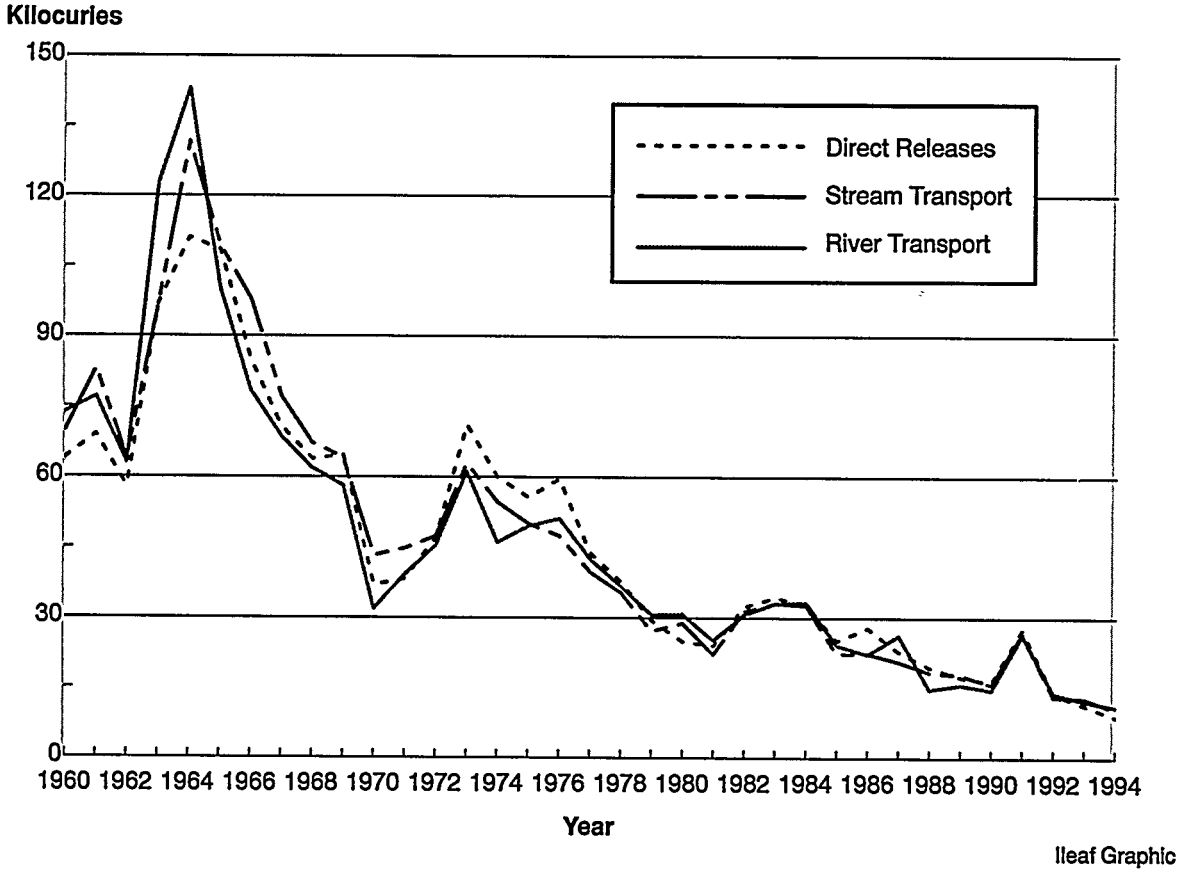

Figure 6–7 SRS Tritium Transport Summary, 1960–1994
SRS has maintained a tritium balance of direct releases, stream transport, and river transport since 1960 in an effort to account for and trend tritium releases in liquid effluents from the site. The general downward slope over time indicates that tritium transport has decreased as production has slowed and effluent controls have been developed.

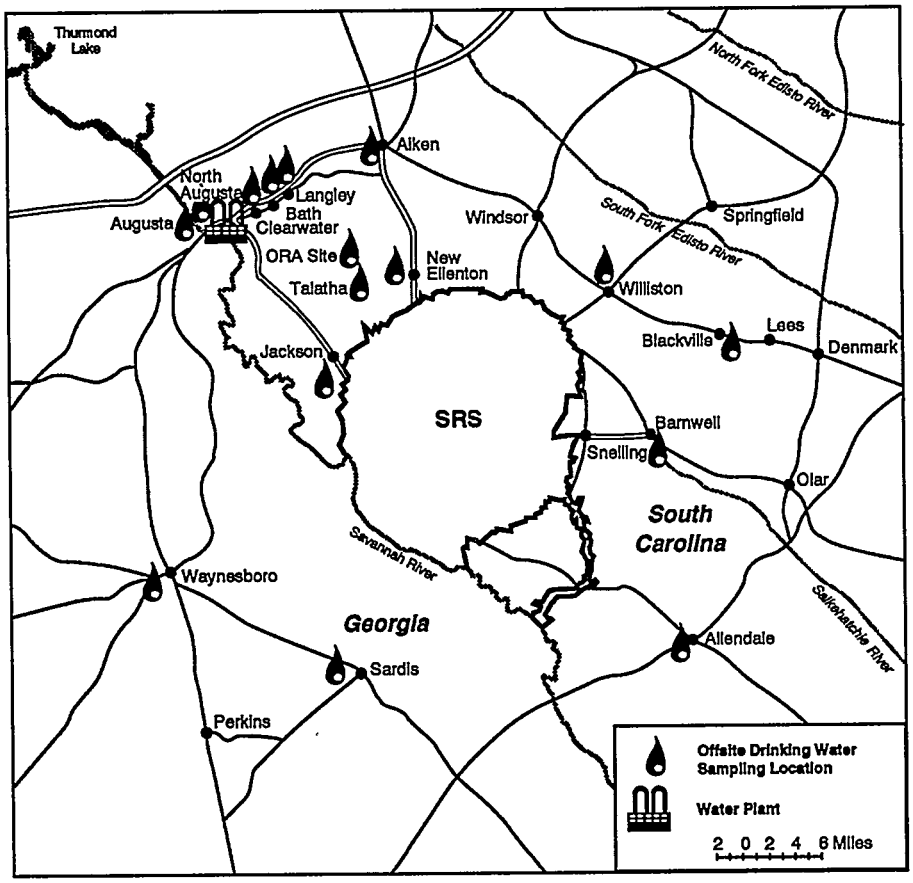

Figure 6–8 Radiological Offsite Drinking-Water Sampling Locations
SRS collects drinking water samples from 16 offsite locations within a 30-mile radius and from three water treatment plants, one of which is shown on the map.

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show direct compliance with any dose standard; however, the data can be used as required to verify dose models and determine environmental trends.

Farm products, including fruit, wheat, corn, soybeans, poultry, beef, pork, peanuts, milk, eggs, and truck crops (edible cultivated plant materials) are collected throughout the year from 24 locations surrounding SRS. Collards—collected annually from the Columbia, South Carolina, area—are used as control samples. Food products are collected at perimeter and 25- and 50-mile-radius locations. Figure 6–9 shows the 50-mile sampling locations—one in each of four geographical quadrants—which were added to the food products sampling program in 1993.

Food samples are analyzed for gamma-emitting radionuclides, tritium, strontium-89,90, uranium and plutonium (nonspecific), plutonium-238, and plutonium-239.

During 1994, EMS collected milk samples monthly at five dairies within a 25-mile radius of SRS, at four dairies within a 50-mile radius, and from locally produced inventories of a major distributor.

Milk samples are analyzed for tritium and gamma-emitting radionuclides, primarily cesium-137 and iodine-131. Additional milk samples are collected quarterly and analyzed for strontium-90.

Surveillance Results

Gamma-Emitting Radionuclides

The only manmade gamma-emitting radionuclide detected in food was cesium-137. The maximum concentration, (4.69 ± 1.03)E–02 pCi/g, was measured in greens from the southwest quadrant 50-mile-radius location. Cesium-137 concentrations at the control location were below detection limits. Generally, concentrations of cesium-137 in indicator samples were similar to those measured at the control location, although some locations showed detectable activity. These concentrations were similar to those observed in previous years.

Cesium-137 was the only manmade gamma-emitting radionuclide detected in milk samples during 1994. Measured concentrations ranged from a high of (5.87 ± 0.89)E–03 pCi/mL to a low of (2.52 ± 0.91)E–03 pCi/mL. The mean concentrations measured in 1994 were similar to those measured in 1993.

Iodine-131 was not detected in any 1994 milk samples. Because of its short physical half-life (8 days), iodine-131 generally is not detected, except shortly after tests of nuclear weapons or in the wake of events such as the Chernobyl incident. There were no announced nuclear weapons tests or other major nuclear incidents in 1994.

Tritium

Tritium concentrations ranged from below detection limit in several samples to a high of 1.29 ± 0.04 pCi/g, measured in collards from the vicinity of Wade Plantation in Georgia. The cause of this unusually high result is unknown. With this exception, tritium concentrations were similar to those measured in 1993.

Tritium in milk is attributed to releases from SRS. Milk from most dairies showed detectable concentrations of tritium at some point during 1994. The maximum concentration for the perimeter and 25-mile-radius locations, (9.60 ± 1.54)E–01 pCi/mL, was measured at the Girard, Georgia, location. The minimum concentration from these locations was below detection limits. Tritium concentrations measured in milk in 1994 were similar to those in 1993 and generally reflect atmospheric releases from the site.

The maximum tritium concentration detected in milk from the 50-mile-radius locations, (7.21 ± 1.33)E–01 pCi/mL, was measured in a sample from the northeast quadrant. The minimum tritium concentration at the 50-mile radius also was below detection limits. As expected, the concentrations of tritium in milk measured at the 50-mile locations were slightly lower than those observed at the perimeter and 25-mile locations.

Strontium

With the exception of collards, all concentrations in food products were below the detection limit of 1.0 E–01 pCi/g. Concentrations of strontium-89,90 in food products ranged from below detection limit in several samples to a high of (1.64 ± 0.85)E–01 pCi/g in greens. The strontium-89,90 concentrations measured in food products were within the ranges observed during past years.

Strontium-90 analysis was performed on milk from the perimeter and 25-mile sample locations. Measured concentrations ranged from a high of (4.58 ± 1.49)E–03 pCi/mL in the Denmark, South Carolina, area to a low below detection limits. The mean concentrations measured in 1994 were similar to those measured in 1993.

Uranium/Plutonium

Most concentrations of total uranium and plutonium (nonspecific) in food products were not detectable. The highest concentration, (4.58 ± 1.15)E–02 pCi/g, was measured in greens collected from the northwest quadrant. This concentration was slightly lower than the 1993 maximum concentration of (5.11 ± 1.18)E–02

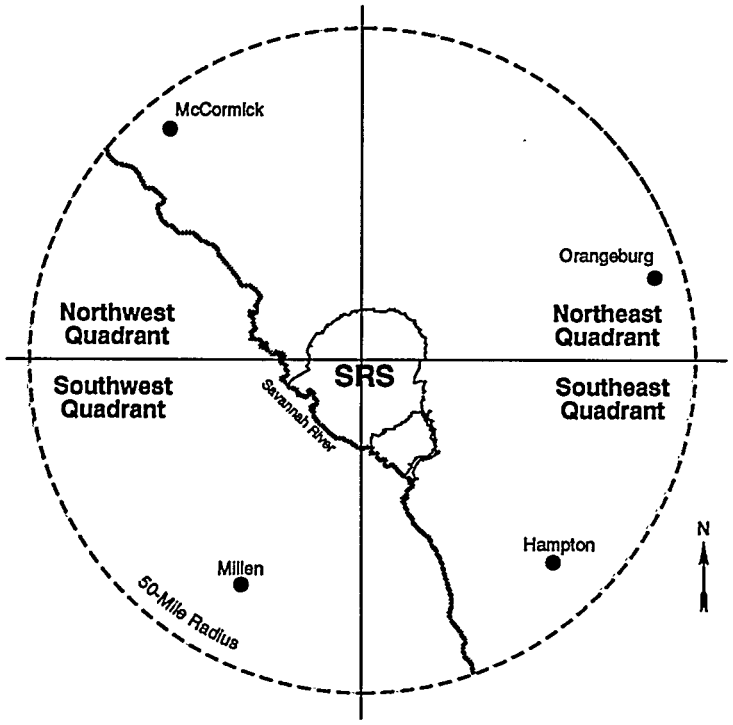

Figure 6–9 Radiological Food-Product 50-Mile Sampling Locations

In 1993, the food product sampling program was expanded to include 50-mile-radius locations. The collection points correspond to general geographic areas because exact locations vary from year to year and crop to crop.

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In 1994, SRS collected milk samples monthly at five dairies within a 25-mile radius of the site, at four dairies within a 50-mile radius, and from locally produced inventories of a major distributor.

pCi/g, which was measured in collards from the Gracewood, Georgia, vicinity.

Concentrations of plutonium-238 in food products during 1994 ranged from below detection limits to a high of (1.67 ± 0.45)E–04 pCi/g, measured in collards collected from the Springfield, South Carolina, vicinity. Plutonium-239 concentrations in food products ranged from below detection limits to a high of (8.85 ± 3.13)E–05 pCi/g in fruit from the Jackson, South Carolina, vicinity. Plutonium-238 and plutonium-239 concentrations measured in food products during 1994 were similar to the 1993 concentrations.

Aquatic Food Products

Description of Surveillance Program

The aquatic food product surveillance program consists of both fish and shellfish.

Nine surveillance points for the collection of fish are located on the Savannah River. These include

- the Augusta Lock and Dam area, above the site
- five areas where site streams enter the Savannah River
- the U.S. Highway 301 bridge, below the site
- Stokes Bluff Landing, below the site
- the U.S. Highway 17A bridge area, below the site

In addition to these nine locations, two points on the Edisto River are used as control locations—one for freshwater fish and the other for saltwater fish.

Nine surveillance points for fish collection also are located within the SRS boundary. These points include PAR Pond, L-Lake, Pond B, Lower Three Runs Creek, Upper Three Runs Creek, Beaver Dam Creek, Pen Branch, Steel Creek, and Four Mile Creek. In 1994, no fish could be collected from Upper Three Runs Creek, Beaver Dam Creek, Four Mile Creek, Pen Branch, Lower Three Runs Creek at Patterson Mill, Pond B, and the West Bank Landing on the Edisto River.

Fish from all the surveillance points are grouped into one of three categories: predatory fish, panfish, or bottom-dwelling fish. Largemouth bass were placed in the predatory group; bluegill, red-breast, and crappie in the panfish group; and catfish in the bottom-dwelling

group. The fish are grouped in this manner because they are the most sought-after fish in the Savannah River, according to the latest creel survey conducted by the Fisheries Management Section of the Georgia Department of Natural Resources Wildlife Resources Division.

In the shellfish surveillance program, samples of oysters and crabs are collected on the coast near Savannah, Georgia.

Surveillance Results

In the following surveillance results discussion, uncertainty values are provided because most measurements were at or near the LLD.

Fish

Savannah River Fifty-three edible composites and 39 nonedible composites of fish from the Savannah River were analyzed in 1994 for gross alpha and gross beta.

Gross alpha activities in the offsite edible composites ranged from (2.69 ± 2.09)E–01 pCi/g to (–9.94 ± 8.89)E–02 pCi/g. The maximum gross alpha activity in an edible composite was detected in a bottom dweller from the mouth of Beaver Dam Creek. The maximum gross alpha activity, in a nonedible composite, 1.12 ± 0.86 pCi/g, was measured in a panfish from the mouth of Lower Three Runs Creek.

The maximum edible gross beta activity from the Savannah River, 4.70 ± 0.56 pCi/g, was measured in panfish and bottom-dweller composites from the mouth of Lower Three Runs Creek. This concentration was slightly lower than the maximum nonedible gross beta activity, 9.03 ± 1.75 pCi/g, measured in a predator composite from the mouth of Lower Three Runs Creek.

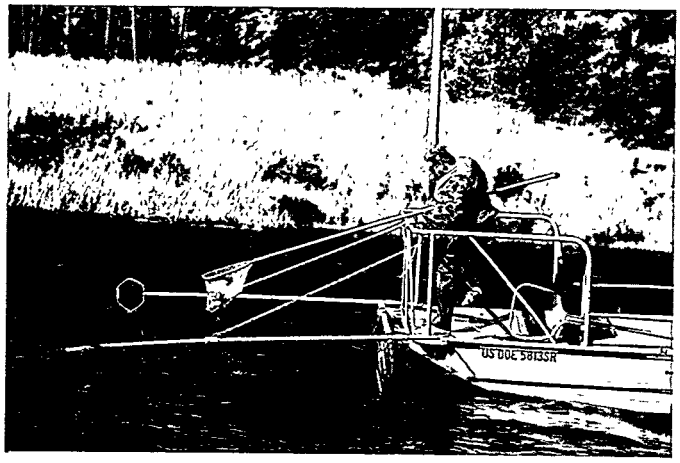
In 1994, composites of fish from the Savannah River were analyzed for gamma-emitting radionuclides. Figure 6–10 shows surveillance locations on the Savannah River and the control locations on the Edisto. Cesium-137 was the only manmade, gamma-emitting radionuclide detected. The maximum cesium-137 activity in edible fish from the Savannah River, 2.12 ± 0.06 pCi/g, was measured in composites of predators from the mouth of Steel Creek. The maximum cesium-137 concentration in nonedible fish from off site was 1.14 ± 0.05 pCi/g, measured in a predator composite from the mouth of Steel Creek.

In 1994, composites of edible portions were analyzed for both strontium-89,90 and strontium-90; composites of nonedible portions were analyzed only for strontium-90. The maximum strontium-89,90 concentration was (1.27 ± 0.55)E+00 pCi/g in a panfish sample from the mouth of Four Mile Creek. The maximum strontium-90 concentration in an edible composite was in a panfish from the mouth of Lower Three Runs Creek. This concentration, (2.25 ± 0.17)E–01 pCi/g, was higher than that measured at the Augusta Lock and Dam location, which is

Electroshocking of Fish

Electroshocking of fish has all but replaced the rod and reel as a means of catching fish for sampling at SRS. The electroshocking method saves time and money and enables EMS collectors to obtain more representative samples of fish.

EMS collectors use a boat equipped with two lines that carry positive electrical charges (anodes) and leads that attract these positive charges (cathodes). The electricity flows through the anodes into the water and back to the cathodes, completing a circuit. The electrical current immobilizes fish within the circuit so they can be caught with insulated dip nets.



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EMS collects samples each year from three categories of fish—bottom dwellers (catfish), panfish (bluegill, red-breast, and crappie), and predators (bass). Electroshocking is used at three onsite and 10 offsite locations, while rods and reels are used only in areas not accessible to the electroshocking boat.

EMS has been collecting fish through electroshocking since 1991.

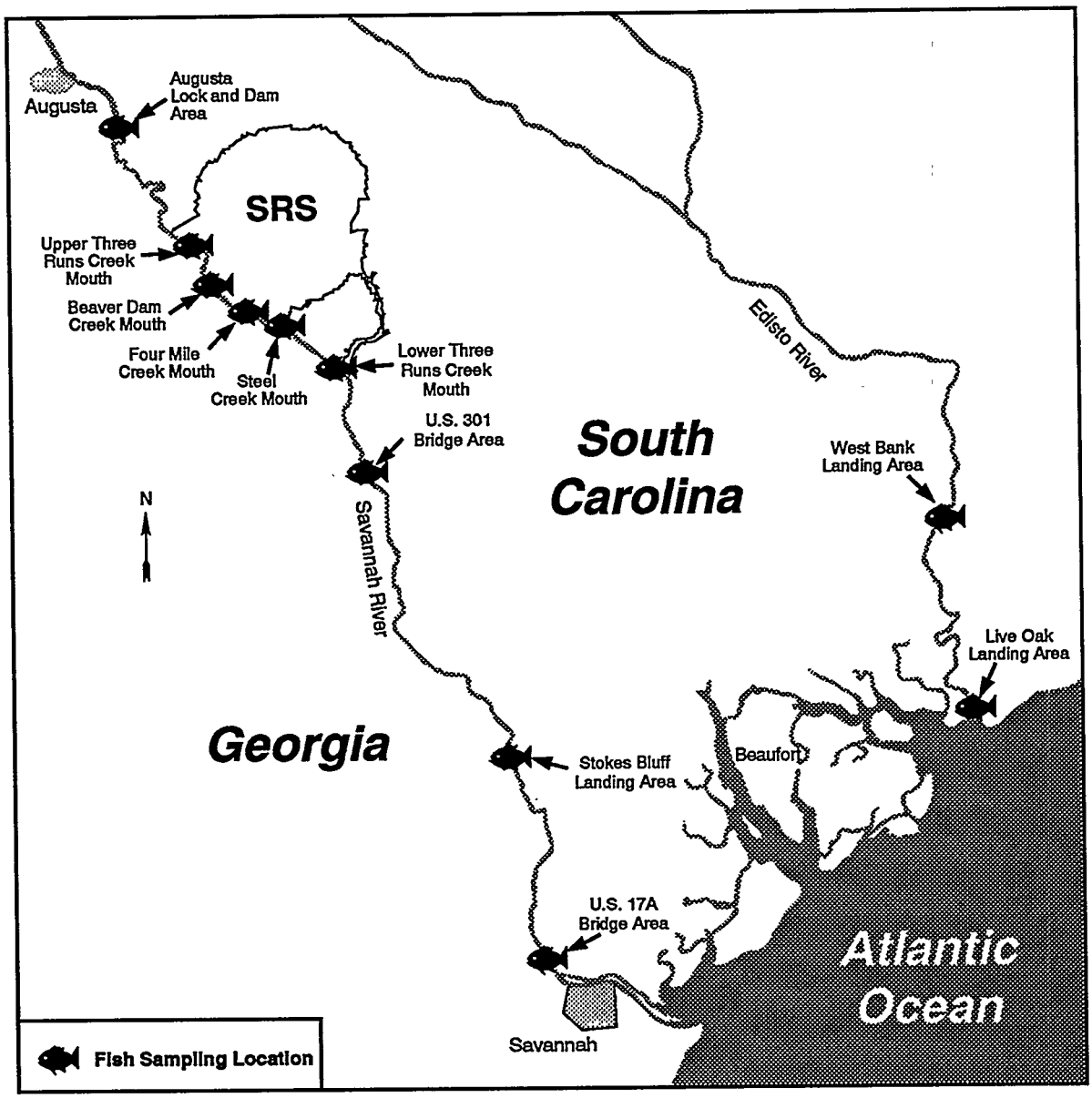

Figure 6–10 Fish-Sampling Points on the Savannah River and at Control Locations
SRS collects fish from the Savannah River above, adjacent to, and below the site, and near the river mouth, as well as from the Edisto River at two control locations. (No fish were caught at the Live Oak Landing Area control location in 1994.)

upriver of SRS. The maximum strontium-90 concentration in an edible composite from the Lock and Dam location, (5.86 ± 3.94)E–03 pCi/g, was measured in a predator. Similarly, the maximum strontium-90 concentration in a nonedible portion came from a site stream mouth, rather than from the Augusta Lock and Dam location. The highest strontium-90 concentration in a nonedible portion at the Augusta Lock and Dam location was (1.39 ± 0.31)E–01 pCi/g in a predator, and the highest concentration at a site stream mouth was (1.39± 0.13)E+00 pCi/g in a bottom dweller from Four Mile Creek.

Maximum tritium concentrations were similar at all locations, with two exceptions. Four Mile Creek Mouth and Steel Creek Mouth edible composites yielded maximum concentrations of 1.49 ± 0.04 pCi/g and 1.31 ± 0.03 pCi/g, respectively. The maximum tritium concentration measured at the Augusta Lock and Dam

location, (3.60 ± 1.58)E–02 pCi/g, was in a predator composite.

Onsite Streams and Ponds Gross alpha and gross beta analyses were performed on edible fish composites collected from SRS streams and ponds. Maximum gross alpha and gross beta concentrations—(2.33 ± 2.47)E–01 pCi/g and (1.42 ± 0.09)E+01 pCi/g, respectively—were measured in predator composites from PAR Pond. Minimum gross alpha and gross beta concentrations—(–1.19 ± 0.93)E–01 pCi/g and 1.12 ± 0.32 pCi/g, respectively—were measured in predator composites from L-Lake.

Cesium-137 was the only manmade, gamma-emitting radionuclide detected in fish from onsite streams and ponds. The maximum cesium-137 concentration in an onsite edible composite, (1.27 ± 0.02)E+01 pCi/g, came from a PAR Pond predator composite. PAR Pond fish contain higher concentrations of cesium-137 than fish from other onsite locations—probably because the pond received discharges of R-Reactor effluents. R-Reactor was operated from the late 1950s until 1964, when it was shut down permanently. During this period, R-Reactor released approximately 170 Ci of cesium-137. The current source of cesium-137 probably is sediment in PAR Pond.

Shellfish

Only one sample of shellfish—oysters, from near the mouth of the Savannah River—was collected in 1994. Analytical results showed that no manmade isotopes above the detection limit were present in the sample.

Deer and Hogs

Description of Surveillance Program

Annual hunts, open to members of the general public, are conducted at SRS to control the site's deer and feral hog populations and to reduce animal-vehicle accidents. Before any animal is released to a hunter, EMS performs field analysis for cesium-137 using portable sodium iodide detectors. The resulting dose from consumption is calculated for each animal, and each hunter's cumulative total is tracked. Media samples (muscle and/or bone) are collected periodically for laboratory analysis based on a set frequency (every 10 animals) and/or exposure limits.

Muscle samples also were collected from offsite animals (deer). The samples were collected from private hunt clubs located within four quadrants (northeast, northwest, southeast, and southwest) surrounding SRS, at a distance of approximately 50 miles from the center of the site. The samples were analyzed for gamma-emitting radionuclides to determine regional background levels of cesium-137 in deer.

Surveillance Results

During the 1994 hunts, 1,591 deer and 106 hogs were harvested from the site. This compares to 1,553 deer and 147 hogs harvested in 1993. The number of hunts, 14, was the same in 1994 and 1993.

Gamma-Emitting Radionuclides

Onsite In 1994, the maximum field measurement of cesium-137 concentration in deer muscle was 29 pCi/g. Similarly, the maximum field measurement of cesium-137 concentration in feral hog muscle was 6 pCi/g. The average cesium-137 concentration in animals from the 1994 hunts was 6 pCi/g[a].

Field measurements are supplemented by laboratory analysis of approximately 10 percent of the animals taken each year. These animals include every 10th animal processed, as well as every animal that results in an individual dose exceeding 25 mrem—either alone or in combination with previous animals killed. In 1994, 206 samples from 184 animals were collected and analyzed for gamma-emitting isotopes.

As in previous hunts, cesium-137 was the only manmade radionuclide detected. Cesium-137 concentrations measured by the field and laboratory methods were comparable. The cesium-137 concentrations measured in the laboratory ranged from 0.55 pCi/g to 28.86 pCi/g, while those in the field ranged from 1 pCi/g to 29 pCi/g.

Offsite A total of 108 samples were collected from the four quadrants. As in previous years, the only manmade radionuclide detected was cesium-137, which was detected in 83 of the samples at concentrations ranging from 0.06 pCi/g to 4.48 pCi/g. These levels generally were consistent with those observed in offsite animals during previous years.

a Because of post-hunt problems encountered with the field computer used during the deer hunts, neither the overall average cesium-137 concentration nor an average concentration by animal type (deer and feral hog) could be retrieved. Thus, the average cesium-137 concentration from the 1994 hunts is not the average of all 1,697 animals taken; rather, it represents the average of a subset (184 animals) collected for laboratory analysis, as described previously. As a result, the reported cesium-137 concentration from 1994 may be slightly higher than the actual average cesium-137 concentration.

Strontium

Tissue from 42 animals (40 deer and 2 feral hogs) was collected for strontium-89,90 analysis. Muscle samples were taken from all 42 animals, and bone samples were taken from 21 (20 deer and one feral hog) of the 42 animals.

Only one of the muscle samples showed strontium-89,90 levels above the detection limit. The sample, from a deer, had a concentration of 0.098 pCi/g. These results were consistent with those observed in 1993.

All 21 bone samples showed strontium-89,90 in quantities above the detection limit; the concentrations ranged from 1.44 pCi/g to 10.52 pCi/g. Higher concentrations of strontium occur in bone than in muscle because of the chemical similarity between strontium and calcium. Both of these elements, whether radioactive or stable, tend to concentrate in bone.

Turkeys

Description of Surveillance Program

Wild turkeys are trapped on site by the South Carolina Wildlife and Marine Resources Department and used to repopulate South Carolina game areas. All turkeys are monitored for cesium-137 with portable sodium iodide detectors before leaving SRS.

Surveillance Results

EMS monitored 82 turkeys in 1994. Concentrations of cesium-137 generally were similar to those measured in the past; however, the maximum concentration measured in 1994 was 10 pCi/g. The minimum was 1 pCi/g. This compares with a 1993 maximum of 5 pCi/g and minimum of 1 pCi/g.

Beavers

Description of Surveillance Program

The U.S. Forest Service administers a contract for the trapping of beavers in selected areas within the SRS perimeter. The purpose of trapping is to reduce the beaver population in specific areas of the site and thereby minimize dam-building activities that can result in flood damage to timber stands, primary and secondary roads, and railroad beds. All beavers are monitored for cesium-137 with a portable sodium iodide detector and disposed of in the SRS sanitary landfill.

Surveillance Results

EMS monitored 178 beavers in 1994. The maximum cesium-137 concentration was 22 pCi/g, measured in an animal trapped on Pen Branch, downstream of K-Area The minimum concentration was 1 pCi/g. This compares with a 1993 maximum of 47 pCi/g and minimum of 1 pCi/g. The maximum and minimum in 1992 were 14 pCi/g and 1 pCi/g, respectively.

Soil

The SRS soil monitoring program provides

- data for long-term trending of radioactivity deposited from the atmosphere (both wet and dry)
- information on the concentrations of radioactive materials in the environment

Routine and nonroutine SRS atmospheric releases, as well as worldwide fallout, are monitored in this program. The concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and in the mechanics of retention and transport in different types of soils. Because of this program's design, a direct comparison of data from year to year is not appropriate.

Description of Surveillance Program

Soil samples are collected annually from 18 uncultivated and undisturbed locations in F-Area, H-Area, S-Area, Z-Area, and E-Area and from four locations on the site perimeter. (figure 6–11). Two control locations approximately 100 miles from SRS—Savannah, Georgia, and Clinton, South Carolina—also are sampled.

Hand augers or other similar devices are used in sample collection. The samples are analyzed for gamma-emitting radioisotopes, strontium-89,90, plutonium-238, and plutonium-239. The rationale for each sampling site is explained in the SRS EM Program.

Surveillance Results

Gamma-Emitting Radionuclides

Cesium-137 was observed at levels above the detection limit (2.4E–02 pCi/g) at 18 of the 24 locations. The highest concentration detected on site was 1.01 pCi/g, from a sample taken near H-Area, and the lowest was 0.05 pCi/g, from a sample near S-Area. Concentrations averaged 0.38 pCi/g at the site perimeter and 0.12 pCi/g at the 100-mile-radius locations.

Plutonium

At only three locations—F-Area (west), Z-Area #7, and 643–26E–1 at the Burial Ground—was pluto-

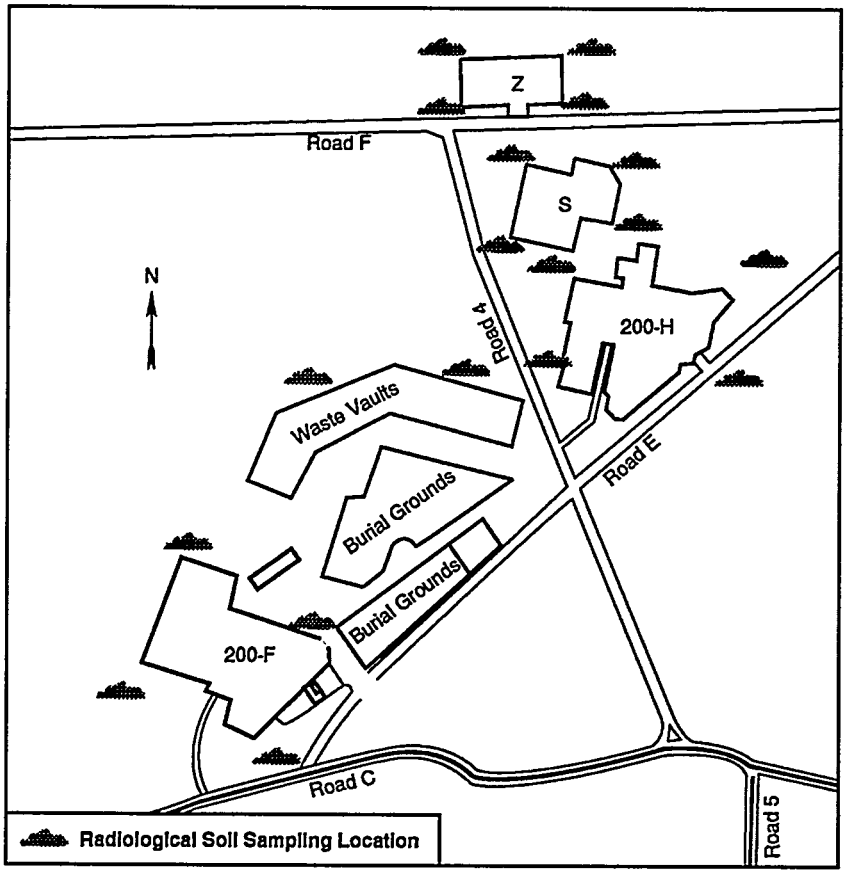

Figure 6–11 Radiological Soil Sampling Locations
SRS collected soil samples from 22 onsite locations (four perimeter locations not shown) and two offsite locations in 1994.

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nium-238 above the minimum detectable concentration. Plutonium-239, which historically had been seen in higher quantities, was observed in concentrations above the detection limit at seven locations, including the two offsite locations: Clinton (4.51E–03 pCi/g) and Savannah (1.78E–03 pCi/g).

Strontium

Samples from all locations were analyzed for strontium-89,90, and all but one were below the LLD for strontium-89,90 in soil (9.45E–02 pCi/g). The sample obtained in Clinton contained 0.143 pCi/g.

Sediment

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in stream beds and in the Savannah River bed. Because of the continuous deposition and remobilization occurring in the stream and river bed, significant year-to-year differences may be evident, but the data obtained can be used to observe long-term environmental trends.

Description of Surveillance Program

Sediment samples are collected annually at 15 locations: six in the Savannah River and nine in site streams (figure 6–12). Samples are obtained from the top 8 cm of sediment in areas where fine sediment accumulates and most radionuclides concentrate. Sediments are analyzed for gamma-emitting fission and activation products, strontium-89,90, plutonium-238, and plutonium-239.

Surveillance Results

Concentrations of radionuclides in river sediment during 1994 were similar to those detected upriver in the control sample from Demier's Landing. Results obtained from onsite streams tended to be higher than those in the river, reflecting contributions from past liquid releases. Maximum activities were observed in samples obtained from Four Mile Creek, which receives discharges from C-Area, H-Area, and F-Area, as well as radioactivity migrating from the H-Area and F-Area seepage basins and the SWDF.

Gamma-Emitting Radionuclides

Cesium-137 was the only manmade gamma-emitting radionuclide observed in river sediment. The highest

level was detected in sediment taken from the mouth of Lower Three Runs Creek, which was listed as a stream location in previous years. This location has shown higher than typical concentrations for the past 2 years. It is possible that this increase is caused by the changes in PAR Pond (chapter 12, "Special Surveys and Projects").

Cesium-137 concentrations were higher in stream sediments than in river sediments. This is to be

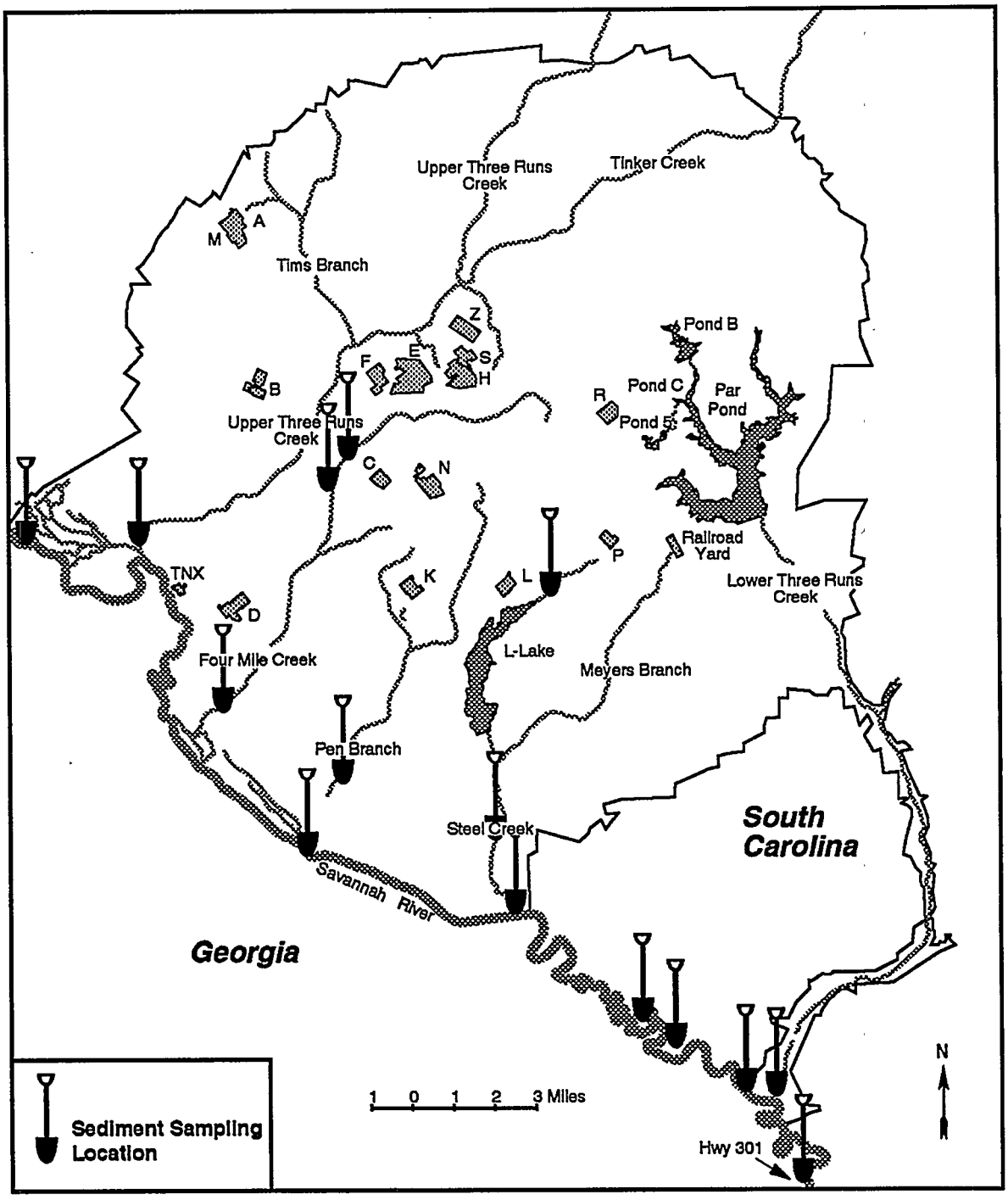

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Figure 6–12 Radiological Sediment Sampling Locations
Sediment samples were collected in 1994 at six Savannah River locations—upriver of, adjacent to, and downriver of the site—and nine site stream locations.

expected because the streams receive radioisotope-containing liquid effluents from the site. Most radionuclides settle out and deposit on the stream bed before reaching the river.

Cobalt-60 was detected in sediment from Four Mile Creek and Steel Creek.

Plutonium

Maximum concentrations of both isotopes of plutonium occurred at Four Mile Creek A-7A. As expected, concentrations of these isotopes in streams generally were higher than concentrations in the river. Changes observed when these data are compared to previous years probably are due to the effects of resuspension and deposition, which occur constantly in sediment media.

Strontium

The maximum strontium-89,90 concentration, which again occurred at Four Mile Creek A–7A, is higher than the result reported in 1993. The change in magnitude probably is due to the year-to-year variations cited earlier.

Vegetation

The radiological program for vegetation is designed to routinely collect and analyze samples from onsite and offsite locations to determine radionuclide concentrations. Vegetation samples are obtained to complement the soil and sediment samples in order to determine the environmental accumulation of radioactivity and help confirm the dose models used by SRS. Furthermore, the program provides information that can be used to determine the effect, if any, of various radioactive operations on the surrounding vegetation.

Typically, grasses are collected for vegetation because of their year-round availability. Bermuda grass is preferred because of its importance as a pasture grass for dairy herds.

Description of Surveillance Program

The onsite samples, collected on a seasonal or quarterly basis, are obtained from

- areas containing soil radionuclide concentrations that are expected to be relatively high
- areas receiving water that may have been contaminated

These onsite collection locations have been determined to be inside and around the many seepage and retention basins, SWDF, F-Area, H-Area, Z-Area, and S-Area.

Offsite vegetation generally is collected in close proximity to the environmental air monitoring stations, which are designated as "614" buildings.

Vegetation samples are analyzed for gamma-emitting radionuclides, tritium, gross alpha and gross beta, and strontium-89,90. These radionuclides, once deposited on the surface of the ground or vegetation, are prone to both vertical and horizontal transfer and can contaminate the local vegetation. EMS recognizes that terrestrial vegetation can be contaminated externally by the deposition of airborne activity and internally by water runoff or precipitation that contains radioactivity. While the program makes no attempt to differentiate between contributions of the external and internal contaminations, the contributions can be approximated given the local soil radionuclide concentrations.

Surveillance Results

The vegetation surveillance program can be divided into three broad areas: quarterly surveillance samples, annual seepage basin and retention basin samples, and quarterly and annual SWDF samples. All results are based on dry weight [SRS Data, 1995].

Quarterly Surveillance Samples

No changes were made in the quarterly surveillance sampling locations for vegetation during 1994. Vegetation samples continued to be collected from 40 onsite and offsite locations. Eighteen locations are on site; 14 are on the site perimeter; four are 25 miles from the site; and four are 100 miles from the site. Onsite locations are shown in figure 6–13.

The onsite locations are 2,000 feet from each of the F-Area and H-Area atmospheric discharge stacks. This distance was chosen to avoid production and construction activities within the areas. Also, the distance places most of the sampling sites outside high-security areas so they can be maintained more easily.

Sampling around S-Area and Z-Area was initiated in 1989 to obtain baseline information prior to the start of radioactive operations at these waste processing facilities. The locations continue to be sampled to determine the effects of the activities on the surrounding vegetation.

The site perimeter locations circle SRS to permit sampling within each 30-degree sector around the site.

The 25-mile-radius locations are used for the accumulation of data to be used for trending. The 100-mile-radius locations serve as control locations and provide historical baseline information.

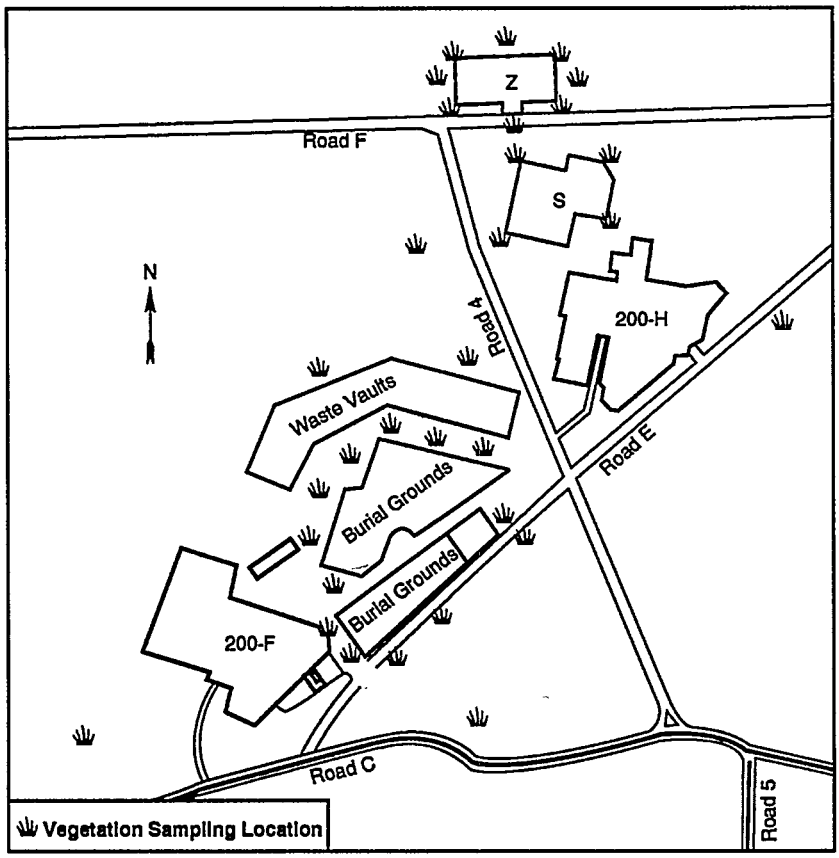

Figure 6–13 Radiological Onsite-Quarterly (18) and Outside-SWDF (13) Vegetation Sampling Locations

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EMS was able to obtain a quarterly sample from every location outside the SWDF except for OBG–4, OBG–12, and OBG–13. Samples were not obtained from these locations during the fall run because of an insufficient availability of grass. EMS also was unable to obtain a sufficient amount of grass at the OBG–4 location during the fourth quarter.

Gross Alpha and Gross Beta The 1994 data indicate that the gross alpha levels for the F-Area and H-Area composites are comparable to the 100-mile-radius composites. This is unexpected because these facilities are involved with the production/isolation of materials that are alpha emitters. An examination of the gross beta values shows there was no significant difference between the onsite surveillance locations and the surrounding control locations.

Many of the gross alpha results (both on and off site) were at or below the EMS LLD, as indicated by the large analytical uncertainty and negative concentrations. Even though many of the alpha concentrations are present at the LLD, it is appropriate to state that the data are comparable to that of previous years because the methods for collection, preparation, and analysis have not changed since 1992. Variations in worldwide fallout patterns and in concentrations of naturally occurring radionuclides in the soil contribute to the differences in the gross beta concentrations.

Gamma-Emitting Radionuclides Most vegetation samples are composited for analysis of gamma-emitting radionuclides. Samples are composited by area (F-Area, H-Area) and by radius (perimeter, 25-mile, and 100-mile). S-Area and Z-Area samples are not composited but are analyzed individually.

An abundance of naturally occurring radionuclides was detected on vegetation, which is to be expected. Cobalt-60, manganese-54, and cesium-137 were the only manmade gamma-emitting radionuclides detected on the 1994 vegetation samples. Cesium-137 was present in samples from most locations, but inferences are difficult because it was not detected in a large percentage of samples. In general, cesium-137, when detected at onsite locations, is present at a slightly higher level than at perimeter and offsite locations. The only exception was the first-quarter Barnwell Gate sample, which had concentrations comparable to some of the samples outside the SWDF.

Cobalt-60 was detected on the first-quarter sample from the Barnwell Gate location. A reanalysis of the sample, with greater sensitivity, confirmed the

presence of cobalt-60 and indicated the presence of manganese-54. The confirmation of cobalt-60 initiated an informal investigation that included an examination of the perimeter air surveillance results.

The review of the environmental air surveillance results revealed the presence of an elevated gross beta result from the Barnwell Gate location during the fourth quarter of 1993. A gamma spectral analysis of that filter paper identified the presence of cobalt-60 and manganese-54, which would explain the presence of the cobalt-60 and manganese-54 on the 1994 first-quarter vegetation sample.

Cobalt-60 also was detected on the first-quarter site perimeter composite, which is to be expected because the first-quarter composite included the previously cited Barnwell Gate sample.

Cobalt-60 and manganese-54 are manmade gamma-emitting radionuclides, but their presence cannot be logically connected to SRS operations. Cobalt-60 and manganese-54 are activation products, which generally result from nuclear power production activities. SRS does not have power production reactors or reactors that operated in 1994; therefore, the site lacked a sufficient source for production of the nuclides.

This is not to say that cobalt-60 cannot be released from the site. However, a review of the onsite effluent results did not identify a significant release of cobalt-60, either continuous or acute, that could have deposited the radionuclides at the given concentrations. Furthermore, historical results reveal that cobalt-60 typically is accompanied by a much higher concentration of cesium-137. Because there was no identified source term for the radionuclides and there was an absence of a substantially elevated cesium-137 concentration on the Barnwell Gate vegetation, it is unlikely that the presence of cobalt-60 and manganese-54 is due to SRS activities.

Strontium The strontium-89,90 levels for the F-Area and H-Area composites are comparable to the 100-mile-radius composites. Because 1993 strontium-89,90 levels for these locations were elevated when compared with 1993 100-mile-radius composites, and because strontium-90 is a long-lived radionuclide in the F-Area and H-Area tank farms, the results of this comparison were unexpected. The variability of the strontium-89,90 results from year to year can be attributed to the lack of homogeneity of strontium in the surrounding soils.

As was the case with the gross alpha results, some of the strontium-89,90 levels were at or below the EMS LLD, as indicated by the large analytical uncertainty and negative concentrations.

Tritium Onsite and perimeter tritium concentrations generally were higher than the concentrations in vegetation samples collected from the 25- and 100-mile-radius locations. These higher concentrations on site and at the perimeter are attributed to atmospheric tritium releases from SRS.

Seepage and Retention Basin Samples

Vegetation samples also are collected in the areas of seepage and retention basins. Vegetation is collected annually, and all samples from a specific operating area are composited for measurements of gross alpha, gross beta, gamma-emitting radionuclides, and strontium-89,90 analyses [SRS Data, 1995].

Gross Alpha and Gross Beta As in previous years, low levels of gross alpha activity were detected in a number of basins, although a large analytical uncertainty is associated with most of these measurements. Generally, the seepage and retention basins' gross alpha levels were consistent with the background levels observed off site and on the site perimeter.

Gross beta activity was detected in all vegetation samples analyzed. In general, the gross beta activity detected was at or near background levels observed off site and on the site perimeter.

Gamma-Emitting Radionuclides As in the previous year, cesium-137 was the only manmade gamma-emitting radionuclide detected; it was present in a majority of the seepage basin vegetation samples. Generally, the cesium-137 concentrations were present at levels greater than the offsite levels.

Strontium Strontium-89,90 was detected in all samples; concentrations in the basin vegetation generally were greater than in the perimeter and offsite vegetation. The greatest concentration was detected at the P-Area seepage basin, where the value was significantly greater than in previous years. The value was suspect because it was four times greater than the gross beta result. The basin vegetation was to be sampled and prepared again; however, the results were not available by the end of 1994.

The strontium-89,90 concentration of the A-Area seepage basin vegetation sample decreased in 1994. That the levels were significantly less than those of 1993 indicates there is not a trend developing for this location. The year-to-year variability of the results probably is attributable to the lack of homogeneity of the strontium in the surrounding soils and the fact that the vegetation could have been collected from a slightly different location within the immediate area.

Most other basins exhibited concentrations comparable to those of previous years. No strong relationship

between gross beta and strontium-89,90 was noted in samples at or near background levels. However, as noted previously, the strontium-89,90 result for the P-Area seepage basin was four times higher than the gross beta result. Because of the relatively short half-life of strontium-89 and the time that has elapsed since SRS reactor operations were discontinued, it is assumed that all strontium-89,90 activity is attributable to strontium-90. Strontium-90 is an environmentally persistent beta emitter; therefore, yittrium-90, also a beta emitter, would be in secular equilibrium with any strontium-90. This means that the gross beta result should be greater than the strontium-89,90 result by at least a factor of two. Because this relationship did not exist for the P-Area location, the strontium-89,90 and gross beta results are questionable, and EMS is awaiting a reanalysis.

Solid Waste Disposal Facility Samples

When available, vegetation samples are collected annually inside the SWDF to determine if there is a significant uptake of radioactivity emanating from the buried waste. No samples were collected from inside the SWDF in 1994 because of procedural controls associated with the removal of materials from a radiologically contaminated area. Thirteen quarterly samples taken just outside the SWDF fence (figure 6–13), however, indicate no spread of radioactive contamination from within the facility.

