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Savannah River Site

Environmental Report for 2004

Editor

Albert R. Mamatey

Technical Consultants

Pete Fledderman
Timothy Jannik

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Westinghouse Savannah River Company
Savannah River Site, Aiken, SC 29808

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Tiajuana Cochnauer	Janice Lawson	Ken McLeod	Jason Ward
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Savannah River Ecology Laboratory (SREL) Technical Reviewers:

Dr. Thomas Hinton - Associate Research Scientist, SREL; Adjunct Associate, Department of Radiological Sciences Colorado State University

Dr. Christopher Romanek - Associate Research Scientist, SREL; Associate Professor, Department of Geology, The University of Georgia

Dr. John Seaman - Associate Research Scientist, SREL; Adjunct Professor, Department of Environmental Engineering, Clark Atlanta University

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Preface

The *Savannah River Site Environmental Report for 2004* (WSRC–TR–2005–00005) is prepared for the U.S. Department of Energy (DOE) according to requirements of DOE Order 231.1A, "Environment, Safety and Health Reporting," and DOE Order 5400.5, "Radiation Protection of the Public and Environment." The report's purpose is to

- present summary environmental data that characterize site environmental management performance
- confirm compliance with environmental standards and requirements
- highlight significant programs and efforts
- assess the impact of SRS operations on the public and the environment

SRS has had an extensive environmental monitoring program in place since 1951 (before site startup). In the 1950s, data generated by the onsite environmental monitoring program were reported in site documents. Beginning in 1959, data from offsite environmental surveillance activities were presented in reports issued for public dissemination. SRS reported onsite and offsite environmental monitoring activities separately until 1985, when data from both programs were merged into one public document. The Savannah River Site Environmental Report for 2004 is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 2004. It is prepared by the Environmental Services Section (ESS) of Westinghouse Savannah River Company (WSRC). The "SRS Environmental Monitoring Plan" (WSRC–3Q1–2–1000) and the "SRS Environmental Monitoring Program" (WSRC–3Q1–2–1100) provide complete program descriptions and document 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.

Complete data tables are included on the CD inside the back cover of this report. The CD also features an electronic version of the report; an appendix of site, environmental sampling location, dose, and groundwater maps; and complete 2004 reports from a number of other SRS organizations. Variations in environmental report data reflect year-to-year changes in the routine monitoring program, as well as occasional difficulties in sample collection or analysis. Examples of such difficulties include adverse environmental conditions (such as flooding or drought), sampling or analytical equipment malfunctions, and compromise of the samples in the preparation laboratories or counting room.

Report Available on Web

Readers can find the *SRS Environmental Report* on the World Wide Web at the following address:

http://www.srs.gov/general/pubs/ERsum/index.html

To inquire about the report, please contact

J.D. Heffner, Manager
Environmental Permitting and Monitoring
Westinghouse Savannah River Company
Building 735–B
Aiken, SC 29808

Telephone: 803–952–6931
E-mail address: james.heffner@srs.gov

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

- Analytical results and their corresponding uncertainty terms generally are reported with up to three significant figures. This is a function of the computer software used and may imply greater accuracy in the reported results than the analyses would allow.
- Units of measure and their abbreviations are defined in the glossary (beginning on page 83) and in charts at the back of the report.
- The reported uncertainty of a single measurement reflects only the counting error—not other components of random and systematic error in the measurement process—so some results may imply a greater confidence than the determination would suggest.
- An uncertainty quoted with a mean value represents the standard deviation of the mean value. This number is calculated from the uncertainties of the individual results. For an unweighted mean value, the uncertainty is the sum of the variances for the individual values divided by the number of individual results squared. For a weighted mean value, the uncertainty is the sum of the weighted variances for the individual values divided by the square of the sum of the weights.

- All values represent the weighted average of all acceptable analyses of a sample for a particular analyte. Samples may have undergone multiple analyses for quality assurance purposes or to determine if radionuclides are present. For certain radionuclides, quantifiable concentrations may be below the minimum detectable activity of the analysis, in which case the actual concentration value is presented to satisfy DOE reporting guidelines.
- 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 beta/gamma radiation from sources external to the body.

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Sampling Location Information

Note: This section contains sampling location abbreviations used in the text and/or on the sampling location maps. It also contains a list of sampling locations known by more than one name (see next page).

Location Abbreviation	Location Name/Other Applicable Information
4M	Four Mile
4MC	Four Mile Creek
BDC	Beaver Dam Creek
BG	Burial Ground
EAV	E-Area Vaults
FM	Four Mile
FMC	Four Mile Creek (Fourmile Branch)
GAP	Georgia Power Company
HP	HP (sampling location designation only; not an actual abbreviation)
HWY	Highway
KP	Kennedy Pond
L3R	Lower Three Runs
NRC	Nuclear Regulatory Commission
NSB L&D	New Savannah Bluff Lock & Dam
PAR	“P and R” Pond
PB	Pen Branch
RM	River Mile
SC	Steel Creek
SWDF	Solid Waste Disposal Facility
TB	Tims Branch
TC	Tinker Creek
TNX	Multipurpose Pilot Plant Campus
U3R	Upper Three Runs

Sampling Locations Known by More Than One Name

Augusta Lock and Dam; New Savannah Bluff Lock and Dam

Beaver Dam Creek; 400–D

Four Mile Creek–2B; Four Mile Creek at Road C

Lower Three Runs–2; Lower Three Runs at Patterson Mill Road

Pen Branch–3; Pen Branch at Road A–13–2

R-Area downstream of R–1; 100–R

River Mile 118.8; U.S. Highway 301 Bridge Area; Highway 301; US 301

River Mile 129.1; Lower Three Runs Mouth

River Mile 141.5; Steel Creek Boat Ramp

River Mile 150.4; Vogtle Discharge

River Mile 152.1; Beaver Dam Creek Mouth

River Mile 157.2; Upper Three Runs Mouth

River Mile 160.0; Dernier Landing

Steel Creek at Road A; Steel Creek–4; Steel Creek–4 at Road A; Steel Creek at Highway 125

Tims Branch at Road C; Tims Branch–5

Tinker Creek at Kennedy Pond; Tinker Creek–1

Upper Three Runs–4; Upper Three Runs–4 at Road A; Upper Three Runs at Road A; Upper Three Runs at Road 125

Upper Three Runs–1A; Upper Three Runs–1A at Road 8

Chapter 1

Introduction

Pete Fledderman and Al Mamatey
Environmental Services Section

THE Savannah River Site (SRS), one of the facilities in the U.S. Department of Energy (DOE) complex, was constructed during the early 1950s to produce materials (such as plutonium-239 and tritium) used in nuclear weapons. The site covers approximately 310 square miles in South Carolina and borders the Savannah River.

Mission

SRS's mission is to fulfill its responsibilities safely and securely in the stewardship of the nation's nuclear weapons stockpile, nuclear materials, and the environment. These stewardship areas reflect current and future missions to

- meet the needs of the enduring U.S. nuclear weapons stockpile
- store, treat, and dispose of excess nuclear materials safely and securely
- treat and dispose of legacy wastes from the Cold War and clean up environmental contamination

SRS will continue to improve environmental quality, clean up its legacy waste sites, and manage any waste produced from current and future operations. Managing this waste will include working with DOE and the State of South Carolina to ensure that there is a safe and acceptable way to permanently dispose of high-level waste and nuclear materials off site and to find mutually acceptable solutions for disposition of waste.

Site Location, Demographics, and Environment

SRS covers 198,344 acres in Aiken, Allendale, and Barnwell counties of South Carolina. The site is approximately 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia.

The average population density in the counties surrounding SRS is about 91 people per square mile, with the largest concentration in the Augusta metropolitan area. Based on 2000 U.S. Census Bureau data, the population within a 50-mile radius of the center of SRS is approximately 712,780.

Various industrial, manufacturing, medical, and farming operations are conducted near the site. Several major industrial and manufacturing facilities are located in the area, and a variety of crops is produced on local farms.

Water Resources

SRS is bounded on its southwestern border by the Savannah River for about 35 river miles and is approximately 160 river miles from the Atlantic Ocean.

The Savannah River is used as a drinking water supply source for some residents downriver of SRS. The 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.

Geology

SRS is located on the southeastern Atlantic Coastal Plain, which is part of the larger Atlantic Plain that extends south from New Jersey to Florida. The center of SRS is approximately 25 miles southeast of the geological Fall Line that separates the Coastal Plain from the Piedmont.

Land and Forest Resources

About 90 percent of SRS land area consists of managed pine plantations or natural forests. The site contains portions of three forest types: Oak-Hickory-Pine Forest, Southern Mixed Forest, and Southern Floodplain Forest.

More than 370 Carolina bays exist on SRS. These unique wetlands provide important habitat and refuge for many plants and animals.

Animal and Plant Life

The majority of SRS is undeveloped; only about 10 percent of the total land area is developed or used for industrial facilities. The remainder has been maintained in healthy, diverse ecosystems. About 260 species of birds, 60 species of reptiles, 40 species of amphibians, 80 species of freshwater fish, and 50 species of mammals exist on site.

Primary Site Activities

Separations

Originally, site facilities generated materials for nuclear weapons. Since the end of the Cold War in 1991, however, use of the facilities has shifted to the stabilization of nuclear materials from onsite and offsite sources to ensure safe long-term storage or disposal.

Spent Nuclear Fuel

The site's spent nuclear fuel facilities house used fuel elements from reactors. These elements were generated during site reactor operations and also come from offsite sources.

Tritium Processing

SRS tritium facilities recycle the tritium from nuclear weapons reservoirs that have been returned from service. This allows the United States to use its tritium supplies effectively and efficiently.

Waste Management

SRS manages

- the large volumes of radiological and nonradiological waste created by previous operations of the nuclear reactors and their support facilities
- newly generated waste created by ongoing site operations

Although the primary focus is on safely managing the high-level liquid waste, the site also must handle, store, treat, dispose of, and minimize solid waste resulting from past, ongoing, and future operations. Solid waste includes hazardous, low-level, mixed, sanitary, and transuranic wastes. More information about high-level and solid wastes is included on the CD housed inside the back cover of this report.

Site Decommissioning and Demolition

With the declining need for a large nuclear weapons stockpile, many SRS facilities no longer produce or process nuclear materials. The facilities have become surplus and must be dispositioned safely and economically. Many of them are large and complex and contain materials that, if improperly handled or stored, could be harmful. In 2002, SRS began extensive decommissioning activities in D-Area, M-Area, and TNX. Site D&D (decommissioning and demolition)—also known as CH2SRC, a subsidiary of CH2M Hill—assumed and significantly expanded these responsibilities in 2003, and continued extensive D&D operations in 2004. More information about site D&D activities is included on the CD accompanying this report.

Soil and Groundwater Closure Projects

Soil and Groundwater Closure Projects (SGCP) is responsible for cleaning up 515 waste and groundwater units (identified by SRS) to reduce risk and protect human health and the environment. Remediation of the waste sites and groundwater is regulated under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The SRS Federal Facility Agreement

- ensures that SRS cleanup satisfies RCRA and CERCLA requirements
- includes cleanup schedules for the lifecycle of SGCP

During 2004, SGCP completed three major strategic planning initiatives that support the organization's cleanup strategies: (1) the Environmental Management Program Performance Management Plan, (2) the Comprehensive Cleanup Plan, and (3) the draft Risk-Based End State Vision. In addition to the planning initiatives, SGCP personnel achieved significant fieldwork accomplishments while maintaining an excellent record of 6 million safe hours.