Chapter 7

Potential Radiation Doses

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Environmental Technology Section

In this chapter...

Introduction

This chapter presents the potential doses to offsite individuals and the surrounding population from 1994 Savannah River Site (SRS) atmospheric and liquid radioactive releases. The methods used to calculate these doses also are described. Additionally, potential doses from special-case exposure scenarios, such as deer meat 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. The effective dose equivalent, which is a risk-equivalent value, is used to express dose in terms of the potential health impact. Use of the effective dose equivalent allows doses from different types of radiation and doses 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), which is scheduled to be issued in 1995. Tables containing all potential dose calculation results are presented in *SRS Environmental Data for 1994* (WSRC–TR–95–077).

The following U.S. Department of Energy (DOE) radiation dose standards for protection of the public in the SRS vicinity are specified in DOE Order 5400.5, "Radiation Protection of the Public and the Environment":

All pathways	100 mrem per year
Airborne pathway	10 mrem per year
Drinking water pathway	4 mrem per year

The all-pathways standard is based on recommendations of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP).

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 immediately downriver of SRS 365 days per year, drinks 2 liters of 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.

The U.S. Environmental Protection Agency (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," 40 CFR Part 61, Subpart H, is adopted in DOE Order 5400.5.

The DOE dose standard 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 effective dose equivalent —of more than 4 mrem (0.04 mSv). Both 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 this chapter 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.

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

Calculating Dose

Offsite doses from SRS releases of radioactive materials (atmospheric and liquid) are calculated for the scenarios listed in table 7–1 for adults residing near SRS or at downriver locations. Because DOE has adopted dose factors only for adults, SRS calculates collective, or population, doses as if the entire population consists of adults [DOE, 1988].

The ICRP, in its Publications #56 and #67, has established age-specific dose factors for six age

Table 7–1
Potential Offsite Dose Calculations for SRS Releases: Receptors and Assumptions

Description	Assumptions about Receptors
	Airborne Effluents[a]
Maximum Site Boundary	Lives at site boundary where highest air concentrations occur Maximum exposure and consumption rates of food produced at residence
Average Site Boundary	Lives at a location of average boundary air concentration[b] Average exposure and consumption rates
Whole Population	Actual distribution of population within 50 miles of center of SRS Average exposure and consumption rates for all pathways
	Waterborne Effluents[a]
Maximum Site Boundary	Lives on shore of Savannah River Maximum consumption rate of river water Maximum consumption rate of fish
Maximum Drinking Water	Maximum consumption of water from downriver water treatment plants
Average Site Boundary	Average consumption of river water and Savannah River fish
Average Drinking Water	Average consumption of drinking water from downriver water treatment plants
Whole Population	Average consumption of water from downriver water treatment plants Average consumption of fish from Savannah River River recreational activity exposure based on survey data

a Specific values of the maximum and average adult consumption rates used in the calculations can be found in *SRS Environmental Data for 1994* (WSRC–TR–95–077)

b Determined by averaging the predicted concentrations at 320 locations along the site perimeter

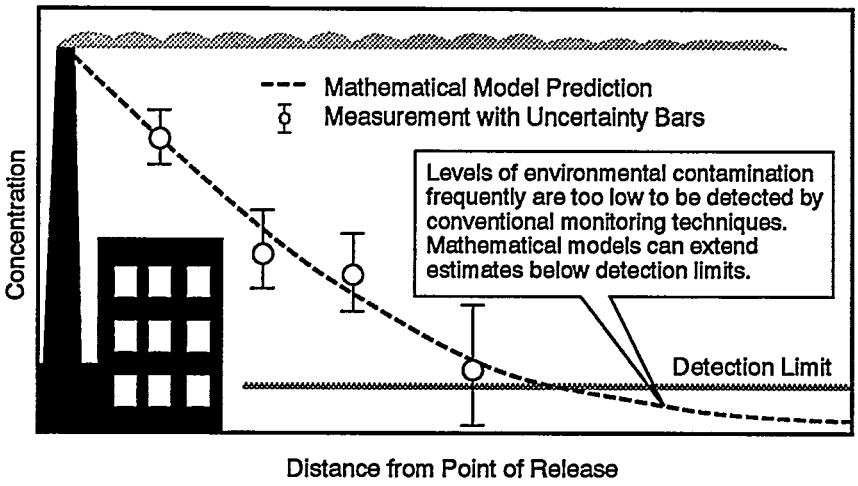

Figure 7–1 Radionuclide Movement Comparisons
Depicted in the illustration are comparisons between mathematical models of radionuclide movement and actual measurements.

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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, 1995]. 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

Figure 7–1 shows how computer models can be used to calculate concentrations that are too small to measure. These models use known transport mechanisms for atmospheric and liquid releases and known major pathways of exposure to man.

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, 1995]:

- 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. Differences in the implementation of the tritium-in-food model in the codes is responsible for most of the differences in the calculated doses. Even with these differences, the doses calculated by the two computer codes are in reasonable agreement. This comparison is discussed further in the Dose Calculation Results section of this chapter (page 96).

Meteorological Database

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

For 1994, all potential offsite doses from release of radioactivity to the atmosphere were calculated with a

quality-assured meteorological database for H-Area (located near the center of the site), which was determined for the period 1987–1991 [SRS Data, 1995]. 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.

The wind rose developed from the 1987–1991 database is shown in figure 7–2. 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 (much turbulence, which leads to good 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 50-mile radius of SRS.

For 1994 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 (i.e., 120 × 120 cells, or 14,400 cells). Thus, each cell covers an area of approximately one-half square mile. This database is transformed by the POPGASP Code into polar coordinates of 16 compass sectors and varying radial distances out to 50 miles. 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 14,400-cell grid into polar coordinates. The population database generated by the POPGASP Code is centered on the geographical center of SRS [SRS Data, 1995].

Within the 50-mile 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 population served by the City of Savannah Industrial and Domestic Water Supply Plant (formerly Cherokee Hill Water Treatment Plant), near Port Wentworth, Georgia (6,500 persons), and for the population served by the Beaufort-Jasper Water Treatment Plant, near Beaufort, South Carolina (50,000 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 United States Geological Survey (USGS) gauging stations at the SRS Boat Dock and at 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). Instead, "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, are used. However, the USGS-measured flow rates are used for comparison to these calculated values.

The 1994 River Mile 120 calculated (effective) flow rate of 9,611 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 16 percent less than the 1993 effective flow rate of 11,469 cubic feet per second. For comparison, during 1994 the USGS-measured flow rate at River Mile 120 was 12,271 cubic feet per second. Therefore, the calculated value is more conservative because it accounts for less dilution.

The 1994 calculated (effective) flow rates determined for the Beaufort-Jasper (14,867 cubic feet per second) and Port Wentworth (12,280 cubic feet per second) water treatment facilities were used to in determining drinking water doses.

The 1994 calculated Savannah River estuary flow rate (13,498 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 input 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

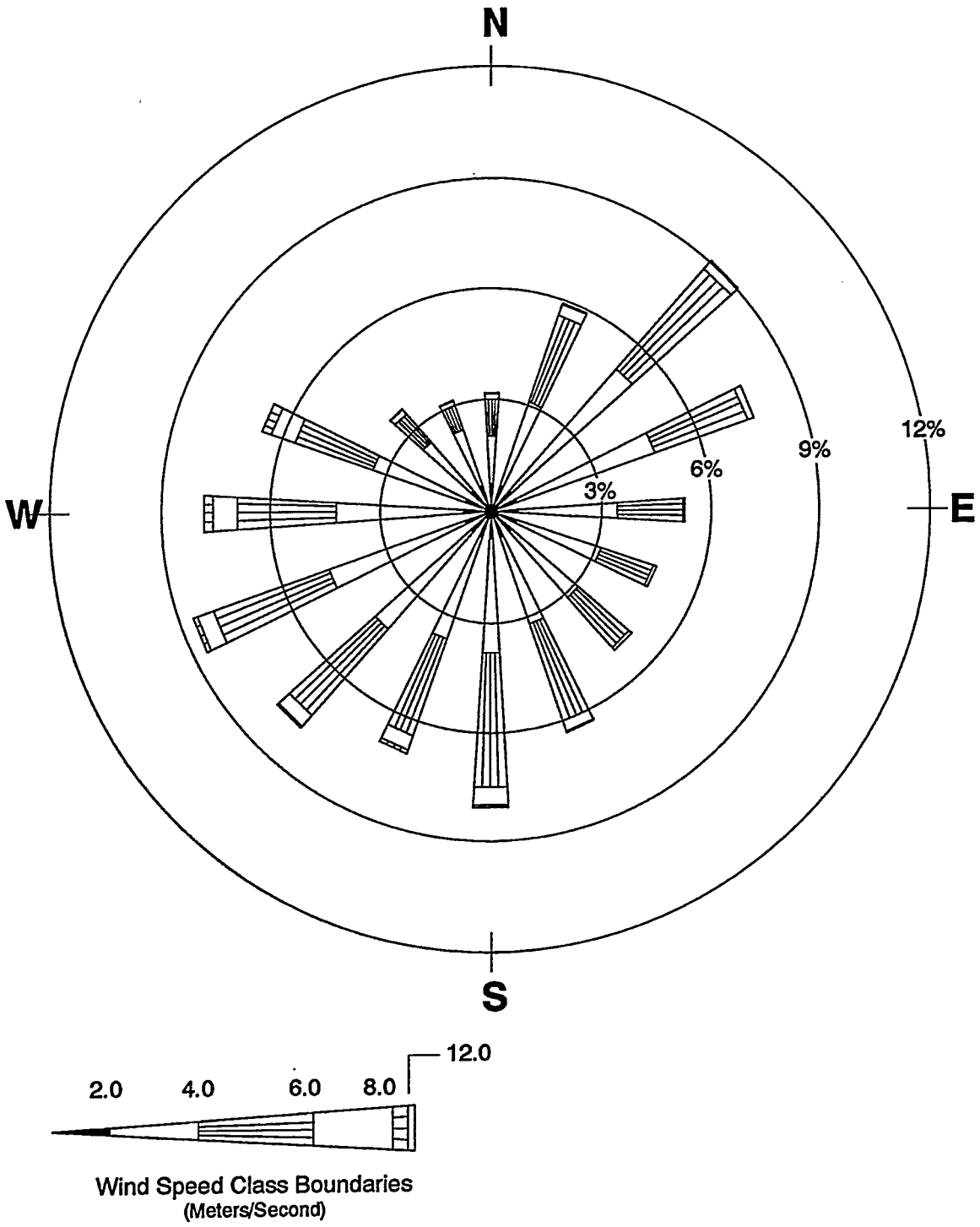

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Figure 7–2 Wind Rose for SRS, 1987–1991

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

few people will eat more than 81 kg, but most will probably 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* (Volume 65, Number 1).

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.

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 1994 radioactive liquid release quantities used as source terms in SRS dose calculations are presented in chapter 5 and summarized by radionuclide in table 7–2. In order to maintain conservatism, the river transport tritium release total of 10,900 Ci (4.0E+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 and cesium-137 in the Savannah River at River Mile 120 (U.S. Highway 301 bridge) and of tritium oxide at the Beaufort-Jasper and Port Wentworth water treatment facilities are shown in table 7–2, 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 at the U.S. Highway 301 bridge (1,270 pCi/L), and at the Beaufort-Jasper

Table 7–2
1994 Radioactive Liquid Release Source Terms and Comparison of Downriver Concentrations (Calculated Concentrations Based on Effective River Flow Rates)

Nuclide	Curies Released	Concentration (pCi/L)		
		Below SRS[a]	Beaufort-Jasper[b]	Port Wentworth[c]
H-3	1.1E+04[d]	1.3E+03[e]	8.2E+02[e]	9.9E+02[e]
Sr-89,90[d,f]	3.9E–01	4.5E–02	2.9E–02	3.5E–02
Tc-99	8.8E–03	1.0E–03	6.6E–03	8.0E–04
I-129	7.4E–02	8.6E–03	5.6E–03	6.7E–03
Cs-137	2.0E–01[d]	2.3E–02[e]	1.1E–02	1.3E–02
Pm-147	1.5E–03	1.8E–04	1.2E–03	1.4E–03
U-235,238	1.0E–05	1.2E–06	7.5E–07	9.1E–07
Pu-239[g]	1.4E–02	1.7E–03	1.1E–03	1.3E–03

a Savannah River Mile 120 (River–10 location), just downriver of SRS at the U.S. Highway 301 bridge
b Beaufort-Jasper, South Carolina, drinking water
c Port Wentworth, Georgia, drinking water
d Curies released based on measured values from River Mile 120 (tritium transport and cesium-137 in fish)
e Measured concentrations; all other concentrations calculated using models verified with tritium measurements H-3 concentration is from EMS [SRS Data, 1995]; Cs-137 concentration is from SRTC [Beals, 1995]
f Includes unidentified beta releases
g Includes unidentified alpha releases

SRS, in conjunction with the Georgia Department of Natural Resources (GDNR) and the South Carolina Department of Health and Environmental Control (SCDHEC), systematically monitors Savannah River fish from Augusta, Georgia, to the Atlantic Ocean to ensure that potential doses to people resulting from consumption of the fish remain below all applicable regulatory standards.

92-2018-6

(821 pCi/L) and Port Wentworth (994 pCi/L) water treatment plants, remained below the EPA and DOE concentration standards of 20,000 pCi/L and 80,000 pCi/L, respectively.

These concentrations were slightly higher than the corresponding 1993 concentrations, even though the amount of tritium oxide released from SRS during 1994 was about 14 percent less than the amount released during 1993 (10,900 Ci in 1994 versus 12,700 Ci in 1993). This is because the Savannah River flow rate was about 16 percent less in 1994 than in 1993, causing less dilution to occur. Additional information about the river's flow rates can be found in the River Flow Rate Data section of this chapter (page 94).

Radionuclide Concentrations in River Fish A major dose pathway for the maximally exposed individual at the site boundary 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 readily detectable in fish flesh. Therefore, the fish-pathway dose from cesium-137 is based directly on the radioanalysis of the fish collected from Savannah River Mile 120 (U.S. Highway 301 bridge), which is the assumed location of the hypothetical maximally exposed individual [SRS Data, 1995]. 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; 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 0.20 Ci (7.4 E+09 Bq). This is about 1.4 times higher than the measured-release value of 0.14 Ci (5.2E+09 Bq). This indicates either some migration of fish from SRS streams to the main channel of the river or a source of release to the river other than measured direct liquid effluents, possibly from streambed and swamp desorption and/or migration from seepage basins. This phenomenon is seen every year but was

slightly higher in 1994 than in 1993, when the calculated concentrations were 1.1 times higher than the measured-release concentrations.

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, which is considered the point of maximum offsite exposure, was determined based on intake parameters discussed earlier in this chapter.

As shown in table 7–3, the highest potential dose to the maximally exposed individual from liquid releases in 1994 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 1994 potential maximally exposed individual dose was the same as the 1993 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 1994 was about 14 percent less than during 1993. This was because of decreases in dilution in the Savannah River due to decreased river flow during 1994.

Approximately 47 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 42 percent resulted from the ingestion (via drinking water) of tritium oxide [SRS Data, 1995].

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. Tritium oxide in downriver drinking water represents the majority of the dose (about 83 percent) received by persons at downriver water treatment plants (figure 7–3).

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 average (1 liter per day for a year) and maximum (2 liters per day for a year) water consumption rates [SRS Data, 1995].

At the Beaufort-Jasper Water Treatment Plant, the potential dose for maximum water consumption rates (2 liters per day for a year) was 0.05 mrem (0.0005 mSv). At the City of Savannah Industrial and Domestic Water Supply Plant, the potential dose was 0.06 mrem (0.0006 mSv).

As shown in table 7–3, 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. This maximum potential drinking water dose is approximately 20 percent greater than the 1993 dose of 0.05 mrem (0.0005 mSv). This increase in dose is attributed to

- decreased dilution in the Savannah River due to decreased river flow during 1994
- decreased dilution from other surface waters

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

Table 7–3
Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 1994

	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]	1.50
At Beaufort-Jasper (public water supply only)	0.05 mrem	4 mrem[b]	1.25

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)

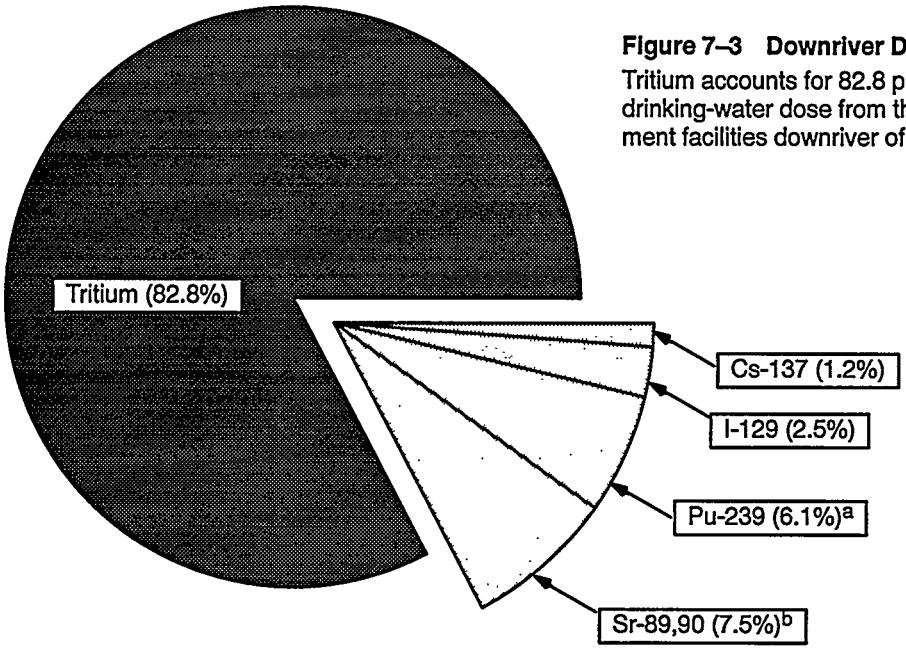


Figure 7–3 Downriver Drinking Water Dose
Tritium accounts for 82.8 percent of the treated-drinking-water dose from the two water treatment facilities downriver of SRS.

lleaf Graphic

a Includes unidentified alpha releases
b Includes unidentified beta releases

from other pathways is calculated for a diffuse population that 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, 1995]. In 1994, the collective dose from SRS liquid releases was estimated at 1.7 person-rem (0.017 person-Sv). This was 13 percent higher than the 1993 collective dose of 1.5 person-rem (0.015 person-Sv)—again, because of less dilution in the Savannah River due to decreased river flow during 1994.

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, a potential offsite dose of 0.09 mrem (0.0009 mSv) to the maximally exposed individual and a collective dose of 6.9 person-rem (0.069 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, 1995].

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 1994 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 unidentified alpha emitters were summed with plutonium-239 releases [SRS Data, 1995].

Estimates of unmonitored diffuse and fugitive source terms again were considered, as required for demonstrating compliance with NESHAP regulations. No fugitive source terms were included for exposed sediments at PAR Pond because limited air sampling in the vicinity of the sediments indicates there was no significant resuspension into the atmosphere during 1994. Most of the estimated diffuse and fugitive releases occurred from the reactor and separations areas and from the Solid Waste Disposal Facility.

Atmospheric source terms are grouped by major release points for dose calculations. For MAXIGASP

calculations of doses to average and maximally exposed offsite individuals at the site perimeter, five release locations with specific release heights were used [SRS Data, 1995].

The CAP88 code is capable of calculating 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, 1995].

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 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 1994 was 23 pCi/m^3 (0.9 Bq/m^3). This value compares favorably with the MAXIGASP and CAP88 computer code values of 30 pCi/m^3 (1.1 Bq/m^3) and 28 pCi/m^3 (1.0 Bq/m^3), respectively. The maximum tritium oxide concentration measured in air at the site perimeter was 42 pCi/m^3 (1.6 Bq/m^3), which occurred at the D-Area location. This value also compared favorably with the MAXIGASP computer code value of 49 pCi/m^3 (1.8 Bq/m^3). The CAP88 code calculated a maximum site perimeter concentration of 40 pCi/m^3 (1.5 Bq/m^3). This value is lower because the CAP88 code assumes that all releases occurred from only one release point, which is located at the center of the site.

In table 7–4, a 10-year history of the average 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 7–4 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.

Dose to the Maximally Exposed Individual

The potential air pathway dose to a hypothetical individual located at the site perimeter, which is considered the point of maximum offsite exposure, was determined based on average and maximum consumption rates [SRS Data, 1995]. The MAXIGASP computer code was used to calculate these doses. The parameters used for the calculations were discussed earlier in this chapter.

In 1994, using a maximum dietary intake, the estimated dose to the maximally exposed individual was 0.09 mrem (0.0009 mSv), which is about 0.9 percent of the DOE Order 5400.5 standard of 10 mrem per year. This dose was approximately 20 percent lower than the 1993 dose of 0.11 mrem (0.0011 mSv) because there was a corresponding 20-percent decrease in tritium oxide releases from 1993 to 1994 (chapter 5). Tritium oxide releases accounted for 88 percent of the dose to the maximally exposed individual. Table 7–5 compares the maximally exposed individual's dose with the DOE standard.

For 1994, the MAXIGASP code determined that the north-northwest sector of the site was the location of the maximally exposed individual. Figure 7–4 shows 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 (48 percent) and from consumption of vegetation (35 percent), cow milk (12 percent), and meat (5 percent).

In response to public concerns, 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 dose using the maximum-consumption goat milk pathway was estimated at 0.10 mrem (0.0010 mSv), which is about 16 percent higher 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

Table 7–4
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)
1985	670,000	490,000	1,760	120	190
1986	425,000	285,000	1,520	79	88
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

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 g/m^3 was used for absolute humidity.

cow milk consumption will continue to be the 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 50 miles of the center of SRS [SRS Data, 1995]. In 1994, the collective dose was estimated at 6.3 person-rem (0.063 person-Sv), which is less than 0.01 percent of the collective dose received from natural sources of radiation (about 195,000 person-rem). The 1994 collective dose was approximately 17 percent lower than the 1993 collective dose of 7.6 person-rem (0.076 person-Sv)—again, because of the 20-percent decrease in tritium oxide releases from 1993 to 1994. Tritium oxide releases accounted for almost 90 percent of the 1994 collective dose.

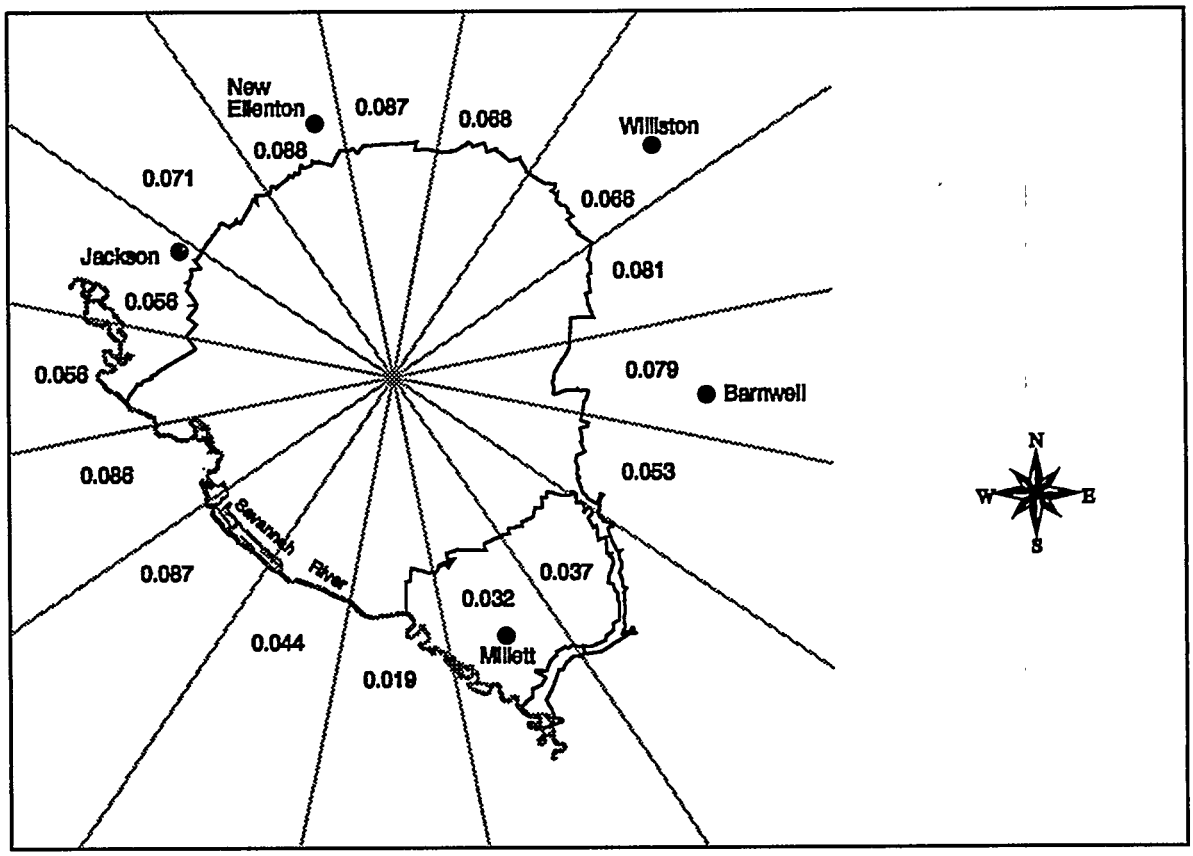
NESHAP Compliance

To demonstrate compliance with NESHAP (Clean Air Act, 40 CFR 61, Subpart H) regulations, maximum individual and collective doses were calculated, and a percentage of dose contribution from each radionuclide

Table 7–5
Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 1994

	MAXIGASP	CAP88 (NESHAP)
Calculated dose	0.09 mrem	0.15 mrem
Applicable standard	10 mrem[a]	10 mrem[b]
Percent of standard	0.9%	1.5%

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



EPD/GIS Map

Figure 7–4 Sector-Specific Adult Maximally Exposed Individual Dose (mrem)
Maximally exposed individual site boundary doses from airborne releases are shown for each of the 16 compass point directions surrounding SRS.

was determined using the CAP88 computer code [SRS Data, 1995].

The dose to the maximally exposed individual, calculated with CAP88, was estimated at 0.15 mrem (0.0015 mSv), which is 1.5 percent of the 10-mrem-per-year EPA standard, as shown in table 7–5. Tritium oxide releases accounted for more than 98 percent of this dose.

The CAP88 collective dose was estimated at 16 person-rem (0.16 person-Sv). Tritium oxide releases accounted for more than 98 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].

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.

For 1994, the potential maximally exposed individual all-pathway dose was 0.23 mrem (0.0023 mSv)—0.09 mrem from airborne pathway plus 0.14 mrem from liquid pathway. This dose is 8 percent lower than the 1993 all-pathway dose of 0.25 mrem (0.0025 mSv), primarily because of the decrease in atmospheric tritium oxide releases during 1994.

Table 7–6 compares the 1994 potential all-pathway dose to the DOE dose standard.

Sportsman Dose

As noted previously, 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.

Fish Consumption Pathway

For 1994, analyses were conducted of fish taken from the mouths of the six SRS streams, and the subsequent estimated doses from the maximum consumption of 19 kg per year [Hamby, 1991] and average consumption of 9 kg (20 pounds) per year of these fish were determined [SRS Data, 1995]. 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 7–6, the maximum hypothetical dose from this pathway was estimated at 1.3 mrem (0.013 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 1994, a fisherman consumed 19 kg of bass caught exclusively from the mouth of Steel Creek. More than 98 percent of this potential dose was from cesium-137. Because access to SRS streams and ponds is restricted, the fish consumption pathway dose does not include fish caught within the SRS boundary.

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 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 1994, the maximum potential dose that could have been received by a hunter was estimated at 46 mrem (0.46 mSv), or 46 percent of DOE's 100-mrem all-pathway dose standard (table 7–6). This dose was determined for a prolific hunter who had harvested 11 animals during the 1994 hunts. The hunter-dose calculation is based on the conservative assumption that the hunter individually consumed the entire edible portion—approximately 247 kg (545 pounds)—of all the animals he harvested from SRS.

An additional deer meat consumption pathway considered during 1994 was for a hypothetical 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 [Hamby, 1991].

Based on these low-probability assumptions and on the average concentration of cesium-137 (6.0 pCi/g) in deer

Table 7–6
1994 All-Pathway Dose and Sportsman Doses Compared to the DOE All-Pathway Dose Standard

	Committed Dose	Applicable Standard	Percent of Standard
Maximally Exposed Individual Dose			
All-Pathway (Liquid Plus Airborne Pathway)	0.23 mrem	100 mrem[a]	0.23
Sportsman Doses			
Creek Mouth Fisherman	1.3 mrem	100 mrem[a]	1.3
Onsite Hunter	46 mrem	100 mrem[a]	46
Offsite Hunter	20 mrem	100 mrem[a]	20

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

harvested from SRS during 1994, the potential maximum dose from this pathway was estimated at 20 mrem (0.20 mSv). As shown in table 7–6, this potential dose is 20 percent of DOE's 100-mrem all-pathway dose standard. This potential dose was about five times higher in 1994 than it was in 1993, primarily because of the use of a lower background concentration value (1 pCi/g in 1994 versus 5 pCi/g in 1993). The background concentration of cesium-137 in deer meat was changed based on newly acquired surveillance data from deer harvested 50 miles from the site [SRS Data, 1995].

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 [SRS Data, 1995].

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 0.012 rad per day (0.00012 Gy per day), which occurred in ducks in Four Mile Creek. This is 1.2 percent of the 1-rad-per-day (.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. Plans are to prepare separate documents for each of the major 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 is presented. As of December 31, 1994, the following eight 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

Documents for noble gases and mercury are scheduled for publication in 1995.

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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In this chapter...

Introduction

Nonradioactive air emissions originating at Savannah River Site (SRS) facilities are monitored at their points of discharge by a combination of direct measurement, sample extraction and measurement, or process knowledge. Air monitoring verifies that 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 is scheduled to be issued in 1995. A summary of data results is presented in this chapter; however, more complete data can be found in *SRS Environmental Data for 1994* (WSRC–TR–95–077).

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. 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. Table 8–1 shows typical standards for criteria pollutants from SRS coal-fired boilers.

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

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

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 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 stacks), and a visible-emissions observation for opacity.

Compliance by all toxic air pollutant and criteria pollutant sources is also 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 1994.

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 diesel engine-powered equipment, package steam generators, powerhouse boilers, and various process facility stacks. Emissions from these sources are determined from calculations using 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 sulfur dioxide also uses the average sulfur content of the coal and assumes 100 percent liberation of sulfur and 100 percent conversion to sulfur dioxide.

At SRS, 102 permitted emission 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 compressors and pumps. Total fuel oil consumption for these sources in 1994 was calculated to be 752,581 gallons of No. 2 diesel fuel oil.

Table 8–2
SRS Power Plant Boiler Capacities

Location	Number of Boilers	Capacity (BTU/hr)
A-Area	2	71.7E + 06
D-Area	4	39.6E + 07
H-Area	3	71.1E + 06

Three coal-fired power plants with nine boilers operate at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 8–2. The four D-Area boilers use pulverized coal as their primary fuel; they use propane, No. 2 fuel oil, and used oil as secondary fuels. The other boilers are overfeed stoker fed and use coal as their only fuel.

The coal-fired boilers burned 231,952 tons of coal in 1994. The D-Area power plant boilers also burned 27,280 gallons of used oil for energy recovery; 298,673 gallons of No. 2 fuel oil; and 3,259 gallons of propane as boiler startup fuel.

SRS also has four package steam generating boilers fired by No. 2 diesel fuel oil. These boilers are used primarily to heat buildings during cold weather. If necessary, they are used during process facility operation. They burned 961,384 gallons of fuel oil during 1994. The location, number of boilers, and capacity of each boiler are shown in table 8–3.

Monitoring Results

Table 8–4, which shows the 1994 atmospheric emissions of sulfur dioxide, oxides of nitrogen, carbon monoxide, particulate matter, and volatile organic compounds from SRS sources, is broken down by types of sources rather than by area. Except for sulfur dioxide emissions at the D-Area powerhouse, all

Table 8–3
SRS Package Steam Boiler Capacities

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

Table 8–4
1994 Nonradiological Air Emissions From Stationary and Portable Combustion Sources

Coal-Fired Boilers	
Sulfur dioxide	6,497.17 tons
Particulates	606.02 tons
Oxides of Nitrogen	3,463.81 tons
Carbon monoxide	158.87 tons
Volatile Organic Compounds	4.85 tons
Fuel Oil-Fired Boilers	
Sulfur dioxide	19.79 tons
Particulates	0.96 tons
Oxides of Nitrogen	9.61 tons
Carbon monoxide	2.40 tons
Volatile Organic Compounds	0.10 tons
Diesel Engine Equipment	
Sulfur dioxide	15.27 tons
Particulates	16.41 tons
Oxides of Nitrogen	232.24 tons
Carbon monoxide	50.03 tons
Volatile Organic Compounds	18.96 tons

calculated emissions were within applicable SCDHEC standards during 1994. During a biennial stack compliance test, one D-Area boiler exceeded its permit limit for sulfur dioxide emissions. The investigation of this occurrence determined that the sulfur content of the coal being burned in the boiler was higher than indicated by the analytical results provided for acceptance of the coal. The higher sulfur content in the coal resulted in higher calculated sulfur emissions for the year. For this exceedance, SRS received a Notice of Violation (NOV) that resulted in the payment of $2,000 in civil penalties and additional monitoring requirements for the coal being burned in the boilers. Additional coal analysis has shown that the boilers are in compliance with applicable regulations and permit conditions.

Also during 1994, a settlement agreement was finalized for an NOV issued in 1993 for H-Area boiler permit exceedances. This agreement resulted in a payment of $4,000 in civil penalties.

The sulfur content of coal burned in 1994 averaged 2.0 percent for pulverized coal and 0.79 percent for stoker coal.

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, air dispersion modeling was conducted during 1993 for existing sources and during 1994 for new emission sources as part of their construction permitting process. The modeling analysis showed that SRS air emission sources were in compliance with applicable regulations.

The Environmental Transport Group, a component of the Environmental Technology Section at SRTC, is responsible for all regulatory nonradiological air quality modeling required by SCDHEC. In 1994, the Environmental Transport Group conducted air dispersion modeling for various new sources using EPA's Industrial Source Complex short-term and long-term models for criteria and toxic air pollutants. These models simulate the dispersion of emissions over extensive areas for time scales ranging from an hour to a year. For realism, a year (1991) of hourly site meteorological data was used as one of the inputs to the model. Other inputs included source information and air emissions rate data from the SRS Air Inventory Reporting System database.

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

In 1994, 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) 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, but because SRS has applied for a new one, discharges can continue under the expired permit until the new one is issued. SCDHEC sent SRS a preliminary draft permit in May 1994, and SRS has sent its comments to SCDHEC for consideration. When the new permit is issued, it will include the discharge points covered under industrial permit SC0044903, which expires November 30, 1995. Until then, the site is discharging industrial wastewater under 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.

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 information can be found in chapters 9, "Nonradiological Environmental Surveillance," and 12, "Special Surveys and Projects."

Monitoring Results

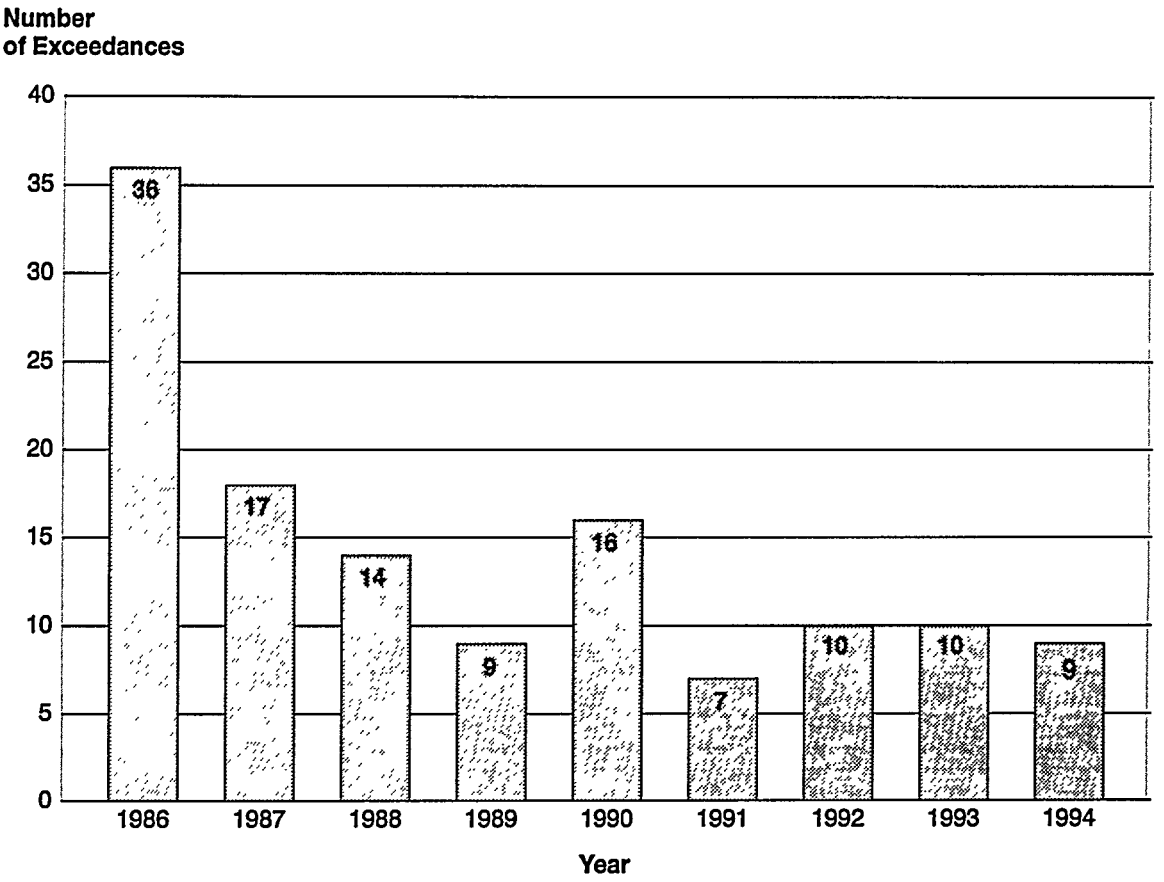
SRS reports analytical results to SCDHEC through a monthly discharge monitoring report. This report includes a list of exceedances or locations at which analyses showed the discharge did not meet permit requirements.

In 1994, 71 of the 83 permitted outfall points discharged; 12 either did not discharge or were not in service. Of the 7,568 analysis results from the discharge samples, nine exceeded permit limits because of process upsets, such as a broken water line that caused erosion (which in turn elevated the total suspended solids at Outfall A–011). With these exceedances, the site had a 99.9-percent compliance rate, which exceeds the 98-percent compliance rate mandated by the U.S. Department of Energy (DOE). A list of these exceedances appears in table 8–5. Figure 8–1 shows the NPDES exceedances at SRS from 1986 through 1994.SCDHEC has not mandated permit limits for stormwater outfalls.

Table 8–5
1994 NPDES Exceedances

Department	Location	Date	Analysis	Result	Possible Cause	Corrective Action
Waste Management	H–016	Aug. 8	O&G	17.8 mg/L (max)	unknown	administrative review
CSWE	A–005	July 14	TCE	48 µg/L (avg and max)	flushing of well water	discontinue well flushing
Power	A–011	Jan. 5	TSS	69.0 mg/L (max)	broken water service line	administrative review
	P–014	Jan. 5	BOD	71.6 mg/L (max)	over-addition of supplementary nutrients	improve regulation by operators
Reactors	K–001	Jan. 11	O&G	24.5 mg/L (max)	storm runoff from parking lot	none applicable
	P–019	June 22	TSS	121 mg/L (avg and max)	excessive algae	clean out algae
	L–007	July 12	TSS	34 mg/L (avg)	overgrown with weeds	clean outfall
Separations	F–005	Dec. 5	TSS	79 mg/L (max)	construction/ storm activity	add erosion control measures
SRTC/TNX	X–008	May 19	pH	5.7 su (min)	low pH	none applicable

Key: *O&G — Oil and grease*
TCE — Trichloroethylene
TSS — Total Suspended Solids
BOD — Biochemical Oxygen Demands



Number of Analyses	6,240	6,560	6,250	6,859	6,810	8,329	7,729	8,000	7,568
Compliance Rating	99.4%	99.7%	99.8%	99.9%	99.8%	99.9%	99.9%	99.9%	99.9%

lleaf Graphic

Figure 8–1 History of NPDES Exceedances, 1986–1994

To determine the compliance rating, the number of analyses not exceeding limits for a given year is divided by the total number of analyses. For example, 6,810 analyses were performed in 1990, with 16 exceedances. To calculate the compliance rating for that year, divide 6,794 (6,810 minus 16) by 6,810 for a quotient of .9976, or 99.8, percent.

Chapter 9

Nonradiological Environmental Surveillance

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Introduction

Nonradiological 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 1994 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. Results of Academy studies for 1994 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 is scheduled to be issued. A summary of data results is presented in this chapter. However, more complete data can be found in *SRS Environmental Data for 1994* (WSRC–TR–95–077). Information on the rationale for the nonradiological environmental surveillance program can be found in chapter 3, "Environmental Program Information."

SRS currently does not conduct onsite surveillance for ambient air quality. However, as a result of permit conditions for several new sources at the site, SRTC conducted air dispersion modeling for criteria pollutants in 1993 and 1994, which indicated compliance with ambient air quality standards. The states of South Carolina and Georgia continue to monitor ambient air quality near SRS as part of a network associated with the federal Clean Air Act.

In 1994, more than 16,000 analyses for specific chemicals and metals were performed on more than 5,600 samples, not including groundwater.

Site Streams

SRS streams 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

Table 9–1 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).

Description of Surveillance Program

EMS samples site streams monthly for chemicals, metals, and physical and biological properties to ensure that water quality criteria are met [SRS EM Program, 1995]. Stream nonradiological surveillance checks for any evident degradation that could be attributed to the water discharges regulated by site National Pollutant Discharge Elimination System (NPDES) permits. It 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.

Table 9–1
South Carolina 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 (April 24, 1992).
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 (April 24, 1992).

SOURCE: [SCDHEC, 1993]

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. An overview of sampling locations is shown in figure 9–1.

Surveillance Results

The stream water quality data showed normal fluctuations expected for surface water. Comparison of the 1994 data to published historical data for site surface water monitoring does not indicate any abnormal deviations from past monitoring data [SRS Data, 1995].

Savannah River

Description of Surveillance Program

The Savannah River is sampled monthly at three locations for organic and inorganic contaminants [SRS EM Program, 1995]. Sampling locations on the river are shown in figure 9–1. These sampling sites are located upriver 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, or 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.

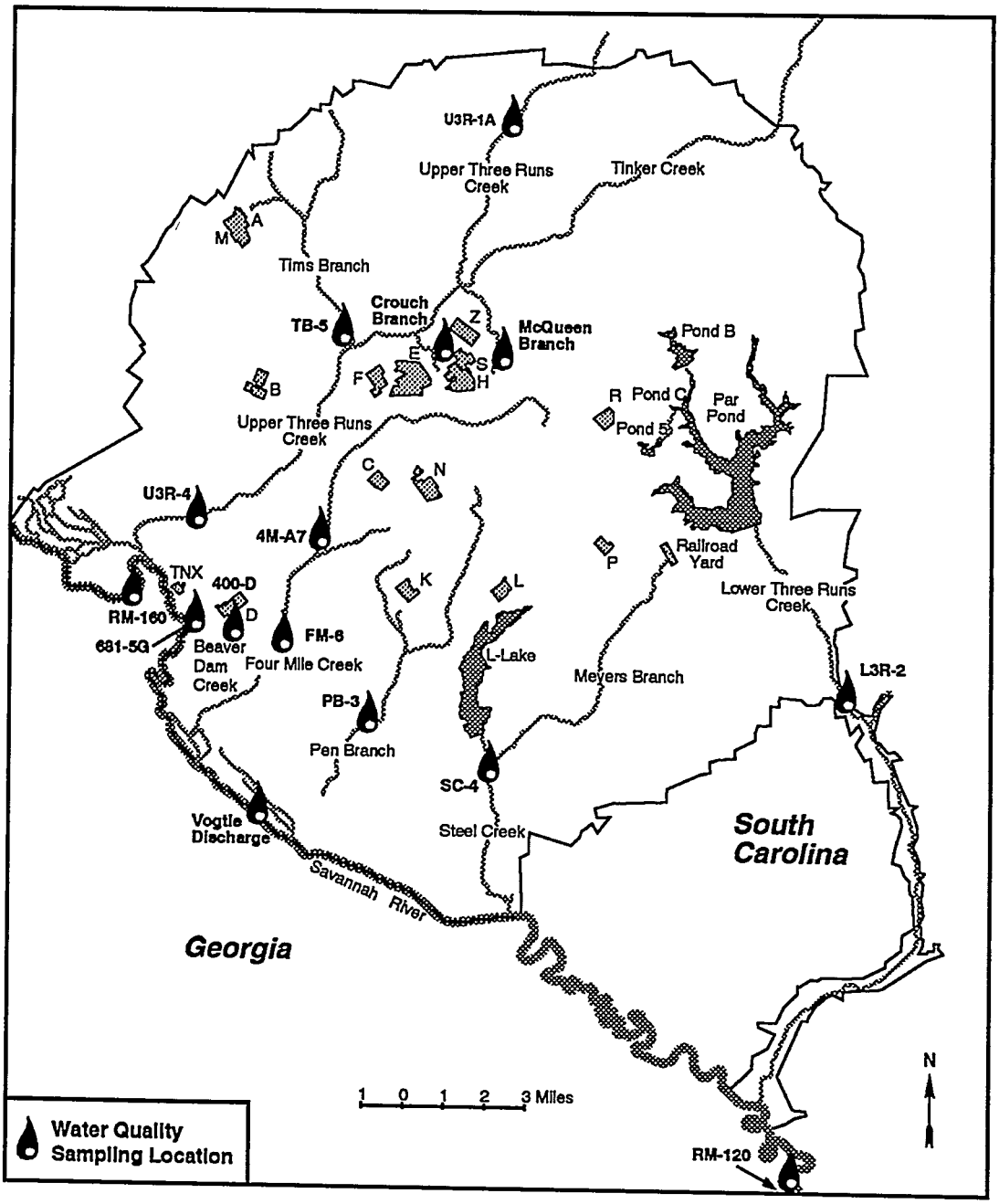

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Figure 9–1 SRS Streams and Savannah River Water Quality Sampling Locations

Note: Other names or abbreviations by which locations are known are listed in parentheses.

On Site		River
Upper Three Runs–1A (U3R–1A)	Pen Branch–3 (PB–3)	River Mile 160 (RM–160)
Four Mile Creek–6 (4MC–6, FM–6)	McQueens Branch	Vogtle Discharge
Lower Three Runs–2 (L3R–2)	Crouch Branch	River Mile 120 (RM–120)
Steel Creek–4 at Road A (SC–4)[a]	400–D	681–5G (GDNR and EMS sampling location)
Tims Branch–5 (TB–5)[a]		
Four Mile Creek at Road A7 (4M–A7)[a]		
Upper Three Runs–4 at Road A (Upper Three Runs–4, U3R–4, U3R–Rd A)[a]		

a EMS and SCDHEC sampling location. Samples from the four SCDHEC locations are also analyzed for pesticides, herbicides, and volatile organic compounds.

Field measurements for conductivity, dissolved oxygen, pH, and temperature also are taken monthly in the Savannah River to monitor the water quality and to ensure that water quality criteria are met.

Laboratory analyses are conducted for other water quality parameters, such as metals, chemicals, and physical and biological properties.

Surveillance Results

A comparison of Savannah River water quality analyses upriver (River Mile 160) and downriver (River Mile 120) of SRS showed no significant differences [SRS Data, 1995].

A comparison to historical data shows that the coliform data are within normal fluctuations for river water in this area and that fewer exceedances occurred in 1994 than in 1993. The monitoring data for the river locations met the Freshwaters standard guides (table 9–1), and comparison of the 1994 data to published historical analytical results and measurements for river samples did not show any abnormal deviations. [SRS Data, 1995].

Drinking Water

Description of Surveillance Program

The 27 drinking water systems at SRS utilize treated well water pumped from the McBean, Congaree, Black Creek, and Middendorf formations. All SRS drinking water supplies are disinfected with sodium hypochlorite for bacteriological control. Sodium hydroxide, soda ash, and phosphates are added in the larger systems for corrosion control. The concentrations of treatment chemicals are monitored daily.

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. The SRS annual chemical analysis program and the A-Area and M-Area chlorocarbon monitoring program were discontinued in September 1994 because they duplicated SCDHEC sampling and other site sampling programs.

Pesticides and Herbicides

Pesticides and herbicides have been monitored at SRS since 1976 to assess their concentrations in surface waters from site streams and the Savannah River. Water samples from seven stream and two river locations were analyzed for 22 pesticides and herbicides during 1994 (figure 9–2).

Pesticides and herbicides analyzed for in SRS river and stream waters were in less than minimum detectable concentrations during 1994 [SRS Data, 1995].

Surveillance Results

In 1994, all drinking water systems complied with SCDHEC bacteriological, chemical, synthetic organic, and volatile organic water quality standards, except in S-Area, which exceeded the SCDHEC action level of 15 parts per billion for lead. A corrective action plan was implemented to elevate pH, and subsequent sampling confirmed that lead concentrations fell below the SCDHEC lead action level.

Sediment

The nonradiological sediment surveillance program provides a method to determine the deposition, movement, and accumulation of nonradiological contaminants in stream systems.

Description of Surveillance Program

The nonradiological sediment surveillance program is divided into two areas: pesticide and herbicide surveillance, and inorganic contaminant surveillance.

Pesticides and herbicides were used on site land before the U.S. Government obtained it in 1950. They have been used since that time as part of the site's forestry management program and for ongoing landscape and roadside maintenance. A pesticide and herbicide surveillance program was established to ensure that there is no buildup of these materials in site streams or the Savannah River. Sediment samples from two Savannah River and seven site stream locations were analyzed for 22 pesticides and herbicides during 1994. Sediment sampling locations are shown in figure 9–2.

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). These locations are shown in figure 9–3.