SGCP exceeded the goal of closures in 2004 by completing 18 waste units on or ahead of schedule. This brought 311 of the 515 units to completion; another 50 units are in the remediation phase. Key achievements also were made in T-Area closure activities, at the Old Radioactive Waste Burial Ground (the highest-risk site in the program), in M-Area Dynamic Underground Stripping, and in the F and H-Area Groundwater Remediation Project. All inactive SRS waste sites that pose a risk to surface water or groundwater are being remediated and controlled, and contaminated groundwater is being remediated, in remediation, or closely monitored. These activities are expected to be completed by 2025. More information about SGCP operations is included on the CD accompanying this report.

Environmental Monitoring

SRS has always been concerned about the safety of the public. The site is committed to protecting human health and reducing the risks associated with past, current, and future operations. Sampling locations, sample media, sampling frequency, and types of analysis are selected based on environmental regulations, exposure pathways, public concerns, and measurement capabilities.

Releases

Releases to the environment of radioactive and nonradioactive materials come from legacy contamination as well as from ongoing site operations. For instance, shallow contaminated groundwater—a legacy—flows slowly toward onsite streams and swamps and into the Savannah River. In ongoing site operations, releases occur during the processing of nuclear materials.

Meeting certain regulations, such as the Safe Drinking Water Act and the Clean Air Act, requires that releases of radioactive materials from site facilities be limited to very small fractions of the amount handled. The site follows a philosophy that emissions (discharges) be kept far below the regulatory standards.

Pathways

The routes that contaminants can follow to get to the environment and then to people are known as exposure pathways. A person potentially can be exposed when he or she breathes the air, eats locally produced foods and milk, drinks water from the Savannah River, eats fish caught from the Savannah River, or uses the Savannah River for recreational activities such as boating, swimming, etc.

One way to learn if contaminants from the site have reached the environment is through environmental monitoring. The site gathers thousands of air, water, soil, sediment, food, vegetation, and animal samples each year. The samples are analyzed for potential contaminants released from site operations, and the potential radiation exposure to the public is assessed. Samples are taken at the points where materials are released from the facilities (effluent monitoring) and out in the environment (environmental surveillance).

Research and Development

The Savannah River National Laboratory (SRNL), formerly the Savannah River Technology Center (SRTC)—the site's applied research and development laboratory—creates, tests, and implements solutions to SRS's technological challenges. Other environmental research is conducted at SRS by the following organizations:

- *Savannah River Ecology Laboratory (SREL)* - More information can be obtained by contacting SREL at 803–725–2473 or by viewing the laboratory's website at http://www.uga.edu/srel. Also, SREL's technical progress report for 2004 is included on the CD accompanying this document.
- U.*S. Department of Agriculture Forest Service–Savannah River (USFS–SR)* - More information can be obtained by contacting USFS–SR at 803–725–0006 or 803–725–0237 or by viewing the USFS–SR website at http://www.srs.gov/general/enviro/srfs.htm. Also, USFS–SR's 2004 report is included on the CD accompanying this document.
- *Savannah River Archaeological Research Program (SRARP)* - More information can be obtained by contacting SRARP at 803–725–3623.

Chapter 2

Environmental Compliance

Linda Karapatakis
Environmental Services Section

IT is the policy of the U.S. Department of Energy (DOE) that all activities at the Savannah River Site (SRS) be carried out in full compliance with applicable federal, state, and local environmental laws and regulations, and with DOE orders, notices, directives, policies, and guidance. Compliance with environmental regulations and with DOE orders related to environmental protection is a critical part of the operations at SRS. The purpose of this chapter is to report on the status of SRS compliance with these various statutes and programmatic documents. Some key regulations with which SRS must comply, and the compliance status of each, are listed in table 2–1.

This chapter also will provide information on Notices of Violation (NOV) issued by the U.S. Environmental Protection Agency (EPA) or the South Carolina Department of Health and Environmental Compliance (SCDHEC). NOVs are the regulatory tool used to inform organizations when their activities do not meet expected requirements. These can include NOVs against the organization's permitted activities or against the general contents of environmental regulations, such as failing to obtain construction permits prior to construction of new air release sources.

Compliance Activities

Resource Conservation and Recovery Act

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

Hazardous waste generators, including SRS, must follow specific requirements for handling these wastes. SRS received one RCRA-related NOV during 2004. The Savannah River National Laboratory (SRNL, formerly the Savannah River Technology Center) mixed waste tanks were found to have inadequate secondary containment. As of December 31, negotiations between SRS and SCDHEC were in progress to remove this facility from the SRS RCRA permit.

Land Disposal Restrictions

The 1984 RCRA amendments established Land Disposal Restrictions (LDRs) to minimize the threat of hazardous constituents migrating to groundwater sources. The same restrictions apply to mixed (hazardous and radioactive) waste.

Treatability variances are an option available to waste generation facilities if alternate treatment methods are appropriate for specific waste streams. SRS has identified three mixed waste streams that are potential candidates for a treatability variance. Because of special problems associated with radioactive components, these variances have been completed and sent to EPA, where they continue to await approval.

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 add provisions concerning the application of certain requirements and sanctions to federal facilities. A Site Treatment Plan (STP) consent order (95-22-HW, as amended) was obtained and implemented in 1995, as required by the FFCAct. A Statement of Mutual Understanding (SMU) for Cleanup Credits was executed in October 2003. The SMU allows SRS to earn credits for certain accelerated cleanup actions. Credits then can be applied to the STP commitments. SRS submitted to SCDHEC an annual update to the approved STP November 9, 2004, that identified changes in mixed waste treatment and inventory. Changes in the 2004 update include deletion of the SRNL sample material waste stream (SR-W007) because this stream was eliminated. Three waste streams were consolidated with existing waste streams. The changes identified and approved by SCDHEC for the 2003 STP update also have been included in the 2004 update. STP updates will continue to be produced annually unless provisions of the consent order are modified.

Table 2–1 Some Key Regulations With Which SRS Must Comply

Legislation	What It Requires
RCRA Resource Conservation and Recovery Act	The management of hazardous and nonhazardous wastes and of underground storage tanks containing hazardous substances and petroleum products
FFCAct Federal Facility Compliance Act	The development by DOE of schedules for mixed waste treatment to meet LDR requirements
CERCLA; SARA Comprehensive Environmental Response, Compensation, and Liability Act (1980); Superfund Amendments and Reauthorization Act (1986)	The establishment of liability, compensation, cleanup, and emergency response for hazardous substances released to the environment
CERCLA/Title III (EPCRA) Emergency Planning and Community Right-to-Know Act (1986)	The reporting of hazardous substances used on site (and their releases) to EPA, state, and local planning units
NEPA National Environmental Policy Act (1969)	The evaluation of the potential environmental impact of federal activities and alternatives
SDWA Safe Drinking Water Act (1974)	The protection of public drinking water systems
CWA: NPDES Clean Water Act (1977); National Pollutant Discharge Elimination System	The regulation of liquid discharges at outfalls (e.g., drains or pipes) that carry effluents to streams
CAA; NESHAP Clean Air Act (1970); National Emission Standards for Hazardous Air Pollutants	The establishment of air quality standards for criteria pollutants, such as sulfur dioxide and particulate matter, and hazardous air emissions, such as radionuclides and benzene
TSCA Toxic Substances Control Act (1976)	The regulation of use and disposal of PCBs

Underground Storage Tanks

The 19 underground storage tanks at SRS that house petroleum products and hazardous substances, as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), are regulated under Subtitle I of RCRA. These tanks require a compliance certificate annually from SCDHEC to continue operations. SCDHEC conducts an annual compliance inspection and records audit prior to issuing the compliance certificate. SCDHEC's 2004 inspection and audit found all 19 tanks to be in compliance.

High-Level Radioactive Waste Tank Closure

The primary regulatory goal of SRS's waste tank closure process at the F-Area and H-Area high-level waste (HLW) tank farms is to close the tank systems in a way that protects public health and the environment in accordance with South Carolina Regulation 61–82, "Proper Closeout of Wastewater Treatment Facilities."

Tanks 17F and 20F were closed in 1997. Waste heel removal was completed in 2003 for tanks 18F and 19F and the 242-F evaporator system, and the residual material has been sampled and characterized. These three systems have been isolated and require only administrative safety basis controls. The next action for these tanks is grouting and operational closure.

In 2003, the Federal Court for the District of Idaho ruled that DOE's process for determining that small quantities of residual waste could remain in HLW tanks was inconsistent with the Nuclear Waste Policy Act. On October 28, 2004, President George W. Bush signed the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005. Section 3116 of the Act authorizes the Secretary of Energy, in consultation with the Nuclear Regulatory Commission, to determine that certain waste from reprocessing is not HLW and that it may instead the disposed of as low-level waste if it meets the criteria set forth in that section, as follows: (1) it does not require permanent isolation in a deep geologic repository for spent fuel or high-level radioactive waste, (2) it has had highly radioactive radionuclides removed to the maximum extent practical, and (3) it does not exceed concentration limits for Class C low-level waste and complies with performance objectives set out in subpart C of NRC regulations (10 CFR 61). DOE had begun preparation of the documentation by the end of 2004.

Activities are under way to revise the General Closure Plan and Tank Closure Modules for tanks 18F, 19F, and the 242-F evaporator system, consistent with the new legislation to support closure and to meet revised FFA dates. FFA dates for the operational closure of HLW tanks 19F and 18F were revised in 2004 with the approval of SCDHEC and EPA Region 4. The revised closure-complete dates for HLW tanks 19F and 18F are October 31, 2006, and February 28, 2007, respectively.

Waste Minimization/Pollution Prevention (WMin/P2) Program

Each operation at SRS has the goal of increasing Pollution Prevention (P2) awareness and identifying and implementing measures that minimize waste and prevent pollution. Pollution prevention is integral to the SRS Environmental Management Policy, Environmental Management System (EMS), and Integrated Safety Management System (ISMS). SRS embraces P2 as a primary strategy to operate in a compliant, cost-effective manner that protects the environment and the safety and health of employees and the public. SRS's P2 Program establishes the environmental management preference of source reduction and recycling over treatment, storage, and disposal and the preferred use of energy-efficient and resource-conservative practices and operations. P2 programs are designed to meet the requirements of RCRA, DOE orders, and applicable executive orders.

The Waste Minimization/Pollution Prevention Program scope includes both in-field generator programs and sitewide programs that affect all SRS operations. The generator program is responsible for the implementation of facility-specific improvement initiatives and is funded through each generator's operating budget.

Sitewide program coordination, which is managed by the Solid Waste Infrastructure organization, is funded separately and provides the following:

- management support of the Waste Minimization/ Pollution Prevention Program
- technical assistance for facility walkdowns, lifecycle waste cost analyses, and pollution prevention opportunity assessments
- support for the SRS ALARA Center to promote radiological control and waste reduction technologies
- forums for waste minimization and P2 information and technology exchanges to support implementation of facility/activity-specific improvement initiatives
- increased employee P2 awareness and training programs
- contaminated metal and large equipment recycling and disposition
- mechanisms to increase waste generator accountability through the Solid Waste Management Council
- completion of required annual plans and regulatory reports
- implementation of sitewide initiatives such as sanitary waste recycling, Green-Is-Clean (GIC) programs, and other cost-cutting initiatives
- establishment of P2 components in SRS's Communication Plan to increase public awareness and support of P2

P2 Program Results

The SRS Pollution Prevention Program is well integrated within site operations and cleanup activities. Accomplishments during 2004 include the following:

- SRS completed 51 P2 projects, resulting in an annualized avoidance of 7,093 cubic meters of waste, with an accompanying cost avoidance of $41.5 million.