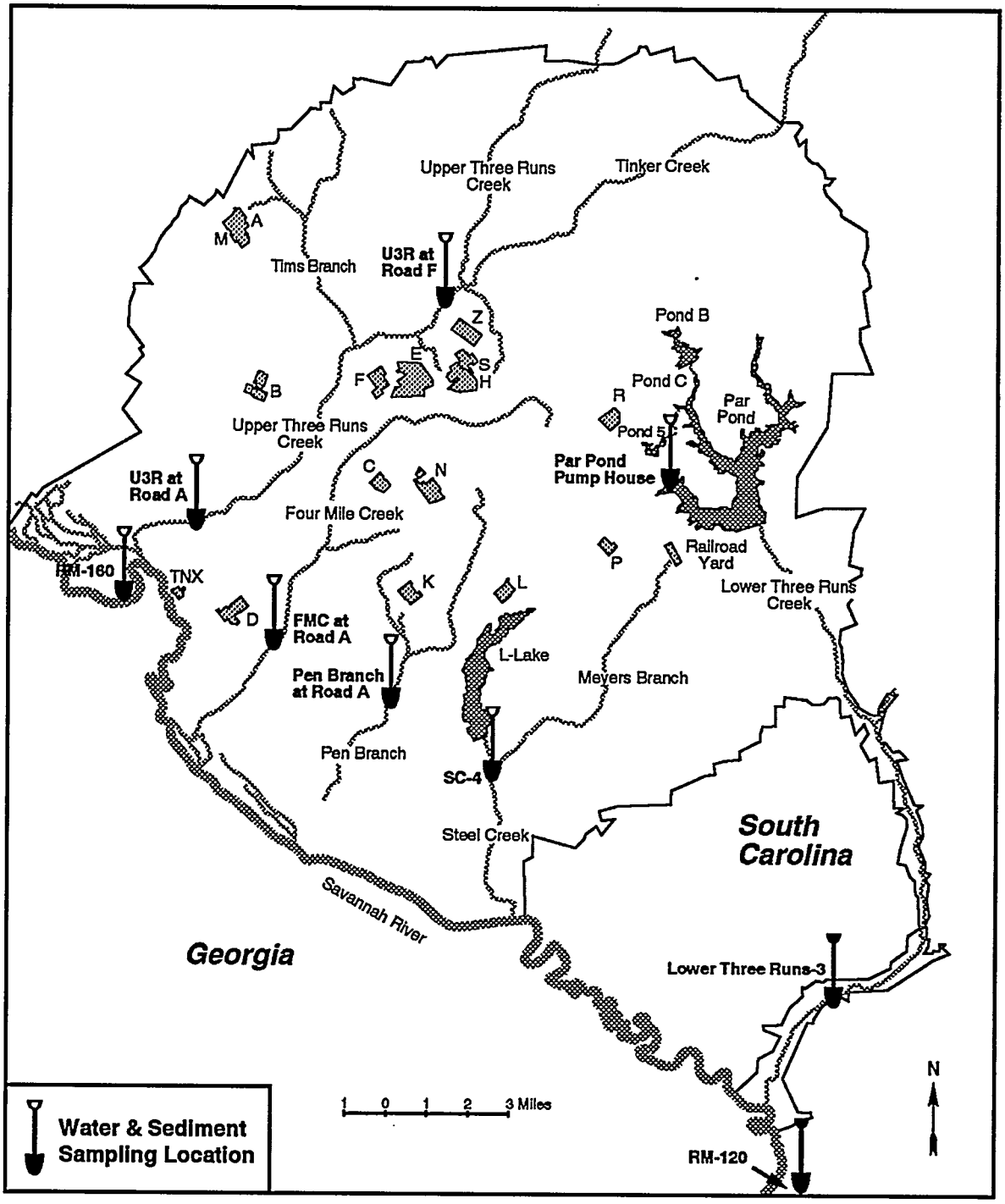

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Figure 9–2 SRS Stream and Savannah River Nonradiological Sampling Locations for Pesticides and Herbicides in Water and Sediment

Water and sediment from seven SRS stream and two Savannah River locations are sampled for pesticides and herbicides.

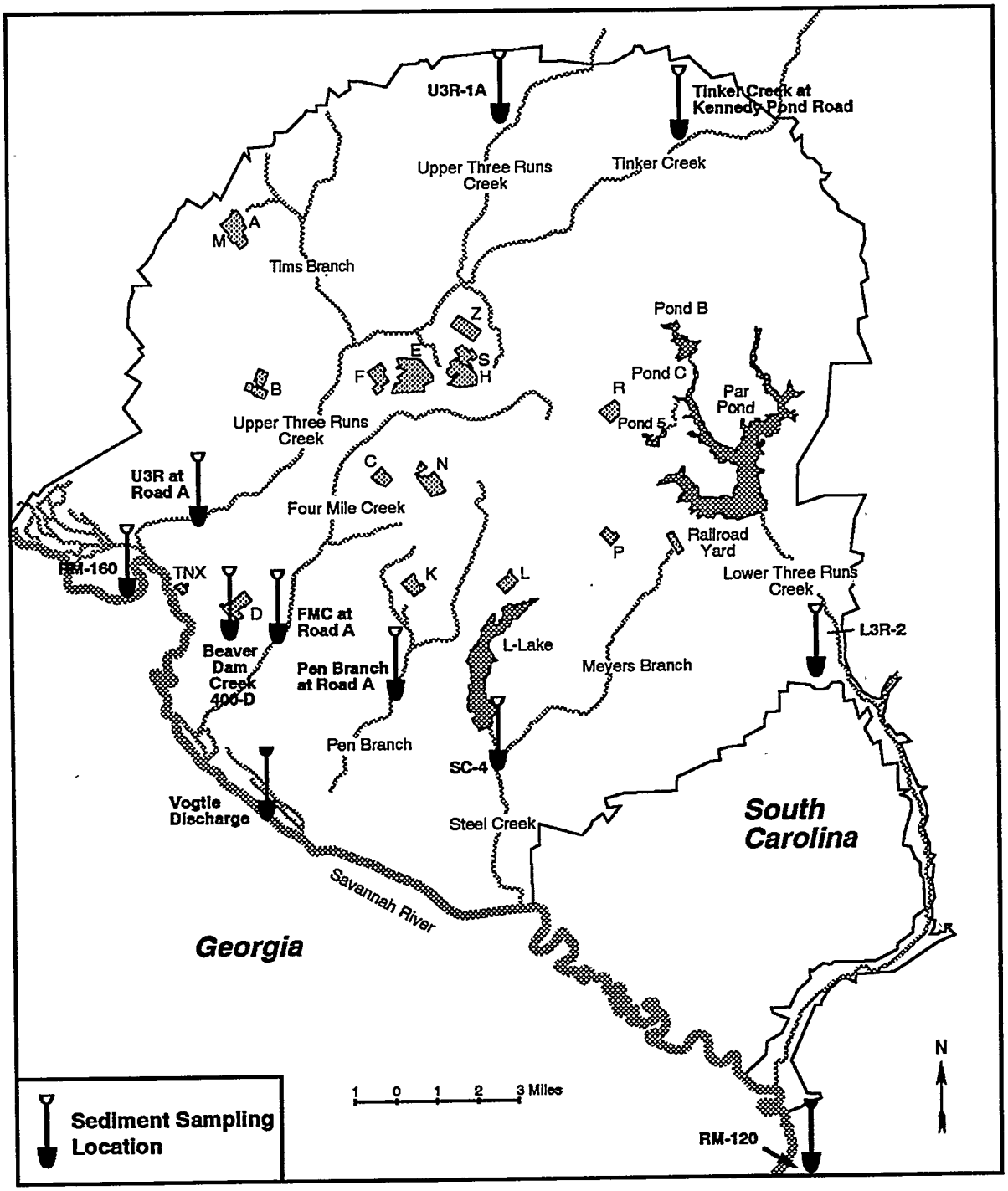

Figure 9–3 SRS Stream and Savannah River Nonradiological Sampling Locations for Inorganic Contaminants in Sediment

Sediment from eight SRS stream locations (six indicator and two control) and three Savannah River locations (two indicator and one control) is sampled for inorganic contaminants.

Perspective on Mercury

Mercury in the environment can come from natural sources, such as volcanoes and venting of the earth's crust, and from man-made sources and processes, such as fungicides and fossil fuel combustion by-products 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 off-site 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.

Surveillance Results

No pesticides or herbicides were detected in 1994 in Savannah River sediment samples or in stream sediment samples. All sample results were below the detection limits of the U.S. Environmental Protection Agency (EPA) analytical procedures used [SRS Data, 1995]. Pesticides and herbicides in stream and river waters are discussed in a sidebar on page 114.

Sediments from each inorganics location were transported to a contract laboratory for analysis. A leaching procedure extraction was conducted on the samples—using EPA-acceptable analyses—to determine their toxicity characterization. Some apparent elevations and reductions were detected in the concentration levels of various parameters from 1993 to 1994, but there were not enough data sets to indicate a trend.

Parameters analyzed are listed in the SRS EM Program. Sodium was deleted from the parameter list because it is a constituent of one of the compounds added to the sample during the analytical procedure.

Because the inorganics area of the program has existed for only 2 years, not enough data have been generated to indicate what a normal concentration of contaminants is in this specific environment, or to develop a trend that reflects the changes in concentrations of these contaminants. Therefore, no conclusions can be drawn from the data generated by the end of 1994.

Fish

Other than occupational exposure, the greatest source of mercury intake by people is the consumption of food, particularly fish. The U.S. Food and Drug Administration (FDA) has established an action limit of 1.0 μg Hg/g [FDA, 1990]. Action limits are established to reflect maximum allowable concentrations for fish destined for interstate commerce. SRS uses the FDA guideline, which has been adopted by SCDHEC, to gauge concentrations of mercury in fish from onsite streams.

Description of Surveillance Program

EMS analyzes the flesh of fish caught from onsite streams and ponds, from the Savannah River, and from the Edisto River (the control location) to determine concentrations of mercury in the fish [SRS EM Program, 1995]. The fish analyzed represent the most common edible species of fish in the Central Savannah River Area (CSRA).

Surveillance Results

In 1994, 98 fish from SRS streams and ponds, the Savannah River, and the Edisto River were collected and analyzed for mercury [SRS Data, 1995].

The mercury concentrations in fish analyzed from onsite waters ranged from a high of 2.10 μg Hg/g in a Steel Creek bass to a low of 0.42 μg Hg/g in a Beaver Dam Creek bream.

Mercury concentrations in offsite fish ranged from a high of 0.83 μg Hg/g in a bass from the West Bank Landing on the Edisto River to a low of 0.07 μg Hg/g in a bream from the mouth of Steel Creek.

Edisto River concentrations ranged from a high of 0.83 μg Hg/g in a bass to a low of 0.20 μg Hg/g in a bream.

Chapter 10

Groundwater

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In this chapter...

Introduction

Groundwater beneath an estimated 5 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. There is no evidence that groundwater contaminated with these constituents has migrated off site. Groundwater in areas indicated on figure 10–1 (page 120) 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 describes the groundwater monitoring results for approximately 1,400 wells in 94 locations (figure 10–1) within designated areas at SRS. Only summaries of results exceeding the standards discussed on page 127 will be found in this report. Detailed results may be found in the following public documents: *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1994* (ESH–EMS–94–0514); *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1994* (ESH–EMS–94–0515); *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1994* (ESH–EMS–94–0516); *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1994* (ESH–EMS–94–0517). 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–94–0518), contains detailed maps of the wells at each monitored location.

During 1994, most analytical results were similar to those of recent years. For the first time, wells at the F-Area tank farm were analyzed for specific volatile organic compounds. Trichlorofluoromethane (Freon 11, which may have been used as a refrigerant, coolant, or degreaser in the past) was reported at elevated levels in two wells.

Strontium-89, with a half-life of 50 days, was reported at elevated levels in F-Area and H-Area seepage basins and in F-Area canyon wells. Based on the last operations date for processes that produce strontium-89, Westinghouse Savannah River Company (WSRC) considers positive results for strontium-89 to originate from errors in the laboratory.

Groundwater Hydrology

Groundwater aquifers are pathways by which potentially hazardous substances at SRS may enter nearby streams and eventually the Savannah River. Substances in the soil may be dissolved in rainwater, which moves them downward through the unsaturated zone to the water table. The water then flows downgradient toward a discharge point.

To identify the extent of contamination in groundwater and to predict the possible fate of the contaminants, scientists must determine the location and movement of groundwater. To make this determination, an understanding is required about how groundwater moves, in general, and about how that movement will be influenced by the specific geologic setting at SRS.

When rain falls, part of the rainwater soaks into the ground, infiltrating soil and rock. The accumulation of groundwater in pore spaces of sediments creates sources of useable water. Groundwater eventually reappears at the surface in springs, swamps, stream and river beds, or wells. Thus, groundwater is a reservoir whose primary input is rainwater infiltrating the soil and whose output is discharge to springs, swamps, streams, rivers, and wells.

Water from the surface moves into the soil by percolating downward through the pore spaces between sediment grains; smaller pore spaces means that less water flows through the sediment. The physical property that describes the ease with which water may move through the pore spaces and cracks in a solid is called permeability, which is determined largely by the number and size of pore spaces in the solid and how well the pore spaces are connected.

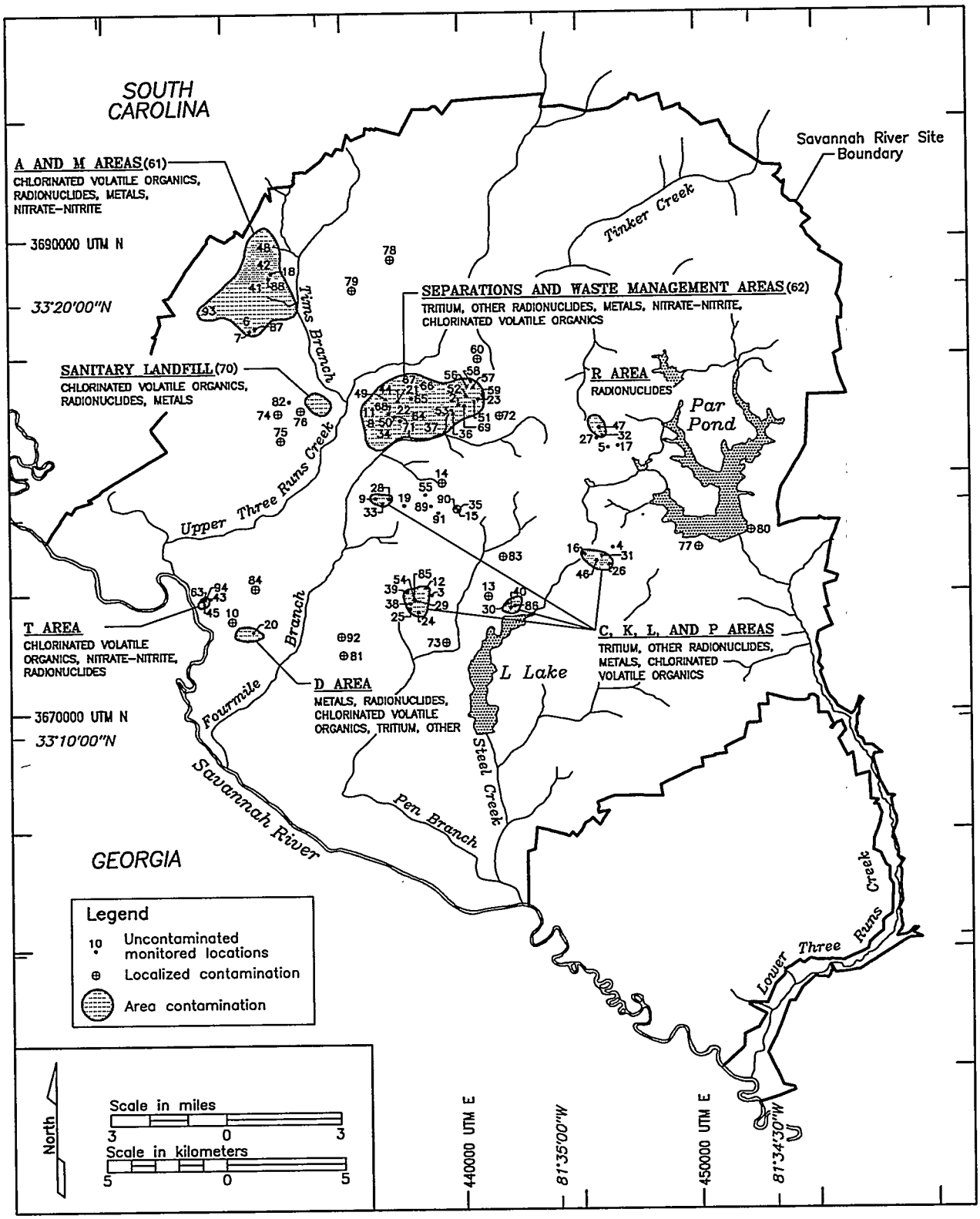

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Figure 10–1 Facilities Monitored by the SRS Monitoring Well Network, Including Areas Having Constituents Exceeding Drinking Water Standards in 1994

Key for Figure 10–1

Acid/Caustic Basins

1. F-Area Acid/Caustic Basin
2. H-Area Acid/Caustic Basin
3. K-Area Acid/Caustic Basin
4. P-Area Acid/Caustic Basin
5. R-Area Acid/Caustic Basin

Burning/Rubble, Rubble, and Metals Burning Pits

6. A-Area Burning/Rubble Pits and A-Area Ash Pile
7. A-Area Metals Burning Pit
8. Burma Road Rubble Pit
9. C-Area Burning/Rubble Pit
10. D-Area Burning/Rubble Pits
11. F-Area Burning/Rubble Pits
12. K-Area Burning/Rubble Pit
13. L-Area Burning/Rubble Pit
14. N-Area (formerly Central Shops) Burning/Rubble Pits
15. N-Area Burning/Rubble Pit South
16. P-Area Burning/Rubble Pit
17. R-Area Burning/Rubble Pits

Coal Pile Runoff Containment Basins and Ash Basins

18. A-Area Coal Pile Runoff Containment Basin
19. C-Area Coal Pile Runoff Containment Basin
20. D-Area Coal Pile Runoff Containment Basin and Ash Basins
21. F-Area Ash Basin
22. F-Area Coal Pile Runoff Containment Basin
23. H-Area Coal Pile Runoff Containment Basin
24. K-Area Ash Basin
25. K-Area Coal Pile Runoff Containment Basin
26. P-Area Coal Pile Runoff Containment Basin
27. R-Area Coal Pile

Disassembly Basins

28. C-Area Disassembly Basin
29. K-Area Disassembly Basin
30. L-Area Disassembly Basin
31. P-Area Disassembly Basin
32. R-Area Disassembly Basin

Seepage and Retention Basins

33. C-Area Reactor Seepage Basins
34. F-Area Seepage Basins and Inactive Process Sewer Line
35. Ford Building Seepage Basin, C-Area
36. H-Area Retention Basins
37. H-Area Seepage Basins and Inactive Process Sewer Line
38. K-Area Reactor Seepage Basin
39. K-Area Retention Basin
40. L-Area Reactor Seepage Basin
41. M-Area Hazardous Waste Management Facility
42. Metallurgical Laboratory Seepage Basin
43. New TNX Seepage Basin
44. Old F-Area Seepage Basin
45. Old TNX Seepage Basin
46. P-Area Reactor Seepage Basins
47. R-Area Reactor Seepage Basins
48. Savannah River Laboratory Seepage Basins

Operating Buildings and Facilities

49. F-Area Canyon Building and A-Line Uranium Recovery Facility
50. F-Area Effluent Treatment Cooling Water Basin
51. H-Area Auxiliary Pump Pit
52. H-Area Canyon Building
53. H-Area Effluent Treatment Cooling Water Basin
54. K-Area Tritium Sump
55. N-Area Hazardous Waste Storage Facility
56. S-Area Background
57. S-Area Low-Point Pump Pit
58. S-Area Vitrification Building
59. Z-Area Low-Point Drain Tank
60. Z-Area Saltstone Facility

Plume Monitoring

61. A-Area and M-Area
62. Separations and Waste Management Areas
63. TNX Area

Radioactive Waste Storage and Disposal

64. Old Burial Ground
65. Mixed Waste Management Facility/Low-Level Radioactive Waste Disposal Facility
66. Burial Ground Expansion (E-Area Vaults)
67. Hazardous Waste/Mixed Waste Disposal Facility, H-Area
68. F-Area Tank Farm
69. H-Area Tank Farm

Sanitary Landfill

70. Sanitary Landfill

Sludge Application Sites

71. F-Area Sanitary Sludge Land Application Site
72. H-Area Sanitary Sludge Land Application Site
73. K-Area Sludge Land Application Site (Formerly the K-Area Borrow Pit)
74. Kato Road Sewage Sludge Application Site
75. Lower Kato Road Sewage Sludge Application Site
76. Orangeburg Sewage Sludge Application Site
77. PAR Pond Sludge Land Application Site (Formerly the PAR Pond Borrow Pit Site)
78. Road F Sewage Sludge Application Site
79. Sandy (Lucy) Sewage Sludge Application Site
80. Second PAR Pond Borrow Pit Sewage Sludge Application Site
81. 40-Acre Hardwood Sewage Sludge Application Site

Other Sites

82. B-Area Gas Station
83. Chemicals, Metals, and Pesticides (CMP) Pits
84. D-Area Oil Disposal Basin
85. K-Area Diesel Tank Spill
86. L-Area Acid/Caustic Basin and L-Area Oil & Chemical Basin
87. Miscellaneous Chemical Basin, A-Area/M-Area
88. Motor Shop Oil Basin, A-Area/M-Area
89. N-Area Diesel Spill
90. N-Area Fire Department Training Facility
91. N-Area Hydrofluoric Acid Spill
92. Road A (Baxley Road) Chemical Basin
93. Silverton Road Waste Site, A-Area/M-Area
94. TNX Burying Ground

As water infiltrates the earth, it travels down through the unsaturated zone, where the pore spaces are filled partly with water and partly with air. Water moving through the unsaturated zone eventually reaches the top of the saturated zone (water table), where the pore spaces are completely filled with water. The water table generally follows, in subtle form, the contour of the surface topography. Springs, swamps, and beds of streams and rivers are the outcrops of the water table, where groundwater is discharged to the surface.

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 (page 154) and 10–4 (page 155) illustrate the potentiometric contours and horizontal flow directions of two regional aquifers monitored beneath SRS. Similar to contour lines on a weather map that connect points of equal barometric pressure, the figures' potentiometric 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 aquifers are indicated on figures 10–3 (page 154) and 10–4 (page 155) by bold arrows perpendicular to the contour lines. In both aquifers, 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 flow of groundwater and the position of the water table may be complicated by variations in the permeability of the subsurface. Because the earth's permeability varies greatly, groundwater flowing through subsurface strata does not travel at a constant rate or without impediment. Strata that transmit water easily (such as those composed primarily of sand) are called aquifers, and strata that restrict water movement (such as clay layers) are called aquitards. A fully saturated aquifer with an aquitard lying above it is termed a confined aquifer. Groundwater moves through aquifers toward natural exits, or discharge points, to reappear at the surface.

The direction of groundwater flow through an aquifer system is determined only partly by the permeability of the strata containing the aquifer. The elevation of the water in a well or piezometer at any given point in an aquifer, or hydraulic head, is a function of the energy associated with elevation and the pressures exerted by surrounding water. Hydraulic gradient, the difference in hydraulic head over a specified distance, is the driving force for groundwater movement. Because hydraulic head is not just a function of elevation, downgradient is not necessarily synonymous with downhill. The downgradient direction will have a horizontal and vertical component, just as a household drain moves wastewater both horizontally and vertically toward the lowest point of exit. Aquitards deflect groundwater movement just as drainpipe walls control the direction of wastewater movement. In an aquifer constrained by aquitards such as horizontal clay layers, the downgradient direction tends to be more horizontal than vertical.

Monitoring wells are used extensively at SRS to assess the effect of operations on groundwater quality, generally to determine the effect of a specific site on groundwater quality nearby. Wells positioned to intercept the groundwater flowing away from a site are called downgradient wells, while wells placed to intercept groundwater before it flows under a site are called upgradient wells. Wells sampling groundwater flowing next to a site are called sidegradient wells. Any contamination of the downgradient wells not present in the upgradient wells at a site may be assumed to be a product of that site.

Wells are drilled to various depths in the saturated zone below the area to be monitored. A portion of the well casing, the screen, is perforated to allow water to enter the well. Thus, the screen zone refers to the zone of subsurface strata whose water is being sampled by the well. The water rises in the well casing to equilibrate with the hydraulic head of the water surrounding the well's screen zone. By comparing the water levels in adjacent wells screened in the same zone, the hydraulic gradient can be determined and the horizontal direction of groundwater flow predicted.

The vertical direction of groundwater movement between aquifers is controlled by the permeability of the aquitards and the relative difference in hydraulic head of the water on either side of an aquitard. Vertical gradients can be determined by comparing the water levels between adjacent wells screened on either side of an aquitard. If the water levels in deeper wells are higher than those in shallower wells, the vertical component of flow is upward.

Geological and Hydrogeological Setting at SRS

SRS is located on the Upper Atlantic Coastal Plain, approximately 20 miles southeast of the Fall Line, which separates the Piedmont and Coastal Plain provinces. The site is on the Aiken Plateau, a relatively flat area that slopes southeastward and is dissected by several tributaries of the Savannah River.

Vertical and horizontal groundwater flow directions are determined in part by the permeability and continuity

of geologic strata. So that the movement of groundwater and any hazardous constituents it may contain can be monitored effectively, researchers at SRS have undertaken many detailed studies of the strata beneath the site.

SRS is underlain by a 700- to 1,200-foot-thick, seaward-thickening wedge of Coastal Plain sediment composed of unconsolidated sands, clayey sands, and sandy clays, and lesser amounts of calcareous sediment. These layers are underlain by dense Paleozoic crystalline igneous and metamorphic rock or younger consolidated sediments of the Triassic Period. The Triassic formations and the older igneous and metamorphic rocks are hydrologically isolated from the overlying Coastal Plain sediments by a regional aquitard. A cross section of the Coastal Plain sediments is presented in figure 10–5, page 156.

Within the Coastal Plain sediments, the sandy strata generally are permeable and may form aquifers. Strata rich in clays are made less permeable by the presence of minute, pore-filling clay particles. Clayey strata, therefore, are less permeable than sandy strata and tend to be aquitards.

Discussed in this report are three major water-bearing zones in Coastal Plain sediments, divided by regional aquitards, as shown in figure 10–5, page 156. In ascending order, these are the Cretaceous zone, the Congaree-Fourmile zone, and the upper saturated zone, including the water table in most areas. (These terms are informal.) Monitoring wells at SRS are used primarily to sample water from these zones.

The deepest aquifer monitored at SRS occurs in sediments of geologic formations of Cretaceous age. These Cretaceous sediments are largely permeable quartz sands and sandy clays capable of yielding abundant water; they constitute a regionally important aquifer. The Cretaceous zone is separated from the overlying Congaree-Fourmile zone by a regional aquitard composed of sandy-clay and clay sediments.

The Congaree-Fourmile zone, a locally important source of groundwater, occurs in moderately to well-sorted sand and interbedded sandy-clay sediments capable of yielding several hundred gallons of water per minute. A local aquitard, composed predominantly of clay and identified in SRS literature as "Green Clay," overlies the Congaree-Fourmile zone, separating it from the upper saturated zone. In the Savannah River Valley between SRS and Georgia, this aquitard and the sediments of the underlying Congaree-Fourmile zone have been eroded by river channel migration and incision.

Sediments of the upper saturated zone are predominantly sandy clay and calcareous sediments and generally yield low amounts of water. Numerous discontinuous clay-rich layers (including the "Tan Clay" of SRS literature) create local aquitards in the upper saturated zone, resulting in locally complex patterns of groundwater flow.

At SRS, the horizontal direction of groundwater movement is governed largely by the depths of incisions of the creeks and streams where water is discharged to the surface. The valleys of the smaller perennial streams allow discharge from the upper saturated formations. The valleys of major tributaries of the Savannah River drain formations of intermediate depth, and the valley of the Savannah River drains deep formations. Generally, groundwater in the deep Cretaceous zone flows toward and discharges into the Savannah River on both the Georgia and South Carolina sides of the river. Groundwater in intermediate-depth lower Eocene-age formations (the Congaree-Fourmile zone) flows toward and discharges into Upper Three Runs Creek or the Savannah River, depending on proximity. Groundwater in younger sediments (the upper saturated zone) generally flows toward and discharges into the nearest perennial stream, swamp, or river.

Few aquitards are continuous across SRS. Generally, in the northwestern part of the site (near A-Area and M-Area; figure 10–5, page 156), aquitards are less continuous, permitting vertical flow of groundwater. Where aquitards are more continuous, as they are in the southeastern portion of SRS, groundwater movement is predominantly horizontal. Along the Pen Branch fault (figure 10–5, page 156), aquitards (and transmissive zones) are offset, making the aquitards effectively discontinuous and increasing the likelihood of vertical interchange of water from one transmissive zone to another.

Beneath much of SRS, hydraulic head decreases with depth, so the vertical component of groundwater flow is downward. This is the case in A-Area and M-Area, where discontinuous aquitards and downward-decreasing hydraulic head allow the downward movement of water from the water table to deeper zones. This type of area is called an aquifer recharge zone (figure 10–6, page 157). However, because of the discharge of groundwater to the valleys of Upper Three Runs Creek and the Savannah River, the hydraulic head in sediments in the Congaree-Fourmile zone near these features is less than the hydraulic head in the Cretaceous zone. Thus, the vertical hydraulic gradient is upward, from the lower to the upper sediments, in some areas. This upward flow occurs, for example, in the separations and waste management areas (in the center of SRS), where both the aquitard and an upward

hydraulic gradient restrict downward flow of groundwater—and any associated hazardous substances—from the Congaree-Fourmile zone into the Cretaceous zone.

Uses of Groundwater in the Vicinity of Savannah River Site

Groundwater is used as a domestic, municipal, and industrial water supply throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County, South Carolina, are developed from the Cretaceous zone. Domestic water supplies are developed primarily from the Congaree-Fourmile zone and the upper saturated zone. In Barnwell and Allendale counties of South Carolina, some municipal users are supplied from the Congaree-Fourmile zone and overlying units that thicken to the southeast.

At SRS, most groundwater production is from the Cretaceous zone, with a few lower capacity wells pumping from the Congaree-Fourmile zone. Every major operating area at the site has groundwater production wells. Total groundwater production at SRS is from 9 to 12 million gallons per day, which is similar to the volume pumped for industrial and municipal production within 10 miles of the site.

Description of 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 suited to house 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 Monitoring Section (EMS) of Westinghouse Savannah River Company's (WSRC) Environmental Protection Department (EPD). 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 Groundwater Monitoring Plan* (WSRC–3Q1–2, Volume 2) provides details about the rationale and practice of the following aspects of the groundwater monitoring program:

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

The next seven sections of this chapter present overviews of several of these topics, along with information specific to 1994.

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 an environmental screening list of constituents (table 10–1, page 125) for four consecutive quarters. Except for a number of old wells not constructed properly for collecting samples for all analyses, these environmental-screening analyses are conducted every third year for all active EMS monitoring wells.

Wells with environmental screening constituent concentrations above certain limits subsequently are sampled either annually or semiannually, depending on the concentrations of the constituents. Field measurements of pH, specific conductance, temperature, turbidity, and water level are taken the first quarter of each calendar year at all active EMS monitoring wells. Alkalinity (as $CaCO_3$) also is measured in the field during most sampling events.

Personnel outside EMS may request samples to be collected 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

Table 10–1 Environmental-Screening Constituents

Aluminum
Arsenic
Barium
Boron
Cadmium
Calcium
Chloride
Chromium
Fluoride
Herbicides/pesticides suite[a]
- 2,4-Dichlorophenoxyacetic acid
- Endrin
- Lindane
- Methoxychlor
- Toxaphene
- 2,4,5-TP (Silvex)

Iron
Lead
Lithium
Magnesium
Manganese
Mercury
Nitrate as nitrogen
pH
Phenols[a]
Potassium
Selenium
Silica
Silver
Sodium
Specific conductance
Sulfate
Total dissolved solids
Total organic carbon
Total organic halogens
Total phosphates (as P)
Gross alpha
Gross beta
Total alpha-emitting radium[b]
Tritium

Gas Chromatographic Volatile-Organic-Analyses (GC VOA) Constituents
Carbon tetrachloride
Chloroform
Tetrachloroethylene
1,1,1-Trichloroethane
Trichloroethylene

a Herbicide/pesticide analyses and phenols are sampled as part of environmental-screening analyses for the first quarter of the initial four quarters for new wells, and on the basis of annual and semiannual screening limits.

b This analysis for radium-223, -224, and -226 was deleted from screening analyses after first quarter.

to the well to prevent cross-contamination among wells. Occasionally, portable sampling equipment is used; it 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) guidance. 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 from scheduled sampling and analysis for 1994 are enumerated in the SRS quarterly groundwater monitoring reports cited on the first page of this chapter.

Approximately 76,000 radiological analyses and 700,000 nonradiological analyses were performed on groundwater samples collected from the 1,400 monitoring wells.

Analytical Procedures

In 1994, 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 and analyzed samples from certain K-Area wells for gross alpha, gross beta, and tritium. Clemson Technical Center, Inc., of Anderson, South Carolina, and Environmental Physics of Charleston performed radiological analyses. TMA/Eberline of Oak Ridge, Tennessee, subcontracted radiological analyses from Roy F. Weston, Inc.

Full lists of constituents analyzed, analytical methods used, and the laboratories' detection 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 are complete for 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 that have been 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 1994

Well Abandonments and Additions to the Sampling Schedule

During 1994, 64 wells were removed from the groundwater monitoring program for the following reasons:

- Three BG wells at the old burial ground (BG 59, 60, 61) were abandoned because of poor construction or not meeting SCDHEC specifications.
- Eight wells at the F-Area canyon building were removed from the groundwater monitoring program because they had been dry or inaccessible for 2 years.
- At Site Q of the Interim Waste Technology Site Characterization Wells, well IDQ 11 was removed from the groundwater monitoring program in 1994 because it had been struck by lightning and could not be sampled.
- Eighteen SSS wells were removed from the groundwater monitoring program after first quarter because they had been scheduled for abandonment. These wells monitored six different sludge application sites at various locations across SRS.
- In H-Area, 29 HC wells were removed from the groundwater monitoring program because sampling required by the Tank 16 Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) work plan was completed. Well HTF 16 was abandoned to allow for construction of a building; well 241–H was decommissioned because it was covered by asphalt; and well HAP 1 was abandoned.
- Two production wells, FSB 1TA in F-Area and HSB 1TB in H-Area, were removed from the groundwater monitoring program because they were not required for RCRA compliance.

The following 111 wells were monitored for the first time in 1994:

- nine new wells installed at the Burma Road rubble pit to support the RFI/RI program
- one new well installed at the N-Area (formerly Central Shops) burning/rubble pit south in support of the RFI/RI work plan for N-Area
- four new wells installed at the F-Area ash basin (288–1F) and four new wells installed at the F-Area acid/caustic basin to comply with SCDHEC approval conditions for closure of those basins
- four new wells installed at the old F-Area seepage basin to support the RFI/RI characterization
- twenty-eight new HAA wells, four new HCA wells, and eight new HSL wells—all installed to fulfill the RFI/RI work plan requirements for Tank 16 in the H-Area tank farm
- eight new wells installed at the L-Area acid/caustic basin and seven new wells installed at the L-Area oil and chemical basin—all to fulfill requirements of the L-Area oil and chemical basin RFI/RI characterization; also, two research wells in L-Area monitored for the first time
- thirty-two new wells installed at the sanitary landfill to comply with SCDHEC and South Carolina Hazardous Waste Management regulations

Changes in Scheduling Policy

Beginning in 1994, EPD changed its policy concerning quarterly field measurements. All wells receive field measurements during the first quarter of each calendar year. After first quarter, only wells scheduled for sampling have field measurements taken. Wells scheduled only for water level measurements have water level measurements taken only during first quarter. If wells need to have additional field or water level measurements collected, a sampling request form must be submitted to EPD.

One analyte, total alpha-emitting radium, was removed from the environmental-screening list after first quarter 1994. Radium occurs naturally at SRS and in surrounding areas, so the results of this analysis did not correspond to effects of site activities on groundwater quality. The frequency of phenols analysis also was changed. Like herbicides/pesticides, analysis for phenols now is scheduled only during the first quarter of environmental screening—on the basis of annual and semiannual screening limits.

Changes in Scheduling Procedures

During 1994, 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, page 125).

Applicable Monitoring Standards

The analytical results of samples taken from SRS monitoring wells that exceed several different types of standards are discussed in this chapter. Most constituents discussed are compared to the final federal primary DWS because it is South Carolina policy to classify groundwater aquifers as potential drinking water sources [SCDHEC, 1985]. The DWS can be found in Appendix D, "Drinking Water Standards." DWS are not, however, invariably the standards applied by regulatory agencies to those 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 chapter. 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 earlier.

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 and thus is inappropriate for groundwater.

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 chapter 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 chapter is the activity per liter that would, if only that isotope were present, exceed the dose equivalent. Similarly, the standards for alpha emitters discussed here 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 here 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, -224, and -226, are compared to the standard for radium-226.

Four other constituents without DWS are discussed in the text when their values exceed certain 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 below 4.0 or equal to or above 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.

Groundwater Monitoring Results

The following sections describe the groundwater monitoring results for approximately 100 locations (figure 10–1, page 120) within designated areas at SRS. The sections are arranged in the following order: acid/caustic basins; burning/rubble, rubble, and metals burning pits; coal pile runoff containment basins, ash basins, and coal piles; disassembly basins; seepage and retention basins; operating buildings and facilities; plume monitoring; radioactive waste storage and disposal facilities; sanitary landfill; sludge application sites; and other sites. Table 10–2, beginning on

page 150, presents an overview of the well network for the monitored locations. The discussions of recent trends in the data are based on the results presented in the groundwater monitoring chapters of the SRS annual environmental reports from 1990 through 1993 and for the first three quarters of 1994. Mechanical failure or inaccessibility prevented the sampling of some wells throughout the year. Other wells were dry or needed to be added to the purged-water containment program before further sampling could occur. The quarterly groundwater monitoring reports referenced earlier identify wells for which scheduled analyses could not be performed—and specify the reason.

Geographical descriptions in the text are based on true north rather than SRS grid coordinates. All figures are oriented by Universal Transverse Mercator grid coordinates. Figure 10–7, page 158, illustrates the entire site. The areas covered in more detailed figures in this chapter are superimposed on figure 10–7.

Acid/Caustic Basins

The acid/caustic basins in F-Area, H-Area, K-Area, L-Area, P-Area, and R-Area are unlined earthen pits (approximately 50 by 50 by 7 feet deep) that received dilute sulfuric acid and sodium hydroxide solutions used to regenerate ion-exchange units in power plant water purification processes at the reactor and separations areas in the center of SRS. The basins allowed mixing and neutralization of the dilute solutions before their discharge to nearby streams.

The basins were constructed between 1952 and 1955. They are uncovered, and most are dry except during periods of prolonged precipitation. The R-Area and L-Area basins were abandoned in 1964 and 1968, respectively. The other basins remained in service until 1982, when the water purification systems were either shut down or modernized. However, the H-Area basin continued to receive steam condensate from a hose box and drainage from a chemical pad until the basin was abandoned in 1985.

The F-Area, H-Area, K-Area, and P-Area basins are RCRA-regulated units. SRS stabilized the H-Area and P-Area acid/caustic basins according to an Interim Status Closure Plan (Revision 3, 2/5/92) that proposes the closure of those four basins. During July through September 1993, the basins were dewatered, vegetation was removed and disposed of, the basins were filled with compacted soil from the Burma Road clay pit, a grass cover was established, and the fences were reinstalled. Soil along the F-Area, H-Area, K-Area, and P-Area acid/caustic sewer lines was sampled for characterization in November and December 1993.

Work plans for characterization of the L-Area and R-Area acid/caustic basins have been submitted to EPA Region IV and SCDHEC as part of the RCRA/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process for determining the extent of contamination at these basins. Since the first L-Area work plan was submitted, the L-Area characterization has been combined with characterization of the L-Area Oil and Chemical Basin; see "Other Sites" (page 147) for further information and monitoring results.

F-Area Acid/Caustic Basin

The F-Area acid/caustic basin is east of F-Area (figure 10–8, page 159). During 1994, analytical results for groundwater samples were similar to those of recent years. Gross alpha, which consistently has been above DWS in one or more wells, was detected above that level in four wells during 1994. The contamination continues to be less than five times the standard.

As in 1993, total alpha-emitting radium (radium-223, -224, and -226) exceeded the proposed standard for radium-226 in one well, but radium-226, measured by a different laboratory, exceeded the same standard in three wells. gross beta exceeded the primary DWS in two wells. Alkalinity was above its standard in one well, and pH exceeded the basic standard in two wells. As in past years, specific conductance exceeded the standard in several wells. Unlike results from 1993, lead did not exceed its DWS at this site in 1994.

H-Area Acid/Caustic Basin

The H-Area acid/caustic basin is southwest of H-Area near the tank farm (figure 10–8, page 159). In 1994, as in recent years, tritium activity exceeded the DWS in all wells in this area. Specific conductance and TDS exceeded the standard in three wells, as they have in one or more wells for several years. For the first time, carbon tetrachloride (during all three quarters and in three of three replicates during third quarter) and heptachlor epoxide (during one of two sampling events) were detected above the primary DWS in one upgradient well.

K-Area Acid/Caustic Basin

The K-Area acid/caustic basin is on the east side of K-Area (figure 10–9, page 160). As in the past, in 1994, specific conductance was elevated in most of the wells at this basin. In addition, results for TDS were above its standard in two of nine wells. Lead, which had exceeded its DWS during 1992 and 1993, was not reported above its DWS in 1994.

P-Area Acid/Caustic Basin

The P-Area acid/caustic basin is east of P-Area and Road F (figure 10–10, page 161). In 1994, specific

conductance was elevated in four of the six wells. Alkalinity and TDS were detected above their standards in two of the downgradient wells.

R-Area Acid/Caustic Basin

The R-Area acid/caustic basin is south of R-Area, just south of Road G (figure 10–11, page 162). In 1994, elevated levels of specific conductance were detected in two of the four wells, one upgradient relative to the basin and one sidegradient. Unlike results from recent years, when lead was above its DWS in at least one well, no other radioactive or chemical constituents were detected above their standards.

Burning/Rubble, Rubble, and Metals Burning Pits

From 1951 to 1973, burnable wastes—such as paper, wood, plastics, rubber, oil, degreasers, and drummed solvents—were received and burned monthly in one or more of the burning/rubble pits in the following areas: A, C, D, F, K, L, N, P, and R. In 1973, the burning of waste stopped, and the pits were covered with a layer of soil. Rubble wastes, including paper, wood, cans, concrete, and empty galvanized-steel barrels and drums, then were disposed of in the pits until they reached capacity and were covered with soil. All burning/rubble pits were inactive by 1981, and all are covered except the R-Area pit, which has not been backfilled. Similarly, lithium-aluminum alloy, aluminum pieces, metal drums, other metal scraps, and plastic pipe were deposited and burned periodically in the A-Area metals burning pit, beginning about 1952. In 1974, the solid materials remaining on the site were covered with soil, and the pit was regraded. The site is inactive.

The Burma Road rubble pit consists of two excavated earthen pits that may contain paint cans, fluorescent light fixtures, metal, concrete, lumber, poles, and glass. Unknown quantities of refuse were deposited here from approximately 1973 through 1983. The pit is inactive and has been covered with soil.

All these pits are RCRA/CERCLA units. Work plans to characterize fully the extent of contamination have been submitted to EPA and SCDHEC. Soil, surface, and groundwater sampling and analysis took place during 1993 and 1994 at several of these pits, after the work plans were approved.

A-Area Burning/Rubble Pits and A-Area Ash Pile

These burning/rubble pits and the A-Area ash pile (active since 1979) are west of Road D, south of A-Area (figure 10–12, page 163). Revision 2 of the RFI/RI work plan was submitted to the regulators in October 1993. As in much of the rest of A-Area and M-Area, tetrachloroethylene and trichloroethylene were the only constituents detected above DWS during 1994.

A-Area Metals Burning Pit

The A-Area metals burning pit is south of the burning/rubble pits (figure 10–12, page 163). In 1994, as in previous years, alkalinity, pH, and specific conductance were elevated in one well, indicating contamination by grout. In a different well, pH exceeded the acidic standard during one quarter.

As in the past and as in the rest of A-Area and M-Area, chlorinated volatile organics were detected above their DWS at this site. Tetrachloroethylene and trichloroethylene were above their DWS in four of the wells. No other chemical constituents or radionuclides were detected above their standards during 1994.

Burma Road Rubble Pit

The Burma Road rubble pit is southwest of F-Area (figure 10–8, page 159). In 1994, lead and tritium were above DWS, and specific conductance was above its standard, similar to results since groundwater at these pits first was sampled in 1990. Chromium, nickel, and nitrate-nitrite as nitrogen exceeded their DWS for the first time in 1994. Similarly, gross beta was above its screening standard; pH exceeded its basic standard for the first time; and gross alpha, ruthenium-106, and thorium-234 exceeded their proposed standards for the first time.

C-Area Burning/Rubble Pit

The C-Area burning/rubble pit is west of C-Area (figure 10–13, page 164). Two wells were not sampled during 1992, 1993, or 1994 because past trichloroethylene levels would require containerizing their purged water. During 1994, one of the other two wells contained levels of trichloroethylene slightly above its DWS, and both contained tritium at or slightly above its DWS. These results are very similar to those of past years.

D-Area Burning/Rubble Pits

Soil and groundwater RFI/RI assessments at these pits, west of D-Area (figure 10–14, page 165), were undertaken during 1993; reports were to be submitted to EPA and SCDHEC during 1994. During 1994, pH exceeded the acidic standard and specific conductance exceeded the standard in at least one well each, as they have since 1988.

F-Area Burning/Rubble Pits

Soil and groundwater RFI/RI assessments at these pits, north of Road C and west of F-Area (figure 10–8, page 159), were undertaken during 1993; a rubble pit where burning did not occur is included. Reports were to be submitted to EPA and SCDHEC during 1994.

During 1994, tetrachloroethylene and trichloroethylene consistently exceeded its DWS in three wells, and carbon tetrachloride exceeded their DWS in two wells. These results generally are similar to those of recent years. Chromium and nitrate exceeded their DWS in one well. Specific conductance exceeded its standard in three wells.

As in 1993, gross alpha exceeded its DWS in two wells. Gross beta exceeded its screening standard in two wells, and radium-226 exceeded its proposed standard in one well.

K-Area Burning/Rubble Pit

The K-Area burning/rubble pit (figure 10–9, page 160) is northeast of K-Area. During 1994, as in recent years, tetrachloroethylene and trichloroethylene were detected above their DWS. Specific conductance was elevated in one downgradient well.

L-Area Burning/Rubble Pit

At this location northwest of L-Area (figure 10–9, page 160), no radioactive or chemical constituents were detected above their standards during 1994. Lead has been above its standard in at least one well in recent years.

N-Area Burning/Rubble Pits

These pits are north of N-Area (figure 10–13, page 164). During 1994, the only analysis above its standard at this site was specific conductance in one well.

N-Area Burning/Rubble Pit South

This pit is southeast of N-Area (figure 10–13, page 164). During 1994, as in previous years, no constituents were detected above their standards.

P-Area Burning/Rubble Pit

This pit is west of P-Area (figure 10–10, page 161). During 1994, tetrachloroethylene and trichloroethylene were the only constituents above their standards, and they were above their DWS in only one sidegradient well. In past years, lead and/or chlorinated volatile organics have been above their standards in two wells.

R-Area Burning/Rubble Pits

These pits are southeast of R-Area, southeast of Road G (figure 10–11, page 162). During 1994, no chemical or radiological constituents were detected above their standards. Lead, which was above its DWS in one well in 1993, and specific conductance, which was elevated in three wells for the first time in 1993, did not exceed their standards.

Coal Pile Runoff Containment Basins, Ash Basins, and Coal Piles

Electricity and steam at SRS are generated by burning coal. Coal piles originally existed in the following areas: A, C, D, F, H, K, L, P, and R. The facilities generally contained a 90-day reserve of coal that was not rotated. During long-term exposure to the environment, chemical and biological oxidation of sulfur compounds in coal resulted in the formation of sulfuric acid.

The R-Area coal pile was removed in 1964, and the L-Area coal pile was removed in 1968. To achieve compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued in 1977, coal pile runoff containment basins in A-Area and D-Area were completed in October 1978, and basins in C-Area, F-Area, H-Area, K-Area, and P-Area were completed in March 1981. The coal piles in C-Area and F-Area were removed in 1985. In 1991, the K-Area coal pile was reduced to a 2-inch base, and 75 percent of the P-Area coal pile was removed.

Currently, rainwater runoff from the remaining coal piles in A-Area, D-Area, H-Area, K-Area, and P-Area flows into the coal pile runoff containment basins via gravity flow ditches and sewers. The basins allow mixing of the runoff and its seepage into the subsurface, thus preventing the entry of large surges of low pH runoff into surface streams. The basins in C-Area and F-Area also still collect runoff, although no coal remains at either location. All of these basins are RCRA/CERCLA units.

Ash sluice water from the D-Area and K-Area powerhouses has been discharged to the D-Area ash basins and the K-Area ash basin, respectively, since 1951. These, like other ash basins and ash piles, are site evaluation units under the Federal Facility Agreement (FFA) executed during 1993 between DOE–SR, EPA, and SCDHEC.

A-Area Coal Pile Runoff Containment Basin

This basin is southeast of A-Area (figure 10–12, page 163). During 1994, as in the past, two wells monitoring this basin had elevated specific conductance. Levels of gross alpha above DWS and total alpha-emitting

radium above its proposed standard were elevated in one of those wells. Nickel was above its DWS in the same well during one quarter. No other chemical or radioactive constituents were detected above their standards at this site.

C-Area Coal Pile Runoff Containment Basin

This basin is southeast of C-Area (figure 10–13, page 164). During 1994, specific conductance exceeded its standard during one sampling event. Prior to this year, no chemical or radioactive constituents or parameters had exceeded their standards at this site.

D-Area Coal Pile Runoff Containment Basin and Ash Basins

The containment basin is south and the ash basins are southwest of D-Area (figure 10–14, page 165). Results in 1994 generally were similar to those of recent years. Analytes above their DWS included trichloroethylene, tritium, gross alpha, and metals, including arsenic, cadmium, chromium, copper, lead, and nickel. Total alpha-emitting radium exceeded the proposed standard for radium-226, and gross beta exceeded its screening standard. Alkalinity exceeded its standard in two wells, TDS in 10 wells, specific conductance in 11 wells, and pH exceeded the acidic standard in seven wells.

F-Area Ash Basin

F-Area ash basin 281-F, east of F-Area and south of the F-Area acid/caustic basin (figure 10–8, page 159), was monitored for the first time during second quarter 1994. Alkalinity, pH, and specific conductance each exceeded its standard in at least one well during each of the last three quarters of 1994. TDS exceeded its standard in two wells.

F-Area Coal Pile Runoff Containment Basin

This basin is southeast of F-Area (figure 10–8, page 159). During 1994, specific conductance exceeded the standard in two wells, as it had in at least one well during the past several years. Lead and total alpha-emitting radium, which had exceeded their standards in one well in recent years, were reported below their standards during 1994.

H-Area Coal Pile Runoff Containment Basin

This basin is east of H-Area (figure 10–8, page 159). In 1994, as in past years, gross alpha and tritium exceeded their DWS in two wells. Trichloroethylene was above its DWS in one well. Specific conductance was elevated in three wells, and pH was above the acidic standard in two wells. Lead, which has been detected above its DWS in an upgradient well in the past, was not elevated in any of the wells.

K-Area Ash Basin

This basin is southwest of K-Area (figure 10–9, page 160). During 1994, gross alpha was detected above its DWS in one downgradient well. Alpha-emitting radium, which has been above its standard in recent years, was not analyzed during 1994. As in the past, alkalinity was elevated in one well and specific conductance was elevated in two wells.

K-Area Coal Pile Runoff Containment Basin

This basin is west of K-Area (figure 10–9, page 160), between the K-Area ash basin and reactor seepage basin. In 1994, tritium slightly exceeded its DWS in one well upgradient to the basin. In one downgradient well, gross alpha was above its DWS, specific conductance was elevated, and pH exceeded the acidic standard. These results are similar to those of past years, when gross alpha and tritium levels have varied within an order of magnitude of their DWS in different wells.

P-Area Coal Pile Runoff Containment Basin

This basin is southeast of the coal pile and south of P-Area (figure 10–10, page 161). In 1994, specific conductance was elevated in three wells. Cadmium exceeded its DWS in one downgradient well. Two wells, one downgradient and one upgradient, exceeded the acidic standard for pH.

R-Area Coal Pile

Two wells were installed inside the boundaries of the former coal storage area, west of the R-Area Reactor Building (figure 10–11, page 162), originally for groundwater assessment in relation to the R-Area coal pile. One of the wells first was sampled during second quarter 1992; the other first was sampled in 1994. Both are being sampled to support the RI for the R-Area reactor seepage basins.

During 1994, alkalinity (as CaCO3), high (basic) pH, and TDS were elevated above their standards in one well. Both wells had elevated specific conductance. Lead had exceeded DWS in 1993 but did not during 1994.

Disassembly Basins

The disassembly basins are concrete-lined tanks containing water. They are inside the reactor buildings, adjacent to the reactors. Irradiated assemblies (reactor fuel and target rods) were rinsed and stored in the basins prior to their shipment to the separations areas. Some radioactivity was transferred to the basin water from leaks in porous components and as a liquid or oxide corrosion film on the irradiated components.

Sand filters were used to remove radioactive particulates from the disassembly basin water. The

filtered water was circulated through deionizers to remove additional constituents and was purged periodically through regenerated deionizers to the reactor seepage basins. The disassembly basin then was filled with clean water.

The disassembly basins are on the site evaluation list of the FFA.