- SRS's comprehensive industrial and office waste recycling programs recycled more than 4,200 metric tons of office and industrial waste, achieving a 34-percent recycling rate for these combined waste streams.
- SRS continued its high level of achievement by winning seven DOE National P2 Awards in FY2004. The DOE National P2 Awards Program is held each year to recognize top achievers in the area of pollution prevention throughout the DOE Complex. All programs winning DOE awards were submitted to the White House Closing the Circle Awards Program.
- The SRS Pollution Prevention Program was noted by EPA as being a well-integrated program throughout the site during the 2004 multimedia environmental program evaluation by EPA Region 4 and SCDHEC.

Comprehensive Environmental Response, Compensation, and Liability Act

SRS was placed on the National Priority List in December 1989, under the legislative authority of CERCLA (Public Law 96–510), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA, Public Law 99–499). In accordance with Section 120 of CERCLA, DOE, EPA Region 4, and SCDHEC entered into the Federal Facility Agreement (FFA), which became effective August 16, 1993.

SRS has 515 waste units in the Soil and Groundwater Closure Projects program. At the end of 2004, remediation was in progress, or had been completed, in 362 units and areas (311 complete and 51 in the remediation phase). Closure activities during 2004 included the following:

- Three RCRA Facility Investigation/Remedial Investigations (RFI/RIs) were initiated.
- Twelve remedial actions were initiated.
- Five remedial actions were completed with post-construction reports/final remediation reports submitted.
- Three removal actions were initiated.
- Nine RODs were submitted.
- Four RODs were approved.
- Nine RODS with certification signatures were issued.
- One ROD amendment was approved.
- Four Explanations of Significant Difference (ESD) were submitted.

No interim-action post-construction reports were submitted in 2004.

A listing of all waste units at SRS can be found in appendix C ("RCRA/CERCLA Units List") and appendix G ("Site Evaluation List") of the FFA.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 requires facilities to notify state and local emergency planning entities about their hazardous chemical inventories and to report releases of hazardous chemicals. The Pollution Prevention Act of 1990 expanded the Toxic Chemical Release Inventory report to include source reduction and recycling activities.

Tier II Inventory Report

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.

Toxic Chemical Release Inventory Report

Under Section 313 of EPCRA, SRS must file an annual Toxic Chemical Release Inventory report by July 1 for the previous year. SRS calculates chemical releases to the environment for each regulated chemical that exceeds its established threshold, and reports the release values to EPA on Form R of the report.

For 2004, SRS identified 11 chemicals, with releases totaling 261,356 pounds. Lead, nitrate, and zinc were the largest contributors to the total reportable releases in 2004.

Executive Order 12856

Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires that all federal facilities comply with right-to-know laws and pollution prevention requirements. SRS complies with the applicable reporting requirements for EPCRA, as indicated in table 2–2, and the site incorporates the toxic chemicals on the Toxic Release Inventory report into its pollution prevention efforts.

Table 2–2 SRS Reporting Compliance with Executive Order 12856

EPCRA Citation	Activity Regulated	Reported per Applicable Requirement
302–303	Planning Notification	Not Required[a]
304	Extremely Hazardous Substances Release Notification	Not Required[a]
311–312	Material Safety Data Sheet/ Chemical Inventory	Yes
313	Toxic Release Inventory Reporting	Yes

[a] Not required to report under provisions of "Executive Order 12856" and SARA Title III Reporting Requirements

National Environmental Policy Act

The National Environmental Policy Act (NEPA) establishes policies and goals for the protection, maintenance, and enhancement of the human environment in the United States. NEPA provides a means to evaluate the potential environmental impact of major federal activities that could significantly affect the quality of the environment and to examine alternatives to those actions.

In 2004, 263 reviews of newly proposed actions were conducted at SRS and formally documented. The types and numbers of NEPA activities conducted on site in 2004 are presented in table 2–3. Among the specific activities were the following:

- A FONSI was issued for the construction, operation, and eventual closure of the Burma Road II Borrow Pit and its alternatives. The proposed action involved construction of a borrow pit to provide SRS with a new source of structural fill material for site projects and included 80 acres to meet site needs past the year 2020.
- The final West Valley Demonstration Project (WVDP) Waste Management EIS (DOE/EIS–0337) was issued in January 2004. The proposed action is to ship radioactive waste that either is in storage on the WVDP site, or that will be generated to continue managing WVDP's onsite waste storage tanks. The final EIS also analyses an alternative under which certain wastes would be shipped to interim offsite storage locations, including SRS, prior to disposal. The preferred alternative does not include SRS. No publication date had been determined for a ROD by the end of 2004.

Safe Drinking Water Act

The federal Safe Drinking Water Act (SDWA) was enacted in 1974 to protect public drinking water supplies. SRS domestic water is supplied by 17 separate systems, all of which utilize groundwater sources. The A-Area, D-Area, and K-Area systems are actively regulated by SCDHEC, while the remaining 14 site water systems receive less frequent regulatory inspections.

Samples are collected and analyzed periodically by SRS and SCDHEC to ensure that all site domestic water systems meet SCDHEC and EPA bacteriological and chemical drinking water quality standards. All samples collected in 2004 met these standards, including A-Area lead and copper samples.

Table 2–3 Types/Quantity of NEPA Activities at SRS During 2004

Type of NEPA Documentation	Number
Categorical Exclusion	234
Tiered to Previous NEPA Documentation	18
Environmental Assessment	2
Supplement Analysis	2
Engineering Evaluation/Cost Analysis	4
Environmental Impact Statement	1
Supplemental Environmental Impact Statement	1
Programmatic Environmental Impact Statement	1
Total	**263**

The B-Area Bottled Water Facility no longer is listed by SCDHEC as a public water system as its source water is provided by the A-Area water system. SCDHEC's Division of Food Protection will continue to conduct periodic inspections of this facility. Results from quarterly bacteriological analyses and annual complete chemical analyses performed in 2004 met SCDHEC and FDA water quality standards. The bottled water facility is not subject to the lead and copper requirements.

EPA conducted an inspection of the B-Area Bottled Water Facility and A-Area, D-Area, and K-Area domestic water systems in June 2004. This inspection was conducted as part of a multimedia inspection by EPA. No findings were identified as a result of the inspection.

SRS received no NOVs in 2004 under the SDWA.

Clean Water Act

National Pollutant Discharge Elimination System

The Clean Water Act (CWA) of 1972 created the National Pollutant Discharge Elimination System (NPDES) program, which is administered by SCDHEC under EPA authority. The program is designed to protect surface waters by limiting releases of nonradiological effluents into streams, reservoirs, and wetlands.

SRS had three NPDES permits in 2004, as follows:

- One permit for industrial wastewater discharge (SC0000175)
- Two general permits for stormwater discharge (SCR000000 for industrial and SCR100000 for construction)

More information about the NPDES permits can be found in chapter 3, "Effluent Monitoring."

The results of monitoring for compliance with the industrial wastewater discharge permit were reported to SCDHEC in the monthly discharge monitoring reports, as required by the permit.

During October, SCDHEC conducted its annual 2-week audit of the SRS NPDES permitted outfalls. As of December 31, SRS had not received the final audit report, so the final rating for the site was not known.

The outfalls covered by the industrial stormwater permit (SCR000000) were reevaluated in 2003. This resulted in the development of a new sampling plan, which was implemented in 2004. Results of preliminary studies of NPDES outfalls conducted in 2004 (in anticipation of a new permit) appear in an effluent monitoring data table on the CD accompanying this report.

Under the Code of Federal Regulations (CFR) 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 2004.

SRS has an agreement with SCDHEC to report petroleum product discharges of 25 gallons or more to the environment. No such incident occurred at the site during 2004.

Notices of Violation (NPDES)

SRS's 2004 compliance rate for the NPDES program under the CWA was 99.8 percent. One NOV was issued to the site during 2004 in association with the NPDES program.

SRS received the NOV from SCDHEC September 13 for permit exceedances for total suspended solids (TSS) at the F–01 NPDES outfall. A definitive cause for the exceedances was not established. Several probable causes were identified during the event critique. The primary contributor was determined to be runoff from decommissioning and demolition (D&D) activities in the outfall drainage area. Secondary contributors were runoff from a graveled area by the Old Fire Station Slab and the change from grab to composite sampling in the new NPDES permit. Subsequent samples obtained at the outfall were below permit limits. Additional controls were established for site D&D activities to prevent recurrence of the problem. No further action was required by SCDHEC.

Seven exceedances at NPDES outfalls occurred at SRS in 2004. A list of these—including outfall locations, probable causes, and corrective actions—can be found in chapter 3 (table 3–4).

Dredge and Fill; Rivers and Harbors

The CWA, Section 404, "Dredge and Fill Permitting," as amended, and the Rivers and Harbors Act, Section 9 and 10," Construction Over and Obstruction of Navigable Waters of the United States," protect U.S. waters from dredging and filling and construction activities by the permitting of such projects. Dredge-and-fill operations in U.S. waters are defined, permitted, and controlled through implementation of federal regulations in 33 CFR and 40 CFR.

In 2004, SRS conducted activities under three Nationwide Permits (NWPs) as part of the NWP program (general permits under Section 404), but under no individual Section 404 permits. The activities were as follows:

- Dam construction on an unnamed tributary to Fourmile Branch for the Mixed Waste Management Facility Groundwater Interim Measures project was conducted under NWP–38, "Hazardous Waste Cleanup." Mitigation for the impact to wetlands must be addressed before the permit can be considered closed.
- The Pond B Dam Repair Project was permitted by letter from the U.S. Army Corps of Engineers in September 2003 under NWP–3, "Maintenance." The Pond B dam repair was completed and the permit was closed in September 2004.
- The Mixed Waste Management Facility dam intake structure modification was applied for under NWP–38, "Hazardous Waste Cleanup." The modification will improve the efficiency of the treatment system for tritium. The approved permit was received in March 2004.

Construction in Navigable Waters

SCDHEC Regulation 19–450, "Permit for Construction in Navigable Waters," protects the state's navigable waters. The only state navigable waters at SRS are Upper Three Runs Creek (through the entire site) and Lower Three Runs Creek (upstream to the base of the PAR Pond Dam).

No Construction in Navigable Waters permit activities occurred in 2004.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act controls the application of restricted-use pesticides at SRS through a state-administered certification program. The site complies with these requirements through Procedure 8.1, "Federal Insecticide, Fungicide, and Rodenticide Act Compliance for Use of Pesticides," of the Environmental Compliance Manual (3Q).

The SRS pesticide procedure provides guidelines for pesticide use and requires that applicators of restricted-use pesticides be state certified. The procedure continues to undergo major revisions that were begun in 2004 with the aim of streamlining and improving it.

Clean Air Act

Regulation and Delegation

The Clean Air Act (CAA) and the Clean Air Act Amendments (CAAA) of 1990 provide the basis for protecting and maintaining air quality. Though EPA still maintains overall authority for the control of air pollution, regulatory authority for most types of emission sources has been delegated to SCDHEC. Therefore, SCDHEC must ensure that its air pollution regulations are at least as stringent as the federal requirements. This is accomplished through SCDHEC Regulation 61–62, "Air Pollution Control Regulations and Standards." The various CAAA Titles covered by these SCDHEC regulations are discussed below.