C-Area Disassembly Basin

As in recent years, both wells at the C-Area disassembly basin (figure 10–13, page 164) consistently contained tritium and lead above their DWS. Conductivity, which has been elevated occasionally in the past several years, exceeded its standard in both wells. For the first time, 1,2-dichloroethane exceeded its DWS in one well.

K-Area Disassembly Basin

Tritium was detected above its DWS in all three wells at the K-Area disassembly basin (figure 10–9, page 160), and concentrations of lead, tetrachloroethylene, and trichloroethylene were above their DWS in two wells. Specific conductance also was elevated in two wells.

L-Area Disassembly Basin

During 1994, lead and tetrachloroethylene exceeded their DWS in one well monitoring the groundwater below this basin (figure 10–9, page 160), and no constituents were detected above standards in the other well. These results are similar to those of past years.

P-Area Disassembly Basin

In 1994, tritium in both wells at the P-Area disassembly basin (figure 10–10, page 161) was detected at approximately one order of magnitude above its DWS. Lead exceeded its DWS in one well, and specific conductance was above its standard in the other.

R-Area Disassembly Basin

During fourth quarter 1994, gross alpha exceeded its DWS in one well at the R-Area disassembly basin (figure 10–11, page 162) for the first time since the monitoring wells were installed in 1990. Specific conductance was elevated in all three wells during 1994, as it has been since 1990, and lead was detected above its DWS in two wells, as it has been since 1992.

Seepage and Retention Basins

Seepage, retention, and settling basins have been used at SRS to store or dispose of wastewater from various operations. Since 1957, active reactor seepage basins have received low-level radioactive purge water from the disassembly basins. Although many radionuclides have been discharged to the basins, almost all of the radioactivity is due to tritium and small amounts of strontium-90, cesium-137, and cobalt-60.

Purge water was pumped directly from the disassembly basins to the seepage basins until the 1960s, when the use of mixed-bed deionizers and sand filters to reduce the radioactivity began. From 1970 to 1978, the seepage basins for active reactors were bypassed, and the filtered, deionized purge water was discharged directly into nearby streams. In 1978, the seepage basins for reactors in C-Area, L-Area, and P-Area were reactivated. The K-Area reactor seepage basin was used from 1957 to 1960 only. The R-Area reactor seepage basins have been filled and covered with asphalt. The K-Area and R-Area reactor seepage basins are RCRA/CERCLA units.

The three C-Area reactor seepage basins were active, periodically receiving purge water, until the C-Area reactor was shut down in 1985. The L-Area reactor seepage basin was used from 1958 until 1968 and from 1985 until the reactor was placed in warm standby in 1988. The L-Area reactor was placed in shutdown status in 1993 and has not been been restarted.

The P-Area reactor was shut down for maintenance and safety improvements in 1988 and has not been restarted. The C-Area, L-Area, and P-Area basins are on the FFA site evaluation list.

The K-Area retention basin was used for disposal of purge water from the K-Area disassembly basin from 1965 until 1988, when the reactor was shut down for maintenance and safety upgrades. The reactor has not been restarted.

C-Area Reactor Seepage Basins

These basins are about 650 feet west of the C-Area reactor building (figure 10–13, page 164). One well monitoring the basins was not sampled because high levels of trichloroethylene would require containerization of its purged water. During 1994, as in recent years, tritium was above its DWS in the groundwater near the basin by as much as three orders of magnitude. Lead was above its DWS in one well all four quarters and in another well less consistently. Trichloroethylene exceeded its DWS in two wells. Specific conductance and pH were above their standards in one well. These results are similar to those of past years.

F-Area Seepage Basins and Inactive Process Sewer Line

Beginning in 1955, the F-Area seepage basins received F-Area wastewater containing low-level radioactivity and chemicals, including chromium, mercury, nitric acid, and sodium hydroxide. The basins operated under

RCRA interim status from 1980 until they were taken out of service in the fourth quarter of 1988. Clay caps were completed early in 1991, and SCDHEC accepted the RCRA closure certification for these basins on April 26, 1991. The F-Area seepage basins are a RCRA/CERCLA unit located southwest of Road C (figure 10–8, page 159). The sewer line goes from northwest of the F-Area canyon building to north of the F-Area seepage basins.

The portion of the sewer lines within the fenced limited-access area is regulated under CERCLA, while the portion from the fence to the seepage basins is governed by RCRA. The RCRA portion of the lines has been extensively characterized, both for soils and groundwater contamination. A draft screening baseline risk assessment based on closure options was submitted in October 1994. An expedited investigation of the CERCLA portion of the lines was authorized by the regulators to characterize soils, and results were provided to the regulators in August 1992. An RFI/RI work plan was submitted in February 1992 to propose a more complete characterization.

During 1994, as in the past, the groundwater in many wells in the vicinity of the F-Area seepage basins was characterized by low pH, high nitrate and nitrate-nitrite as nitrogen concentrations, and elevated specific conductance. TDS also was above its standard in many wells. Only two wells had elevated levels of alkalinity. Cadmium, lead, and mercury were detected above their DWS in several wells monitoring the upper saturated zone. Beryllium, thallium, and nickel were detected above their DWS in at least three wells each. The only organic constituents detected above their DWS were carbon tetrachloride in one well and trichloroethylene in three wells.

Radionuclide contamination is widespread in the upper saturated zone near the basins. Most of these wells contain tritium above its DWS. Approximately two-thirds of such wells exhibit gross alpha, gross beta, strontium-90, and iodine-129 above their standards. Other radionuclides found above their proposed standards in several upper saturated zone wells include americium-241, curium-243,244, radium-226, radium-228, strontium-89, total alpha-emitting radium, uranium-233,234, uranium-235, and uranium-238. Cesium-137, curium-245,246, ruthenium-106, technetium-99, and thorium-234 were above their proposed standards in one to four wells each. These results are similar to those of 1993, when more isotopes were analyzed than had been in past years.

Tritium was above its DWS in seven of the nine sewer line wells, including the wells close to the canyon building and associated facilities. Other radionuclide contamination along the sewer line is limited to the wells closer to the tank farm and seepage basins. Gross alpha, gross beta, and total alpha-emitting radium were above their standards in one to three wells each.

Contamination in the Congaree-Fourmile zone at the F-Area seepage basins is less extensive than in the upper saturated zone. Tritium activity exceeded its DWS in several of the seepage basin wells monitoring the Congaree-Fourmile zone. Iodine-129, nitrate and nitrate-nitrite as nitrogen, gross beta, pH, and TDS were above their standards in at least one well each. Elevated specific conductance, found in most of the wells monitoring the zone, may result from the natural occurrence of soluble calcium carbonate minerals in the Congaree and associated formations. Elevated pH in a few wells indicates that leaching of well grout may be affecting the water quality in these wells.

Ford Building Seepage Basin

The Ford Building seepage basin, in the southeast portion of N-Area (figure 10–13, page 164), received low-level radioactive wastewater from Ford Building operations (repairing heat exchangers) from 1964 to January 1984. The basin is a RCRA/CERCLA unit.

In 1994, tritium was above its DWS in two wells monitoring this basin. Specific conductance also was elevated in two wells. These results are similar to those of recent years.

H-Area Retention Basins

A small, unlined earthen retention basin (the old H-Area retention basin) was used from 1955 to 1973 to provide temporary emergency storage for cooling water from the chemical separations process that contained radionuclides and possible trace quantities of chemicals. That basin is open but inactive and is a CERCLA unit. Preliminary screening of remedial technologies has been performed, and a Phase I RI work plan for preliminary characterization was approved in October 1993. Soil samples were obtained at the old H-Area retention basin in November 1993.

A larger, rubber-lined retention basin replaced the original basin in 1973 and is still in use for receipt of diverted cooling water or tank farm stormwater runoff. Both basins are southeast of the intersection of Road 4 and Road E (figure 10–8, page 159).

In 1994, as in past years, tritium was above its DWS in four of the six wells monitoring these basins. No other chemical or radiological constituents were detected above their standards.

H-Area Seepage Basins and Inactive Process Sewer Line

Starting in 1955, the H-Area seepage basins received wastewater from H-Area containing low-level radioactivity and chemicals, including nitric acid, mercury, and sodium hydroxide. Basin 3 has been inactive since 1962. Basins 1, 2, and 4 operated under RCRA interim status from 1980 until they were taken out of service in the fourth quarter of 1988. Clay caps were completed early in 1991, and SCDHEC accepted the RCRA closure certification for these basins on November 30, 1991.

The basins are southwest of H-Area, southwest of the intersection of Road E and Road 4 (figure 10–8, page 159), and the sewer line extends from the southwest portion of H-Area to north of the H-Area seepage basins. See "F-Area Seepage Basins and Inactive Process Sewer Line," page 132, for more information on the sewer lines.

During 1994, as in the past, the groundwater in many wells in the vicinity of the H-Area seepage basins was characterized by high nitrate and nitrate-nitrite as nitrogen concentrations and elevated specific conductance. TDS was above its standard in several wells, as was alkalinity in three upper saturated zone wells. Cyanide, lead, and mercury were detected above their DWS in a few wells monitoring the upper saturated zone. The pH level exceeded the basic standard in some wells and the acidic standard in others. Arsenic and cadmium appeared above their DWS in one well each. The only organic constituent detected above its DWS was tetrachloroethylene in four wells in the upper saturated zone.

Radionuclide contamination is widespread in the upper saturated zone near the basins. More than half of the wells contained tritium above its DWS. Approximately half of the wells exhibited gross beta and iodine-129 levels above their standards. Gross alpha, strontium-89, and strontium-90 were above their standards in several wells. Other radionuclides elevated above their proposed standards included total alpha-emitting radium and ruthenium-106 in six wells, cobalt-60 and radium-226 in two wells, and thorium-234 and zirconium-95 in one well each. These results are similar to those found in 1993, when more isotopes were analyzed than had been in past years.

Tritium was above its DWS in most of the upper saturated zone sewer line wells. Gross beta, gross alpha, and strontium-90 were above their standards in one sewer line well, as was gross beta in a second. Technetium-99 was above its proposed standard in one well. Alkalinity, cyanide, lead, mercury, nitrate and nitrate-nitrite as nitrogen, PCBs, and acidic and basic pH were above their standards in one well each. TDS were elevated in four sewer line wells and specific conductance in six.

Contamination in the Congaree-Fourmile zone is less extensive than in the upper saturated zone. Tritium exceeded its DWS in three seepage basin wells monitoring the Congaree-Fourmile zone. Antimony, lead, nitrate and nitrate-nitrite as nitrogen, gross beta, and PCBs exceeded their standards in one to three seepage basin wells each. In the Congaree-Fourmile zone wells along the sewer line, gross beta, alkalinity, antimony, lead, and pH were above their standards in one well each. PCBs were detected above their standard in two of these wells.

TDS was above its standard in several Congaree-Fourmile zone wells across the entire seepage basin area, including the sewer line. Elevated specific conductance, found in all the wells monitoring this zone, may result from the natural occurrence of soluble calcium carbonate minerals in the Congaree and associated formations. Elevated pH and alkalinity in a few wells may indicate leaching of well grout in these wells.

K-Area Reactor Seepage Basin

This basin is west of K-Area (figure 10–9, page 160). During 1994, as in the past, tritium exceeded its DWS in all wells monitoring this basin, reaching levels three orders of magnitude above its DWS in some wells. Trichloroethylene above its DWS was found in two wells, and tetrachloroethylene was detected above its DWS in one well.

K-Area Retention Basin

This basin is northwest of K-Area (figure 10–9, page 160). In 1994, tritium was detected consistently in all four wells, as it has been since these wells first were sampled in 1991. No other constituents were detected above their standards.

L-Area Reactor Seepage Basin

This basin is southeast of L-Area, adjacent to the L-Area oil and chemical basin (figure 10–9, page 160). During 1994, tritium exceeded its DWS in one downgradient and one upgradient well. Lead, which had been elevated in at least one well in the past, was not detected above its DWS for the second year in a row.

M-Area Hazardous Waste Management Facility

The unlined M-Area settling basin, in operation from 1958 until 1985, received wastewater containing metal-cleaning solvents, depleted uranium, and other chemicals and metals from fuel fabrication processes in

M-Area. Because surface water flowed from this basin, it is classified as a settling basin rather than a seepage basin. Water from the basin flowed through an overflow ditch to Lost Lake, a shallow upland depression. A seepage area formed adjacent to the ditch and Lost Lake. The M-Area hazardous waste management facility, a RCRA-regulated unit south of A-Area and M-Area and west of Road D (figure 10–12, page 163), comprises the settling basin, overflow ditch, seepage area, and Lost Lake. A closure cap was completed on the basin during 1989–1990, and closure under RCRA was certified by SCDHEC on April 26, 1991.

Since the beginning of a full-scale recovery system for groundwater remediation in April 1985, groundwater flow has changed markedly near this facility, and changes over time in concentrations of analytes are difficult to interpret. See the "Plume Monitoring" section of this chapter (page 138) for more information on remediation.

As in past years, chlorinated volatile organics were the primary constituents above DWS among the point-of-compliance wells during 1994. Trichloroethylene and tetrachloroethylene were detected above their DWS in numerous wells. In six wells, 1,1-dichloroethylene was above its standard.

In an apparently anomalous result, gross alpha was reported above its DWS in one background well. Gross beta was elevated above its screening standard in three wells. Specific conductance was elevated in several wells, and nitrate or nitrate-nitrite as nitrogen exceeded its DWS in 17 wells. Alkalinity was above its standard in six wells, and pH exceeded the acidic standard in 12 wells.

Metallurgical Laboratory Seepage Basin

The Metallurgical Laboratory seepage basin, at the eastern edge of A-Area (figure 10–12, page 163), received wastewater effluent from the Metallurgical Laboratory Building from 1956 until 1985. Wastewater released to the basin consisted of small quantities (5 to 10 gallons per day) of laboratory wastes—mostly rinse water—from metallographic sample preparation (degreasing, cleaning, etching) and corrosion testing of stainless steel and nickel-based alloys. Noncontact cooling water (approximately 900 gallons per day) also was discharged.

Revision V of the RCRA closure plan for the hazardous waste management facility, comprising the seepage basin, the process sewer line leading to it, and the adjacent Carolina bay, was approved by SCDHEC in late 1991. The basin was dewatered, backfilled, and capped with low-permeable clay. The basin closure construction was completed in May 1992 and certified by SCDHEC in July 1992.

Consistent with results from previous years, several of the wells at this basin had levels of chlorinated volatile organics, including tetrachloroethylene and trichloroethylene, above their DWS in 1994. Lead and gross alpha were above their DWS in one well each during first quarter. Four wells had elevated levels of specific conductance, two had elevated pH, and one had elevated alkalinity. These parameter results may be the effect of grout contamination.

New TNX Seepage Basin

The new TNX seepage basin, in the east section of T-Area across Road A–4.7 from the TNX process area (figure 10–14, page 165), replaced the old TNX seepage basin and operated from 1980 to 1988. This basin is a RCRA-regulated unit. A waste site assessment report and a groundwater quality assessment/corrective action feasibility plan have been submitted to SCDHEC for review. A closure plan was submitted in March 1992.

Results during 1994 were very similar to those of recent years. No radioactive or chemical constituents were detected above their DWS, but specific conductance was elevated in one sidegradient/upgradient well.

Old F-Area Seepage Basin

The old F-Area seepage basin, the first seepage basin constructed in F-Area, was used for disposal of wastewater from the canyon building from November 1954 until mid-May 1955, when it was abandoned. The basin is north of F-Area (figure 10–8, page 159). During operation, the seepage basin received a variety of wastewaters, including evaporator overheads, laundry wastewater, and an unknown amount of chemicals. For three months in 1969, spent nitric acid solutions used to etch depleted uranium were discharged to the basin. In 1984, low-level contaminated water was released to the basin.

An RFI/RI work plan was submitted to EPA and SCDHEC in February 1993, and characterization was initiated during that year.

Groundwater monitoring results in 1994 were consistent with those of previous years at this site. Gross alpha, gross beta, strontium-90, and tritium were above their standards in three wells. Radium-228, uranium-234, and uranium-238 were above their proposed standards in two wells, and iodine-129, ruthenium-106, and thorium-234 were above their proposed standards in one well each. Beryllium in one well and nitrate as nitrogen in two were the only chemical constituents exceeding their DWS. Specific

conductance was elevated in five wells, pH exceeded the acidic standard in two wells, and TDS were elevated in one well.

Old TNX Seepage Basin

The old TNX seepage basin, in the southwest corner of T-Area (figure 10–14, page 165), received waste from pilot-scale tests conducted at TNX from 1958 to 1980. In 1981, the basin wall was breached and the impounded water was drained into the adjacent wetlands. The basin then was backfilled with a sand and clay mixture, and the top was capped with clay. This basin is a RCRA/CERCLA unit.

During 1994, nitrate or nitrate-nitrite as nitrogen exceeded its DWS in five wells at this site. Elevated levels of specific conductance were detected in six of seven wells, and TDS was elevated above its standard in one well. Carbon tetrachloride exceeded its DWS in two wells, as did trichloroethylene in five wells, including two downgradient wells. No radioactive constituents were detected above their standards.

P-Area Reactor Seepage Basins

These basins are southwest of the reactor building (figure 10–10, page 161). In 1994, as in the past, tritium exceeded its DWS in all seven wells monitoring these basins. Lead was detected above its DWS in one well.

R-Area Reactor Seepage Basins

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.

In 1960, Basins 2 through 5 were closed and backfilled. The ground surface above Basins 1 through 5 was treated with herbicide and covered with asphalt. In addition, a kaolinite cap and dike were constructed over and around Basin 1 and the northwest end of Basin 3 to minimize lateral movement of the radioactive contamination. Basin 6, which received water directly from the disassembly basin from 1960 until 1964, was backfilled in 1977. The basins are northwest of R-Area (figure 10–11, page 162).

A revised RFI/RI work plan for this RCRA/ CERCLA unit is to be submitted in April 1995.

In 1994, cadmium, lead, and gross alpha exceeded their DWS in numerous wells. Gross beta was above its screening standard in many of the wells. Mercury concentration in six wells and chromium in four wells also were reported above their DWS. Tritium exceeded its DWS in two wells. Levels of TDS in two wells, high pH and low pH in one well each, and specific conductance in three wells exceeded their standards.

These results are consistent with those found in 1993, when the number of wells with elevated constituents increased above past years. Total alpha-emitting radium, which had been above the proposed DWS for radium-226 in 34 wells during 1993, did not exceed that standard in any wells during 1994. Strontium-90 had been above its proposed standard in several wells during 1993, but neither specific strontium nor gamma pulse height analyses were performed during 1994.

Savannah River Laboratory Seepage Basins

The Savannah River Laboratory seepage basins (figure 10–12, page 163)—located across the road from the Savannah River Technology Center (SRTC), formerly the Savannah River Laboratory—received low-level radioactive laboratory wastewater through underground drains until they were taken out of service in October 1982. Two basins were placed in operation in 1954; two more were added in 1958 and 1960, respectively, to provide additional holding capacity.

An exception to the practice of discharging only low-level alpha or beta-gamma wastewater was made in 1971, when 0.68 Ci of curium from a leaking separator pit in the Savannah River Laboratory radioactive waste tanks was disposed of in the basins. Approximately 34 million gallons of wastewater were discharged to the basins during their operating life.

The basins are a RCRA/CERCLA Unit. A closure plan revision was submitted to SCDHEC for review in December 1993. The closure will consist of placement of a RCRA-style cap over the basin.

In 1994, chlorinated volatile organics—specifically, tetrachloroethylene and trichloroethylene—were detected above their DWS in several wells at this site. Tritium was above its DWS in three wells. Specific conductance and pH were elevated in at least two wells. These results are similar to those of previous years.

Mercury was above its DWS in one well for the first time in at least 5 years. Gross alpha was above its DWS in two wells, and radium-228 and ruthenium-106 were above their proposed standards in one well, as they had been at least once in recent years.

Operating Buildings and Facilities

F-Area Canyon Building and A-Line Uranium Recovery Facility

At the canyon building (figure 10–8, page 159), irradiated product from the reactors is dissolved using nitric acid, and the desired radionuclides are separated from fission products. At the A-Line uranium recovery facility, adjacent to the canyon building, uranium oxide is produced from uranyl nitrate.

In 1994, the majority of the groundwater monitoring results were similar to those of previous years. Several chlorinated volatile organics consistently exceeded their DWS in at least one well each during the year. Nitrate as nitrogen and nitrate-nitrite as nitrogen were found above their DWS in several wells. Gross alpha and tritium consistently exceeded their DWS, and total alpha-emitting radium and gross beta exceeded their proposed DWS or screening standard, respectively, in at least one well each during 1994. Strontium-89 and strontium-90 were above their proposed DWS consistently in one well at this site, with activities up to almost 1,000 times that standard. Specific conductance was above its standard consistently in numerous wells, and alkalinity was above its standard in one well.

Results for lead were consistent with those of 1993, during which this constituent was elevated in more wells than it had been previously. A similar increase in occurrence is noted for pH, which was in excess of the basic standard in one well and the acidic standard in two wells.

F-Area Effluent Treatment Cooling Water Basin

The F-Area effluent treatment cooling water basin, south of F-Area (figure 10–8, page 159), receives diverted cooling water from the separations processes. The cooling water is sent from the basin to the F-Area and H-Area Effluent Treatment Facility (ETF) if contaminated or to a permitted outfall if uncontaminated. The ETF, on the south side of H-Area, was placed in service in 1988 to treat wastewater formerly sent to the F-Area and H-Area seepage basins. In addition to cooling water, it also receives separations area stormwater runoff and condensed overheads from the evaporators in the tank farms. The treatment facility removes hazardous and radioactive contaminants from these low-level liquid wastes and concentrates them for immobilization as saltstone.

In 1994, as in the previous year, no radioactive or chemical constituents were detected above their standards at the F-Area effluent treatment cooling water basin.

H-Area Auxiliary Pump Pit

The H-Area auxiliary pump pit facility will pump high-level radioactive sludge and precipitate from the H-Area tank farm to the S-Area low-point pump pit en route to the vitrification facility. When the pumps are shut down, this facility at the east end of H-Area (figure 10–8, page 159) will collect the solution in a temporary holding tank via gravity flow lines.

No chemical or radioactive constituents were detected above their standards in 1994 at the one well at this site, including specific conductance, which had been elevated in 1993. Strontium-90, detected above its proposed DWS during 1993, was not analyzed.

H-Area Canyon Building

As in F-Area, materials from the reactors are dissolved at the canyon building (figure 10–8, page 159), and the desired radionuclides are separated from waste products.

In 1994, tritium exceeded its DWS in four wells monitoring this site. Lead exceeded its standard in two wells, tetrachloroethylene was above its standard in three wells, and trichloroethylene, copper, and 1,2-dichloroethane were above their standards in one well each. Specific conductance, pH, and TDS were elevated in several wells. These results are similar to those of previous years.

H-Area Effluent Treatment Cooling Water Basin

See "F-Area Effluent Treatment Cooling Water Basin." The H-Area effluent treatment cooling water basin is southwest of H-Area (figure 10–8, page 159). As in recent years, all four wells had levels of tritium above its DWS. No chemical or other radiological constituents were detected above their standards.

K-Area Tritium Sump

A single well, installed in 1992, monitors the water table just west of the K-Area reactor building (figure 10–9, page 160). The well was placed near the K-Area process water storage tank, which stores water collected in sumps within the K-Area reactor building. Tritium activity in this sump water has been reported as greater than 5 Ci/mL.

In 1994, tritium activity was above its DWS, as it has been since the groundwater below the K-Area tritium sump was first monitored in 1992. No other constituents were detected above their standards.

N-Area Hazardous Waste Storage Facility

Building 645–N of the hazardous waste storage facility has been in service since 1983, 645–2N since 1987, and 645–4N since 1984. Buildings 645–N and 645–4N contain hazardous waste, and building 645–2N contains mixed waste (a mixture of low-level radioactive waste and hazardous waste). Wastes are stored inside the buildings in drums placed on diked concrete floors designed to contain liquid spills. This facility, an active RCRA-regulated unit operated under SCDHEC Hazardous Waste Permit SC1 890 008 989, is northwest of N-Area (figure 10–13, page 164).

In 1994, as in recent years, no radioactive or chemical constituents were detected above their standards in the groundwater below these buildings.

S-Area Facilities

S-Area (figure 10–8, page 159) contains several facilities for processing high-level radioactive waste from the tank farms at F-Area and H-Area into borosilicate glass solidified within stainless steel canisters. The glass will be stored temporarily in specially designed storage buildings within S-Area. Eventual permanent disposal is expected to be in an offsite federal geologic repository.

In 1994, as in previous years, tritium exceeded its DWS in two wells, and tetrachloroethylene and trichloroethylene exceeded their DWS in one well.

S-Area Low-Point Pump Pit

The S-Area low-point pump pit, at the south end of S-Area (figure 10–8, page 159), will receive high-level radioactive sludge and precipitate from the H-Area tank farm and pump it to the Defense Waste Processing Facility (DWPF) vitrification building; it also will receive waste being recycled from the vitrification building back to the tank farm. As at the H-Area auxiliary pump pit, when the pumps are shut down, the sludge and precipitate remaining in the line will drain back into a temporary holding tank via gravity flow lines.

No radiological or chemical constituents have been detected above their standards at this site since 1989.

S-Area Vitrification Building

The S-Area vitrification building (figure 10–8, page 159), also known as the S-Area canyon building, contains the process and auxiliary equipment to incorporate high-level radioactive waste into leach-resistant glass. The facility is expected to begin radioactive operations in late 1995.

Two major compliance agreements affect the site—the 1991 SRS Land Disposal Restrictions Federal Facility Compliance Agreement between DOE and EPA and the 1993 FFA. After startup, removal of the waste stored in the tank farms is expected to require 24 years.

In 1994, tritium exceeded its DWS in four wells downgradient to sidegradient relative to the building. Specific conductance was elevated in the same four wells, and alkalinity was elevated in one well. No results above standards were reported for any of the wells located within the building.

Z-Area Low-Point Drain Tank

The Z-Area low-point drain tank facility (in southeastern S-Area, figure 10–8, page 159) receives low-level radioactive salt solution from the H-Area tank farm and pumps it to the Z-Area salt solution holding tank. When the H-Area pump is shut down, the low-point drain tank can collect the solution remaining in the lines via gravity flow.

In 1994, as in previous years, tritium in both wells monitoring this facility was the only chemical or radiological constituent detected above its DWS. Specific conductance was elevated above its standard in one well.

Z-Area Saltstone Manufacturing and Disposal Facility

The Z-Area saltstone manufacturing and disposal facility (figure 10–8, page 159) processes and permanently disposes of low-level radioactive salt solution supernatant from the underground storage tanks at F-Area and H-Area and from ETF concentrate. Z-Area began radioactive operations in June 1990.

In November 1992, a tank in the Z-Area saltstone manufacturing and disposal facility overflowed, and a portion of the liquid leaked from the building into a storm drain. Approximately 2 gallons of solution reached a drainage pipe that flows into a series of sedimentation basins and eventually into McQueen Branch. Sediment samples showed small amounts of cesium-137 exceeding those amounts observed in the Savannah River, but within the activity ranges in site streams.

In 1994, specific conductance was elevated above its standard in four wells, alkalinity was elevated in one well, and pH exceeded the acidic standard in two wells.

Plume Monitoring

A-Area and M-Area

In addition to the groundwater monitoring conducted at specific locations in A-Area and M-Area, numerous

plume definition wells also monitor a 5-square-mile area to assess the extent of volatile organic contamination (figure 10–12, page 163). The first plume definition wells were installed soon after discovery of the contamination in June 1981.

The plume definition well network extends from the region north of SRTC, between Road 1 and the SRS boundary, south to wells near the miscellaneous chemical basin and the metals burning pit, and from Tims Branch in the east toward the Silverton Road waste site in the west. The plume encompasses approximately 3 square miles and consists primarily of trichloroethylene, tetrachloroethylene, and 1,1,1,-trichloroethane.

Contaminant Recovery Beneath A-Area and M-Area A groundwater remediation program has been under way in A-Area and M-Area for more than 10 years. Following the successful demonstration of a prototype stripper in 1983 and 1984, a full-scale recovery system consisting of 11 recovery wells and a 400-gallon-per-minute air stripper began decontaminating the groundwater in September 1985. That stripper, known as M–1, has operated at approximately 450 to 500 gallons per minute since April 1990 and has removed approximately 300,000 pounds of solvent from more than 2 billion gallons of groundwater. The resulting uncontaminated water is released to Tims Branch, which flows into Upper Three Runs Creek.

The prototype stripper, with one recovery well, has been used since 1992 to remove solvents from groundwater near SRTC. Known as the A–1, it operates at approximately 55 gallons per minute and has removed more than 1,600 pounds of solvent from 72.5 million gallons of groundwater.

The Integrated Demonstration Vadose Zone Unit (IDU), an innovative technology for the removal of volatile organic compounds from soils, was put into experimental operation in 1990 and full-scale operation in August 1994. Located south of M-Area, the IDU is a joint project of SRTC and DOE's Office of Technology Development. It consists of one horizontal vapor extraction well (figure 10–2, page 140), a vacuum pump, a control system, and a catalytic-oxidation unit. Solvent-laden air from the extraction well is placed into an 825 °F catalytic-oxidation unit that destroys the contaminants. From August through December 1994, the IDU removed approximately 2,000 pounds of solvent and destroyed approximately 94 percent of that total. When combined with experimental vadose zone stripping conducted since 1987, the IDU has removed a total of nearly 20,000 pounds of solvent.

The remediation program serves two purposes. Removing and processing contaminated groundwater lowers the amount of contamination present in the ground. Removal of the contaminated groundwater also causes groundwater to flow toward the recovery wells, reducing the spread of the remaining contamination. In general, water within a well's zone of influence (zone of capture) flows toward the well and is removed from the ground. The zone of capture of a recovery well increases as pumping continues, thereby directing groundwater flow and some contamination flow toward the recovery well and removal.

The upper saturated zone is unconfined, and water elevations may be plotted on a map to represent the water table surface. This water table surface, also known as the piezometric surface, represents the interface between the overlying unsaturated zone and the saturated zone below. A zone of low permeability known as a confining layer lies beneath the upper saturated zone. Below this zone, the aquifers each have zones of low permeability (confining layers) above and below them, and therefore are referred to as confined aquifers. Pressure is exerted on water in confined aquifers by the surrounding water, thus causing water elevations taken within them to be higher than the elevation at the upper limit of the aquifer. The water elevation at any point within the aquifer is called the hydraulic head. By plotting water elevations of confined aquifers on a map, we can graphically represent the surface of the hydraulic head, which is known as the potentiometric surface.

Figures 10–15 through 10–17 (pages 166–168) are three-dimensional representations of the piezometric surface of the upper saturated zone and potentiometric surfaces of both the upper portion and the lower portion of the Congaree-Fourmile zone. The shapes of the surfaces were plotted from water elevation measurements taken during third quarter 1989 (top of figure) and third quarter 1994 from plume definition and point-of-compliance wells in A-Area and M-Area. Because groundwater flows from areas of high hydraulic head to areas of low hydraulic head, figures 10–15 through 10–17 can be used to visualize groundwater flow directions. Differences between high and low water elevations within an aquifer zone vary between 20 and 35 feet across A-Area and M-Area. A vertical exaggeration factor of 15 was used to accentuate the mounds and depressions found on the surfaces to allow easier interpretation of flow patterns.

Trichloroethylene plumes and the zones of capture of the recovery wells also are shown on figures 10–15 through 10–17. The zones of capture are superimposed onto each surface and show the extent to which the recovery wells influence groundwater flow in each aquifer. Groundwater and associated contamination

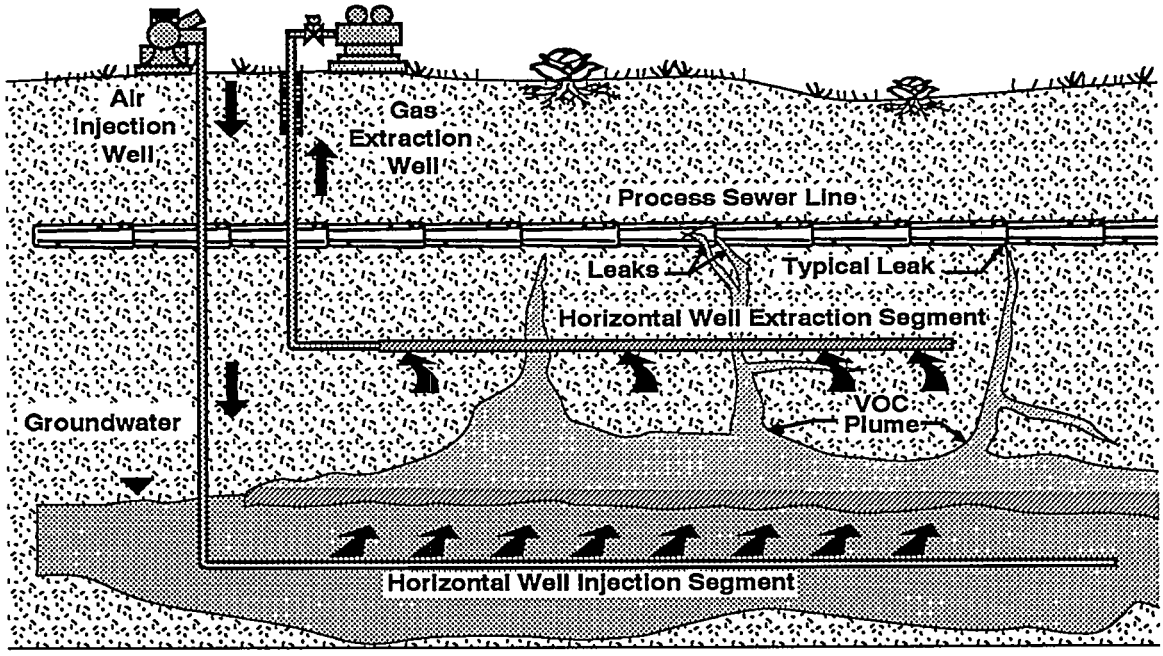

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Figure 10–2 Horizontal Wells

Horizontal wells installed beneath a source of solvent contamination can be used for remediation of solvent contamination in groundwater or soil. At SRS's Integrated Demonstration Vadose Zone Unit (IDU), a horizontal extraction well similar to the upper well shown above is connected to the suction side of a vacuum extraction blower. As air is pulled through the soil, contaminants are volatilized from the soil pore spaces. The extracted vapor flows into a catalytic oxidation unit, where the contaminants are reduced to elemental constituents. The air injection system shown in the figure was an experimental method of treating groundwater. It was placed in standby condition in August 1994, when the extraction well system was put into full-scale operation.

occurring upgradient of the zone of capture may flow into the zone and be removed by the recovery wells. Flow that occurs outside the zone of capture will not be affected by the recovery system and will continue to move away from A-Area and M-Area toward downgradient discharge points.

The piezometric surface for the upper saturated zone, shown in figure 10–15, page 166, is relatively flat in most of the area. However, differences in the hydrogeology across the area combine with localized reduction in groundwater volume near the recovery wells to produce the mounds and depressions found on the piezometric surface. South of A-Area and M-Area, a water table divide appears to divert flow naturally to the southwest and southeast.

Figure 10–15 shows the changes in the water table surface, zone of capture, and trichloroethylene plumes between 1989 and 1994. The zone of capture has increased over the past 5 years because of stripper and recovery well operation. Increases in the zone of capture and the associated cone of depression in the upper saturated zone surface seem to have influenced the area of contamination; areas of higher contamination levels appear to have been drawn toward the recovery well network. The extent of trichloroethylene contamination has decreased slightly since 1989.

Beneath the upper saturated zone lies the upper portion of the Congaree-Fourmile zone. The potentiometric surface of the upper portion of this zone indicates a semiradial groundwater flow pattern around the recovery wells, with flow away from the highest hydraulic heads north of A-Area and M-Area to the southwest, south, and southeast (figure 10–16, page 167). A mound in the potentiometric surface south of the M-Area hazardous waste management facility may result from local recharge of water from the upper saturated zone at this location, possibly enhanced by water level drawdown associated with recovery wells north of the mound.

As in the upper saturated zone, a moderate increase in the size of the zone of capture has occurred in the upper portion of the Congaree-Fourmile zone during the past 5 years (figure 10–16, page 167). Changes in the

trichloroethylene plume since 1989 are characterized by a general movement of the plume to the south or southeast. The downgradient shift of the plume occurs both within and outside the zone of capture.

Flow in the lower portion of the Congaree-Fourmile zone (figure 10–17, page 168) is multidirectional, toward the east, southeast, and south. The most prominent feature of the potentiometric surface is a north-south oriented depression beneath the M-Area hazardous waste management facility. This depression is especially evident to the south of the M-Area hazardous waste management facility and is probably a result of the recovery well system.

The most pronounced change during the past 5 years in the lower portion of the Congaree-Fourmile zone is the substantial increase in the area influenced by the recovery wells (their zone of capture) (figure 10–17). A general migration of the contaminant plume to the south also is evident over the past 5 years. The extent of contamination in this zone, however, has remained essentially the same since 1989.

1994 Groundwater Monitoring Results The groundwater plume beneath A-Area and M-Area was characterized during 1994, as in the past, by chlorinated organic solvent concentrations—primarily trichloroethylene and tetrachloroethylene—at or above DWS. Other volatile chlorinated organics, such as carbon tetrachloride, chloroform, 1,1-dichloroethylene, trans-1,2 dichloroethylene, and dichloromethane, also were detected above their DWS in several wells.

The highest concentrations of chlorinated organic solvents were detected in many upper saturated zone and upper and lower Congaree-Fourmile zone wells in the vicinity of known point sources in A-Area and M-Area. From 1990 through 1994, trichloroethylene was reported above its DWS in wells within approximately 2,000 feet of the nearest SRS boundary. Concentrations of chlorinated organic solvents and chlorinated volatile organics in the Ellenton Sand Unit and the Black Creek Unit are nearly as widespread as in the upper saturated and Congaree-Fourmile zones.

In the upper saturated zone, metals (copper, lead, and nickel), alkalinity, nitrate-nitrite as nitrogen, and radionuclides (including gross alpha, lead-212, gross beta, radium-228, and total alpha-emitting radium) exceeded DWS in a few wells. Elevated levels of alkalinity, basic pH, and specific conductance in a few wells in this zone indicate the possible influence of well grout. pH values below the acidic standard also were detected in a few upper saturated zone wells.

Groundwater monitoring results in the upper and lower Congaree-Fourmile zone wells are consistent with those from the upper saturated zone. Chlorinated organic solvents and volatile organics exceeded DWS in most of the wells in these zones. Specific conductance, elevated pH, alkalinity, and nitrate and nitrate-nitrite as nitrogen were detected above their standards in several wells in each zone. Antimony, lead, mercury, acidic pH, and radionuclides (gross alpha, gross beta, total alpha-emitting radium, and tritium) exceeded their standards in fewer than four wells in the upper Congaree-Fourmile zone. Benzene, mercury, and gross alpha exceeded DWS in fewer than three wells in the lower Congaree-Fourmile zone.

Tetrachloroethylene was detected during 1994 above its DWS in approximately one-third of the Ellenton Sand Unit wells and one-sixth of the Black Creek Unit wells, as was trichloroethylene in approximately half the wells in the Ellenton Sand Unit and more than one-third of those in the Black Creek Unit.

Trichloroethylene was detected above its DWS in eight wells in the Black Creek Unit in 1994, an increase from two wells in 1993. Constituents detected above their standards in fewer than four wells in the Ellenton Sand zone were alkalinity, cadmium, pH, and specific conductance. Constituents detected above their standards in fewer than four wells in the Black Creek unit included benzene, cadmium, pH, and specific conductance.

The distribution of trichloroethylene in the groundwater generally is linked to hydraulic gradients and to proximity to point sources. Low horizontal gradients in the upper saturated zone and downward vertical gradients from the water table to the Cretaceous zone have resulted in the downward transport of trichloroethylene into lower zones. Horizontal flow in the Congaree-Fourmile zone to the south and southwest has resulted in the transport of trichloroethylene into regions in this zone downgradient of surface point sources.

Separations and Waste Management Areas

A number of wells were installed in the separations areas (figure 10–8, page 159) in 1951 and 1952. These wells, which range from approximately 15 to 90 feet in depth, measure water table elevations and monitor for radioactive constituents (gross alpha, gross beta, and tritium) in the groundwater in and around F-Area and H-Area. They have steel casings that could affect the metal concentrations in the water.

Lead and cadmium exceeded their DWS in several wells monitoring this plume in 1994. Tritium was detected above its DWS in four wells, and mercury exceeded its DWS in two wells. Gross alpha exceeded its DWS in one well. Specific conductance was elevated in five wells. These results are similar to those

obtained in 1993, when these wells were monitored for chemical constituents for the first time.

T-Area (TNX)

Because operations in this area have caused a contaminant plume, primarily of volatile organics, TNX groundwater (figure 10–14, page 165) is a RCRA/CERCLA unit. An Interim Action Proposed Plan and a Record of Decision were issued for the TNX Groundwater Operable Unit in 1994. The plan proposes the evaluation through treatability and feasibility studies of the most effective and efficient method to remediate the groundwater contamination.

During 1994, nitrate or nitrate-nitrite as nitrogen exceeded DWS standards in five of 12 TNX assessment wells. Elevated levels of carbon tetrachloride, tetrachloroethylene, and trichloroethylene were found in one well downgradient of the new TNX seepage basin and upgradient of the old TNX seepage basin. Similarly elevated concentrations of trichloroethylene were found in three wells within the swamp, downgradient of the area. Elevated levels of specific conductance were detected in several wells.

Many of the constituents found above DWS in wells downgradient of the new TNX seepage basin and upgradient of the old TNX seepage basin were similarly elevated in a centrally located well in 1993 and in downgradient wells from 1990 through 1992.

Radioactive Waste Storage and Disposal Facilities

Burial Grounds

The burial grounds, located in E-Area between F-Area and H-Area in the center of SRS (figure 10–8, page 159), have been used for storage and disposal of radioactive solid waste produced at SRS or shipped from other facilities since 1952. The original area, known as the old burial ground, contains low-level alpha beta-gamma trenches, intermediate-level beta-gamma trenches, and alpha waste trenches. As the trenches were filled, they were covered with soil. When the old burial ground was filled in 1974, operations shifted to the adjacent Low-Level Radioactive Waste Disposal Facility (LLRWDF).

Until 1965, transuranic (TRU) waste was placed in plastic bags and cardboard boxes and buried in earthen trenches. Between 1965 and 1974, lower level TRU waste was buried unencapsulated in trenches, and higher level TRU waste was buried in retrievable concrete containers or encapsulated in concrete. Since 1974, TRU wastes contaminated with greater than 1.0E–02 Ci/g have been stored in watertight containers on concrete pads with monitoring sumps. TRU waste storage pads 1–17 are on the FFA's list of RCRA-regulated units.

Since mid-1984, newly generated low-level beta-gamma waste has been placed in metal boxes or metal drums. Currently, it is disposed of in engineered trenches and covered with at least 4 feet of soil. Some wastes that do not have forms conducive to containerization are disposed of in shallow land-burial slit trenches.

Mixed wastes (low-level radioactive waste and hazardous waste) stored or disposed of within the old burial ground and portions of the newer grounds include lead, cadmium, mercury, and tritiated pump oil. Some of the waste is contained in welded stainless steel containers or metal drums and stored within concrete cylinders. Degraded radioactive organic solvents and tritiated pump oil have been stored in 22 underground storage tanks in the old burial ground. In addition, two areas of the old burial ground were used for incineration of solvents.

The burial ground complex, comprising the old burial ground, solvent storage tanks S01–S22, and the portions of the LLRWDF not otherwise regulated, is a RCRA/CERCLA unit. A Revision 2.0 RFI/RI work plan was submitted in December 1994. Seismic, soil gas, and ground-penetrating radar surveys conducted in 1993 are to be submitted during 1995.

Solvent storage tanks S23–S30 are RCRA-regulated units. The tritiated pump oil from mixed waste storage tank S32 has been removed and incinerated in the beta-gamma incinerator; closure under RCRA of that tank by grouting was certified by SCDHEC in September 1988.

The newer burial ground, the LLRWDF, contains two regulated sections. Closure under RCRA of one of these sections of the Mixed Waste Management Facility (MWMF), where disposal of mixed waste was halted in 1986, was certified by SCDHEC in April 1991. A RCRA Part B post-closure permit application was submitted in November 1992, a corrective action plan was submitted in November 1993, and a field investigation plan was submitted in September 1993. Revision 1.0 of the field investigation plan, submitted in June 1994, outlines all field characterization activities to identify groundwater contamination horizontally and vertically away from the burial ground complex.

Generally, since March 1986, only radioactive wastes certified as free of hazardous materials have been accepted for disposal in the burial grounds. However, mixed wastes in the form of rags and wipes used for radioactive decontamination and containing RCRA-

listed solvents were disposed of until January 1990 in portions of the LLRWDF outside the MWMF. A Revision 1.0 closure and post-closure plan for the solvent rags portion, 10 discrete areas comprising a total of about 21 noncontiguous acres, was submitted to SCDHEC in January 1994.

The sections of the LLRWDF currently being operated, known as the Solid Waste Disposal Facility (SWDF), contain trenches for only radioactive waste. Concrete vaults, known as the E-Area vaults, have been constructed east and north of the LLRWDF for disposal of solid radioactive waste. The first waste was placed in them in September 1994.

Mixed waste storage building 643–29E, within the boundaries of the LLRWDF, has been in use since March 1987. A review of the operating procedures for the adjacent mixed waste storage building, 643–43E, continued during 1994. This facility is expected to begin receiving waste in 1995. Both buildings are RCRA-regulated units. A hazardous waste/mixed waste disposal facility is being proposed for permanent disposal of hazardous and mixed wastes in specially engineered vaults. RCRA Part B permitting issues, a review of the site treatment plan for mixed wastes, and funding deferrals have delayed construction of the hazardous waste/mixed waste vaults, which were scheduled to begin operations in 1999.

Burial Ground Expansion (E-Area Vaults) During 1994, one well at this site in the northern section of E-Area (figure 10–8, page 159) could not be sampled because water purged from the well requires special disposal procedures because previous levels of pH exceeded its standard.

Results for these wells generally were similar in 1994 to those of the past several years. Tritium remains in excess of its DWS in several wells. Lead, gross beta, and trichloroethylene exceeded their standards in at least one well each.

During 1994, as in 1993, alkalinity, specific conductance, and TDS exceeded their standards in at least one well monitoring the Congaree-Fourmile zone. Tritium and lead, both consistently high since 1991, did not appear in excess of their DWS during 1994 in wells monitoring the lower zone.

Alkalinity, TDS, and specific conductance in excess of their standards, and pH in excess of the basic standard in at least one well in the upper saturated zone suggest the continued influence of well grout, as do similar results during the past 2 years in the Congaree-Fourmile zone wells.

Hazardous Waste/Mixed Waste Disposal Facility This site is northwest of the burial ground expansion (figure 10–8, page 159). In 1994, as in recent years, lead exceeded its DWS in one well, and TDS were elevated above its standard in the same well. Tritium was detected above its DWS in two wells.

Old Burial Ground The old burial ground is in the southern portion of E-Area (figure 10–8, page 159). In 1994, as in previous years, most wells monitoring the upper saturated zone at this site had tritium at or above its DWS. The highest tritium activity, up to four orders of magnitude above the DWS, was recorded in samples from wells within the facility's boundaries, especially along the southern margin of the facility. Gross alpha, total alpha-emitting radium, and gross beta were above their applicable standards (primary DWS, proposed DWS for radium-226, and screening standard, respectively) in groundwater below the old burial ground. Several metals (cadmium, chromium, lead, and mercury) also exceeded their DWS in one or more wells.

Concentrations of chlorinated organic solvents (chiefly trichloroethylene) above their DWS were reported for several wells in the upper saturated zone, generally in the southwest corner of the old burial ground. One well was not sampled during 1994 because previous trichloroethylene values were high enough that purged water would require containerization.

Several wells within the upper saturated zone and the Congaree-Fourmile zone showed levels of alkalinity, pH, specific conductance, and TDS above their respective standards. Three wells were not sampled during 1994 because previous pH values exceeded standards enough that purged water would require containerization. Three sampled wells within the upper saturated zone had pH in excess of the basic standard, and two had pH in excess of the acidic standard during 1994.

In 1994, the extent and location of the tritium and chlorinated solvent plumes changed little from previous years.

Radioactive Waste Burial Ground A single network of wells monitors the LLRWDF, the MWMF, and the SWDF. Tritium exceeded its DWS in most upper saturated zone wells by as much as three orders of magnitude. Gross beta exceeded its screening standard in one upper saturated zone well, and uranium-233,234 and uranium-238 exceeded their proposed DWS in another.

Concentrations of chlorinated organic solvents (chiefly trichloroethylene) were detected above DWS in several wells. Chloroethane and 1,1-dichloroethylene were detected above their DWS in two upper saturated zone

wells. Lead was found above its DWS in a few of these wells. Elevated pH and specific conductance were detected in several wells, while alkalinity and TDS were above their standards in three wells.

In the Congaree-Fourmile zone, specific conductance was elevated in most wells, and alkalinity, pH, and TDS were above their standards in several. Tritium was above its DWS in one well, and several chlorinated volatile organics were detected above DWS in one well. Benzene was detected above its DWS in three Congaree-Fourmile zone wells.

These results are similar to those obtained in 1993.

Tank Farms

Liquid radioactive wastes are stored and processed at the tank farms, which are comprised of subsurface tanks containing high-level aqueous radioactive wastes in the form of sludges, supernatant liquid of varying salt concentrations, and salt cake. Roughly 129 million liters of waste are stored in the tanks.

The high-level liquid waste volume is reduced in the tank farm evaporators. Certain tanks are used for pretreatment of the wastes before they are processed at the DWPF into saltstone (low-level waste) or a glass form (high-level waste). As described earlier, saltstone manufacturing and disposal is ongoing; vitrification is being tested. Pretreatment processes at the tank farms include in-tank precipitation and extended sludge processing.

More information about the function of the tank farms may be found in previous sections of this chapter, including the discussions of the F-Area effluent treatment cooling water basin, H-Area auxiliary pump pit, S-Area, S-Area low-point pump pit, S-Area vitrification building, Z-Area low-point drain tank, and Z-Area saltstone manufacturing and disposal facility.

F-Area Tank Farm The F-Area tank farm, in the southwest portion of F-Area (figure 10–8, page 159), is comprised of 22 subsurface tanks. In 1961, Tank 8 was overfilled, causing soil and possible groundwater contamination.

During 1994, cadmium, gross alpha, and lead were detected above their DWS, and gross beta and specific conductance were elevated above their standards in most of the wells at the F-Area tank farm. Chromium was above its DWS in five wells, as was tritium in three wells, and total alpha-emitting radium was above the proposed standard for radium-226 in three wells. Mercury, nitrate as nitrogen, and nitrate-nitrite as nitrogen were above their DWS in two wells each. In three wells, pH exceeded the basic standard, and the acidic standard was exceeded in one well.

Because of previous high levels of total organic halogens, these wells were analyzed for volatile organic compounds for the first time during fourth quarter 1994. High levels of trichlorofluoromethane (Freon 11) were reported in two wells. This compound, which does not have a DWS, may have been accidentally released from a compressor in the area, or it may have been used as a degreaser in past years. Resampling for confirmation is scheduled for early 1995.

High specific conductance and pH values in some wells indicate probable grout contamination.

Because of limitations on the disposal of purged water, wells at the tank farms are bailed and not purged.

H-Area Tank Farm The H-Area tank farm, at the south end of H-Area (figure 10–8, page 159), is comprised of 29 subsurface tanks. In 1960, Tank 16 leaked an unknown quantity (a few tens of gallons to a few hundred gallons) of waste into the soil. The tank's remaining waste was removed by 1972. Revision 2 of a RCRA/CERCLA work plan for Tank 16 was submitted to EPA and SCDHEC in November 1992. Characterization activities began in August 1993 and continued in 1994. To fulfill the Tank 16 RFI/RI work plan requirements, 40 new wells were installed during 1994.