Title V Operating Permit Program

Under the CAA, and as defined in federal regulations, SRS is classified as a "major source" and, as such, falls under the CAAA Title V Operating Permit Program. On February 19, 2003, SCDHEC's Bureau of Air Quality issued SRS its Part 70 Air Quality Permit, TV–0080–0041, which had an effective date of April 1, 2003, and an expiration date of March 31, 2008. As issued, the Part 70 Air Quality Permit regulates both radioactive and nonradioactive toxic and criteria pollutant emissions from approximately 98 nonexempt emission units, with each emission unit having specific emission limits, operating conditions, and monitoring and reporting requirements. The permit also contains a listing, known as the Insignificant-Activities List, identifying 1,329 SRS sources that are exempt based on insignificant emission levels, or equipment size or type. During 2004, SRS also held two construction permits: one for a new facility that is under construction and the other that permitted five existing and five new soil vapor extraction units under one emission unit permit.

During 2004, SCDHEC issued four revisions to the SRS Part 70 Air Quality Permit, in which 35 of the permitted nonexempt emission units were voided on the permit. Of those 35 emission units, eight had been removed from service and the other 27 had been reclassified as exempt sources and placed on the Insignificant-Activities List. Of the permitted nonexempt emission units, four units were maintained in a "cold standby" status and the remaining units were operated in some capacity in 2004.

Compliance with the SRS Part 70 Air Quality Permit conditions was evaluated by both EPA and SCDHEC during 2004 as part of the EPA multimedia assessment, and subsequently by SCDHEC during the Annual Air Compliance Inspection. It was determined that SRS air emission sources were operating in compliance with their respective permit conditions and limitations.

Notices of Violation (CAA)

No Notices of Violation were issued to SRS under the CAA in 2004.

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, benzene, and asbestos. The current list of 189 air pollutants includes all radionuclides as a single item. Regulation of these pollutants has been delegated to SCDHEC; however, EPA Region 4 continues to regulate some aspects of NESHAP radionuclides.

NESHAP Radionuclide Program Subpart H of 40 CFR 61 was issued December 15, 1989, after which an evaluation of all air emission sources was performed to determine compliance status. The Savannah River Operations Office (DOE–SR) and EPA Region 4 signed a Federal Facility Compliance Agreement (FFCA) October 31, 1991, providing a schedule to bring SRS's emissions monitoring into compliance with regulatory requirements. The FFCA was officially closed—and the site declared compliant—by EPA Region 4 May 10, 1995. Subpart H was revised by EPA September 9, 2002, with an effective date of January 1, 2003. This revision added inspection requirements for existing SRS sources and allowed the use of ANSI N13.1–1999 for establishing monitoring requirements. SRS is performing all required inspections, has monitoring systems compliant with the regulation, and remains in compliance with Subpart H of 40 CFR 61.

During 2004, the maximally exposed individual effective dose equivalent, calculated using the NESHAP-required CAP88 computer code, was estimated to be 0.06 mrem (0.0006 mSv), which is 0.6 percent of the 10 mrem per year (0.10 mSv per year) EPA standard (chapter 5, "Potential Radiation Doses").

NESHAP Nonradionuclide Program

SRS uses many chemicals identified as toxic or hazardous air pollutants, but most of them are not regulated under the CAA or under federal NESHAP regulations. Except for asbestos, SRS facilities and operations do not fall into any of the "categories" listed in the original subparts. Under Title III of the federal Clean Air Act Amendments (CAAA) of 1990, EPA in December 1993 issued a final list of hazardous air pollutant-emitting source categories potentially subject to maximum achievable control technology (MACT) standards.

As a result of (1) EPA failing to meet the original rule development schedule and (2) a subsequent lawsuit by an environmental watch group (The Sierra Club), a settlement agreement was reached in November 2002 that resulted in EPA proposing a new schedule for promulgating the final rules for the remaining MACT source categories. This extended the rule development date to August 2005. As of December 31, 2004, EPA had been able to meet the new schedule and has promulgated several new MACT rules.

During 2004, EPA published three MACT rules with potential impact to SRS facilities. Two of the rules, "Miscellaneous Metal Parts and Products (MMPP), Surface Coatings" and "Reciprocating Internal Combustion Engines (RICE)," were applicable to some existing SRS facilities but included exemptions that excluded the SRS sources from being subject to the rules. As written, the MMPP MACT impacts the SRS construction paint facility in N-Area such that the site will have to document future paint usage to demonstrate compliance with the 250-gallon-per-year usage exemption. Under the RICE MACT, existing diesel-powered equipment is exempt, but future nonemergency RICE equipment will have to meet the control requirements of the rule. The third MACT rule impacting SRS is for "Industrial, Commercial, and Institutional Boilers and Process Heaters." SRS currently operates two coal-fired boilers that are subject to the rule and will have to comply with the rule by September 2007. The precise impacts of this rule still were being evaluated at the end of 2004.

In an attempt to regulate hazardous or toxic air pollutants in South Carolina, SCDHEC established Air Pollution Control Regulation 61–62.5, Standard No. 8, "Toxic Air Pollutants," in June 1991. To date, SRS has continued to demonstrate compliance with this standard for all existing and new sources of toxic air pollutants. During 2004, SRS submitted one permit application, which included the results of an air dispersion modeling analysis, for 10 soil vapor extraction units that emit toxic air pollutants at a rate that was in compliance with this regulation.

Accidental Release Prevention Program

Under Title III of the CAAA, EPA established a program for the prevention of accidental releases of large quantities of hazardous chemicals. As outlined in Section 112(r), any facility that maintains specific hazardous or extremely hazardous chemicals in quantities above specified thresholds must develop a risk management program (RMP). The RMP establishes methods that will be used for the containment and mitigation of large chemical spills.