There have been several other releases of waste from H-Area tanks, including a spill of approximately 100 gallons at Tank 13 in 1983. In 1989, approximately 500 pounds of volume-reduced waste leaked from a transfer line at Tank 37. The leak sites have been cleaned up or stabilized to prevent the further spread of contamination.

Cadmium, lead, and tritium were above their DWS in numerous wells in 1994. Gross alpha was above its DWS in six wells during the year, and gross beta exceeded its screening standard in five wells. Mercury and iodine-129 exceeded their primary or proposed DWS in one or two wells each. One well had cesium-137 levels 2 to 3 orders of magnitude higher than its proposed DWS during third quarter; the same well had been reported at 2 orders of magnitude below the proposed DWS earlier in the year. Trichloroethylene was detected above its DWS in four wells.

Specific conductance was elevated in more than half of the H-Area tank farm wells. Four wells had pH levels above the basic standard, two had levels above the acidic standard, and alkalinity was elevated in three wells.

Sanitary Landfill

The sanitary landfill, south of Road C (figure 10–18, page 169), 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 the site's wastewater treatment plant are 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 active portion of approximately 16 acres is known as the northern expansion, or the interim sanitary landfill.

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. As required by a settlement agreement between DOE and SCDHEC, a RCRA closure permit application for the original landfill and its southern expansion was submitted to SCDHEC in March 1993.

The interim landfill is operating under a revision of a domestic waste permit that expires in October 1995.

During 1994, trichloroethlyene and chloroethane exceeded their DWS, and specific conductance was elevated in numerous wells in the original sanitary landfill and its southern expansion. Tritium, benzene, and tetrachloroethylene were detected above their DWS in nine or 10 wells each, and alkalinity was above its standard in 12 wells. TDS was elevated in seven wells, and pH exceeded its acidic standard in six wells. Tritium, benzene, and chlorinated volatile organics have been detected above their DWS for several years.

Other constituents reported above DWS in at least two wells in the original landfill and southern expansion were mercury, 1,2-dichloroethane, and 1,2-dichloroethylene. Radium, which has been detected above proposed standards in recent years, was not elevated in 1994. Lead, which has been detected above its DWS in past years, also was not elevated. One well monitoring this site could not be sampled because its purged water requires containerization because of previously high levels of chloroethene (vinyl chloride).

Gross alpha was detected above its DWS in five wells in the original sanitary landfill and one well in the interim sanitary landfill. No other constituents exceeded their standards in wells in the interim sanitary landfill in 1994. In past years, no constituents have exceeded their standards.

Sludge Application Sites

These sites originally were the subject of a research program using domestic sewage sludge to reclaim borrow pits and to enhance forest productivity at SRS. In 1980, as permitted by SCDHEC, sludge was applied to the following application sites: K-Area, Kato Road, Lower Kato Road, Orangeburg, PAR Pond, Road F, Sandy (Lucy), Second PAR Pond Borrow Pit, and 40-Acre Hardwood. After sludge was applied to the sites, hardwoods and pines were planted to quantify the effectiveness of the sludge as a fertilizer and soil conditioner.

As permitted by SCDHEC IWP–175, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the following sites: F-Area, H-Area, Kato Road, Lower Kato Road, Orangeburg, Road F, Sandy (Lucy), Second PAR Pond Borrow Pit, and 40-Acre Hardwood. All are on the FFA site evaluation list. Wastewater sludge was applied to the K-Area and PAR Pond sites in 1981 and 1988. All these sludge application permits have expired; revegetating of the sites is continuing.

Except at the F-Area, H-Area, K-Area, and PAR Pond sites, SCDHEC in November 1993 approved the discontinuation of groundwater monitoring at all of these sites because they have not received applications of sewage sludge since 1981, and historical monitoring results show no impact from sludge applications. Monitoring was not canceled, however, until after first quarter 1994.

F-Area Sanitary Sludge Land Application Site

The F-Area sanitary sludge land application site covers 8 acres southeast of F-Area (figure 10–8, page 159). Sludge from SRS sanitary wastewater treatment plants was disposed of at this location from 1987 until third quarter 1990. A closure plan was approved in November 1993 for the site. Groundwater monitoring will continue because of the proximity of the wells to the old burial ground.

In 1994, as in previous years, lead and copper were above their DWS in two wells. Tritium also exceeded its DWS in two wells, and specific conductance was above its standard in two wells. No single well exceeded standards for all four parameters.

H-Area Sanitary Sludge Land Application Site

Sewage sludge from SRS sanitary wastewater treatment plants was disposed of at this 13-acre site southeast of H-Area (figure 10–8, page 159) from

November 1990 to May 1992. A closure plan for the site was approved in November 1993. In 1994, lead was the only analyte exceeding its DWS at the site; it was elevated in only one well, as it has been since 1989.

K-Area Sludge Land Application Site (Formerly K-Area Borrow Pit)

In 1981, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the K-Area and PAR Pond borrow pits under SCDHEC permit IWP–175. In 1988, the N-Area sanitary sewage sludge lagoon was closed, and the lagoon sludge was applied to the K-Area and PAR Pond borrow pits. In 1989, the K-Area location, now called the K-Area sludge land application site, which covers 17 acres southeast of K-Area (figure 10–9, page 160), was declared a RCRA/CERCLA unit because of the presence of chlordane in the lagoon sludge applied to the site.

In 1994, as in previous years, lead in one well was the only analyte reported above its DWS.

Kato Road Sewage Sludge Application Site

This site is in the western portion of SRS, south of B-Area (figure 10–18, page 169). In 1994, barium was detected above its DWS in one well for the second year in a row. Gross alpha was above its DWS and gross beta was above its screening standard in the same well. No other wells had constituents exceeding their standards.

Lower Kato Road Sewage Sludge Application Site

This site is south of the Kato Road sewage sludge application site (figure 10–18, page 169). As in 1993, all three wells had gross alpha activity above its DWS in 1994. Only one well had gross beta activity above its screening standard; the other two were just below that standard. Barium and chromium, which had been elevated in 1993 for the first time in at least 5 years, were below their DWS in 1994.

Orangeburg Sewage Sludge Application Site

This site is in the western portion of SRS, southwest of the sanitary landfill (figure 10–18, page 169). Gross alpha exceeded its DWS and gross beta was above its screening standard in both wells sampled during 1994; this was similar to results during 1993, when those constituents were above their standards for the first time in at least 5 years. Chromium, which had been above its DWS in two wells in 1993, was elevated in only one well in 1994.

PAR Pond Sludge Land Application Site (Formerly PAR Pond Borrow Pit Site)

In 1981, sludge from Aiken and Augusta municipal wastewater treatment plants was applied to the K-Area borrow pit and to this site under SCDHEC permit IWP–175. In 1988, the N-Area sanitary sewage sludge lagoon was closed, and the lagoon sludge was applied to the K-Area and PAR Pond borrow pits. In 1989, this site, covering 22 acres south of PAR Pond (figure 10–10, page 161), became a RCRA/CERCLA unit because of the presence of chlordane in the lagoon sludge applied to the site. Chlordane never has been detected in the groundwater below this site.

In 1994, chromium, gross alpha, gross beta, and radium-226 were detected above their standards in one up-to-sidegradient well. Chromium, gross alpha, and gross beta also were above their standards in 1993.

Road F Sewage Sludge Application Site

This site is in the northern portion of SRS (figure 10–7, page 158). In 1994, gross alpha was detected above its DWS in all three wells, as it had been during 1993 for the first time since at least 1988. No other constituents were detected above their standards, including chromium, which had been elevated in one well during 1993.

Sandy (Lucy) Sewage Sludge Application Site

This site is in the northwestern portion of SRS, east of M-Area (figure 10–12, page 163). During 1994, barium and cadmium were detected above their DWS for the second year in a row. Neither of these metals had been elevated prior to 1993. Gross alpha exceeded its DWS in both wells sampled, and gross beta exceeded its screening standard in one well.

Second PAR Pond Borrow Pit Sewage Sludge Application Site

This site is in the eastern portion of SRS, on the east edge of PAR Pond (figure 10–7, page 158). In 1994, gross alpha exceeded its DWS in all three wells. Gross beta and radium-226 were detected above their standards in one well. These results were consistent with those of past years. During 1993, lead had been detected above its DWS in two wells for the first time in at least 5 years; it was not elevated during 1994.

40-Acre Hardwood Sewage Sludge Application Site

This site is in the southwestern portion of SRS, south of the Road A chemical basin (figure 10–14, page 165). As in previous years, gross alpha was above its DWS in two wells and gross beta was above its screening

standard in one well in 1994. No other radioactive or chemical constituents were detected above their standards.

Other Sites

B-Area Gas Station

Elevated benzene, which could be the result of old underground gasoline or diesel storage tanks, has been detected near B-Area (figure 10–18, page 169). EMS has inspected the area and believes there may be two underground storage tanks southeast of B-Area. The first suspected tank appears to be at an abandoned gas station between Kato Road and Road C–2. The second appears to be an old diesel tank in front of a storage and laboratory facility.

Groundwater from the well cluster east of this site was analyzed only on the basis of previous results above flagging criteria in 1994. No radiological or chemical constituents exceeded their standards at this site.

Chemicals, Metals, and Pesticides Pits

The chemicals, metals, and pesticides pits were used from 1971 to 1979 to dispose of drummed oil, organic solvents, and small amounts of pesticides and metals. In 1984, the pits, which are west of Road C approximately 2 miles southeast of N-Area (figures 10–9, page 160, and 10–13, page 164), were excavated to form two trenches, backfilled, and capped. During excavation, most of the contaminated material (liquid in original drums, free liquid drummed during excavation, and contaminated soil) was removed to the hazardous waste storage facility. The chemicals, metals, and pesticides pits are a RCRA/CERCLA unit.

Lead, trichloroethylene, and tetrachloroethylene were detected above their DWS in several wells monitoring this site in 1994. Alkalinity, specific conductance, and pH also exceeded their standards in numerous wells, probably because of the presence of naturally occurring carbonate rock. These results are similar to those of previous years. Gross alpha exceeded its DWS in one well for the first time in several years.

D-Area Oil Disposal Basin

The D-Area oil disposal basin was constructed in 1952 and received waste oil products from D-Area that were unacceptable for incineration in the powerhouse boilers. These waste oils may have contained hydrogen sulfide, chlorinated organics, or other chemicals. In 1975, the oil basin was removed from service and backfilled with soil. The basin is a RCRA/CERCLA unit also known as the D-Area oil seepage basin. The site, north of D-Area (figure 10–14, page 165), is monitored in accordance with the RFI/RI work plan.

An interim action proposed plan was submitted to EPA and SCDHEC in November 1993 to remove drums located within the basin. Pending regulatory approval—originally anticipated in 1994—the interim action has been scheduled for completion in October 1995.

In 1994, tetrachloroethylene and trichloroethylene were detected above their DWS in one well monitoring this site. Chloroethene (vinyl chloride) was detected above its DWS in a single analysis in the same well, and specific conductance exceeded its standard in that well. These results are similar to those obtained since 1988.

K-Area Diesel Tank Spill

Following the discovery of a leaking buried diesel supply line, most of the diesel-contaminated soil was removed from this area—in the center of K-Area, north of the K-Area disassembly basin (figure 10–9, page 160)—except where continued excavation would have jeopardized the structural integrity of an underground storage tank. Because some of the diesel-contaminated soil was left in place, SCDHEC required the installation of a monitoring well.

During 1994, as in the past, tritium was the only constituent above its DWS.

L-Area Acid/Caustic Basin and L-Area Oil and Chemical Basin

From 1961 to 1979, the L-Area oil and chemical basin received small quantities of radioactive oil and chemical waste that could not be discharged to effluent streams, regular seepage basins, or the 200-Areas' waste management systems. The waste came from throughout SRS, primarily from the reactor areas and the contaminated-equipment workshop through a pipeline known to have leaked. The basin, a radiologically controlled area south of L-Area (figure 10–9, page 160), has been inactive since 1979.

Groundwater below the acid/caustic basin has been affected by its proximity to the oil and chemical basin. The two areas were combined as one operable RCRA/CERCLA unit in the RFI/RI Phase II work plan for the L-Area oil and chemical basin.

In 1994, carbon-14 exceeded its proposed DWS in numerous wells in this area for the first time. Tetrachloroethylene and thorium-234 were above their standards in several wells, as were thallium, tritium, trichloroethylene, and promethium-147 in three or four wells each. Ruthenium-106 was detected above its proposed DWS in one well. As in previous years, alkalinity, specific conductance, TDS, and pH were above their standards in some of the wells in this area, suggesting the influence of grout.

Miscellaneous Chemical Basin

The miscellaneous chemical basin, in operation by 1956, was closed and graded in 1974. There are no records of the materials disposed of at this location, west of Road D near the A-Area metals burning pit (figure 10–12, page 163). However, soil gas investigations revealed volatile organics in the near-surface soils at the basin. It is assumed that the site was used to dispose of waste solvents and possibly waste oil. The basin is inactive and, with the A-Area metals burning pit, is a RCRA/CERCLA unit.

Three chlorinated volatile organics were detected above DWS in several wells monitoring this site in 1994. Alkalinity, pH, and specific conductance were elevated in two wells, probably because of grout contamination. These results are similar to those obtained since 1988. Gross alpha was above its DWS in one well, as was lead. Lead, alpha-emitting radium, and gross beta had been above their standards prior to 1993.

Motor Shop Oil Basin

This unlined basin was placed in service in 1977 to receive liquid effluent from the Motor Shop, including trace quantities of engine oil, grease, kerosene, ethylene glycol, and soap. All waste passed through an oil skimmer prior to discharge into the basin. In August 1983, all discharges to the basin were terminated. This basin is inactive but collects rainwater during periods of heavy precipitation.

The basin is at the south edge of A-Area (figure 10–12, page 163), near NPDES Outfall A–14, a source of volatile organics. It is a RCRA/ CERCLA unit.

Tetrachloroethylene and trichloroethylene were detected above their DWS in one well during 1994. These results are similar to those of previous years.

N-Area Diesel Spill

Tanks buried at the diesel fuel storage facility southeast of the hazardous waste storage facility in N-Area are leaking (figure 10–13, page 164). Characterization and remediation of diesel contamination are under way .

During 1994, results for chlorinated volatile organics were above the DWS in several wells. Specific conductance exceeded its standard in two wells, and pH exceeded its basic standard in one well. These results are similar to results obtained since the wells first were sampled in 1990.

N-Area Fire Department Training Facility

The fire department training facility, also known as the N-Area burnable-oil basin, is a shallow pit surrounded by an 18-inch-high asphalt dike. It was used from 1979 to 1982 by the SRS Fire Department to train personnel in the use of firefighting equipment. After this time, the area was excavated and backfilled. The facility, at the southeast end of N-Area near the Ford Building seepage basin (figure 10–13, page 164), is on the FFA site evaluation list.

The only constituents analyzed during 1994 were aluminum and field parameters; none of these exceeded applicable standards during 1994.

N-Area Hydrofluoric Acid Spill

It is uncertain whether a spill occurred at the hydrofluoric acid spill area or if contaminated soil or containers were buried there. The spill or burial occurred prior to 1970, and an identification sign is the only evidence that material was released. This location, at the south end of N-Area near Road 3 (figure 10–13, page 164), is a RCRA/CERCLA unit.

During 1994, as in 1991, lindane was reported above its DWS in one analysis from the upgradient well at this site. No other radiological or chemical constituents had results above applicable standards at this site.

Road A (Baxley Road) Chemical Basin

The Road A chemical basin is reported to have received miscellaneous radioactive and chemical aqueous waste, but no records of the materials disposed of at the basin are available. The basin was closed and backfilled in 1973. Located east of D-Area (figure 10–14, page 165), it is a RCRA/CERCLA unit.

Lead was the only constituent detected above its DWS in wells at this basin. This constituent has exceeded its DWS at this site consistently during the past 5 years.

Silverton Road Waste Site

The Silverton Road waste site, south of Silverton Road (figure 10–12, page 163), was used for disposal of metal shavings, construction debris, tires, drums, tanks, and miscellaneous other items. The startup date is unknown, and no records of waste disposal activities were kept. Operations at this location ceased in 1974, and the waste material is presently covered with soil and vegetation. It is a RCRA/CERCLA unit.

Soil and groundwater RFI/RI assessments at this waste site began in 1993 and continued into 1994. Reports will be submitted to EPA and SCDHEC during 1995.

Carbon tetrachloride was detected above its DWS in five wells monitoring this site in 1994, as was trichloroethylene in two wells. Lead, which was elevated in several wells in 1993, was found above its DWS in only two wells and only during second quarter. Two wells exceeded standards for specific conductance and basic pH during fourth quarter only. Ruthe-

nium-106 was detected above its proposed DWS in one well.

TNX Burying Ground

In 1994, all constituents reported above standards (carbon tetrachloride, gross alpha, nitrate and nitrate-nitrite as nitrogen, gross beta, and trichloroethylene, as well as elevated levels of specific conductance) were detected in the same downgradient well.

The TNX burying ground was created to dispose of debris from an experimental evaporator that exploded at TNX in 1953. The buried material included contaminated conduit, tin, drums, structural steel, and depleted uranium. Although most of this material was excavated and sent to the LLRWDF between 1980 and 1984, an estimated 27 kg of uranyl nitrate remains buried at this location. The TNX burying ground, located within the T-Area fence (figure 10–14, page 165), is a RCRA/CERCLA unit.

Table 10–2 Aquifer and Gradient Assignments of Wells

Location	Upper Saturated Zone Wells				Lower Zone	
	Up	Down	Side	Una[a]	Wells	Fig. No.
Acid/Caustic Basins						
F-Area (FAC)	2	2	3		4	10–8
H-Area (HAC)	1	1	2			10–8
K-Area (KAC)	2	3	4			10–9
L-Area (LAC); (*see L-Area Oil and Chemical Basin*)						10–9
P-Area (PAC)	2	3	1			10–10
R-Area (RAC)	1	2	1			10–11
Burning/Rubble, Rubble, and Metals Burning Pits						
A-Area Burning/Rubble Pits and A-Area Ash Pile (ARP)	1	1	2			10–12
A-Area Metals Burning Pit (ABP)	2	4	2		2	10–12
Burma Road Rubble Pit (BRR)	4	4			5	10–8
C-Area Burning/Rubble Pit (CRP)	2	1	1			10–13
D-Area Burning/Rubble Pits (DBP)	2	2	1			10–14
F-Area Burning/Rubble Pits (FBP)	5	4	1			10–8
K-Area Burning/Rubble Pit (KRP)	2	1	1			10–9
L-Area Burning/Rubble Pit (LRP)	1	2	1			10–9
N-Area Burning/Rubble Pit (CSR)	2	1	1			10–13
N-Area Burning/Rubble Pit South (CBR)				3		10–13
P-Area Burning/Rubble Pit (PRP)	1	1	2			10–10
R-Area Burning/Rubble Pits (RRP)	1	2	1			10–11
Coal Pile Runoff Containment Basins, Ash Basins, and Coal Piles						
A-Area Coal Pile Runoff Containment Basin (ACB)	1	2	1			10–12
C-Area Coal Pile Runoff Containment Basin (CCB)	1	1	2			10–13
D-Area Coal Pile Runoff Containment Basin and D-Area Ash Basin (DCB)	3	12				10–14
F-Area Ash Basin (FAB)	2	2				10–8
F-Area Coal Pile Runoff Containment Basin (FCB)	2	3	1			10–8
H-Area Coal Pile Runoff Containment Basin (HCB)	1	2	1			10–8
K-Area Ash Basin (KAB)	2	1	1			10–9
K-Area Coal Pile Runoff Containment Basin (KCB)	1	1	1			10–9
P-Area Coal Pile Runoff Containment Basin (PCB)	1	1	2			10–10
R-Area Coal Pile (RCP)		1			1	10–11

a Unassigned

Table 10–2 Aquifer and Gradient Assignments of Wells

Location	Upper Saturated Zone Wells				Lower Zone	
	Up	Down	Side	Una[a]	Wells	Fig. No.
Disassembly Basins						
C-Area (CDB)		2				10–13
K-Area (KDB)		3				10–9
L-Area (LDB)		2				10–9
P-Area (PDB)	1		1			10–10
R-Area (RDB)	1	2				10–11
Seepage and Retention Basins						
C-Area Reactor Seepage Basins (CSB)	1	3	2			10–13
F-Area Seepage Basins and Inactive Process Sewer Line (F, FSB, FSL)	6	27	9	9	50	10–8
Ford Building Seepage Basin (HXB)	3	2				10–13
H-Area Retention Basins (HR3, HR8)	2	2	1			10–8
H-Area Seepage Basins and Inactive Process Sewer Line (HSB, HSL)	14	36	8	8	80	10–8
K-Area Reactor Seepage Basin (KSB, K301P)	2	1	2			10–9
K-Area Retention Basin (KRB)	1	3				10–9
L-Area Reactor Seepage Basin (LSB)	1	1	2			10–9
M-Area Hazardous Waste Management Facility (MSB point-of-compliance and background wells)	5	10	3		29	10–12
Metallurgical Laboratory Seepage Basin (AMB)	1	7	2		8	10–12
New TNX Seepage Basin (YSB)	1	1	2			10–14
Old F-Area Seepage Basin (FNB)	1	2	2		3	10–8
Old TNX Seepage Basin (XSB)		5	1		1	10–14
P-Area Reactor Seepage Basins (PSB)		5	2			10–10
R-Area Reactor Seepage Basins (RSA, RSB, RSC, RSD, RSE, RSF, P20)	33	18			4	10–11
Savannah River Laboratory Seepage Basins (ASB)	3	2	3		13	10–12
Operating Buildings and Facilities						
F-Area Canyon Building and A-Line Uranium Recovery Facility (FAL, FCA, NBG)	1	12	1			10–8
F-Area Effluent Treatment Cooling Water Basin (FET)	1	3				10–8
H-Area Auxiliary Pump Pit (HAP)		1				10–8
H-Area Canyon Building (HCA)	2	2			4	10–8
H-Area Effluent Treatment Cooling Water Basin (HET)	1	3				10–8
K-Area Tritium Sump (KSM)		1				10–9
N-Area Hazardous Waste Storage Facility (HWS)	1		1			10–13

a Unassigned

Table 10–2 Aquifer and Gradient Assignments of Wells

Location	Upper Saturated Zone Wells				Lower Zone	
	Up	Down	Side	Una[a]	Wells	Fig. No.
S-Area Background (SBG)	3	2	1			10–8
S-Area Low-Point Pump Pit (SLP)		1	1			10–8
S-Area Vitrification Building (SCA)	4	3	1	2		10–8
Z-Area Low-Point Drain Tank (ZDT)		1	1			10–8
Z-Area Saltstone Facility (YSC, ZBG)	2	4			2	10–8
Plume Monitoring						
A-Area and M-Area Plume (ABP, ABW, AC, ACB, AMB, AOB, ARP, ASB, MCB, MSB, SRW) In this context, these wells help delineate a contaminant plume over a 5-square-mile area; it is inappropriate to assign a gradient designation to them.						10–12
Separations and Waste Management Areas (E, F, and H) Plume (Z 9, ZW)				11		10–8
TNX Area Background (TNX, P26)	2	8	4		1	10–14
Radioactive Waste Storage and Disposal Facilities						
Burial Ground Expansion (E-Area Vaults) (BGX)	2	7	2		6	10–8
Hazardous Waste/Mixed Waste Storage Facility (HMD)	1	3				10–8
Old Burial Ground (BG, BGO, MGA, MGC, MGE, MGG)		44			21	10–8
Low-Level Radioactive Waste Disposal Facility (BG, BGO, HSB 85)	4	27	12		30	10–8
F-Area Tank Farms (FTF)	4	21	2			10–8
H-Area Tank Farms (HTF, P27, [Tank 16], HAA [Tank 16])		34			17	10–8
Sanitary Landfill (LFW)	5	62	7		15	10–18
Sludge Application Sites						
F-Area Sludge Land Application Site (FSS)	1	1	2			10–8
H-Area Sludge Land Application Site (HSS)		2	1			10–8
K-Area Sludge Land Application Site (KSS)	1	2				10–9
Kato Road Sewage Sludge Application Site (SSS 19–21)	1	2				10–18
Lower Kato Road Sludge Application Site (SSS 4–6)	1	2				10–18
Orangeburg Sewage Sludge Application Site (SSS 7–9)	1	2				10–18
PAR Pond Sludge Land Application Site (PSS, SSS 17)	1	2	1			10–10
Road F Sewage Sludge Application Site (SSS 22–24)	1	2				10–7
Sandy (Lucy) Sewage Sludge Application Site (SSS 10–12)	1	2				10–12

a Unassigned

Table 10–2 Aquifer and Gradient Assignments of Wells

Location	Upper Saturated Zone Wells				Lower Zone	
	Up	Down	Side	Una[a]	Wells	Fig. No.
Second PAR Pond Borrow Pit Sewage Sludge Application Site (SSS 25–27)	2	1				10–7
40-Acre Hardwood Sewage Sludge Application Site (SSS 1–3)	1	2				10–14
Other Sites						
B-Area Gas Station (P29)				1	2	10–18
Chemicals, Metals, and Pesticides Pit (CMP)	4	2	1		12	10–9
D-Area Oil Disposal Basin (DOB)				4		10–14
K-Area Diesel Tank Spill (KDT)		1				10–9
L-Area Acid/Caustic Basin and Oil and Chemical Basin (LAC, LAW, LCO)	6	8	2		15	10–9
Miscellaneous Chemical Basin (MCB)	1	5			3	10–12
Motor Shop Oil Basin (AOB)	1	1	1			10–12
N-Area Diesel Spill (CSD)				9		10–13
N-Area Fire Department Training Facility (CSO)		2				10–13
N-Area Hydrofluoric Acid Spill (CSA)	1	1	2			10–13
Road A (Baxley Road) Chemical Basin (BRD)	2	3				10–14
Silverton Road Waste Site (SRW)	5	10	2		22	10–12
TNX Area Burying Ground (TBG)	1	6			1	10–14

a Unassigned

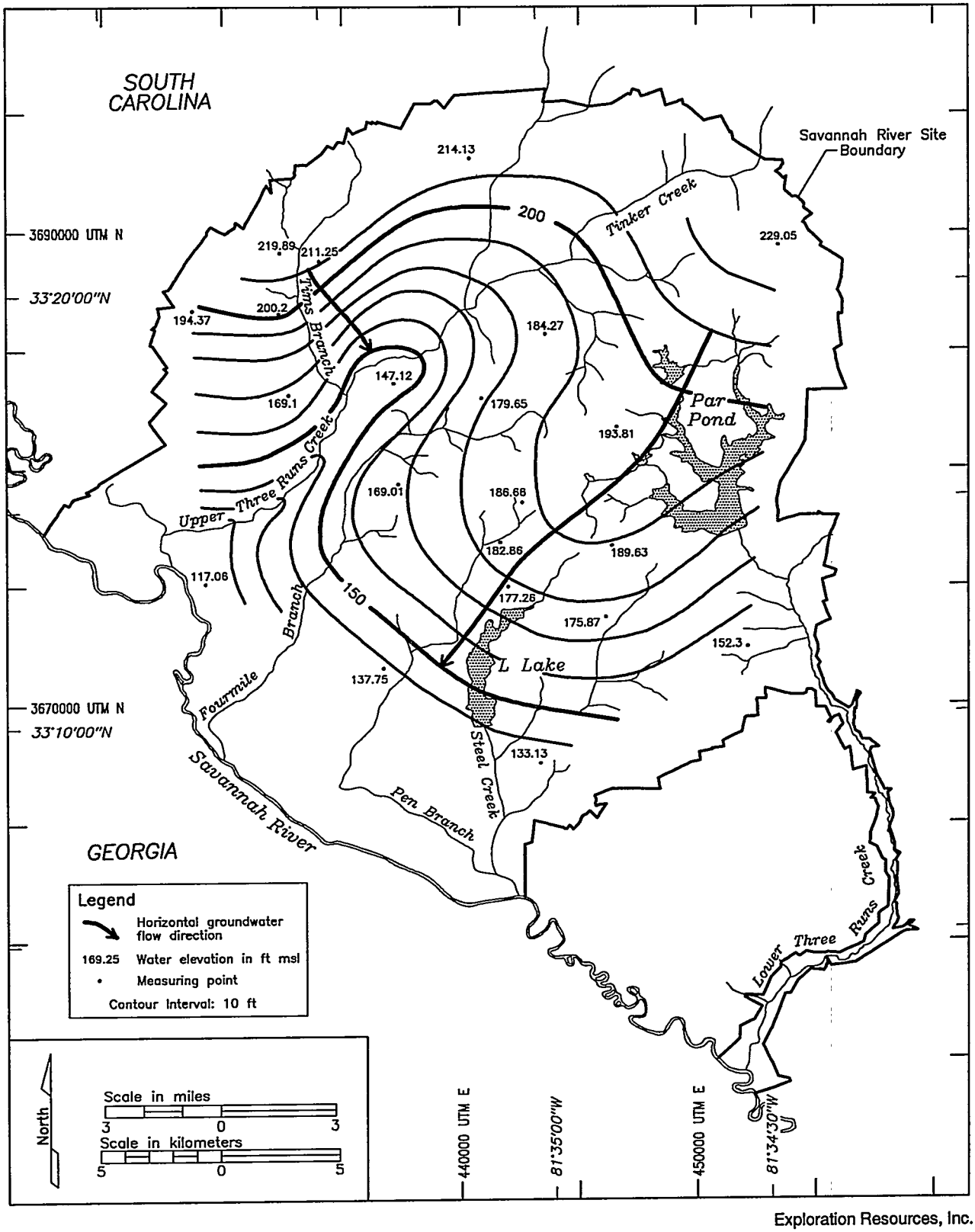

Figure 10–3 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Congaree-Fourmile Zone at SRS During the First Quarter of 1994

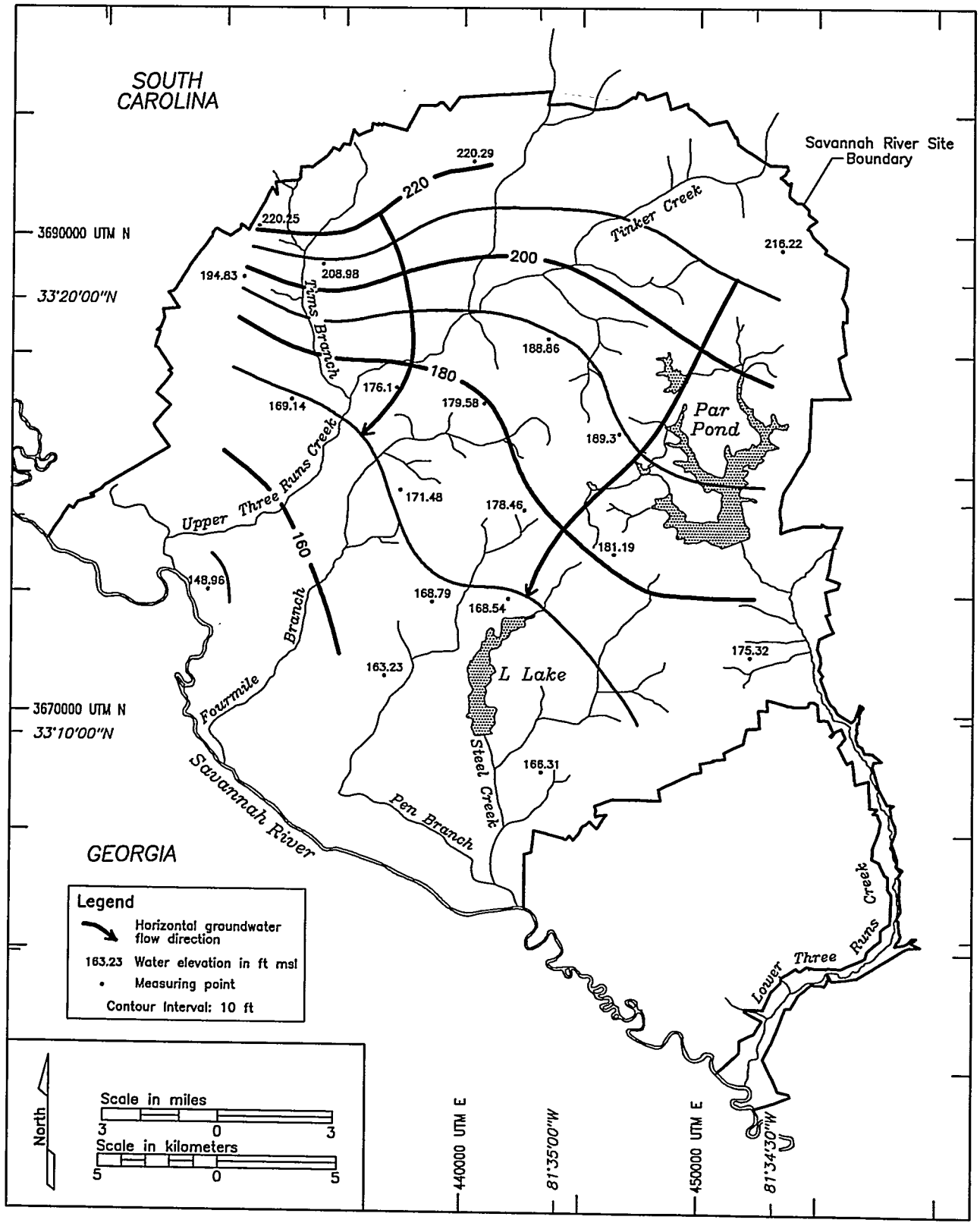

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Figure 10–4 Potentiometric Surface and Horizontal Groundwater Flow Directions of the Cretaceous Zone at SRS During the First Quarter of 1994

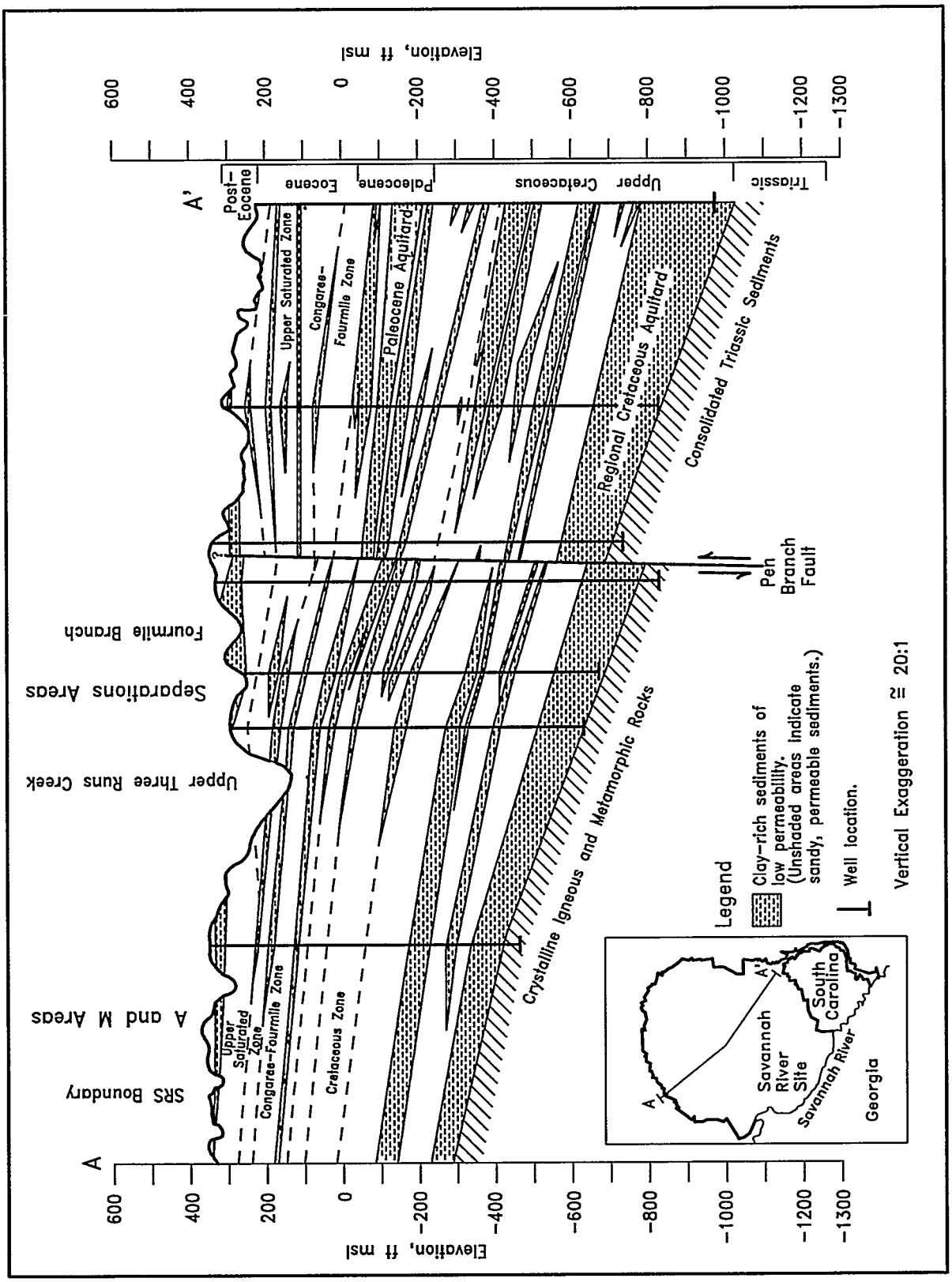

Figure 10–5 Geologic Cross Section of Coastal Plain Sediments at SRS

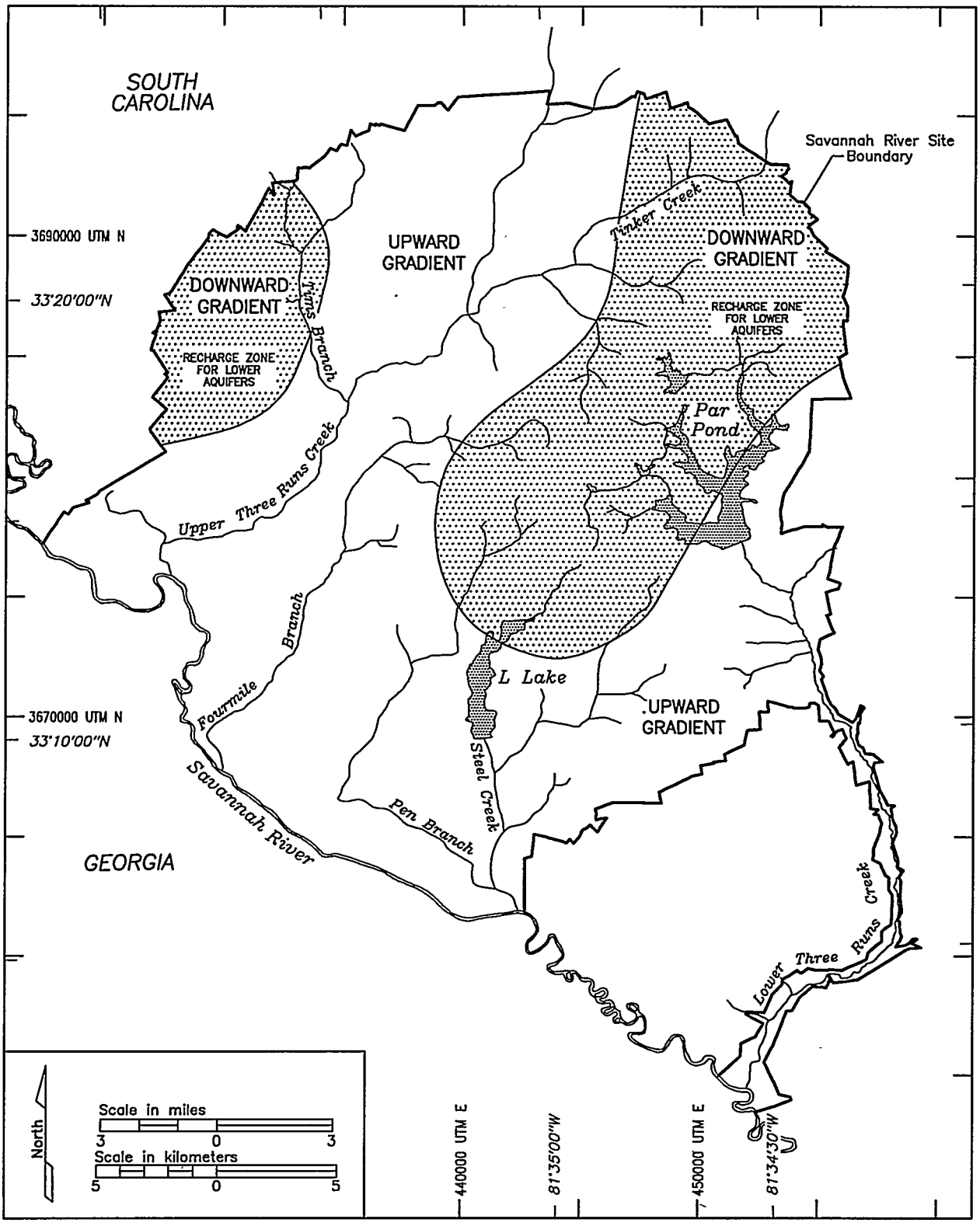

Figure 10–6 Vertical Gradient Relationships Between the Congaree-Fourmile and Cretaceous Zones at SRS During the First Quarter of 1994

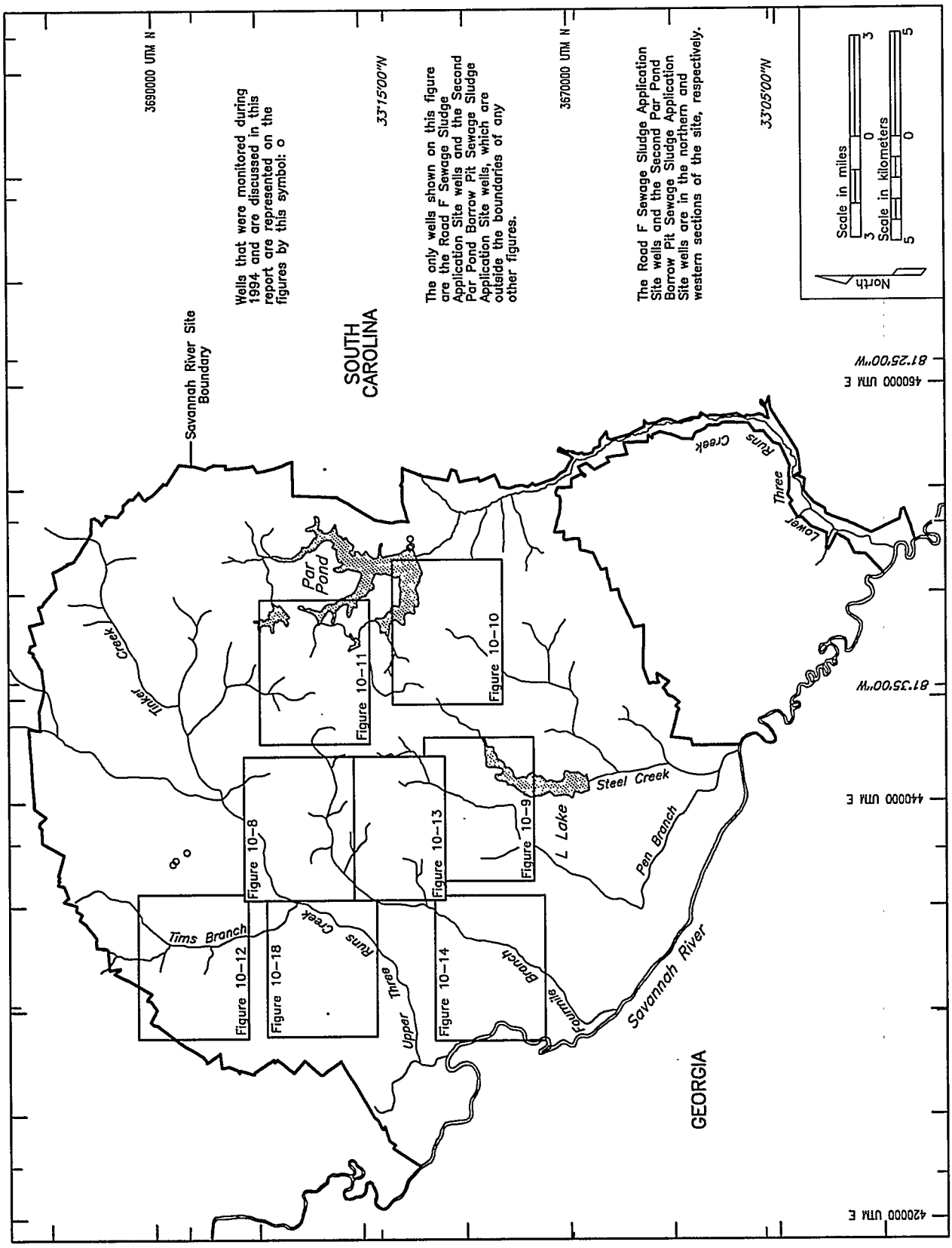

Figure 10–7 Overall View of the Savannah River Site, Showing Areas Covered by Other Figures

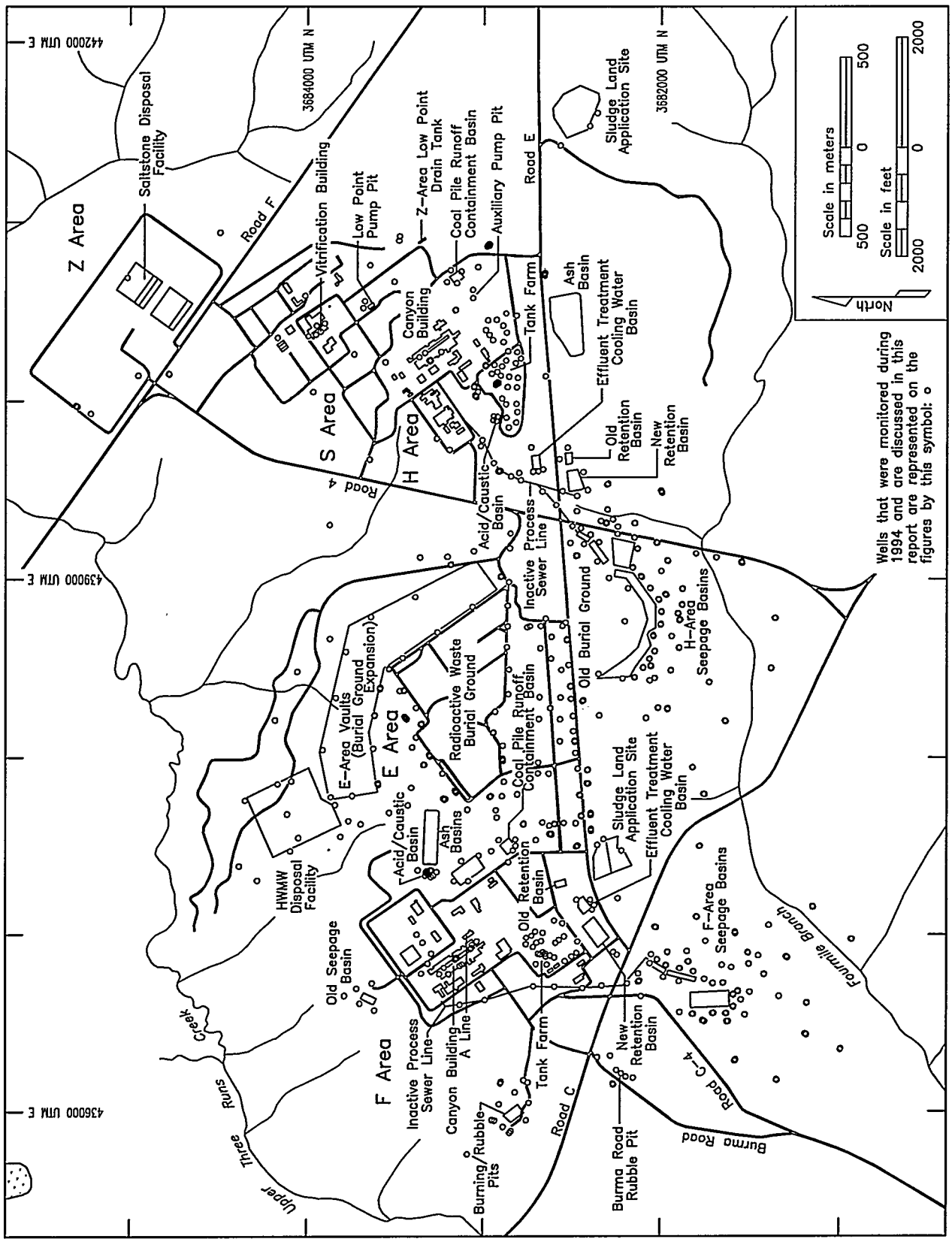

Figure 10–8 Separations and Waste Management Areas: Major Facilities and Groundwater Monitoring Wells

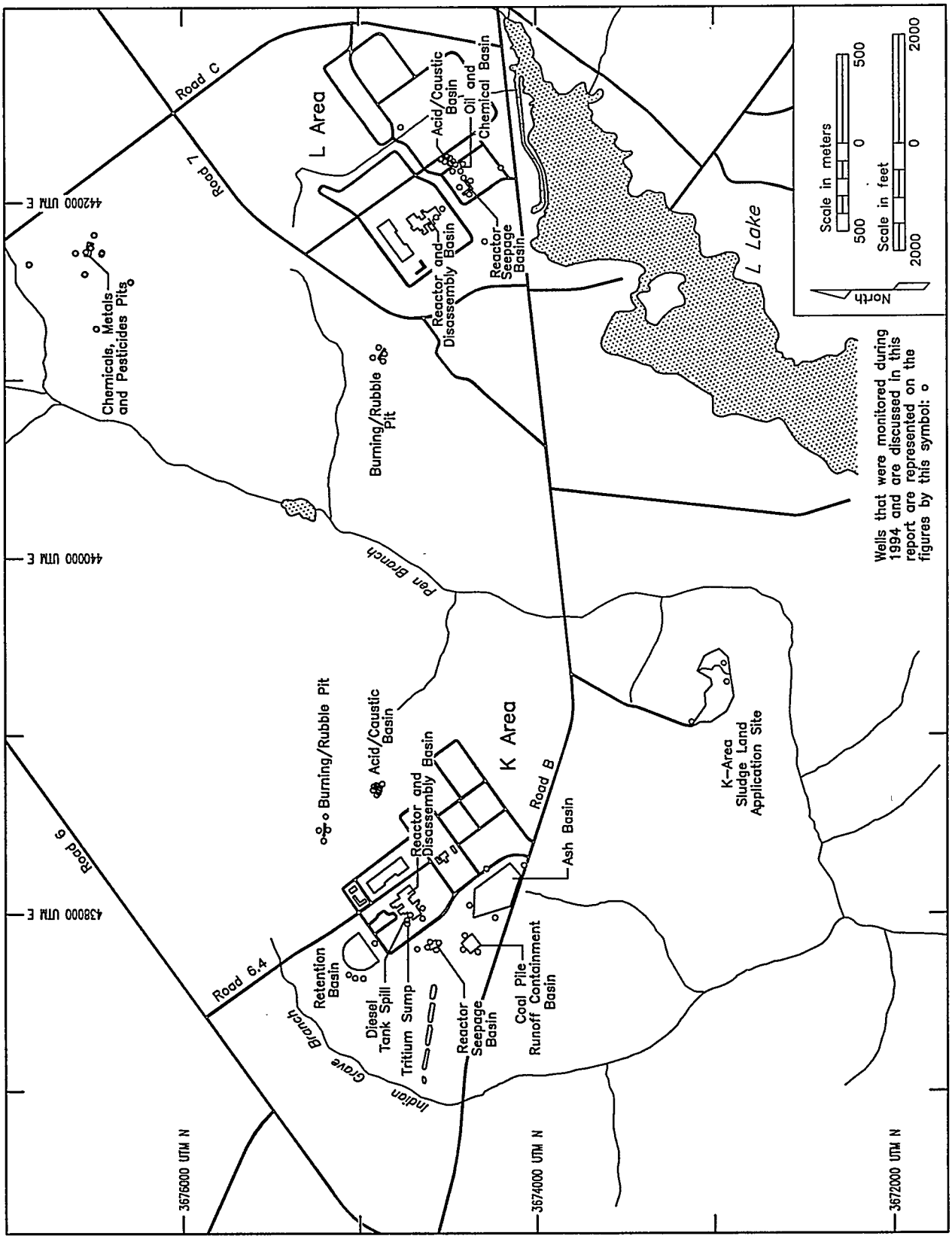

Figure 10–9 K-Area and L-Area and the Chemicals, Metals, and Pesticides Pits: Major Facilities and Groundwater Monitoring Wells

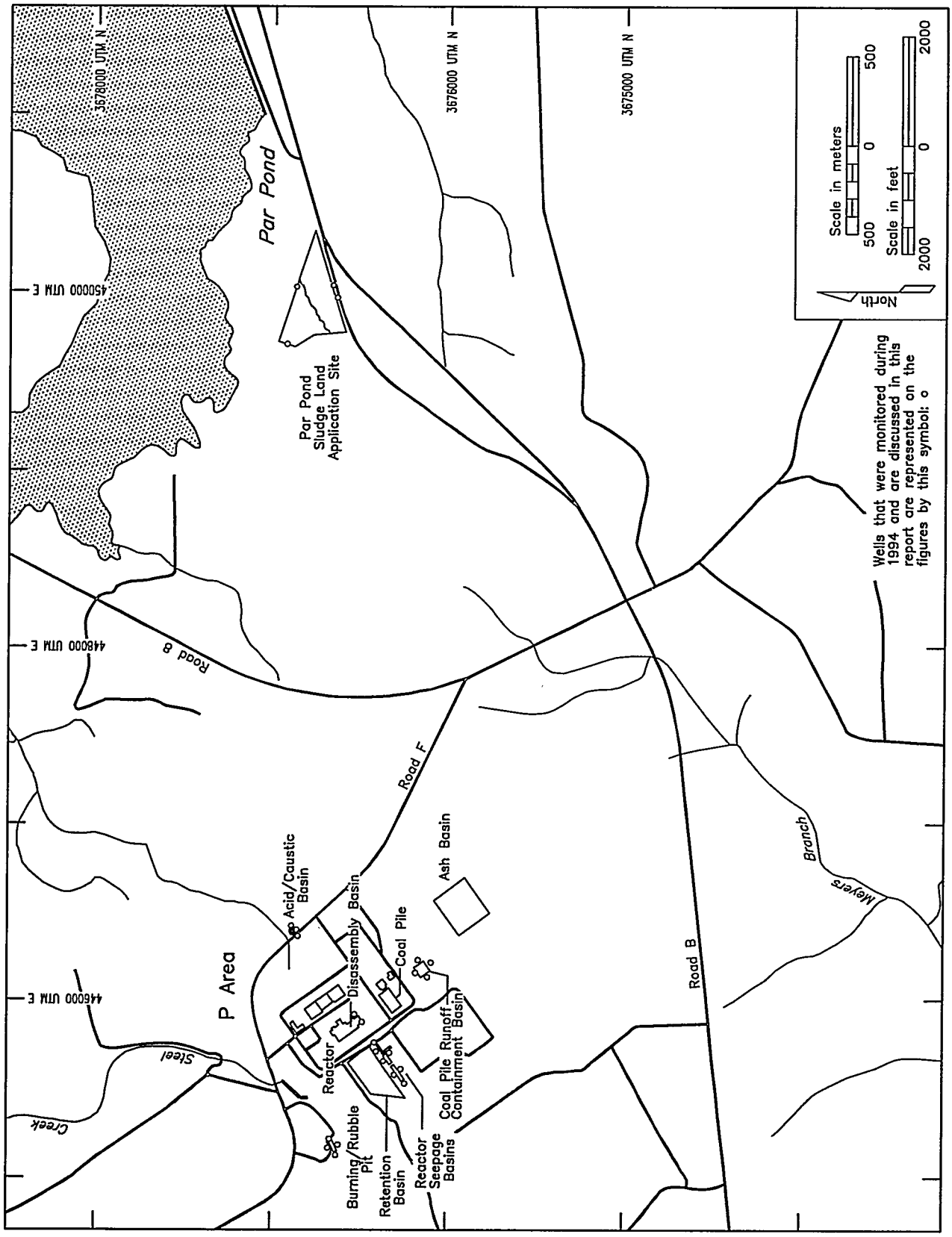

Figure 10–10 P-Area and PAR Pond: Major Facilities and Groundwater Monitoring Wells

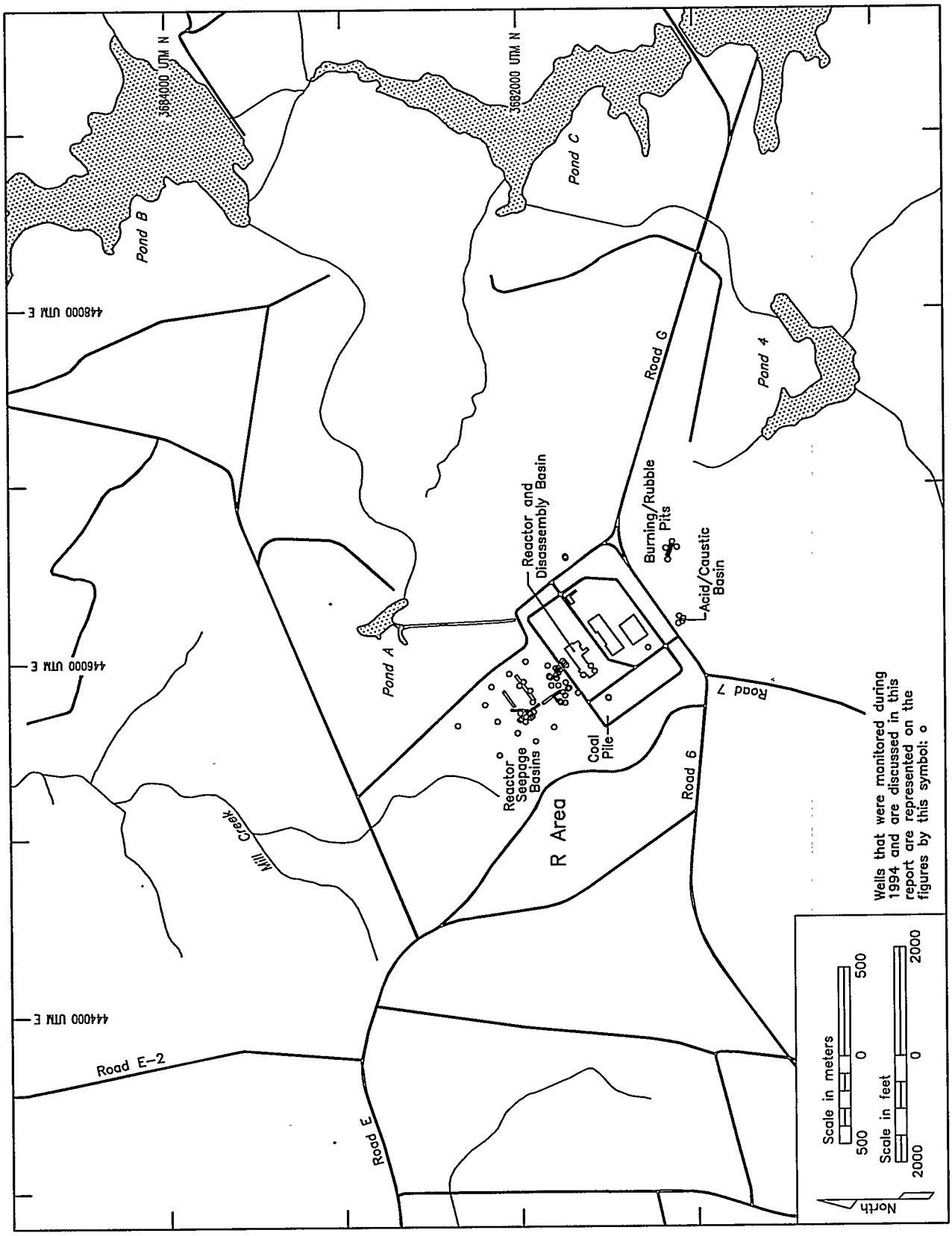

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Figure 10–11 R-Area: Major Facilities and Groundwater Monitoring Wells

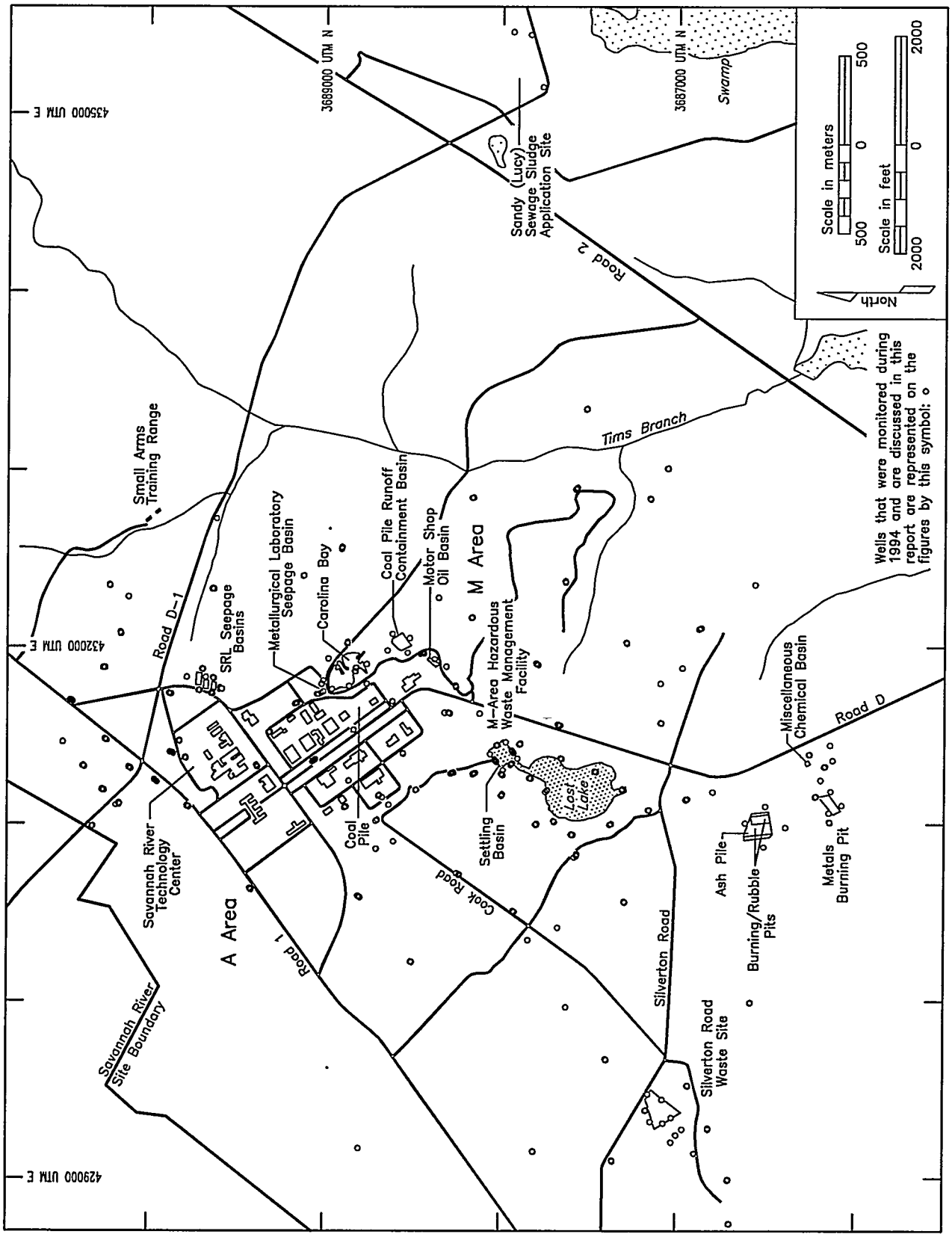

Figure 10–12 A-Area and M-Area: Major Facilities and Groundwater Monitoring Wells

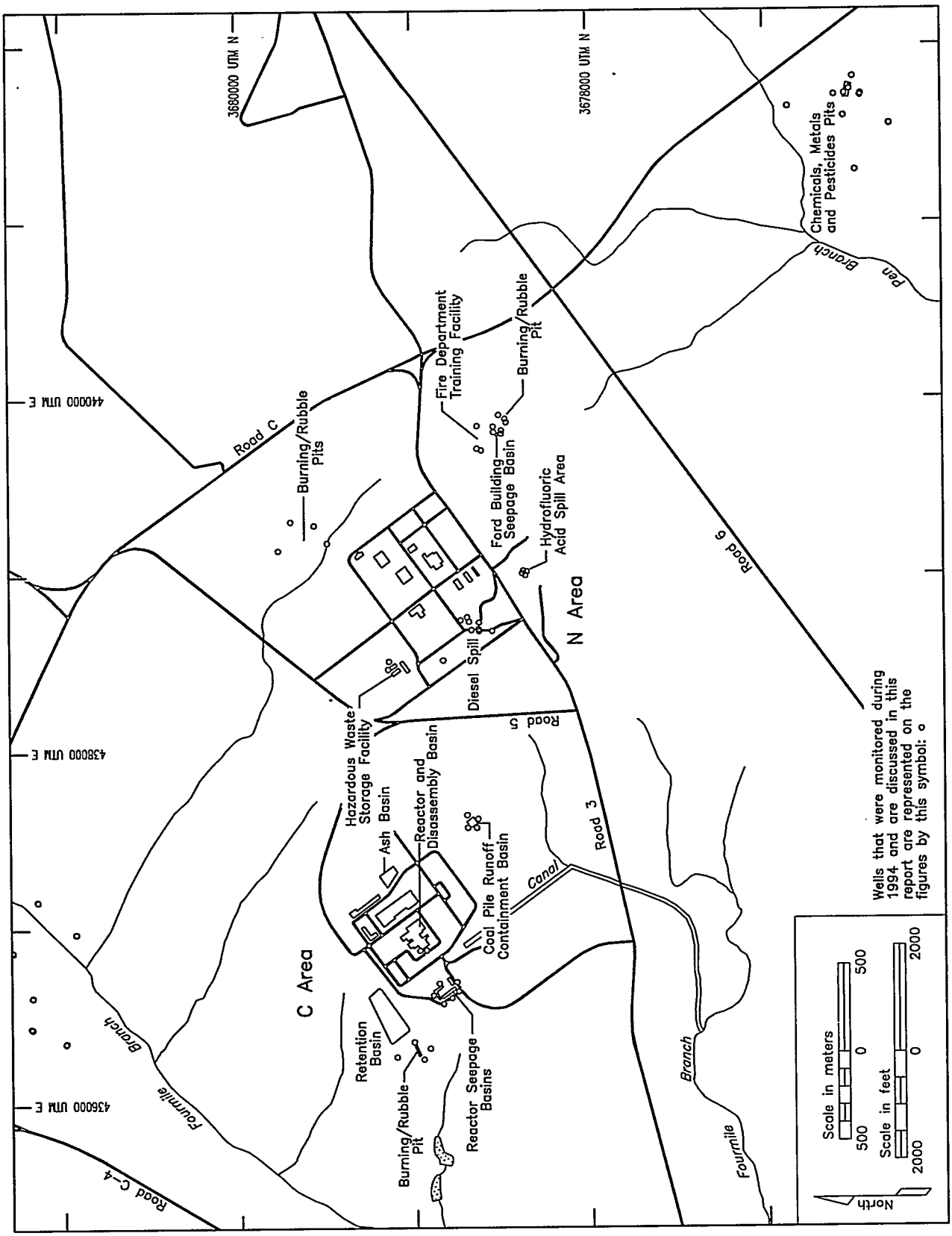

Figure 10–13 C-Area and N-Area: Major Facilities and Groundwater Monitoring Wells

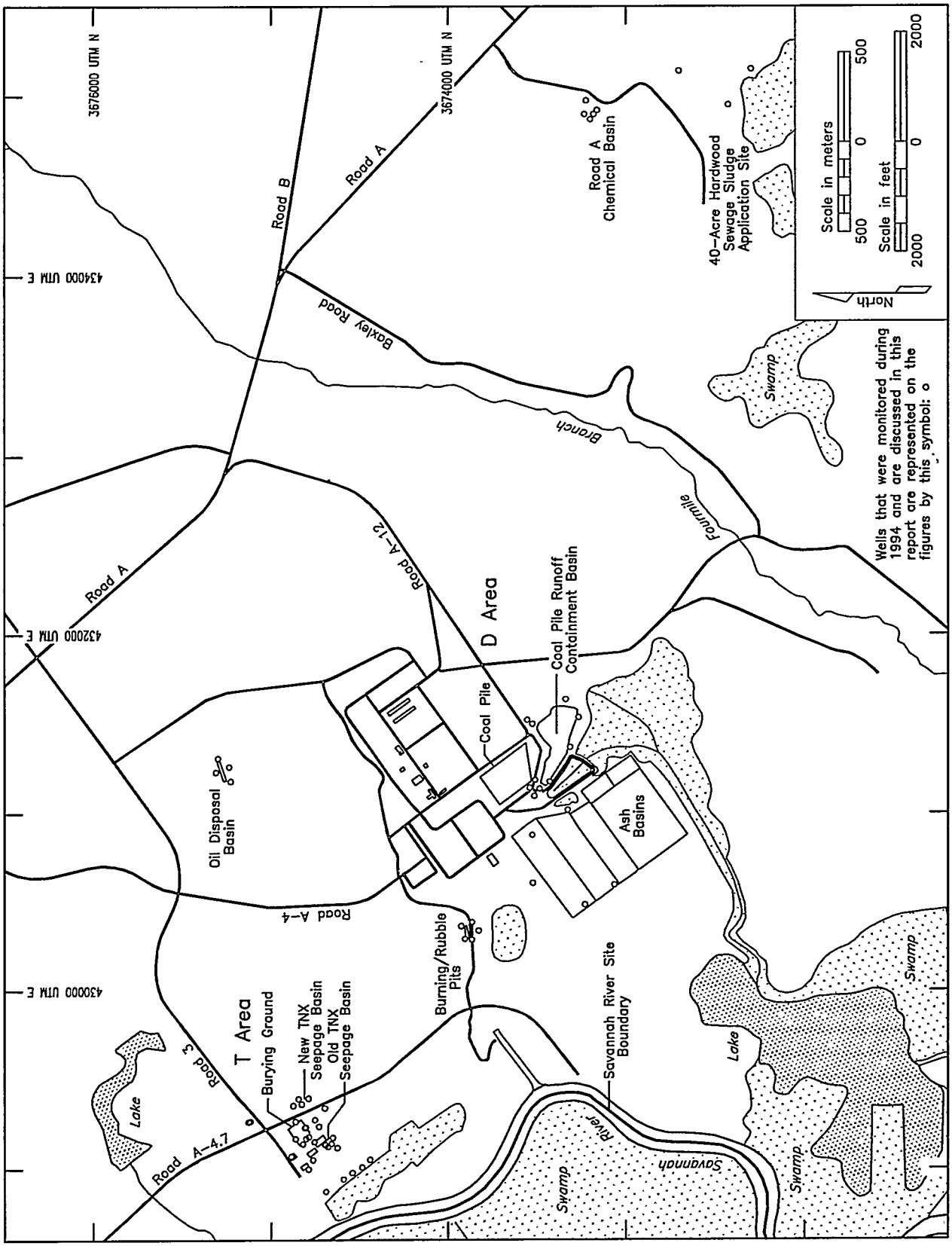

Figure 10–14 D-Area and T-Area (TNX): Major Facilities and Groundwater Monitoring Wells

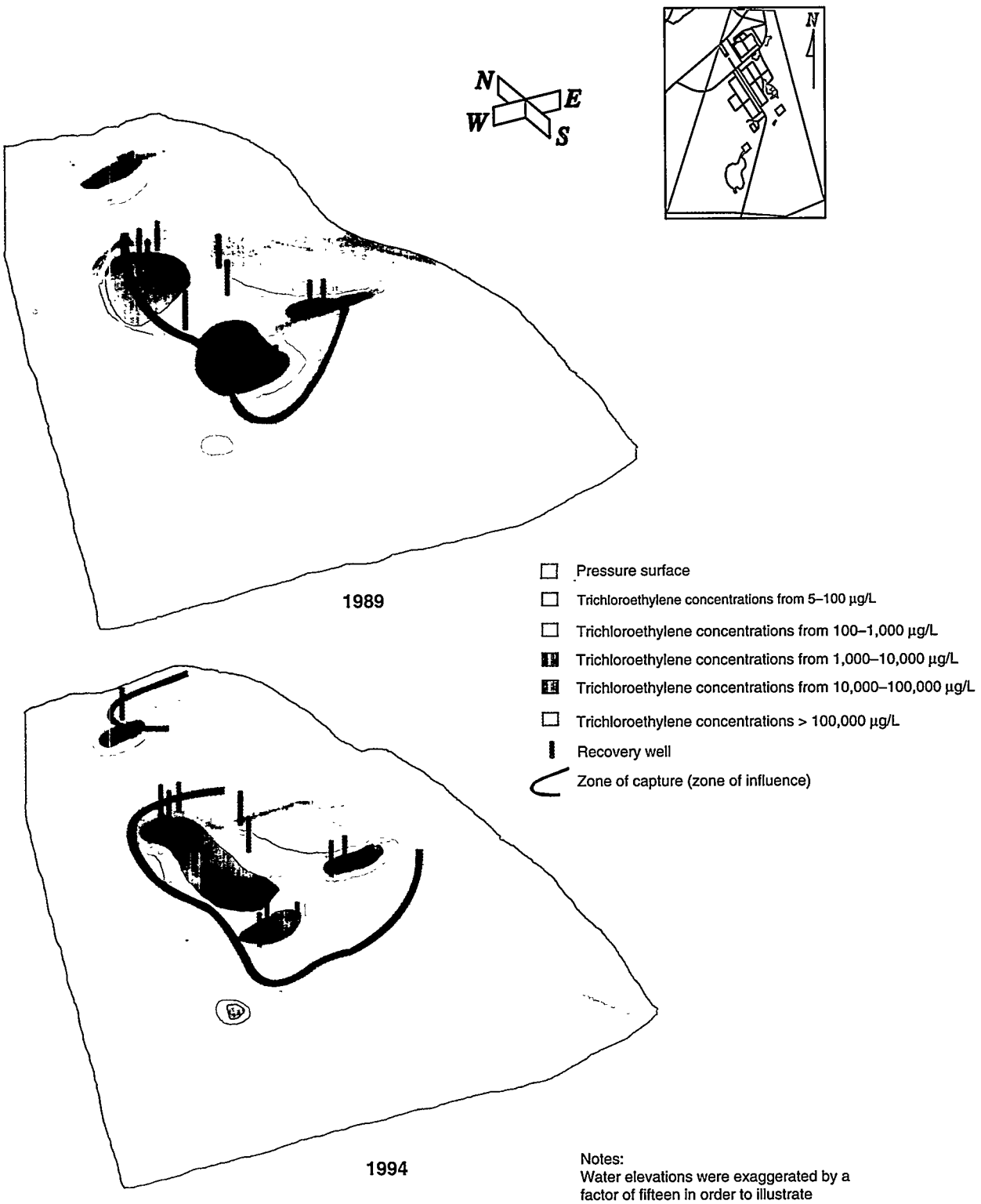

Figure 10–15 Potentiometric Surface of the Upper Saturated Zone (Piezometric Surface) and M-Area Plume Location, 1989 and 1994

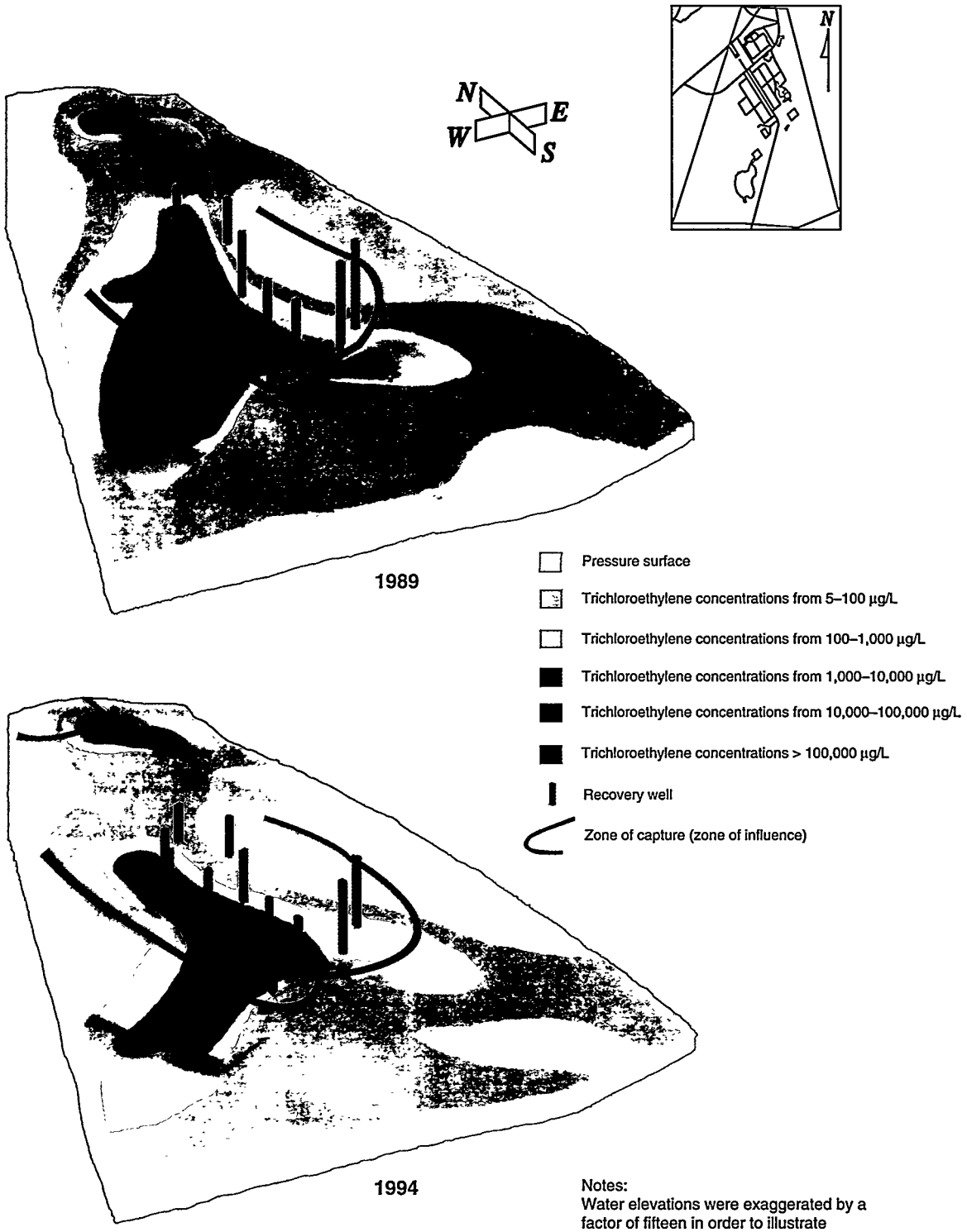

Figure 10–16 Potentiometric Surface of the Upper Congaree-Fourmile Zone and M-Area Plume Location, 1989 and 1994

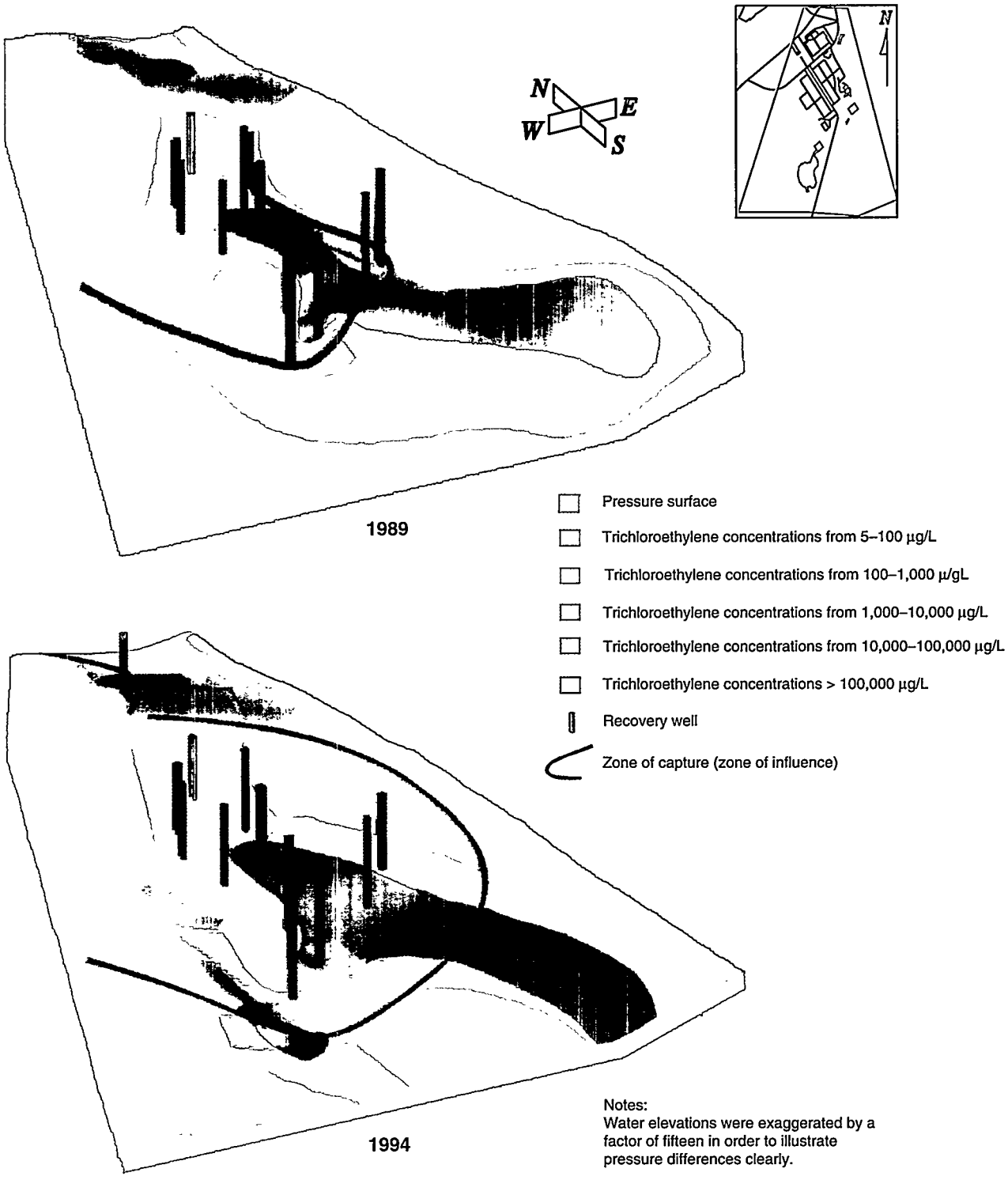

Figure 10–17 Potentiometric Surface of the Lower Congaree-Fourmile Zone and M-Area Plume Location, 1989 and 1994

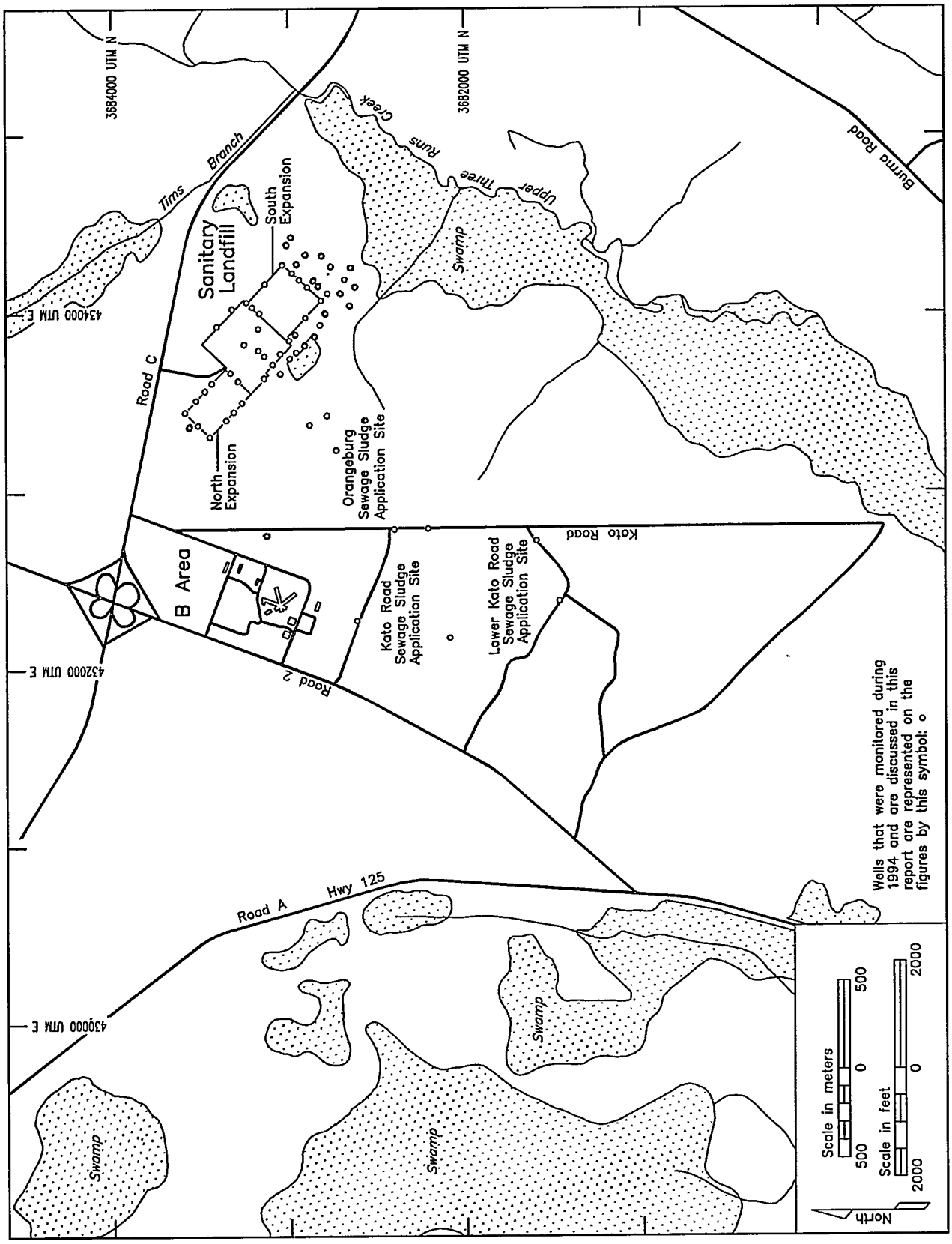

Figure 10–18 Sanitary Landfill and Sludge Sites: Major Facilities and Groundwater Monitoring Wells

Chapter 11

Quality Assurance

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In this chapter...

Introduction

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 verify the integrity of data generated within the environmental monitoring program and 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 QA/QC environmental monitoring program. This chapter summarizes the QA/QC program; tables containing the 1994 QA/QC data can be found in *SRS Environmental Data for 1994* (WSRC–TR–95–077). A 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), which is scheduled to be issued in 1995.

Guidelines and applicable standards for the QA/QC environmental monitoring program can be found in appendix A of this document. Figure 11–1 shows the guidance documents that support the EMS QA/QC program.

QA/QC for EMS Laboratories

The 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 are responsible for understanding and complying with all requirements applicable to the activities with which they are involved. Consequently, appropriate training courses are provided to assist them in understanding and fulfilling their responsibilities. Courses include training on applicable QA procedures, Occupational Safety and Health Administration-mandated training, and General Employee Training. Emphasis is placed on regulations and procedures that govern the environmental monitoring program.

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

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

***t*-test** statistical test of significance frequently employed by laboratories to assess the comparability of two sets of data

- "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

Each EMS group conducts specific QA checks and conforms to accepted practices, as described below.

Collections

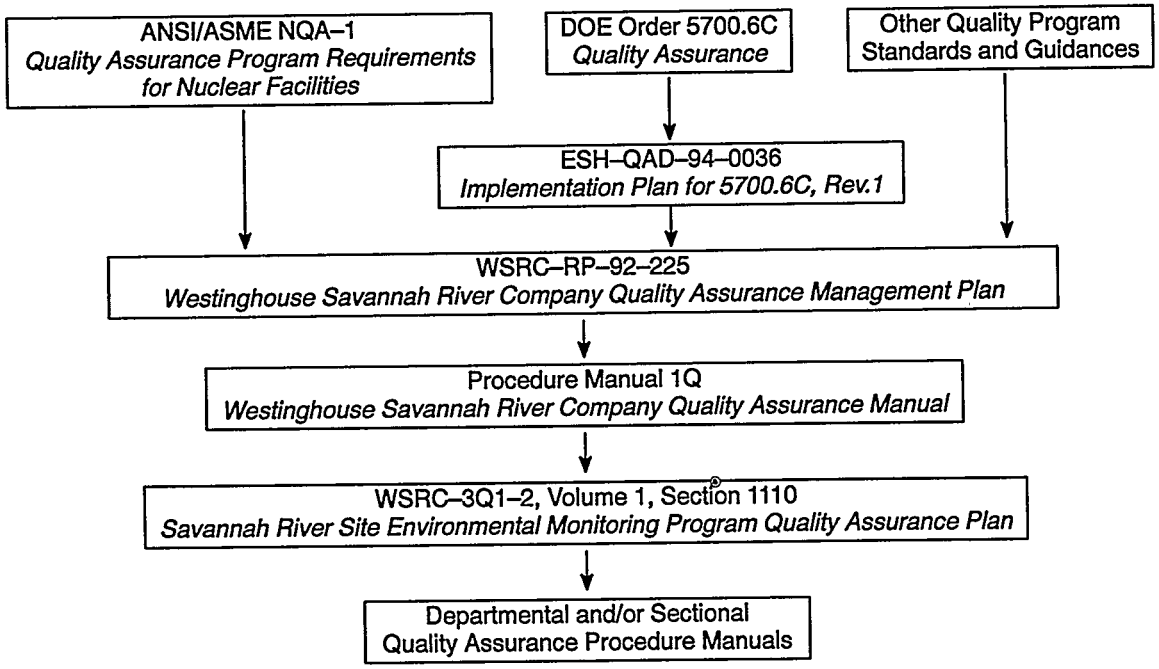
As part of the nonradiological monitoring program, EMS routinely conducts a blind-sample program for field measurements of pH and conductivity to assess the quality and reliability of field data measurements.

During 1994, blind pH field measurements were taken for 36 samples, and blind conductivity field measurements were taken for 37 samples. Ninety-seven percent of the field pH measurements were within the U.S. Environmental Protection Agency's (EPA) suggested acceptable control limit of ± 0.4 pH units of the true (known) value [SRS Data, 1995]. All conductivity measurements differed from the true value by less than 11 percent—below EMS internal QA/QC requirements of 15 percent.

EMS personnel also perform field measurements for chlorine, dissolved oxygen, and temperature; however, because of their changing physical nature, these parameters are not suitable for a blind-sample program. Quality control of these analyses relies on instrumentation calibration, per the WSRC–3Q1 procedure series.

Counting and Chemistry Laboratories

Laboratory performance is evaluated through instrument checks, control charts, and data analysis. In the chemistry group, graphical and numerical trending is conducted on technician and method performance, with reports generated for sample results exceeding



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

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

The EMS quality assurance program includes assignment-specific training for each analyst. This training ensures that each analyst can use all equipment properly and can implement all quality assurance techniques.

92–1933–7

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 a routine analysis. Spikes and blanks are used to calculate a recovery efficiency of an analytical method, to adjust for background radiation, and/or 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 laboratory proficiency. 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 analyses, ratios between the measured and true values are calculated (measured/true), 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 1994, blind samples were analyzed for tritium and gamma-emitting radionuclides. All 1994 blind samples were less than two standard deviations from their true value, which is the laboratory control warning limit, thus validating analytical work in the chemistry and counting laboratories. Greater than two standard deviations indicates that samples are out of the control range and must be reevaluated.

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, or resampling for verification.

Data Reporting

Before data are reported, they must be reviewed and validated by supervisory 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 because of its 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 two interlaboratory comparison programs to track performance accuracy. Under both 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 Environmental Measurements Laboratory and sent to participating laboratories. Analytical results are reported to the Environmental Measurements Laboratory within 90 days and compared with the test results of other laboratories. The Environmental Measurements Laboratory 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-Las Vegas. This division is responsible for QC of environmental radiological measurements. EPA provides participating laboratories with water, air, 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 QAP and QAD results. Warning limits are set at two times the standard deviation of the known value; acceptance limits, at three standard deviations. 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 a 3-standard-deviation acceptance level, and a majority were within EPA's 2-standard-deviation warning level. One exception was for cesium-137 in water; this was resolved by a recalibration of the counting instruments. The other exception was for uranium in water, performed by a nonspecific screening method for uranium and plutonium. This screening method will be discontinued in 1995 with the development of nuclide-specific separation lab techniques for the actinides. The results reported by EMS in the QAP program generally fell within 20 percent of the DOE values. The results were in consistent agreement with the true values, showing the greatest bias in samples with low activity levels and in difficult matrices for chemical separation. Both the QAD and QAP programs indicate that EMS results are accurate, according to the standards of intercomparison agencies, and that they compare favorably with those of other environmental laboratories.

Table 11–1
Subcontracted Laboratories for 1994

General Engineering Laboratories	
	groundwater
	soil/sediment
Roy F. Weston, Inc.	
	groundwater
	soil/sediment
	metals analyses for SRS streams and the Savannah River
Environmental Physics	
	groundwater radiological analyses
	soil/sediment
Clemson Technical Center	
	groundwater radiological analyses
ThermoAnalytical, Inc.	
	subcontracted groundwater radiological analyses for Roy F. Weston, Inc.
	soil/sediment
	NPDES analyses
	metals analyses for SRS streams and the Savannah River

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 1994 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 the D-Area laboratory for fecal coliform; by EMS for temperature, pH, dissolved oxygen, and chlorine; and by a subcontracted laboratory for other constituents, such as metals, organics, and oil and grease. In 1994, ThermoAnalytical, Inc. (TMA) was the primary subcontractor for the NPDES program.

Interlaboratory Comparison Program

Interlaboratory comparison studies are used to compare the quality of results between laboratories performing the same analyses. During 1994, TMA 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 1994, TMA ran analyses for 23 parameters under the EPA program. Results for all parameters were within the acceptance range of 80 percent of the true values, as set forth by EPA. EMS performed analyses for only two of the EPA parameters, chlorine and pH; results of both analyses were within the 80-percent acceptance range.

Intralaboratory Comparison Program

The intralaboratory program compares performance within a laboratory by analyzing duplicate and blind samples throughout the year. TMA analyzed 554 duplicates samples for various parameters during 1994. Percent difference calculations showed that 460 of these samples were within the acceptable range of 20 percent. Seventy exceedances involved either total suspended solids, oil and grease, biological oxygen demand, or fecal coliform, the analyses of which typically produce highly variable results. Eleven exceedances occurred because results at or near the analytical detection limit produce large percent variations for small differences in actual data.

TMA also analyzed 42 blind samples submitted by EMS. Percent difference calculations showed that 37 of these samples were within the acceptable range of 20 percent. Of the five exceedances, three were for biological oxygen demand, total suspended solids, and oil and grease. The remaining exceedances were the result of data at or near the analytical detection limit.

EMS personnel performed a data validation audit of TMA to ensure that the laboratory had maintained technical competence throughout the year. Ten percent of all NPDES samples analyzed by TMA were evaluated for instrument calibration, analytical procedures, data verification, and data reports. EMS will report the findings and recommendations to TMA and conduct followup evaluations as necessary.

Stream and River Water Quality

Metals analyses for 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. In the first three quarters of 1994, split samples were sent for metals analyses to TMA, the subcontractor laboratory, and to Weston, the verifying laboratory. Paired *t*-tests concluded that the median of differences did not deviate statistically from zero at the 95-percent confidence level for all three quarters, indicating agreement of results between labs.

Laboratory methodology and analysis reproducibility between the subcontracted and the verifying laboratories were checked during the first three quarters of 1994. 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. Mean relative difference calculations indicated that agreement between laboratories was acceptable for all three quarters. The average percent coefficient of variation for analyses for all three quarters was below 10 percent, an indication that result reproducibility was satisfacto-

QA Terminology in the Laboratory

quality assurance (QA) planned and systematic actions taken to provide adequate confidence in monitoring and measurement data

quality control (QC) overall system of activities that control and verify the quality of monitoring and measurement data

accuracy degree of agreement between a measurement and an accepted reference or true value

bias systematic (constant) underestimation or overestimation of the true value

precision measure of mutual agreement among individual measurements of the same property

spiked sample sample to which a known amount of a substance has been added

duplicate sample repeated but independent determinations on the same sample

split sample portions taken from the same sample and analyzed by different technicians or laboratories

blind sample (blind duplicate or blind blank) mock sample of known constituent(s) or concentration(s); used as a control

blanks clean samples analyzed to establish a baseline or background value used to adjust or correct results

standard reference materials materials with certain properties certified by the National Institute of Standards and Technology

control chart graphical chart of some measured parameter for a series of samples

ry. For individual analyses, there were three instances where the coefficient of variation exceeded 20 percent. In the first quarter, the Weston aluminum coefficient of variation was 25.21 percent, indicating a greater than expected variance in reproducibility. In the third quarter, the Weston zinc coefficient of variation was 58.99 percent and the TMA lead coefficient of variation was 23.67 percent. The actual analytical data for both parameters 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.

Groundwater

Groundwater analyses at SRS are performed by subcontracted laboratories. During 1994, General Engineering Laboratories and Roy F. Weston, Inc., were the primary subcontractors for nonradiological analyses. Environmental Physics and Clemson Technical Center were the primary subcontractors for radiological analyses. Some samples for radiological analyses were sent to Weston, which in turn subcontracted them to TMA.

During 1994, 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 the acceptable concentration range of the certified values. During 1994, Clemson analyzed 19 constituents, and 14 (73.7 percent) fell within the acceptance limits.

A statistical measure, the mean relative difference, 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 done for General Engineering/Weston and Environmental Physics/Clemson Technical Center.

As in past years, General Engineering and Weston results for QC standard samples were 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 1994, General Engineering participated in both water pollution and water supply laboratory studies. In the water pollution study, of 146 samples analyzed, General Engineering reported only one result (an analysis for zinc) outside the acceptable range. In the water supply study, General Engineering reported four of 70 results outside the acceptable range: analyses for nitrate as nitrogen, calcium, corrosivity, and sodium.

Full results—including mean relative difference calculations, where appropriate—for all these QA/QC evaluations may be found in the following groundwater reports:

- *The Savannah River Site's Groundwater Monitoring Program, First Quarter 1994* (ESH–EMS–940514)

- *The Savannah River Site's Groundwater Monitoring Program, Second Quarter 1994* (ESH–EMS–940515)
- *The Savannah River Site's Groundwater Monitoring Program, Third Quarter 1994* (ESH–EMS–940516)
- *The Savannah River Site's Groundwater Monitoring Program, Fourth Quarter 1994* (ESH–EMS–940517)

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 lists the primary subcontractors for soil/sediment analyses.

EMS personnel validate and manage approximately 200,000 analytical records annually from soil/sediment investigations. The program is expected to increase in scope and size as the number of waste site investigations increases. Data are validated according to EPA/CERCLA validation guidelines for Definitive Data (formerly QA Objective 3 Data) unless specified otherwise by site customers. EMS delivers about 10 project summary reports per year; each includes

- a project QA/QC summary
- a discussion of validation findings
- precision and accuracy calculations
- 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

- interim 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*, June 1991
- *Test Methods for Evaluating Solid Waste; Physical/Chemical Methods*, SW–846
- *Data Validation Procedures for Radiochemical Analysis*, WHC–SD–EN–SPP–001

Data management personnel perform several additional functions to ensure the quality of the data released by EMS. Two people enter the data for each entry in a double-entry system that helps eliminate errors. The specified data-deliverable format required by EMS of its subcontracted laboratories allows for 100-percent electronic verification of all field data, shipping data, invoice data, and analytical data.

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. Standards are not being used with this program because of the difficulty in achieving a blind homogenous soil standard.

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. A description of the activities performed during a record review, an example check list, and a report description can be found in the Environmental Geochemisty Group Operating Handbook, ESH–EMS–95–0061.

Chapter 12

Special Surveys and Projects

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In this chapter...

Introduction

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 the Savannah River Site (SRS) Environmental Protection Department's Environmental Monitoring Section (EMS) and other groups, including the Savannah River Technology Center (SRTC) and the Academy of Natural Sciences of Philadelphia (ANSP). 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 available samples and/or analyses. Because of sampling and/or analytical difficulties, some sample analyses may be missing. Details about the number of samples analyzed and the results of those analyses appear in *SRS Environmental Data for 1994* (WSRC–TR–95–077).

Lower Three Runs Creek Radiological Survey

A survey of the Lower Three Runs Creek corridor was conducted during the fall of 1993 to characterize the corridor following the PAR Pond drawdown of 1991 and prior to refilling the pond. The 1993 survey, results of which were not available until 1994, is the latest in a series of Lower Three Runs surveys dating to 1971—and the first conducted since 1988.

Eleven sampling trails were established during previous Lower Three Runs surveys (figure 12–1) to monitor the stream system. The trails provide uniform spacing along the Lower Three Runs corridor. Several are located downstream of the Lower Three Runs Creek's confluence with major offsite streams—especially streams with contamination potential. The 1993 survey utilized six of the established trails; their names and the rationale for their selection are listed in table 12–1.

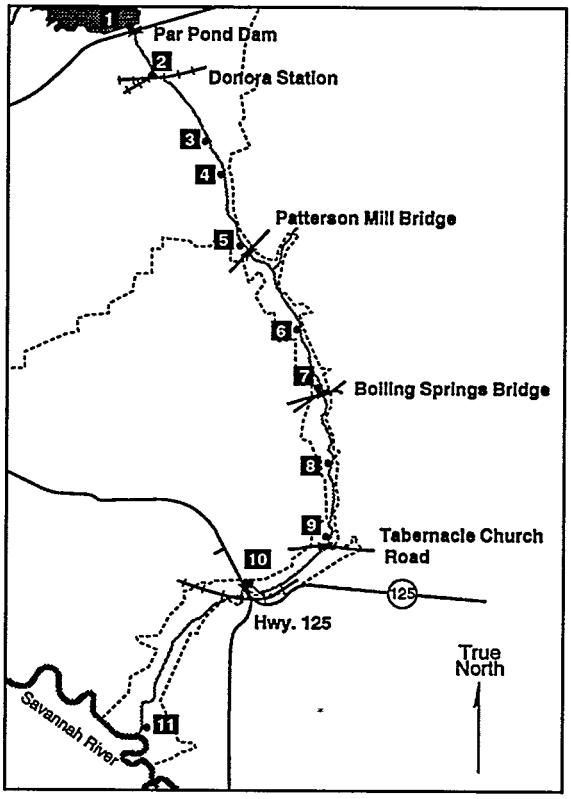

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Figure 12–1 Survey Sampling Locations
Eleven sampling trails have been established to survey the Lower Three Runs Creek corridor, which is located downstream of the PAR Pond Dam. The latest survey was conducted in late 1993 to characterize radionuclide levels along the corridor after the PAR Pond drawdown.

During the survey, ambient gamma exposure rates were determined, and samples of soil and vegetation were collected for laboratory analysis. For media

Table 12–1
Lower Three Runs Creek Radiological Survey Trails/Rationale

Trail	Rationale
T–1	At PAR Pond Dam
T–2	Downstream of PAR Pond Dam and of drawdown diffusers
T–5	Boundary of main body of site; routine EMS water surveillance location
T–7	Public access at Boiling Springs Natural Area
T–10	Public access from S.C. High way 125; routine EMS water surveillance location
T–11	Stream mouth (Note: T–11 covers only the east bank of Lower Three Runs Creek)

sampling, each trail was divided into three areas (stream bank, floodplain, and high ground) on each bank, for a total of six monitoring sites per trail. At each location, shallow (12-inch-deep) soil cores and green vegetation were collected. Each core was split into 3-inch segments for analysis.

Soil samples were analyzed for gamma-emitting radionuclides, strontium-89,90 plutonium-238, and plutonium-239. Vegetation samples were analyzed for gross alpha, gross beta, gamma-emitting radionuclides, and tritium.

Gamma-Emitting Radionuclides in Soil and Vegetation

The survey indicated the presence of detectable quantities of gamma-emitting radionuclides in most of the samples analyzed. Of 132 soil samples analyzed, 121 showed manmade radioisotopes, while 29 of 33 vegetation samples indicated the presence of manmade gamma activity. The predominant manmade radionuclide in all the samples was cesium-137. Cobalt-60 was observed in five soil samples at significantly lower levels than cesium-137; no other manmade gamma emitters were observed in the vegetation samples.

The maximum cesium-137 concentration measured in soil was 86.8 pCi/g from the T–7 east floodplain 3-to-6-inch core segment. The maximum cesium-137 concentration observed in vegetation was 116.0 pCi/g on the T–2 west bank. Generally, the cesium-137 levels are higher than background sites or routine onsite soil monitoring locations, but are consistent with levels observed in PAR Pond sediments during the 1991 drawdown and with levels observed in the Savannah River Swamp.

As expected from theoretical considerations and previous survey results, cesium-137 concentrations in the soil column generally decreased with increasing depth. Although the vertical distribution varied from location to location, the highest cesium-137 concentrations and the majority of the observed activity were located in the top 6 inches.

The spatial distribution of radioactivity in the stream corridor indicates several trends. Stream bank and floodplain samples show elevated cesium-137 concentrations. Generally, the high-ground locations are comparable to historical onsite and background (site perimeter and offsite) levels, although the T–7 East high-ground concentrations are above historical levels. This is to be expected because the source of contamination (stream water) rarely, if ever, reaches this area. No clear relationship between stream bank and floodplain soil concentrations is evident, while vegetation levels clearly are higher at stream bank sites relative to their corresponding floodplain locations. Soil activity appears to be concentrated on the east side; cesium-137 levels generally are higher on that side. However, with several exceptions, the vegetation results show the opposite trend. The cause of this anomaly is unknown.

No strong correlation was observed between downstream distance and cesium-137 levels. In fact, the location showing the highest cesium-137 level in soil (T–7) was well downstream of the main body of the site. Generally, the cesium-137 levels remained relatively constant down the length of the stream corridor. The soil cesium-137 concentrations were similar between T–1 and T–2. Some decrease in soil cesium-137 was observed between T–2 and T–5, but levels remained fairly constant on the remaining trails. Similarly, vegetation results showed little variance from T–1 through T–7, but levels dropped dramatically on the final two trails. This information is consistent with aerial survey results, which show a relatively uniform contamination pattern down the length of Lower Three Runs Creek.

Strontium in Soil

The analytical results showed total strontium-89,90 concentrations above the EMS detection limit in 17 of the 132 samples collected. Because of the relatively short half-life of strontium-89, all total strontium activity is assumed to be attributable to strontium-90.

The maximum strontium-89,90 concentration observed was 0.32 pCi/g at the T–7 east floodplain location at a depth of 6 to 9 inches.

Because of the relatively small data set, few conclusions on the strontium-89,90 distribution can be drawn. The activity appears to be distributed in a relatively uniform manner down the stream corridor, with the highest levels on the stream bank and floodplain. No firm conclusions regarding the depth profile can be determined, and no relationship between the presence of strontium-89,90 and the concentration of other radionuclides was observed.

Plutonium in Soil

The survey indicated the presence of plutonium-239 above the EMS detection limit in 112 of 132 soil samples, while plutonium-238 was detected in 61 of 132 soil samples. The maximum concentration of plutonium-238 was approximately 0.045 pCi/g and the maximum concentration of plutonium-239 was 0.166 pCi/g. These maximums were measured at the same location (T–10 east bank, 3 inches to 6 inches). The concentrations generally were above levels in routine site perimeter samples; however, most results were below levels observed near F-Area and H-Area, and the maximum concentrations were consistent with the results found near F-Area and H-Area.

Plutonium-238 was detected in only two samples that did not show plutonium-239 activity. A plutonium-239:plutonium-238 ratio of approximately 10:1 was observed consistently in the samples. This ratio is similar to that found in routine site perimeter surveillance samples. Generally, the plutonium-238 levels mirrored the plutonium-239 levels; as plutonium-239 concentrations increased, plutonium-238 concentrations also increased.

Generally, the concentration of both plutonium-238 and plutonium-239 in the soil decreased as depth increased. The majority of the activity (the highest plutonium levels) is located in the top 6 inches of the soil column. This relationship is similar to—but not as pronounced as—that observed for cesium-137. Likewise, the spatial distribution is similar to that of cesium-137. The deposited activity appears to gradually decrease with increasing distance from the PAR Pond Dam. The majority of the activity (the highest plutonium levels) is located in the stream bank and floodplain, while the high-ground results are comparable to historical onsite and background levels. However, no consistent relationship was observed between cesium-137 and either plutonium-238 or plutonium-239 concentrations.

Gross Beta in Vegetation

All 33 vegetation samples were analyzed for gross beta activity, and all showed gross beta concentrations above the EMS detection limit. The maximum observed gross beta level was 86.3 pCi/g in the sample from the T–5 east bank. Gross beta results provide a mechanism to identify total beta activity without providing nuclide identification. In environmental samples, gross beta activity is attributed largely to potassium-40, to the uranium decay series, to the thorium decay series, and to cesium-137.

The gross beta results generally mirrored the cesium-137 results with regard to spatial distribution. However, a quantifiable relationship was not evident in this trend. Considering the relatively large contribution of cesium-137 to the total gross beta activity, the trend was anticipated.

Gross Alpha in Vegetation

All 33 vegetation samples were analyzed for gross alpha activity, with 10 samples showing gross alpha concentrations above the EMS detection limit. The maximum observed gross alpha level was 11.1 pCi/g in the sample from the T–2 east bank. Gross alpha results provide a mechanism to identify total alpha activity without providing nuclide identification. In environmental samples, gross alpha activity is attributed largely to the uranium decay series and the thorium decay series, with a smaller contribution from transuranic nuclides such as plutonium and americium.

Because of the relatively small data set, few conclusions on the gross alpha activity distribution can be drawn. As was the case with plutonium-238 and plutonium-239 in soil, the activity appears to be located in the stream bank and floodplain and gradually decreases past T–5.

Tritium in Vegetation

Only vegetation samples were analyzed for tritium as tritiated water. All 33 samples showed detectable tritium concentrations, although the levels were consistent with routine quarterly site perimeter surveillance samples. These results are not surprising, given the lack of a direct source of tritium into Lower Three Runs Creek, the history of the Lower Three Runs system, and previous liquid monitoring results on Lower Three Runs Creek.

Gamma Exposure Rates

The Lower Three Runs Creek survey indicated gamma exposure rates in the stream corridor that were higher than rates observed at most routine onsite and offsite monitoring locations. The measured exposure rates

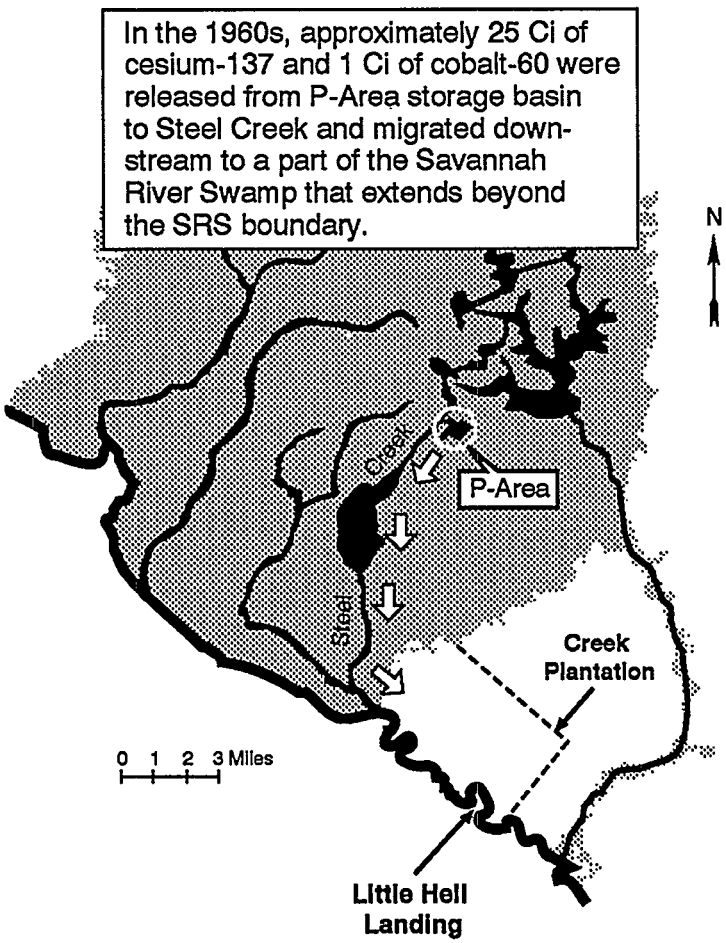

Figure 12–2 Swamp Contamination
Radioactivity released from SRS operations contaminated the Savannah River Swamp between Steel Creek and Little Hell Landing during the 1960s.

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varied from 0.44 mrems per day (161.56 mrems per year) to 0.7 mrems per day (255.7 mrems per year).

The results generally are consistent with soil concentrations of gamma-emitting radionuclides measured during the survey. Typically, gamma exposure rates are highest at the stream bank, decrease slightly in the floodplain, and are lowest on high ground. As with the cesium-137 results, no discernible spatial distribution was observed, with exposure rates relatively constant down the length of the stream. No decrease in exposure rates was observed with increasing distance down the stream; in fact, the highest average rates were observed on T–7.

These results generally agree with previous aerial radiation surveys, which show a fairly uniform pattern of elevated exposure rates along the Lower Three Runs corridor.

Savannah River Swamp Survey

In the 1960s, a portion of the Savannah River Swamp between Steel Creek Landing and Little Hell Landing was contaminated with approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60 (figure 12–2). The contamination resulted from failed fuel elements that leaked radioactivity into the P-Area storage basin; occasionally, this water was discharged to Steel Creek. During periods of high river flow, Steel Creek flowed along the lowlands comprising the swamp and entered the Savannah River at Little Hell Landing. Consequently, some radioactivity settled into part of the swamp. The contaminated swamp area extends beyond the SRS boundary to private property known as Creek Plantation. The offsite swamp area is uninhabited and not easily accessible.

Ten sampling trails were established in the Savannah River Swamp in 1974 so that specific locations could be monitored routinely to determine the amount and migration of radioactivity within the swamp (figure 12–3). Fifty-four monitoring locations starting at the river bank and extending to high ground were established along these trails. These locations are identified by the distance (in feet) from the river, beginning at the river bank; i.e., 0 feet is on the bank;

1,000 feet is inland 1,000 feet from the bank, etc. This convention will be followed throughout this section.

Comprehensive surveys were conducted annually along the trails from 1974 to 1977 to characterize the contaminated area. The frequency of the comprehensive surveys was reduced to 5-year intervals after 1977 because no significant changes in radiological conditions were measured. The most recent comprehensive survey was conducted in 1990. Cursory surveys, which consist of gamma radiation measurements and sampling at selected locations, have been conducted annually to provide interim monitoring of the swamp.

The 1994 survey—a cursory survey—followed the program changes implemented in 1990. Thermoluminescent dosimeters (TLDs) were placed at each of the 54 sampling locations to provide an integrated exposure measurement, and samples of soil and vegetation were collected from one location on each trail. These 10 sampling locations, a subset of the 54 established historical locations, were designated in 1990 as the points to be used for comparative purposes during cursory surveys. Each location corresponds to the area on its trail that historically has exhibited the highest activity levels.

Gamma Exposure Rates

As previously indicated, TLDs were placed at each of the 54 previously established sampling and monitoring locations. However, because of heavy rains and the resulting high water in the swamp, the TLDs could not be retrieved in 1994. Likewise, a planned radiation

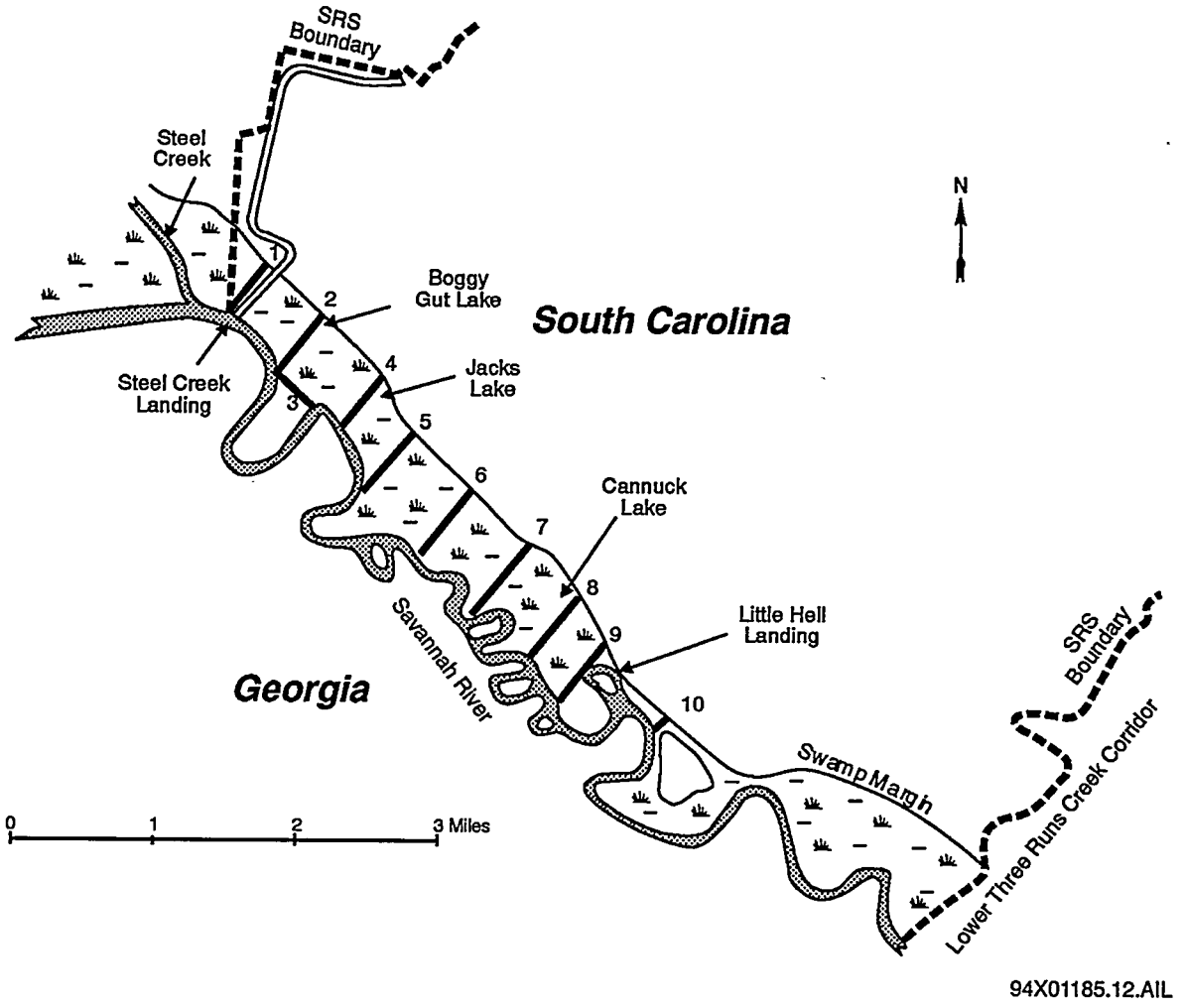

Figure 12–3 Savannah River Swamp Sampling Trails
Ten sampling trails were established in the Savannah River Swamp in 1974 so that surveys could be conducted of the movement of contamination from SRS operations.

survey using portable radiation detection instruments (microR meters) could not be conducted.

Gamma-Emitting Isotopes

Soil plugs (0 to 3 inches) and vegetation were collected from each of the 10 established monitoring locations (described earlier) and analyzed for gamma-emitting radionuclides. The primary isotope detected was cesium-137, with a smaller number of samples having detectable cobalt-60. These results were expected and are consistent with the source term and previous survey results.

Cesium-137 was detected in all 10 of the soil samples and in eight of the 10 vegetation samples. Cobalt-60 was detected in smaller concentrations than cesium-137 in five of the 10 soil samples and two of the 10 vegetation samples. The maximum cesium-137 level in soil was 198.0 pCi/g, measured at 2,700 feet on T–7, and the maximum cesium-137 level in vegetation was 27.0 pCi/g, measured at 2,530 feet on T–6. Cobalt-60 was detected at 2,150 ft. on T–1, 1,900 feet on T–4, and 2,900 feet on T–8, with a maximum concentration of 0.34 pCi/g on T–1. The levels are consistent with those observed in previous surveys. Although the maximum cesium-137 and cobalt-60 concentrations were observed at the same location, no correlation was observed between levels of these two nuclides in soil.

As indicated in the 1993 cursory survey, the distribution of cesium-137 in swamp soil from the 1990–1994 surveys indicates some movement of the activity within the swamp. Some locations, particularly T–3 and T–7, have shown an unusually large increase in cesium-137 concentrations, while others, such as T–1 and T–6, have shown a similarly large decrease in cesium-137 concentrations. Considered as a whole, these analytical results seem to indicate localized movement rather than a general overall migration of activity along the entire swamp. The largely unchanged results from T–10 indicate that the activity has not left the swamp on its lower end and that the contaminated area has not expanded.

Cesium-137 activity was detected in nine of the 10 vegetation samples. Although the concentrations were consistently lower than those in soil from the same location—and generally followed activity levels in the soil—no constant ratio between the two was observed. The two trends of note identified in the 1993 survey appear to have stabilized. With time, changes in the cesium-137 levels in vegetation are more variable because of the many biological and physical factors influencing the results.

Strontium

The soil and vegetation samples also were analyzed for strontium-89,90; because of the relatively short half-life of strontium-89, all activity is assumed to be attributable to strontium-90. Four soil samples showed strontium-89,90 activities above the minimum detectable activity; likewise, four vegetation samples showed concentrations above the minimum detectable activity. The maximum strontium-89,90-in-soil level was 0.154 pCi/g on T–1 and T–5. The maximum strontium-89,90-in-vegetation level was 0.692 pCi/g on T–2. Generally, the levels observed are consistent with historical results.

As expected, those locations showing detectable strontium-89,90 levels in soil also show strontium-89,90 in vegetation. However, because of the relatively small data set, few other conclusions on distribution or uptake can be reached from these results—either in 1994 or historically. Likewise, the distribution of strontium-89,90 in vegetation shows little correlation to the cesium-137 levels observed in vegetation.

Mitigation Action Plan for Pen Branch Reforestation

The significant reduction in the production mission of SRS reactors has resulted in reevaluation of the mitigation strategies identified in the 1991 Mitigation Action Plan (MAP) and its 1992 annual update. The annual MAP update provided a status and target date for activities within each of the five program elements. The Mitigation Action Plan–Program Implementation Plan described the actions to be taken, the responsible organizations, and the status of actions required to meet the above commitments. The text of the MAP identified mitigation commitments and other mitigation-related issues requiring resolution, and referenced pertinent sections of the Final Environmental Impact Statement for the continued operation of K-Reactor, L-Reactor, and P-Reactor [DOE, 1990]. The MAP was composed of the following five elements, which acted as discrete units or plans:

- mitigation for fish kills resulting from reactor operation
- mitigation for wetlands adversely impacted by continued operation of K-Reactor
- mitigation for impacts on individual workers from termination of reactor operations
- evaluation of options for disassembly basin purge water discharges
- studies to determine if entrainment mitigation is needed

Essentially, as a result of the mission change, mitigation activities were reduced to three program elements—those associated with Pen Branch reforestation, with the socioeconomic impact of the workforce reduction, and with seepage basin usage. Because of mission changes at SRS, the elements associated with fish kills and entrainment mitigation needs no longer are required. Elements associated with individual workers were completed in the 1993 MAP update. Elements of the disassembly basin purge water discharges have been deferred until the K-Reactor mission is further defined. The only purges that may occur would be in emergency conditions. The mitigation for wetlands adversely impacted by operations is the only section of the MAP that remains an active program element. At the direction of the U.S. Department of Energy (DOE), it has been agreed by all parties involved in the reporting process that the annual *Savannah River Site Environmental Report* will be used as the document to report progress on the reforestation portion of the commitment, beginning with the 1993 update [New, 1994].

A precise history of the regulatory commitment for the reforestation can be found in the MAP 1992 update [DOE, 1992a]. 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 by reducing the acreage.

The following paragraphs describe the implementation of mitigation measures related to reforestation mitigation actions to which DOE has committed.

Mitigation for Wetlands Adversely Impacted by K-Reactor Operations

The DOE policy is to preserve and protect wetland resources at SRS according to the national goal of "no net loss of wetlands" [Watkins, 1989]. Consistent with that policy, DOE has committed to restore all wetlands impacted by the operation of K-Reactor. Integral to this mitigation is the understanding of actual effects incurred by wetlands from K-Reactor operations. Phase I of the Pen Branch mitigation began in 1993 with reforestation of the corridor area. If necessary, any mitigation involving enhancements to riverine wetlands, streams, or areas other than Pen Branch will begin in the year 2000. The general flow path for the restoration effort is outlined in figure 12–4.

A number of preliminary tasks were required prior to implementation of the operational reforestation effort, including a literature review of other studies that included similar restoration efforts. A baseline characterization was conducted of the plant communities present in the Pen Branch corridor and delta [WSRC, 1991]. Studies of the effects of cold-flow testing on biological communities in Pen Branch and its associated wetlands also were conducted [Wilde, 1991; Gladden et al, 1991; Paller et al, 1991], and a report on the effects of the power ascension testing has been issued [ETT, 1995]. A program in place to monitor the post-thermal recovery will be continued, with control plots in all the areas of reforestation. A number of research studies have been conducted testing species selection and seedling characteristics to identify appropriate methods for the reforestation effort, including work by the Savannah River Ecology Laboratory (SREL) and the Southeastern Forest Experiment Station, near Charleston, South Carolina. Many research cooperators have provided valuable information that has contributed to the planning of the operational effort.

DOE has proposed the following ways to mitigate wetland losses incurred as a result of past K-Reactor operations:

- reforestation of the Pen Branch Corridor and Delta by natural succession
- reforestation of the Pen Branch Corridor and Delta by planting
- compensatory mitigation

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 (1988). This is supported by the occurrence of natural revegetation in Steel Creek during the past 25 years. At that time, cooling of L-Reactor was accomplished by using L-Lake instead of Steel Creek. In 1991, SRTC initiated a project to reevaluate the acreage of wetland forest affected by previous reactor operations and to document areas that had shown recovery since K-Reactor shut down in 1988. Through the use of aerial photography and aircraft-acquired multispectral data, it was determined in 1992 that an area of 583 acres was included in the swamp and marsh area that either had been or could be clearly affected in the form of tree canopy loss or vegetation damage [Blohm, 1992]. This is a substantial reduction from the 670 acres estimated in the Final Environmental Impact Statement [DOE, 1990]. Continued monitoring has shown increasing coverage of willow and scrub-shrub vegetation, indicating a normal successional sequence for this type of habitat. Generally, these increases in woody vegetation cover occurred through a reduction in the primrose (*Lugwigia*

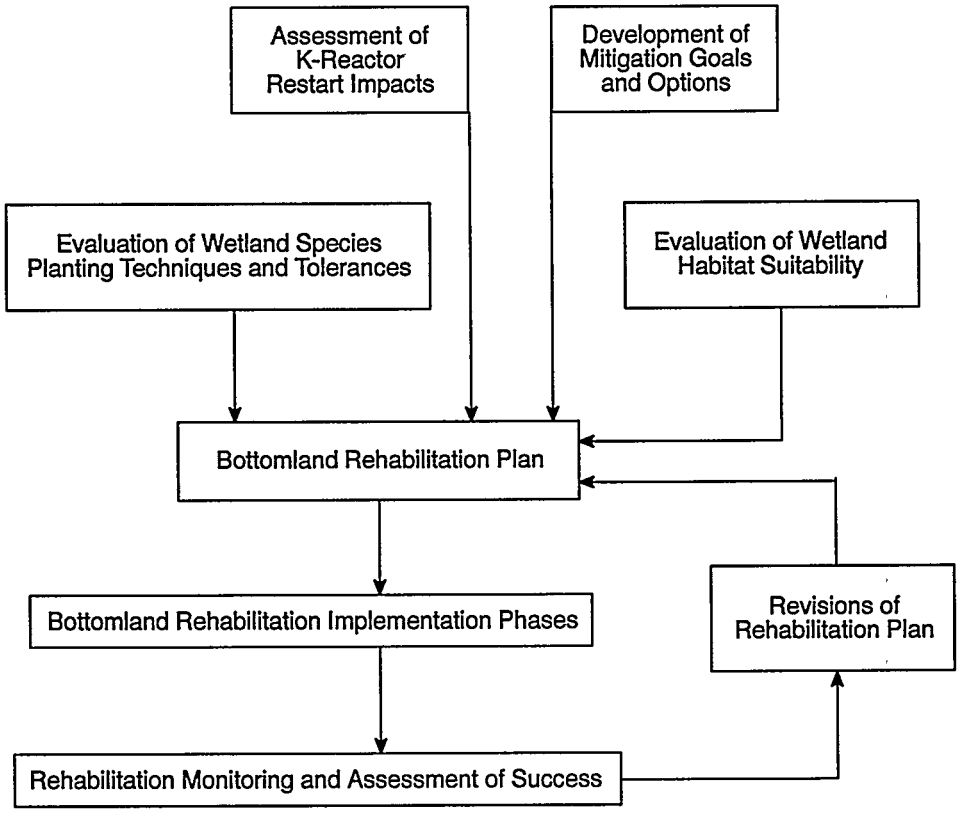

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Figure 12–4 Wetlands Rehabilitation Process

spp.), mud-flat, and open-water-cover categories. These willow stands, however, have tended to become permanent in Steel Creek rather than to occur as an early successional stage. Intervention through planting will be necessary to successfully reforest these areas. Reassessment of this area using data from 1992 and 1993, including documentation of areas known to have experienced natural reseeding by cypress, may further reduce the acreage targeted for active reforestation actions.

Reforestation of the Pen Branch Corridor and Delta by Planting

The Pen Branch corridor and delta will be reforested using indigenous wetlands species. The reforested areas will be managed until successful reforestation has been achieved. This is the preferred method of mitigation for Pen Branch. Recent observations indicate that cypress, tupelo, and other species are becoming reestablished naturally in portions of the Pen Branch delta. This natural reforestation has been quantified and will be monitored. Intervention into this process will be considered only to maximize survival of the desired species.

Areas of the Pen Branch corridor and delta judged not to be revegetating satisfactorily are being replanted with indigenous bottomland forest species appropriate for the soil types and hydrologic regime. A number of tasks were identified in the MAP relating to the Pen Branch reforestation element. All these have been met, changed due to mission, or scheduled for later target dates. The initial seedling planting of the entire corridor area has been completed. This consisted of planting approximately 31 acres of the lower corridor with a mixture of flood-tolerant hardwood species and cypress seedlings. An additional 47 acres of the upper corridor was planted with a mixture of bottomland hardwood species seedlings in fiscal year 1994. Species planted included water hickory, green ash, swamp and water tupelo, black gum, persimmon, cherrybark and water oak, bald cypress, and swamp chestnut oak. The actual species planted in an area was determined by the expected hydrology of the area and the flood tolerance of the species. Seedlings were planted at approximately 450 trees per acre, and permanent monitoring plots were installed to assess the survival of the seedlings in the corridor area. Preliminary indications are that survival and growth in the lower corridor area are quite good. Many of the

SRFS Photo (NFN)

Seedlings are prepared for planting as part of the ongoing Pen Branch reforestation project at SRS.

seedlings planted in the upper corridor were uprooted and eaten by large feral hog populations in that area. Mortality was extensive, especially among the oak species, and will require replanting of seedlings in fiscal year 1995. Hog populations have been greatly reduced, and the problem is not expected to recur within the replanting area. Within each of the planted areas, there are areas that will serve as untreated controls to assess the effectiveness of the reforestation effort. This acreage, part of that committed to in the MAP, will be assessed later to see if it will reforest naturally because of its proximity to the mitigated acreage. If it does not, it may have to receive planting at a later date. Planning for the restoration of about 150 acres of the delta area is under way for fiscal year 1995. Preparation of the area to support the planting program took place during the summer of 1994.

Compensatory Mitigation

Compensatory mitigation will provide equivalent mitigation at sites other than Pen Branch, either by enhancing degraded wetlands or by creating new wetlands. This option will be evaluated in detail following evaluation of the success of reforesting Pen Branch corridor and delta in the year 2000. However, it is the least desired option. Compensatory mitigation is described in the following paragraphs.

Restoration of In-Kind Bottomland Hardwood Habitat on Four Mile Creek or Steel Creek

Four Mile Creek (also known as Fourmile Branch) and Steel Creek—previously disturbed streams similar to Pen Branch—are located within the SRS boundary. The restoration of wetland forests along this watercourse would provide functionally equivalent, in-kind mitigation and achieve a restoration of wetland functions and habitat closest to those present in the Pen Branch area.

Restoration of Carolina Bays and Other Degraded Wetlands at SRS

The original site area was farmed extensively before it was established in 1951, and many of its wetlands were adversely impacted during this time. Bays were ditched and drained and bottomland forest communities were impacted by farm ponds and highway crossings. Altered or degraded wetlands are being identified. Those deemed most valuable can be restored through alteration of the hydrologic regimen. As an example, ditches can be plugged and causeways removed to restore wetland acreage.

Restoration and Purchase of Offsite Wetlands

If additional mitigation is required, DOE could locate, purchase, and donate lands of suitable value through a state, federal, or private conservation organization. This could involve the purchase of Carolina bays threatened with development and currently not protected, or the purchase of wetlands that have been converted to croplands. In the case of the latter, mitigation would involve restoration of the fields to forested wetlands. These lands could be purchased only from willing sellers and could be contained within the Savannah River drainage basin.

A number of tasks associated with compensatory mitigation actions were listed in the MAP. The only one that has been completed is the identification of ecologically significant SRS wetlands that have been degraded or altered [DOE, 1992b]. The necessity to perform the other listed tasks will be determined based on the results of the Pen Branch mitigation.

Academy of Natural Sciences of Philadelphia River Quality Surveys

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.

The ANSP surveys examine algae, rooted aquatic plants, protozoa, insects and other macroinvertebrates, fish, and basic water chemistry. Detailed studies (comprehensive surveys) of all components have been conducted roughly every 4 years, and studies (cursory surveys) of certain groups of organisms, notably a type of algae called diatoms, have been conducted annually. Multiple levels of the aquatic food web are studied because no single group is reliably the best indicator of ecosystem health and because there is a broad consensus that maintaining the integrity of the entire system is important.

The study design employed in the ANSP comprehensive Savannah River surveys includes four sampling stations: three exposed to SRS influence (stations 3, 5, and 6) and one unexposed reference station (station 1) upriver (figure 12–5). Multiple exposed stations are required because of the complex pattern of SRS inputs along the river. Potential impacts are assessed by determining whether differences exist—between the exposed and reference stations—that are either greater or of a different character than would be expected if they were due merely to natural differences among sampling sites.

For example, the character of differences among stations is judged in part by comparing the individual species collected. Evidence of impact exists if a station shows elevated abundances of species known to tolerate pollution and depressed abundances of species known to be sensitive to pollution. If this pattern is detected at the exposed stations, but not at the reference station, SRS is implicated. If, however, the pattern is seen at the reference station, the impact must be due to sources upstream from the study area.

Other types of evidence for impact include decreased numbers of species, decreased cumulative numbers of individuals, numerical dominance by a small proportion of the species present, decreased individual growth rates (e.g., in fish), and decreased body weights of individuals relative to their lengths. These patterns arise because pollution tends to reduce individual and population growth rates in a majority of species, while a few are able to thrive under such conditions.

Determining whether exposed and reference stations differ is complicated by the fact that considerable variation exists even among samples collected at the same time from the same location. Apparent differences therefore may be misleading if each station is characterized by only a single sample. For this reason, the ANSP surveys typically collect multiple samples from each station, making it possible to quantify both important components of variation: within and among stations. Compelling evidence for station differences exists if variation among samples from different stations is significantly greater than (average) variation among samples from the same station, as judged by appropriate statistical techniques. Otherwise, apparent station differences can be explained simply by natural variability.

The ANSP surveys also address variation over time. Important components of temporal variation include seasonal trends, multiyear trends, and trendless variability. All these components can be assessed using the unique data set generated by ANSP's long-term monitoring program in the Savannah River. Regular sampling with standardized collection techniques has continued largely unmodified since the early 1950s, making this one of the most comprehensive ecological data sets available for any of the world's rivers. Unfortunately, the complete ANSP data set has not been analyzed or integrated with biological and chemical information from other sources (e.g., SRS,

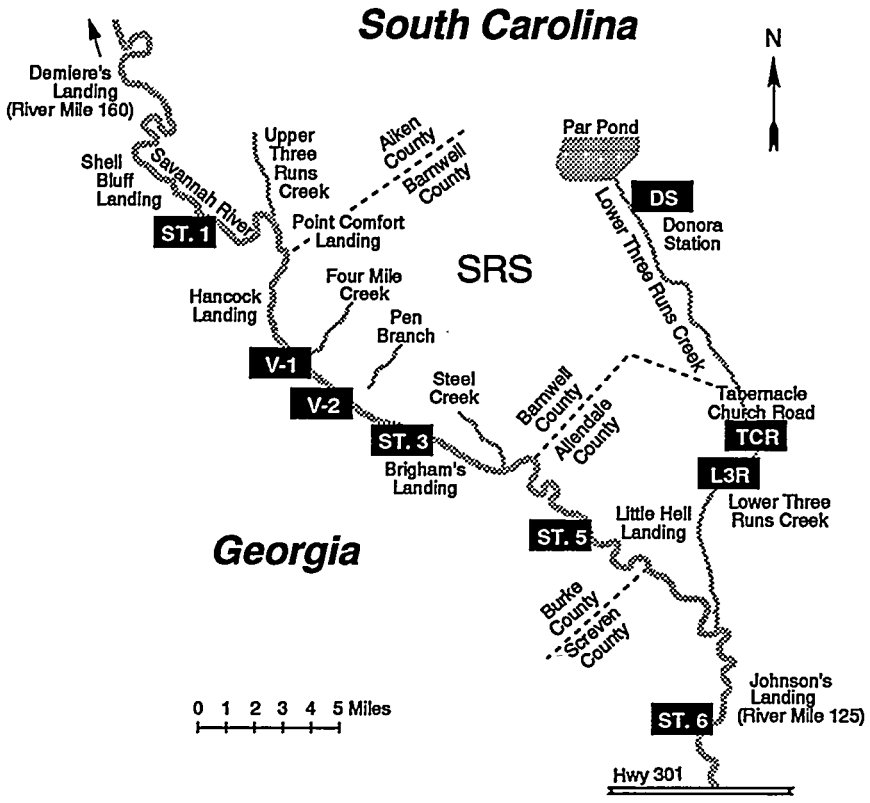

Figure 12–5 Academy Survey Sampling Sites

The Academy of Natural Sciences of Philadelphia has established specific sampling locations for surveys of the Savannah River—three exposed to SRS influence (stations 3, 5, and 6) and one unexposed reference station (station 1).

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state and federal agencies) monitoring the Savannah River. The following, however, does present an examination of notable trends over approximately the past 10 years.

Such long-term records of biological change are valuable for several reasons. Because they allow the normal degree of year-to-year variability at a site to be quantified, changes observed from one survey to the next can be assessed to determine whether they fall within the normal range, much as one would use a control chart (figure 12–6). Changes that are outside this range provide evidence of potentially altered conditions at the study site.

These data sets also are useful in distinguishing between potential impacts of SRS and variation caused by other factors. In particular, part of the biological variation observed over time is caused by documented changes in river flow, wastewater treatment methods, dredging activities, and so on. Correlations between the known history of such changes on the one hand, and components of variation in long-term data sets on the other, provide evidence that these components were not caused by activities at SRS.

Finally, long-term data sets can provide compelling evidence for multiyear trends of improvement or deterioration in ecosystem health. For example, preliminary analyses of some of the academy's long-term data suggest a relatively steady increase in the number of different kinds of aquatic insects living in the Savannah River during the past 35 years. Because aquatic insect diversity is believed to be a sensitive measure of environmental quality, this pattern may indicate a long-term trend of improving water quality in the river.

Progress Reports

The 1994 ANSP studies on the Savannah River included biweekly diatometer monitoring throughout the year, cursory surveys in the vicinity of the SRS (algae, aquatic macrophytes, insects, and fish), and sampling near Vogtle Electric Generating Plant in September (algae, protozoa, noninsect macroinvertebrates, insects and fish). Plant Vogtle stations lie within the area potentially impacted by SRS and are examined to note measurable influences to river health issuing from Plant Vogtle that potentially can be separated from those contributed by the SRS facilities. Analysis of samples from these studies is under way. Progress to date for each study component is reported in the following paragraphs.

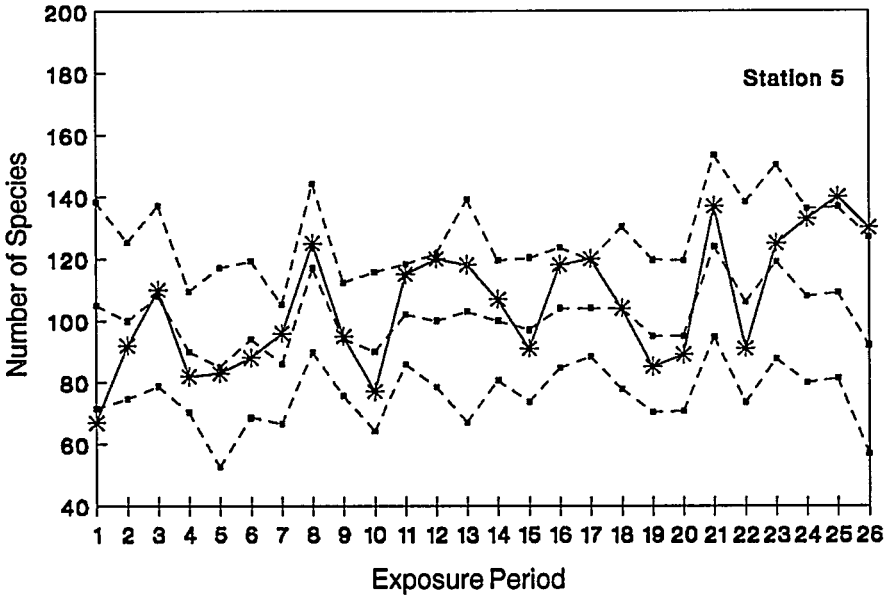


Figure 12–6 Station 5 Diatom Species
Shown are the number of diatom species in diatometers at station 5, with the 1993 values (solid line) superimposed on the mean plus or minus 1 standard deviation (dotted lines) during the period 1978–1993. Exposure periods represent 26 2-week intervals during which diatometers were deployed in the Savannah River.

ANSP Graphic

Diatometer Monitoring

Periphyton is an assemblage of simple plants (e.g., algae) that attach to rocks and other underwater surfaces in the river. Diatoms, a type of periphyton, are collected using devices called Catherwood Diatometers that float glass microscope slides in the water. The diatoms attach to the slides and can be scraped off and examined in the laboratory.

In 1994, diatoms were collected continuously at locations above SRS (reference station 1), below Steel Creek (exposed station 5) and below Lower Three Runs Creek (exposed station 6). Samples were analyzed for each biweekly exposure period to determine the number and relative abundances of diatom species. More detailed analyses were performed on slides for two exposure periods (slides removed April 26 and October 25). Water quality was assessed by comparing stations and sampling periods based on the relative abundance and richness of species and on their ecological requirements and tolerances.

As in the previous 6 years of study, the number of diatom species (species richness) was consistently lower at exposed station 6 (below Lower Three Runs Creek) than at the reference station (station 1). In addition, the number of species at station 5 (below Steel Creek) was similar to that at station 1 and consistently higher than that at station 6. A similar trend was observed for percent dominance, an index measuring the degree of numerical dominance by a small proportion of the species. Percent dominance generally was higher at station 6 than at stations 1 or 5. The decreased species richness and increased percent dominance at station 6, compared to stations 1 and 5, indicate a less diverse biota. As in past years (1988–1994), diatom communities at station 6 suggest that some component(s) of water quality is poorer, probably resulting from conditions on Lower Three Runs Creek. No differences in water quality between stations 1 and 5 are apparent.

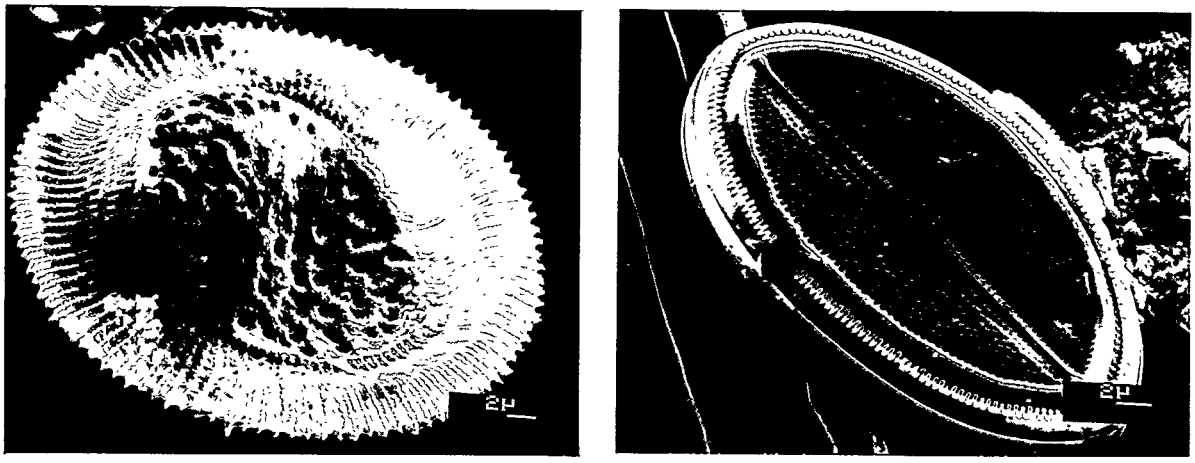
Conclusion Decreased diatom diversity in the Savannah River at exposed station 6 suggests that some component(s) of water quality is poorer relative to upstream locations, probably resulting from conditions on Lower Three Runs Creek.

Algae and Aquatic Macrophyte Studies

The cursory algal studies were carried out on the Savannah River at the reference station above SRS and at the two exposed stations below SRS. Although sample analysis is incomplete, preliminary results suggest there has been no significant change in water quality at any of the stations since 1993.

The comprehensive algal study carried out on the Savannah River near Plant Vogtle revealed 96 algal species at station V–1 (reference, above Plant Vogtle) and 64 algal species at station V–2 (exposed, below Plant Vogtle). These results are within the range found during the previous five surveys at these stations, suggesting there was no major change in water quality in 1994.

The number of algal species was similar at the two stations during 1985, 1986, and 1987. Since then, the number of species has differed between the two



ANSP Photos (NFN)

Diatoms—unicellular algae such as these photographed by the ANSP's scanning electron microscope—are used to monitor the water quality of the Savannah River near SRS. Such use of diatoms is effective because researchers know the conditions that various species "prefer." Examining the species that live in a particular stretch of the river thus enables the researchers to determine the quality of the water. The symbol at the lower right of each photo is a scale of measurement expressed in microns; one micron equals about 0.000039 inch.

stations, possibly reflecting inherent natural variation. However, since 1987, station V–1 has averaged about 10 more species than station V–2, suggesting that some component(s) of water quality may be somewhat better above Plant Vogtle than below it.

Conclusions Preliminary analysis of 1994 algal communities above and below SRS provides no evidence of an impact of site operations on Savannah River water quality.

The number of algal species collected in 1994 above and below Plant Vogtle was similar to that of previous years, suggesting water quality did not change. However, there is some indication that some component(s) of water quality may be poorer below Plant Vogtle.

Protozoa Studies

Differences in species abundance and richness (11 species) between the two Plant Vogtle stations in 1994 were within the range of variation observed in past surveys. The 54 species from station V–1 represent the lowest number ever collected at this site and probably reflect limited accessibility to permanently watered habitats because of rising water levels. The historical range in diversity at station V–1 (54 to 80 species) is similar to that at station V–2 (54 to 75 species).

Conclusion The protozoan communities above and below Plant Vogtle in 1994 indicate no detrimental impact on water quality, while long-term trends reflect variable water levels and associated scouring of habitats.

Noninsect Macroinvertebrate Studies

Preliminary examinations of 1994 macroinvertebrate collections above and below Plant Vogtle reveal 13 species. This is a decline from the number of species taken in each of the 1990, 1991, and 1993 surveys. All four of these collections were made in years during which the submerged vascular plant beds were absent, and the numbers of species are lower than during the period 1985–1988, when beds of submerged plants were present. The lower numbers in 1994 also reflect decreased collecting efficiency due to rising water levels. Differences between stations were within the expected range of one to three species, as was typical of past surveys.

Conclusion The noninsect macroinvertebrate communities above and below Plant Vogtle in 1994 indicate no impact on water quality, while long-term trends probably reflect the loss of submerged vascular plant habitat and rising water levels.

Insect Studies

Cursory surveys of insect communities above and below SRS were conducted in 1994, but analyses are not yet complete. Results of the 1993 surveys and long-term trends are summarized in the following paragraphs.

The 1993 cursory insect surveys show that taxa richness (number of taxa) and diversity (Shan-

non-Wiener) generally were higher below SRS (exposed station 6) than above it (reference station 1), potentially indicating that some component(s) of water quality improved downstream of the site. Aquatic insects generally showed lower levels of pollution tolerance below SRS (station 6) than above it (station 1). These results may indicate that environmental impacts occur upstream of SRS and that some component(s) of water quality then improves as the pollutants are carried downstream.

During 1994, the ANSP initiated the first thorough investigation of long-term ecological changes in the Savannah River's aquatic insect assemblage; these data have been collected continuously since 1958. This study of the long-term patterns of aquatic insects indicates that the number of insect taxa generally has increased over time (figure 12–7), perhaps as the result of greater efforts to control pollution sources throughout the Savannah River drainage basin. Analysis of the long-term insect assemblage also reveals that the number of taxa generally has been greater below SRS (station 6) than above it (station 1) throughout the study; this may indicate that the "health" of the river nearly always has been better below the the site.

Conclusion Cursory surveys from 1993 indicate better water quality conditions below SRS than above it, possibly reflecting an in-stream recovery process as the Savannah River passes the site. Analyses of long-term insect data indicate that some component(s) of water quality may have been consistently better below the site.

The 1993 studies in the area of Plant Vogtle detected no significant differences between the insect assemblage above and below the plant.

Fish Studies

The 1994 fish studies consisted of a cursory survey and a Plant Vogtle survey, both conducted in September. While neither data set has been statistically analyzed to date, it appears that species richness at both Plant Vogtle stations was low relative to previous surveys. This was due to the scarcity of several groups commonly found in wooded cover or vegetation, such as sunfishes. Some of these species were noted to be uncommon in the 1993 Plant Vogtle survey as well. This scarcity is attributable to decreases in macrophyte beds in the river and to effects of changing water levels. One notable record is the occurrence of a juvenile redeye bass (collected below Plant Vogtle). Redeye bass typically are found in the headwaters of the river and have not been recorded in previous ANSP surveys.

Conclusion Preliminary analysis of the Plant Vogtle fish survey data suggests that species numbers are reduced at both stations relative to previous years; however, rather than indicating poorer water quality, the lower species numbers probably reflect the reduction in macrophyte beds in the river, as well as variable water levels.

Chemistry and Bacteriology

Since the beginning of chemistry sampling of the Savannah River near Plant Vogtle, 28 different elements, compounds, and physical measures have been analyzed from stations V–1 and V–2 above and below the plant. Most analytes are influenced very little by industrial or other human activities. During the period when samples were collected, measures of these have varied little, if at all. The nutrients, including nitrate and phosphate, are not among this group and often are considered contaminants because they are found in various industrial processes, including sewage

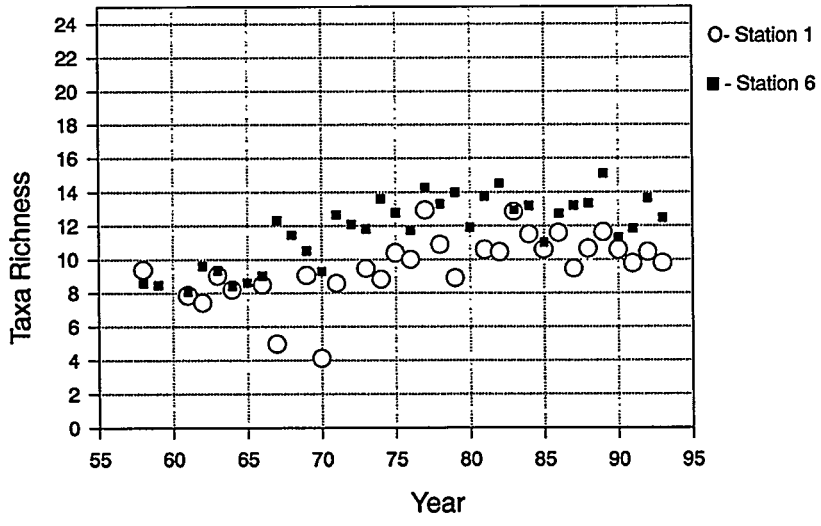


Figure 12–7 Long-Term Trends In Mean Number
This graph shows long-term trends in the mean number of insect taxa collected from the Savannah River above (station 1) and below (station 6) SRS.

ANSP Graphic

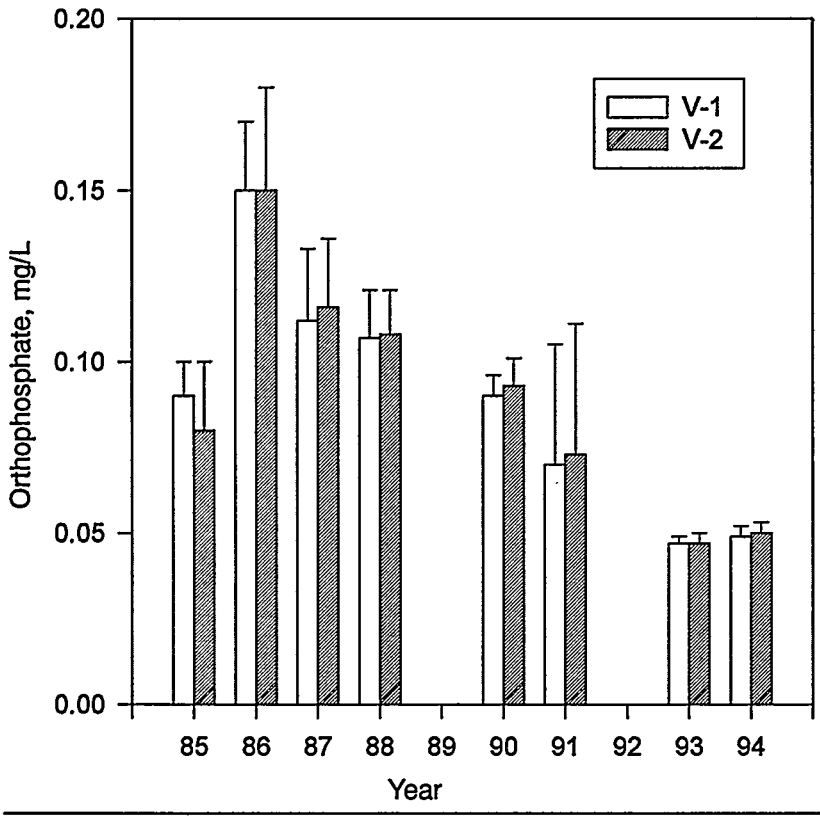


Figure 12–8 Orthophosphate Concentrations
The graph shows orthophosphate concentrations at stations above (V–1) and below (V–2) Plant Vogtle during the period 1985–1994. Analyses for orthophosphate concentrations were not conducted in 1989 and 1992.

ANSP Graphic

treatment. Phosphate, for example, historically has been found in detergents, which some wastewater treatment plants do not remove from the waste. Phosphate, a very important nutrient for freshwater organisms, can result in plant growth in water, which may harm other organisms or the water quality. Phosphate that is not removed from waste is discharged into streams and lakes with treated sewage effluent. In recent years, reduction of the amount of orthophosphate in industrial discharges has been an important goal. The data collected since 1985 (figure 12–8) show a large increase in orthophosphate concentration in water between 1985 and 1986. Since 1986, the amount of orthophosphate found in water at the Plant Vogtle site has been declining, reaching a value in 1993 about one-third the amount found in 1986. The 1994 sample shows that the phosphate concentration in water has leveled off at about 0.05 parts per million. Depending upon turbidity, levels of orthophosphate above 0.05 parts per million may elevate primary productivity. The drop in orthophosphate concentration since 1986 should contribute to improved water quality at the Vogtle site.

Conclusion Water quality in the vicinity of Plant Vogtle has improved since 1986, primarily because of declining concentrations of orthophosphate, a nutrient that in excess can lead to poor water quality.

Education, Research and Development Association of Georgia Universities Study

SRS contracted with the Education, Research and Development Association of Georgia Universities (ERDA) to conduct a study in 1993 and 1994 that compares pollutants released from the site with those that have entered the environment from other sources [ERDA, 1995]. The levels of these pollutants then could be considered in terms of impact on the health of the environment and of the public.

Information was gathered by researchers at the Georgia Institute of Technology in Atlanta and evaluated on three topics pertinent to preparation of the annual *Savannah River Site Environmental Report*—Savannah River water quality, foodstuffs, and general surveillance data. The study is expected to be published in 1995.

Savannah River Water Quality

For the first topic—water quality of the Savannah River—five rivers in the southeastern United States were compared with the Savannah River.

The rivers selected for water quality comparisons were the Roanoke, Santee, Altamaha, Chattahoochee, and Alabama. These were considered most similar to the

Savannah River in the specified region with regard to flow; extent and physiography of the drainage basin; and patterns of dams, major towns, and nearby industrial development. On the other hand, the various factors that control water quality along its length made each river unique. Attempts were made to obtain data from two U.S. Geological Survey water quality stations per river—one in the Piedmont region and one in the Coastal Plain region. For the Savannah River, the station upstream from SRS was in the Broad River in Georgia and the one downstream was at Clyo, Georgia. Data from other stations were used when applicable.

The data for 1988–1992 show water pollution at levels above maximum contaminant levels for drinking water in the Savannah River only for fecal coliform bacteria and lead. Data for lead concentrations, however, are noted in the data summary reports as being analytically uncertain, while coliform levels normally would be reduced by water treatment. Savannah River water quality was as good or better than that of the other five rivers. Water quality at the downstream monitoring location was not significantly degraded relative to the location upstream from SRS, except for phosphorus concentrations, which are attributed to discharges near Augusta, Georgia (upstream from the site).

Foodstuffs

The second topic was the potential of foodstuffs grown near SRS as pathways to humans for effluent radionuclides. The study considered amounts and locations of foods grown and processed near the site and compared foodstuff monitoring at SRS and at a comparable facility.

Recently compiled food production data were obtained from South Carolina and Georgia state agencies. The information presented, by county, the amounts of various grains, fruits, milk, poultry, eggs, and meats produced annually. The Georgia agency also listed the number of food processors by county.

The information helped identify the presence of such foodstuffs near SRS to estimate maximum individual radiation doses by the ingestion pathway and to indicate the quantity available for estimating collective radiation doses. Calculational models for these estimates are in use at SRS. The doses, given in recent annual site environmental reports, are relatively small. The new information did not indicate any potential for significantly increasing the ingestion dose.

The nuclear facility in the southeastern United States selected for comparison of foodstuff radiological monitoring was the Oak Ridge National Laboratory, Oak Ridge, Tennessee. Although there are numerous differences in the location and operating characteristics of SRS and Oak Ridge National Laboratory, no other nuclear facilities as large as SRS exist in this region.

ERDA

ERDA provides partnerships between South Carolina and Georgia universities and SRS.

In addition to the 1993–94 ERDA study discussed in this chapter, a study was begun in late 1994 by Georgia Institute of Technology researchers to identify all foodstuffs produced near SRS, including dairy products, meats, fish, fruits, and vegetables. The purpose of this study is to obtain a more accurate account of all food pathways in which contaminants or radiation could be passed to the local population.

The researchers have been commissioned to identify the types of foodstuffs and how much of each is produced within a 50-mile radius of the site. They also will attempt to determine what portion of a typical area resident's diet comes from local foodstuffs and what portion comes from outside the region.

As part of the Georgia Tech study, a detailed (door-to-door) survey—also begun in late 1994—is examining food production and consumption within a 6-mile radius of the site.

The study's results, which should be available during the summer of 1995, will be used by EMS to update its dose assessment models and to adjust its field monitoring program. The results are expected to help EMS determine if it needs to increase or decrease sampling in any areas.

Foodstuff monitoring was considerably more extensive at SRS than at Oak Ridge from 1987 to 1991, according to a comparison of site environmental reports from SRS (annual reports) and Oak Ridge (quarterly reports for the entire Oak Ridge Reservation). Both facilities monitored milk, potable water, and fish for radioactivity content, but Oak Ridge did not report any additional media, whereas SRS reported radionuclide levels in various grains, fruits, meats, and wildlife. In part, the more extensive monitoring at SRS reflects greater agricultural production in its vicinity.

The researchers concluded that low radiation doses to persons in the SRS environment do not justify additional routine monitoring efforts for the food ingestion pathway.

General Surveillance Data

The third topic was the comparison of SRS environmental radionuclide and radiation measurement results with results obtained by other groups. Data from the SRS environmental radiological

monitoring program were compared to data from similar programs conducted by the South Carolina Department of Health and Environmental Control (SCDHEC), the Georgia Department of Natural Resources (GDNR), and the Georgia Power Company at Plant Vogtle. Radiological measurements during 1987–1991 were compiled in computer spreadsheets from environmental reports produced by each of these groups. Media, measurements, and locations for comparisons then were selected.

Only a few data sets from the large number of measurements reported by the four groups could be used for comparison. Not many sampling points are colocated by all groups, and few radionuclides released by SRS or Plant Vogtle are detectable—even with the sensitive environmental monitoring procedures applied by the groups. The results were compared in terms of annual averages for each of the 5 years because the *Savannah River Site Environmental Report* provides annual averages.

Comparisons are presented at one or more sites for tritium concentrations and gross beta particle activity in water supplies and surface water; gross beta particle activity on airborne particle filters; tritium concentrations in milk and vegetation; cesium-137 concentrations in fish and sediment; and external radiation exposure. No comparisons were feasible for other media, such as deposition, soil, and foods (other than milk), or for other manmade radionuclides.

Results by SRS generally were similar to results reported by the three comparison groups, considering the variability of the individual measurements in terms of the two-standard-deviation values relative to annual averages. Some differences in results can be attributed to differences in sample collection and sampling location, notably for sediment and fish. The various groups used different means of collecting sediment (dredge, scoop, core). Fish results were for a few fish, which can be highly mobile. Several, but not all, comparisons of tritium levels differed—possibly because some laboratories that do not distill samples before analysis obtain higher results. Some large mean values with large standard deviations can be attributed to combining measurements that result from individual release events with measurements of routine releases, although an attempt was made to separate unusual values for data comparisons. Some differences may have been due to analytical problems with specific samples taken by one or another of the groups, but no consistent and significant deviations were found.

Appendix A

Applicable Guidelines, Standards, and Regulations

Introduction

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 these requirements is audited by regulators, including the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Environmental Protection Agency (EPA), and by DOE.

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 201.

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 proven 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 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 1994.

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 201.

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, para. 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.

In 1994, 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) 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 plants. Industrial permit SC0000175 expired in 1988, but because SRS has applied for a new one, discharges can continue to be made under the expired permit until the new one is issued. The South Carolina Department of Health and Environmental Control (SCDHEC) sent SRS a preliminary draft permit in May 1994, and SRS has sent its comments to SCDHEC for consideration. When the new permit is issued, it will include the discharge points covered under industrial permit SC0044903, which expires November 30, 1995. Until then, the site is discharging industrial wastewater under 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.

Chart 1
South Carolina 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 (April 24, 1992).
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 (April 24, 1992).

SOURCE: [SCDHEC, 1993]

Site Streams

SRS streams 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

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 SCDHEC classifies the Savannah River as a Freshwater system, the river is governed by the same regulations as 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. SCDHEC implements drinking water standards which are at least as stringent as

EPA standards. Drinking water standards for specific contaminants are provided in appendix D, "Drinking Water Quality 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. The SRS annual chemical analysis program and the A-Area and M-Area chlorocarbon monitoring program were discontinued in September 1994 because they duplicated SCDHEC sampling and other site sampling programs.

Groundwater

Most groundwater constituents at SRS are compared to the final federal primary drinking water standards (DWS), because it is South Carolina policy to classify groundwater aquifers as potential drinking water sources [SCDHEC, 1985]. DWS are not, however, invariably the standards applied by regulatory agencies to those SRS waste units under their jurisdiction. For instance, standards under RCRA are DWS, groundwater protection standards, background levels, and alternate concentration limits.

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 and thus is inappropriate for groundwater.

Of the radionuclides discussed in this report, only gross alpha, strontium-90, and tritium are compared to true primary drinking water standards. 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 nonvolatile 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 nonvolatile beta result above the standard is an indication that one or more radioisotopes are present in quantities that would exceed the EPA's annual dose equivalent for persons consuming 2L 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 are calculated to present the same risk at the same rate of ingestion.

Although radium has a current drinking water standard of 5 pCi/L for the sum of radium-226 and radium-228, the standards discussed 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.

Four other constituents without drinking water standards are discussed when their values exceed certain 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 below 4.0 or equal to or above 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.

Fish

Other than occupational exposure, the greatest source of mercury intake by people is the consumption of food, particularly fish. The U.S. Food and Drug Administration (FDA) has established an action limit of 1.0 μg Hg/g [FDA, 1990]. Action limits are established to reflect maximum allowable concentrations for fish destined for interstate commerce. SRS uses the FDA guideline, which has been adopted by SCDHEC, to gauge concentrations of mercury in fish from onsite streams.

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 improbable.

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 govern 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. 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, 1992b].

Quality Assurance/Quality Control

DOE Order 5700.6C, "Quality Assurance," sets requirements and guidelines for departmental quality assurance (QA) practices. WSRC has recently 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 has 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). The Environmental Monitoring Computer Automation Project (EMCAP), a computer-based sample tracking and radiological data repository system, serves as a NESHAP-required sample tracking system for the EMS laboratory.

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 SRS. 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)
0080–0041–A–CB	250-GPM AIR STRIPPER, A–002; CATALYTIC OXIDATION UNIT (A–001A OUTFALL); SRTC
0080–0041–CI	1000-KW EMERGENCY POWER DIESEL GENERATOR TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), 654–G
0080–0041–CS–CA	ABRASIVE-BLAST FACILITY, UNIT A; CENTRAL SHOPS
0080–0041–CS–CA	ABRASIVE-BLAST FACILITY, UNIT B; CENTRAL SHOPS
0080–0041–CS–CB	SPRAY-PAINT BOOTH, CENTRAL SHOPS
0080–0041–H–CG	CONSOLIDATED INCINERATION FACILITY (CIF) FOR NONRADIOACTIVE HAZARDOUS WASTE, 261–H
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–CH	MODIFICATION TO 0080–0041–S13; LATE-WASH FACILITY, 241–10H
0080–0041–H–CI	CONSOLIDATED INCINERATION FACILITY (CIF) CEMENT STORAGE SILO
0080–0041–H–CI	CONSOLIDATED INCINERATION FACILITY (CIF) CEMENT DAY HOPPER
0080–0041–H–CI	CONSOLIDATED INCINERATION FACILITY (CIF) ASHCRETE UNIT
0080–0041–H–CJ	12,500-GALLON NO. 2 FUEL OIL STORAGE TANK TO SERVE CONSOLIDATED INCINERATION FACILITY (CIF)
0080–0041–M–CA	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SEWER (GROUNDWATER REMEDIATION)
0080–0041–M–CB	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA BASIN (GROUNDWATER REMEDIATION)
0080–0041–M–CC	VADOSE ZONE SOIL VAPOR EXTRACTION UNIT; M-AREA SOLVENT STORAGE (GROUNDWATER REMEDIATION)
0080–0041–M–CD	SOIL VAPOR EXTRACTION/CATALYTIC OXIDATION UNIT, M-AREA

Air Permits, continued

Permit Number	Permit Title
0080–0041–M–CE	MIXED-WASTE VITRIFICATION PROCESS, M-AREA
0080–0041–M–CF	CATALYTIC OXIDATION UNIT TO REDUCE VOC EMISSIONS FROM 610-GPM M–1 AIR STRIPPER, M-AREA
0080–0041–PORT–CB	15,000-LB/HR PORTABLE PACKAGE STEAM GENERATOR #1, GENERAL SITE
0080–0042–CJ	SOLVENTS DISTILLATION & CONDENSATION PORTABLE UNIT #3, ALL AREAS
0080–0042–CJ	SOLVENTS DISTILLATION & CONDENSATION PORTABLE UNIT #4, ALL AREAS
0080–0042–CJ	SOLVENTS DISTILLATION & CONDENSATION PORTABLE UNIT #5, ALL AREAS
0080–0042–CN	OFF-GAS COMPONENTS TEST FACILITY, 678–T
0080–0045–CI	NAVAL FUEL MATERIALS FACILITY (FMF) CEMENT & FLY-ASH SILOS & BAG-HOUSE, 247–F
0080–0045–CK	NEW SPECIAL RECOVERY PROCESS WITH CYCLONE, SCRUBBERS, & 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, & 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

Air Permits, continued

Permit Number	Permit Title
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)
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–D01	396-MMBTU/HR COAL BOILER #1, CYCLONES; ESP, 484–D
0080–0041–D02	396-MMBTU/HR COAL BOILER #2, CYCLONES; ESP, 484–D
0080–0041–D03	396-MMBTU/HR COAL BOILER #3, CYCLONES; ESP, 484–D
0080–0041–D04	396-MMBTU/HR COAL BOILER #4, CYCLONES; ESP, 484–D
0080–0041–D05	150-KW EMERGENCY POWER DIESEL GENERATOR, 501–D
0080–0041–D06	1.1-TON/HR REJECT SYSTEM; BAGHOUSE, 484–D
0080–0041–D07	300-TON/HR COAL CRUSHER, 484–2D
0080–0041–D08	15,000-GALLON #2 FUEL OIL STORAGE TANK, 500–01; 454–D, NSPS
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

Air Permits, continued

Permit Number	Permit Title
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 & 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, & NINE HEPA FILTERS FOR NAVAL FUEL MATERIALS FACILITY (FMF), 247–F
0080–0041–F27	455-KW EMERGENCY POWER DIESEL GENERATOR, 720–F
0080–0041–G01	WASTE PAINT SOLVENTS DISTILLATION & CONDENSATION UNIT #1, ALL AREAS
0080–0041–G02	WASTE PAINT SOLVENTS DISTILLATION & CONDENSATION UNIT #2, 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; ALL AREAS
0080–0041–G16	190-KW MOBILE EMERGENCY GENERATOR, SRO # 0391; ALL AREAS

Air Permits, continued

Permit Number	Permit Title
0080–0041–G17	250-KW MOBILE EMERGENCY GENERATOR, SRO # 7835; ALL AREAS
0080–0041–G18	PORTABLE SOIL VAPOR EXTRACTION UNIT, 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–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 & 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
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

Air Permits, continued

Permit Number	Permit Title
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–H29	IN-TANK PRECIPITATION (ITP) COLD-FEEDS AREA (SODIUM TETRAPHENYLBORATE [STPB] TANK), 241–32H
0080–0041–H30	IN-TANK PRECIPITATION (ITP) TANK #50; 241–950H
0080–0041–H31	IN-TANK PRECIPITATION (ITP) TANK #22; 241–922H
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, & 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
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

Air Permits, continued

Permit Number	Permit Title
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 & 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, & CHEMICAL STORAGE TANKS – ZONE 2, 221–S); HEPA FILTER
0080–0041–S09	DWPF PROCESS STACK (PROVIDES VENTILATION FOR PROCESS CELLS, PROCESS VESSEL VENT, & 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, & 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 & SECONDARY SEALS, NITROGEN BLANKET, & HEPA FILTER

Air Permits, continued

Permit Number	Permit Title
0080–0041–S12	DWPF LOW-POINT PUMP PIT (TRANSFER OF RADIOACTIVE SLURRIES & SOLUTIONS, 511–S); HEPA FILTERS
0080–0041–T02	300-KW EMERGENCY POWER DIESEL GENERATOR, 673–T
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, & 2 HEPA FILTERS (1 IN SERVICE, 1 STANDBY) 210–Z
0080–0041–Z08	LOW-POINT DRAIN TANK VENT WITH HEPA FILTER, 551–Z

C.O.E. 404 (Dredge & Fill) Permit

Permit Number	Permit Title
84–2Z–209	RAW-WATER INTAKE CANALS (681–1G, 681–3G, & 681–5G) ON SAVANNAH RIVER

Domestic Water Permits

SCDHEC has granted WSRC–EPD the authority—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 "M" fall under the MPP.

Permit Number	Permit Title
203427	SODIUM HYPOCHLORITE SYSTEM, 280–F
203467	SODIUM HYPOCHLORITE SYSTEM, 280–H
206474	DOMESTIC WATER TEST WELL, 905–136G, TO SERVE CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF)
411337	SODIUM HYPOCHLORITE SYSTEM, 780–1A

Domestic Water Permits, continued

Permit Number	Permit Title
603505	FORESTRY AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS (SODA ASH FEED SYSTEM)
200092	DOMESTIC WATER DEEP WELLS, 905–104L & 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 & DISTRIBUTION SYSTEM TO SERVE CONSTRUCTION SUPPORT AREA, S-AREA
203590	DOMESTIC WATER WELL, 905–126G, TO SERVE 100-AREA FIRE STATION, 709–1G (INTERSECTION OF ROAD C & 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 & STORAGE TANK TO SERVE AUGUSTA BARRICADE, 701–6G (REPLACED WELL 905–10G)
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 & 905–113G, TO SERVE A-AREA & M-AREA

Domestic Water Permits, continued

Permit Number	Permit Title
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
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), & 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 & 905–97G, TO SERVE TNX-AREA
210657	DOMESTIC WATER DEEP WELL, 905–103F, & DISTRIBUTION SYSTEM TO SERVE F-AREA (REPLACED WELL 905–39F)
212745	DOMESTIC WATER DEEP WELLS, 905–1 & 905–2, TO SERVE S-AREA
304134	TNX-AREA DOMESTIC WATER TREATMENT PLANT MODIFICATIONS
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

Domestic Water Permits, continued

Permit Number	Permit Title
404608	DOMESTIC WATER LINE TO SERVE 717–K
404618	DOMESTIC WATER LINE TO SERVE 705–C
405184	DOMESTIC WATER LINE TO SERVE 773–41A & 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 & REDRUMMING FACILITY, 645–1N & 645–2N (FORMERLY 709–1G & 709–2G)
406871E1	DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING CENTER, 730–B
407830	DOMESTIC WATER LINE TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING & STORAGE FACILITIES (MMRSF), 731–N THROUGH 731–4N
408221	K-AREA DOMESTIC WATER TREATMENT & DISTRIBUTION SYSTEM UPGRADE
408285	DOMESTIC WATER LINE TO SERVE TNX-AREA SANITARY WASTEWATER TREATMENT PLANT CHEMICAL FEED FACILITY, 607–41T
408552	K-AREA FILTER BACKWASH SYSTEM
408595	DOMESTIC WATER LINE TO SERVE CONSTRUCTION OFFICE BUILDING, 305–1M
409484	DOMESTIC WATER LINE TO SERVE REACTOR SIMULATOR FACILITY, 707–C
409955	DOMESTIC WATER & FIRE PROTECTION LINES TO SERVE HELICOPTER FACILITY, 703–5G & 703–6G
410406	DOMESTIC WATER LINE TO SERVE VEHICLE PROTECTION SHELTER SAFETY SHOWER & EYE WASH STATION, 777–A
411357	DOMESTIC WATER LINE TO SERVE THREE SAFETY SHOWERS AT ETF–H LIFT STATION
411995	DOMESTIC WATER LINE TO SERVE 340–M & 341–M
412255	DOMESTIC WATER LINE FROM DOMESTIC WATER DEEP WELLS (905–112G & 905–113G) TO SERVE A-AREA & M-AREA
412917	DOMESTIC WATER LINE TO SERVE F/H ETF CONTROL BUILDING, 241–84H & F/H ETF TREATMENT BUILDING, 241–81H
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

Domestic Water Permits, continued

Permit Number	Permit Title
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 & 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, & OFFICES 704–44S, 704–45S, & 704–46S (Formerly FPF Construction Engineers' Offices, 225–1H, 225–2H, & 225–3H) & TOILET TRAILER, 704–47H, & OFFICES 704–27H, 704–32H, 704–37H, & 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, & 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 & 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, & 773–42A
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 & ENVIRONMENTAL SUPPORT FACILITY, 735–11A
LS–60–W	DOMESTIC WATER LINE TO SERVE 704–S ADMINISTRATION BUILDING
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, & 221–18F
LS–8–W	DOMESTIC WATER LINE TO SERVE 703–4A, 703–6A, & 703–34A

Domestic Water Permits, continued

Permit Number	Permit Title
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 & FIRE PROTECTION LINES TO SERVE TEMPORARY MODULAR OF FICES 706–8C THROUGH 706–19C & 703–1C THROUGH 703–28C
LS89008	EXPANSION OF DOMESTIC WATER & FIRE PROTECTION TO SERVE MODULAR OF FICES, 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 & STORAGE FACILITIES (MMRSF) FIRE WATER STORAGE TANK MAKEUP WATER SYSTEM, 681–17N, & 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
LS91007	DOMESTIC WATER LINE REROUTE TO SERVE SAFETY SHOWER/EYEWASH 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

Domestic Water Permits, continued

Permit Number	Permit Title
407123M	DOMESTIC WATER LINE TO SERVE B-AREA ENGINEERING & OPERATIONS SUPPORT FACILITY
M0012E2	DOMESTIC WATER LINE TO SERVE B-AREA FIRE PROTECTION SUPPLY SYSTEM
M0013	DOMESTIC WATER LINE TO SERVE 221–S NITRIC TANK SAFETY SHOWER/EYE WASH STATION
M0014E1	DOMESTIC WATER LINE TO SERVE 766–H TRAINING CENTER (FORMERLY 225–H)
M0015	DOMESTIC WATER LINE TO SERVE 284–H CHANGE ROOM
M0022	DOMESTIC WATER LINE TO SERVE PORTABLE BOILER, 183–2P
M0023E1	DOMESTIC WATER LINE TO SERVE CONSOLIDATED INCINERATION FACILITY, 261–H
M0024	DOMESTIC WATER LINE REROUTE TO SERVE ESSENTIAL MATERIALS WAREHOUSE, 315–M
M0025	DOMESTIC WATER LINE TO SERVE DWPF LATE-WASH FACILITY
M0032	DOMESTIC WATER LINE TO SERVE PORTABLE BOILER, 183–2K
M0033E1	DOMESTIC WATER LINE TO SERVE F-AREA & E ROAD FIRE PROTECTION SUPPLY
M0034	DOMESTIC WATER LINE TO SERVE RESTROOM TRAILER, 760–21G
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 412–D & 413–D ASBESTOS ABATEMENT SHOWERS
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
M0054	DOMESTIC WATER LINE TO SERVE B-AREA UTILITIES UPGRADE; 735–4B & 735–2B
M0063R1	DOMESTIC WATER LINE TO SERVE ADMINISTRATIVE SUPPORT BUILDING, 708–1B
M0064	DOMESTIC WATER LINE TO SERVE COMPRESSED-GAS STORAGE FACILITY, 731–6N
M0072E2	DOMESTIC WATER LINE TO SERVE FLAMMABLE-STORAGE FACILITY, 731–5N
M0073E1	DOMESTIC WATER LINE TO SERVE SAFEGUARDS & HEALTH PROTECTION SHOP, 228–H
M0074R1	DOMESTIC WATER LINE TO SERVE 421–6D SAFETY SHOWER/EYEWASH STATION

Domestic Water Permits, continued

Permit Number	Permit Title
M0082	DOMESTIC WATER LINE TO SERVE CSWE FACILITY, 717–11A
M0083	DOMESTIC WATER LINE TO SERVE RESTROOM TRAILER, 704–11K
M0084	DOMESTIC WATER LINE TO SERVE 241–2H CONTROL BUILDING, TYPE III TANK SALT REMOVAL
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 & 233–21H,
M0103E1	DOMESTIC WATER LINE TO SERVE 740–4A DRINKING WATER FOUNTAIN
M0112	DOMESTIC WATER LINE TO SERVE TEMPORARY MODULAR OFFICES, 742–G & 742–1G THROUGH 742–14G,
M0113	DOMESTIC WATER LINE TO SERVE 704–11K, 704–12K, & 705–K
M0122	DOMESTIC WATER LINE TO SERVE SRTC MODULAR RESTROOM UNIT, 773–71A
M0123E1	DOMESTIC WATER LINE TO SERVE 673–T, 678–T, & 679–8T SAFETY SHOWERS/ EYEWASH STATIONS
M0133	DOMESTIC WATER LINE TO SERVE OFFICE TRAILER, 707–18B

Industrial Wastewater Permits

Permit Number	Permit Title
12888	METALLURGICAL LABORATORY NEUTRALIZATION FACILITY, 723–A
14214	MODIFICATIONS TO NAVAL FUEL (FMF) WASTEWATER TREATMENT FACILITY; BATCH MIXER SYSTEM
16119	F/H ETF PERMANENT pH ADJUSTMENT SYSTEM
17022	UPGRADE D-AREA NEUTRALIZATION FACILITY, 483–1D
17587–IW	TNX-AREA CROSS-FLOW FILTER TEST FACILITY
17596–IW	DWPF PRECIPITATE-FEED LATE-WASH FACILITY
17614–IW	250-GPM AIR STRIPPER (A–002), SRTC
17617–IW	OIL/WATER SEPARATOR TO SERVE 701–3H VEHICLE BARRIER
17618–IW	OIL/WATER SEPARATOR TO SERVE 701–4F VEHICLE BARRIER
17763–IW	SKID-MOUNTED ION-EXCHANGE DEMONSTRATION FACILITY, TNX-AREA
17765–IW	INVESTIGATION DERIVED WASTE (IDW) TRANSFER STATION AT F/H EFFLUENT TREAT MENT FACILITY (ETF)
10253	M-AREA 610-GPM AIR STRIPPER

Industrial Wastewater Permits, continued

Permit Number	Permit Title
10287	LIQUID EFFLUENT TREATMENT FACILITIES (LETF), 300–M
10349	672–T TNX PROCESS SEWER TO OUTFALL X–008
10358	S-AREA OIL/WATER SEPARATOR
10389	M-AREA DRAIN LINE
10469	735–11A LAB BUILDING PROCESS SEWER SYSTEM NEUTRALIZATION FACILITY, 607–17A
10475	NONCONTACT COOLING WATER DIVERSION, 300–M AREA
10696	INTERIM SLUDGE STORAGE TANK, M-AREA
10765	WASTEWATER NEUTRALIZATION FACILITY, 704–B
10920	SREL WASTEWATER DISINFECTION FACILITY
10949	TRADE WASTE FLOW EQUALIZATION TANK, 607–18A FOR 703–43A SILVER RECOVERY
10955	DWPF CONCRETE BATCH PLANT WASTEWATER TREATMENT POND, S-AREA
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 BASINS; 200–D (H-Area also covered under this permit)
11588	POWERHOUSE EFFLUENT DIVERSION TO ASH BASINS; 200–H (D-Area also covered under this permit)
11589	POWERHOUSE EFFLUENT DIVERSION TO ASH BASIN, 184–P (184–K also covered under this permit)
12622	ORGANICS REMOVAL FACILITY (ORF), TNX
12633	TNX AREA EFFLUENT TREATMENT PLANT (ETP)
12683	INDUSTRIAL WASTEWATER TREATMENT FACILITY TO SERVE Z-AREA SALT-STONE MANUFACTURING FACILITY
12782	REPLACEMENT TRITIUM FACILITY (RTF) PROCESS SEWER
12870	F/H EFFLUENT TREATMENT FACILITY (ETF)
12894	FILTRATE HOLD TANK COVERS, M-AREA

Industrial Wastewater Permits, continued

Permit Number	Permit Title
12922	MODIFICATIONS TO NAVAL FUEL (FMF) WASTEWATER TREATMENT FACILITY (PIPING MOD.)
12973	P-AREA NEUTRALIZATION FACILITY, 183–2P
13105	F/H ETF PROCESS SEWER LINES
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
13431	FLUME AT M–004 OUTFALL
13735	INDUSTRIAL WASTEWATER pH CONTROL SYSTEM, 211–F
13978	TNX ION-EXCHANGE FACILITY
14020	MERCURY & ORGANIC REMOVAL FACILITY FOR F/H ETF
14100	REPAIR ASH BASIN DIKE 488–1D
14218	NPDES OUTFALL STRUCTURES F–012 & F–013 (FLOW MONITORING WEIR BOX STRUCTURES)
14219	NPDES OUTFALL STRUCTURES H–017 & 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
14832	MODIFICATION TO M-AREA LIQUID EFFLUENT TREATMENT FACILITIES (LETF); SUPERNATANT TRANSFER & POLYMER ADDITION SYSTEMS
15256	EVAPORATOR RECYCLE LINE FOR F/H ETF
15467	UPGRADE PROCESS SEWERS, 211–F/H ETF (211–F&H)
15892	F/H ETF INTERIM pH ADJUSTMENT SYSTEM (CAUSTIC & ACID SUPPLY)
16449	K-REACTOR EMERGENCY RETENTION BASIN PERCOLATION DRAIN FIELD
16478	FOUNDATIONS & SUPPORTING STRUCTURE SURROUNDING CWST; K-AREA RETENTION BASIN
16614	K-REACTOR EMERGENCY RETENTION BASIN LINER & COVER

Industrial Wastewater Permits, continued

Permit Number	Permit Title
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 & RECOVERY WELL INSTALLATION
16938	K-REACTOR RETENTION BASIN UMBRELLA TOP STRUCTURE
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
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
9974	DWPF CONCRETE BATCH PLANT WASTEWATER TREATMENT POND DECANT STRUCTURE, S-AREA
LS–112–S	FIRE TRAINING FACILITY PROCESS SEWER, 904–D
LS–42–S	INERT L-FACILITY LOADING DOCK SEWER RELOCATION, 234–H

NPDES – Discharge Permits

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

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	SIX NPDES-PERMITTED CONSTRUCTION STORMWATER SITES AT SAVANNAH RIVER SITE

RCRA Permit

Permit Number	Permit Title
SCI80008989	FIVE PERMITTED RCRA FACILITIES AT SAVANNAH RIVER SITE

Sanitary Wastewater Permits

Permit Number	Permit Title
17528–IW	SANITARY SEWER TO SERVE ENGINEERING SUPPORT FACILITY, 730–1B, & OPERATIONS SUPPORT FACILITIES, 730–2B & 730–4B
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, & 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, & 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, & S-AREA)
17690–IW	COLLECTION SYSTEM FOR CENTRAL SANITARY WASTEWATER TREATMENT FACILITY (CSWTF), ZONE 2 (A-AREA, C-AREA, & 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

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
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
02–91040041	SEPTIC TANK & TILE FIELD TO SERVE OFFICE BUILDING, 704–56H (A.K.A. 5002–H)
02–92080098	SEPTIC TANK & TILE FIELD TO SERVE SREL PAR POND LABORATORY, 737–G
10131–P	SEPTIC TANK & TILE FIELD TO SERVE TOILET TRAILER, 704–47H, & OFFICES 704–27H, 704–32H, 704–37H, & 704–42H
10132–P	SEPTIC TANK & TILE FIELD TO SERVE TOILET TRAILER, 704–47S, & OFFICES 704–44S, 704–45S, & 704–46S (FORMERLY FPF CONSTRUCTION ENGINEERS' OFFICES, 225–1H, 225–2H, & 225–3H)
10236	SANITARY SEWER SYSTEM (LIFT STATION & 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 & 607–23A
10522	CHEMICAL FEED FACILITY (607–19F) FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7F & 607–21F
10523	CHEMICAL FEED FACILITY (607–20H) FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7H & 607–21H
10524	CHEMICAL FEED FACILITY (607–22P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7P & 607–23P
10525	CHEMICAL FEED FACILITY (607–38N) FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–18N & 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 & 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 & SEWER LINE) TO SERVE ECR/ICR CONTROL HOUSE, 241–82H

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
11615	B-AREA 25,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–1B
11687	SEPTIC TANK & TILE FIELD TO SERVE WACKENHUT HELICOPTER FACILITY, 703–5B
11755	SEPTIC TANK & TILE FIELD TO SERVE 100-AREA FIRE STATION, 709–1G (INTERSECTION OF ROAD C & 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 & 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
13173	SANITARY SLUDGE LAND APPLICATION, K-AREA (761–4G), & PAR POND (761–5G) BORROW PITS
13175	97,500-GALLON SANITARY FLOW EQUALIZATION BASIN (607–22A) FOR SANITARY WASTEWATER TREATMENT PLANTS, 607–7–1A, 607–7–2A, & 607–23A
13291	SEPTIC TANK & TILE FIELD TO SERVE AUXILIARY PUMP PIT
13430	F-AREA 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–21F
13538	SEPTIC TANK & TILE FIELD TO SERVE K-AREA COOLING TOWER CONSTRUCTION TRAILER
13539	SEPTIC TANK & TILE FIELD TO SERVE K-AREA COOLING TOWER ECR/ICR BUILDING, 153–1K
13717	SEPTIC TANK (831–1Z) & 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 & 607–23P
14315	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR F-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7F & 607–21F

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
14316	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR H-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7H & 607–21H
14317	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR S-AREA SANITARY WASTEWATER TREATMENT PLANTS, 831–1S & 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, & 607–23A
14321	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR SREL WASTEWATER DISINFECTION FACILITY, 737–21A
14322	INTERIM SODIUM HYPOCHLORITE DISINFECTION FOR N-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–18N & 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 & 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 & 607–42G
15416	12,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–16K) FOR SANITARY WASTEWATER TREATMENT PLANT, 607–17K
15417	11,000-GALLON SANITARY FLOW EQUALIZATION BASIN (607–24P) FOR P-AREA SANITARY WASTEWATER TREATMENT PLANTS, 607–7P & 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

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
15740	SANITARY SEWER SYSTEM EXPANSION (2 LIFT STATIONS & SEWER LINE) TO SERVE C-AREA
16477	SANITARY SEWER TO SERVE N-AREA MATERIAL MANAGEMENT RECEIVING & 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 & 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 & 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 & 233–21H
17419–IW	SANITARY SEWER TO SERVE H-AREA TRAILERS 742–10G THROUGH 742–12G
17499–IW	SANITARY SEWER & LIFT STATION TO SERVE 704–2H
7947	L-AREA 35,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–16L
8611–P	SEPTIC TANK & TILE FIELD TO SERVE INTERIM STORAGE & REDRUMMING FACILITY, 645–1N (FORMERLY 709–1G), N-AREA
8670	K-AREA 24,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–17K
8928	NAVAL FUEL (FMF) 30,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–17F
9256P	SEPTIC TANK & 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, & P-Area also included under this permit)
9326	P-AREA 10,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–23P (F-Area, H-Area, & N-Area also included under this permit)
9326	N-AREA 30,000-GPD (607–18G) & 40,000-GPD (607–42G) SANITARY WASTEWATER TREATMENT PLANTS (F-Area, H-Area, & P-Area also included under this permit)

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
9326	F-AREA 60,000-GPD SANITARY WASTEWATER TREATMENT PLANT, 607–7F (H-Area, N-Area, & P-Area also included under this permit)
9694	SANITARY SEWER SYSTEM (LIFT STATION & SEWER LINE) TO SERVE 773–41A & 773–42A
9888	S-AREA TWO 12,000-GPD SANITARY WASTEWATER TREATMENT PLANTS, 831–1S & 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 & 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 & 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 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 & 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, & CENTRAL ALARM STATION (CAS), 720–F
LS–240–S	SANITARY SEWER TO SERVE 720–2A (3/700 AREA SECURITY UPGRADE, PACAS FAGILITY)
LS–244–S	SANITARY SEWER TO SERVE SECURITY FACILITIES; ENTRY CONTROL FACILITY (ECF), 701–3H, & CENTRAL ALARM STATION (CAS), 720–H
LS–256–S	MACERATOR FOR F-AREA SANITARY FLOW EQUALIZATION BASIN, 607–18F
LS–275–S	SANITARY SEWER TO SERVE EQUIPMENT STORAGE & 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 & 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

Sanitary Wastewater Permits, continued

Permit Number	Permit Title
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 & STORES WAREHOUSE

SCWRC 401 (Water Quality) Permit

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

Solid Waste Permits

Permit Number	Permit Title
025500–1601	D–F STEAM-LINE INDUSTRIAL SOLID WASTE LANDFILL (ASBESTOS)
025500–1602	F-AREA INERT-MATERIALS LANDFILL (RAILROAD TIE PILE)
CWP–030	BURMA ROAD INERT-MATERIALS LANDFILL
DWP–087A	SANITARY LANDFILL
IWP–211	H-AREA INERT-MATERIALS LANDFILL
IWP–217	Z-AREA SALTSTONE DISPOSAL FACILITY

Underground Injection Control Permits

Permit Number	Permit Title
126	TNX-AREA TRACER TEST
194	BIOREMEDIATION OPTIMIZATION TEST AT THE SANITARY LANDFILL, 740–G
118	F-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION
119	H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION

Underground Injection Control Permits, continued

Permit Number	Permit Title
119M	H-AREA SEEPAGE BASIN GROUNDWATER REMEDIATION (MCBEAN TEST)
139	F-AREA SEEPAGE BASIN INFILTRATION GALLERIES GROUNDWATER REMEDIATION (H-Area also covered under this permit)
139	H-AREA SEEPAGE BASIN INFILTRATION GALLERIES GROUNDWATER REMEDIATION (F-Area also covered under this permit)

Underground Storage Tank Permits

Permit Number	Permit Title
C–02–GF–09467	FORESTRY AREA 2000-GALLON UNDERGROUND GASOLINE STORAGE TANK, 620–G (A)
C–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, & 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, & 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, & 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, & 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, & 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, & 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, & 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, & 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, & 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, & 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]	Radionuclide	Symbol	Half-Life[a,b]
Americium-241	Am-241	432.7 y	Osmium-185	Os-185	93.6 d
Americium-243	Am-243	7.37E3 y	Phosphorus-32	P-32	14.28 d
Antimony-125	Sb-125	2.758 y	Polonium-210	Po-210	138.38 d
Argon-41	Ar-41	1.82 h	Plutonium-238	Pu-238	87.7 y
Berylium-7	Be-7	53.28 d	Plutonium-239	Pu-239	2.41E4 y
Californium-252	Cf-252	2.638 y	Potassium-40	K-40	1.28E9 y
Carbon-14	C-14	5,730 y	Promethium-147	Pm-147	2.6234 y
Cerium-141	Ce-141	32.50 d	Ruthenium-103	Ru-103	39.27 d
Cerium-144	Ce-144	284.6 d	Ruthenium-106	Ru-106	1.020 y
Cesium-134	Cs-134	2.065 y	Selenium-75	Se-75	120.4 d
Cesium-137	Cs-137	30.2 y	Strontium-89	Sr-89	50.52 d
Cobalt-58	Co-58	70.88 d	Strontium-90	Sr-90	29.1 y
Cobalt-60	Co-60	5.271 y	Technetium-99	Tc-99	2.13E5 y
Curium-242	Cm-242	163 d	Tritium	H-3	12.3 y
Curium-244	Cm-244	18.1 y	Uranium-235	U-235	7.04E8 y
Iodine-129	I-129	1.57E7 y	Uranium-238	U-238	4.47E9 y
Iodine-131	I-131	8.04 d	Xenon-133	Xe-133	5.243 d
Krypton-85	Kr-85	10.73 y	Xenon-135	Xe-135	9.10 h
Krypton-88	Kr-88	2.84 h	Yttrium-90	Y-90	64.08 h
Manganese-54	Mn-54	312.2 d	Zirconium-95	Zr-95	64.02 d
Niobium-95	Nb-95	34.97 d			

Nomenclature for Common Chemical Analyses

Analysis	Symbol	Analysis	Symbol
Biochemical Oxygen Demand	BOD	Total Organic Carbon	TOC
Chemical Oxygen Demand	COD	Total Organic Halogens	TOH
Dissolved Oxygen	DO	Total Phosphates	TPO_4
Particulate Matter <10 microns	PM_{10}	Total Solids	TS
Polychlorinated Biphenyl	PCB	Total Suspended Solids	TSS
Total Dissolved Solids	TDS	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]
Note: "ede" denotes "calculated effective dose equivalent."				
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
Americium-241	6.34E+00 (ede)	pCi/L	proposed	EPA, 1991
Americium-243	6.37E+00 (ede)	pCi/L	proposed	EPA, 1991
Antimony	0.006	mg/L	final	CFR, 1993
Antimony-125	1.94E+03 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	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	5.82E+02 (ede)	pCi/L	proposed	EPA, 1991
	9.E+01 (ede)	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	4.35E+04 (ede)	pCi/L	proposed	EPA, 1991
	6.E+03 (ede)	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	3.20E+03 (ede)	pCi/L	proposed	EPA, 1991
	2.E+03 (ede)	pCi/L	interim final	EPA, 1977
Carbon tetrachloride	0.005	mg/L	final	CFR, 1993
Cerium-141	1.89E+03 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	pCi/L	interim final	EPA, 1977
Cerium-144	2.61E+02 (ede)	pCi/L	proposed	EPA, 1991
Cesium-134	8.13E+01 (ede)	pCi/L	proposed	EPA, 1991

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 236.
c Longer than 10 μm

Analyte	Level[a]	Units	Status	Reference[b]
Cesium-137	1.19E+02 (ede)	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	pCi/L	interim final	EPA, 1977
Chlordane	0.002	mg/L	final	CFR, 1993
Chlorobenzene (monochlorobenzene)	0.1	mg/L	final	CFR, 1993
Chloroethene (Vinyl chloride)	0.002	mg/L	final	CFR, 1993
Chloroform[c]	0.1	mg/L	final	CFR, 1993
Chromium	0.1	mg/L	final	CFR, 1993
Chromium-51	3.80E+04 (ede)	pCi/L	proposed	EPA, 1991
	6.E+03 (ede)	pCi/L	interim final	EPA, 1977
Cobalt-58	1.59E+03 (ede)	pCi/L	proposed	EPA, 1991
	9.E+03 (ede)	pCi/L	interim final	EPA, 1977
Cobalt-60	2.18E+02 (ede)	pCi/L	proposed	EPA, 1991
	1.E+02 (ede)	pCi/L	interim final	EPA, 1977
Curium-242	1.33E+02 (ede)	pCi/L	proposed	EPA, 1991
Curium-243	8.3E+00 (ede)	pCi/L	proposed	EPA, 1991
Curium-244	9.84E+00 (ede)	pCi/L	proposed	EPA, 1991
Curium-246	6.27E+00 (ede)	pCi/L	proposed	EPA, 1991
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

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 236.
c The level for total trihalomethanes is set at 0.1 mg/L. Because bromated methanes are rarely detected in SRS groundwater, EPD presumes that most of the trihalomethanes present in site groundwater are chloroform.

Analyte	Level[a]	Units	Status	Reference[b]
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	5.73E+02 (ede)	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	pCi/L	interim final	EPA, 1977
Europium-155	3.59E+03 (ede)	pCi/L	proposed	EPA, 1991
	6.E+02 (ede)	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
Hexachlorocyclopentadiene	0.05	mg/L	final	CFR, 1993
Iodine-129	2.10E+01 (ede)	pCi/L	proposed	EPA, 1991
	1.E+00 (ede)	pCi/L	interim final	EPA, 1977
Iodine-131	1.08E+02 (ede)	pCi/L	proposed	EPA, 1991
	3.E+00 (ede)	pCi/L	interim final	EPA, 1977
Iron-55	9.25E+03 (ede)	pCi/L	proposed	EPA, 1991
	2.E+03 (ede)	pCi/L	interim final	EPA, 1977
Iron-59	8.44E+02 (ede)	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	pCi/L	interim final	EPA, 1977
Lanthanum-140	6.52E+02 (ede)	pCi/L	proposed	EPA, 1991
	6.E+01 (ede)	pCi/L	interim final	EPA, 1977
Lindane	0.0002	mg/L	final	CFR, 1993
Manganese-54	2.01E+03 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	pCi/L	interim final	EPA, 1977
Mercury	0.002	mg/L	final	CFR, 1993
Methoxychlor	0.04	mg/L	final	CFR, 1993
Neptunium-237	7.06E+00 (ede)	pCi/L	proposed	EPA, 1991
Nickel	0.1	mg/L	final	CFR, 1993
Nickel-59	2.70E+04 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	pCi/L	interim final	EPA, 1977
Nickel-63	9.91E+03 (ede)	pCi/L	proposed	EPA, 1991
	5.E+01 (ede)	pCi/L	interim final	EPA, 1977
Niobium-95	2.15E+03 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	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

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 236.

Analyte	Level[a]	Units	Status	Reference[b]
Nitrite (as N)	1	mg/L	final	CFR, 1993
Nonvolatile beta	4 mrem/yr	pCi/L	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
Plutonium-238	7.02E+00 (ede)	pCi/L	proposed	EPA, 1991
Plutonium-239	6.21E+01 (ede)	pCi/L	proposed	EPA, 1991
Plutonium-239/240	6.21E+01[c] (ede)	pCi/L	proposed	EPA, 1991
Plutonium-240	6.22E+01 (ede)	pCi/L	proposed	EPA, 1991
Plutonium-241	6.26E+01 (ede)	pCi/L	proposed	EPA, 1991
Plutonium-242	6.54E+01 (ede)	pCi/L	proposed	EPA, 1991
Potassium-40	300 (ede)	pCi/L	proposed	EPA, 1986
Radium-226/228 (Total)	5	pCi/L	final	CFR, 1993
Radium-228	7.85E+0 (ede)	pCi/L	proposed	EPA, 1991
Radon-222	300 (ede)	pCi/L	proposed	EPA, 1991
Ruthenium-103	1.81E+03 (ede)	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	pCi/L	interim final	EPA, 1977
Ruthenium-106	2.03E+02 (ede)	pCi/L	proposed	EPA, 1991
	3.E+01 (ede)	pCi/L	interim final	EPA, 1977
Selenium	0.05	mg/L	final	CFR, 1993
Simazine	0.004	mg/L	final	CFR, 1993
Sodium-22	4.66E+02 (ede)	pCi/L	proposed	EPA, 1991
Strontium-89	5.99E+02 (ede)	pCi/L	proposed	EPA, 1991
	2.E+01 (ede)	pCi/L	interim final	EPA, 1977
Strontium-89/90	4.20E+01[c] (ede)	pCi/L	final	CFR, 1993
Strontium-90	4.20E+01 (ede)	pCi/L	proposed	EPA, 1991
	8.E+00	pCi/L	final	CFR, 1993
Styrene	0.1	mg/L	final	CFR, 1993
Technetium-99	3.79E+03 (ede)	pCi/L	proposed	EPA, 1991
	9.E+02 (ede)	pCi/L	interim final	EPA, 1977
Tetrachloroethylene	0.005	mg/L	final	CFR, 1993
Thallium	0.002[d]	mg/L	final	CFR, 1993
Thorium-228	1.25E+02 (ede)	pCi/L	proposed	EPA, 1991
Thorium-230	7.92E+01 (ede)	pCi/L	proposed	EPA, 1991
Thorium-232	8.8E+01 (ede)	pCi/L	proposed	EPA, 1991
Thorium-234	4.01E+02 (ede)	pCi/L	proposed	EPA, 1991

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 236.
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]
Tin-113	1.74E+03 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	pCi/L	interim final	EPA, 1977
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
Toxaphene	0.003	mg/L	final	CFR, 1993
Tritium	6.09E+04 (ede)	pCi/L	proposed	EPA, 1991
	2.E+01 (ede)	pCi/mL	final	CFR, 1993
Uranium	0.02	mg/L	proposed	EPA, 1991
Uranium alpha activity	30 (ede)	pCi/L	proposed	EPA, 1991
Uranium-234	1.39E+01 (ede)	pCi/L	proposed	EPA, 1991
Uranium-235	1.45E+01 (ede)	pCi/L	proposed	EPA, 1991
Uranium-238	1.46E+01 (ede)	pCi/L	proposed	EPA, 1991
Xylenes	10	mg/L	final	CFR, 1993
Zinc-65	3.96E+02 (ede)	pCi/L	proposed	EPA, 1991
	3.E+02 (ede)	pCi/L	interim final	EPA. 1977
Zirconium-95	1.46E+03 (ede)	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	pCi/L	interim final	EPA. 1977
Zicronium/Niobium-95[d]	1.46E+03	pCi/L	proposed	EPA, 1991
	2.E+02 (ede)	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 236.
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 69–302	Jan–Dec 1968
DPST 65–302	Jan–Dec 1964	DPST 70–302	Jan–Dec 1969
DPST 66–302	Jan–Dec 1965	DPST 71–302	Jan–Dec 1970
DPST 67–302	Jan–Dec 1966	DPSPU 72–302	Jan–Dec 1971
DPST 68–302	Jan–Dec 1967	DPSPU 73–302	Jan–Dec 1972

Environmental Monitoring at the Savannah River Plant (cont.)

DPSPU 74–302	Jan–Dec 1973	DPSPU 80–302	Jan–Dec 1979
DPSPU 75–302	Jan–Dec 1974	DPSPU 81–302	Jan–Dec 1980
DPSPU 76–302	Jan–Dec 1975	DPSPU 82–302	Jan–Dec 1981
DPSPU 77–302	Jan–Dec 1976	DPSPU 83–302	Jan–Dec 1982
DPSPU 78–302	Jan–Dec 1977	DPSPU 84–302	Jan–Dec 1983
DPSPU 79–302	Jan–Dec 1978	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–IM–91–28	Jan–Dec 1990
DPSPU 87–30–1	Jan–Dec 1986	WSRC–TR–92–186	Jan–Dec 1991
DPSPU 88–30–1	Jan–Dec 1987	WSRC–TR–93–075	Jan–Dec 1992
WSRC–RP–89–59–1a	Jan–Dec 1988	WSRC–TR–94–075	Jan–Dec 1993
WSRC–IM–90–60	Jan–Dec 1989		

Savannah River Site Environmental Data

WSRC–TR–93–077	Jan–Dec 1992	WSRC–TR–94–077	Jan–Dec 1993

Appendix F

Errata from 1993 Report

The following information was reported incorrectly in the Savannah River Site Environmental Report for 1993, *WSRC–TR–94–075:*

Page 1, right column, first full paragraph: The date given for all five reactors' achieving criticality should be March 1955, not March 1958.

Page 8, left column, first paragraph under "Reactor Materials Area": The reference to Effluent Treatment Facility (ETF) should be to Liquid Effluent Treatment Facility (LETF).

Page 83, left column, third paragraph: The phrase "including milk" should be omitted.

Page 119, right column, first full paragraph: The reference to "more than 1,600 monitoring wells" should be to "about 1,500 monitoring wells."

Page 183, right column, green box: The reference to cobalt-6 should be to cobalt-60.

Page 56, right column, sixth full paragraph: The reference to—and listing of—1993 effluent sampling and monitoring changes should appear in the Air Effluents section of the chapter.

Pages 128, 159, 160, 162, and 163: The stream identified as Tims Branch on the maps should be identified as Upper Three Runs Creek.

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 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are commonly used:

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

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

microcurie (μCi) – 10^{-6} Ci, one-millionth of a curie; 3.7×10^4 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.

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 2.58×10^{-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.

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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