SRS's RMP maintains hazardous and extremely hazardous chemical inventories below the threshold quantity. This cost-effective approach minimizes the regulatory burden of 112(r) but does not eliminate any liability associated with the general duty clause, as stated in 112(r)(1). To date, no hazardous or extremely hazardous chemical releases have been reported by SRS.

EPA issued a revision to its RMP final rule April 9, 2004, changing reporting requirements of its chemical accident prevention regulations. Chemical facilities subject to these regulations now are required to submit significant-chemical-accident information and emergency contact information. These changes seek to improve and assist federal, state, and local risk management programs in implementing the new homeland security measures.

NESHAP Asbestos Abatement Program

SRS began its asbestos abatement program in 1988 and continues to manage asbestos-containing material by "best management practices." Site compliance in asbestos abatement, as well as demolitions, falls under South Carolina and federal regulations, including SCDHEC Regulation R.61–86.1 ("Standards of Performance for Asbestos Projects") and 40 CFR 61, Subpart M ("National Emission Standards for Hazardous Air Pollutants - Asbestos").

During 2004, SRS personnel removed and disposed of an estimated 295 square feet and 2,185 linear feet of regulated asbestos-containing material. SRS personnel also removed 108,557 square feet, 2,857 linear feet, and 2 cubic feet of nonregulated asbestos-containing material.

Radiological asbestos waste was disposed of at the SRS E-Area low-level vaults, engineered trench, and slit trench, which are permitted by SCDHEC as asbestos waste disposal sites. Nonradiological asbestos waste was disposed of at the Three Rivers Solid Waste Authority Landfill and the C&D Landfill (Building 632-G), which also are SCDHEC-approved asbestos waste landfills.

Ozone-Depleting Substances

Title VI of the CAAA of 1990 addresses stratospheric ozone protection. This law requires that EPA establish a number of regulations to phase out the production and consumption of ozone-depleting substances (ODSs). Several sections of Title VI of the CAAA of 1990, along with recently established EPA regulations found in 40 CFR 82, apply to the site. The ODSs are regulated in three general categories, as follows:

- *Class I substances* – chlorofluorocarbons (CFCs), Halons, carbon tetrachloride, methyl chloroform, methyl bromide, and hydrobromofluorocarbons (HBFCs)
- *Class II substances* – hydrochlorofluorocarbons (HCFCs)
- *Substitute substances*

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.

SRS has reduced CFC refrigerant usage in large ODS emission sources more than 99 percent compared to 1993 baseline data. The site used 50 pounds of CFC refrigerants in large ODS sources in 2003 and 45 pounds in 2004.

The SRS CAAA of 1990 Title V operating air permit application includes ODS emission sources. All large (greater than or equal to 50-pound charge) heating, ventilation, and air conditioning/chiller systems for which there are recordkeeping requirements are included as fugitive emission sources.

SRS is phasing out its use of Halon as part of a goal to eliminate use of Class I ODSs by 2010 "to the extent economically practicable."

A Halon 1301 phaseout plan and schedule have been developed by Fire Protection Engineering to help meet DOE's goal. The plan includes an SRS Halon 1301 fire suppression system inventory that identifies systems in operation, systems abandoned in place, and systems that have been dismantled and taken to the DOE complex's Halon repository, located at SRS.

Halon 1301 total inventory on site decreased from 102,285 pounds in 2002 to 75,577 pounds in 2003 and 74,664 pounds in 2004. The site had an inventory of 52,645 pounds of stored Halon 1301 at the end of 2004, after having received approximately 2,206 pounds from Pantex. In addition, 22,019 pounds are contained in the 94 operating systems (down from 111 in 2002). During 2004, the two remaining systems abandoned in place that still contained Halon charges were dispositioned.

Air Emissions Inventory

SCDHEC Regulation 61–62.1, Section III ("Emissions Inventory"), requires compilation of an air emissions inventory for the purpose of locating all sources of air pollution and defining and characterizing the various types and amounts of pollutants. To demonstrate compliance, SRS personnel conducted the initial comprehensive air emissions inventory in 1993. The inventory identified approximately 5,300 radiological and nonradiological air emission sources. Source operating data and calculated emissions from 1990 were used to establish the SRS baseline emissions and to provide data for air dispersion modeling. This modeling was required to demonstrate sitewide compliance with Regulation 61–62.5, Standard No. 2 ("Ambient Air Quality Standards"), and Standard No. 8.

Regulation 61–62.1, Section III, requires that inventory data be updated and recorded annually but reported only every even calendar year. The emissions inventory is updated each year in accordance with SRS procedures and guidelines. Calendar year 2003 operating data for permitted and other significant sources were collected and reported to SCDHEC in 2004. Because data collection for all SRS sources begins in January and requires up to six months to complete, this report provides emissions data for calendar year 2003. Compilation of 2004 data will be completed in 2005 but will not have to be submitted to SCDHEC. Emissions data for 2004 will be reported in the *SRS Environmental Report for 2005*.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) gives EPA comprehensive authority to identify and control chemical substances manufactured, imported, processed, used, or distributed in commerce in the United States. Reporting and record keeping are mandated for new chemicals and for any chemical that may present a substantial risk of injury to human health or the environment.

Polychlorinated biphenyls (PCBs) have been used in various SRS processes. The use, storage, and disposal of these organic chemicals are specifically regulated under 40 CFR 761, which is administered by EPA. SRS has a well-structured PCB program that complies with this TSCA regulation, with DOE orders, and with WSRC policies.

The site's 2003 PCB document log was completed in full compliance with 40 CFR 761, and the 2003 annual report of onsite PCB disposal activities was submitted to EPA Region 4 in July 2004. The disposal of nonradioactive PCBs routinely generated at SRS is conducted at EPA-approved facilities within the regulatory period. For some forms of radioactive PCB wastes, disposal capacity is not yet available, and the wastes must remain in long-term storage. Such wastes are held in TSCA-compliant storage facilities in accordance with 40 CFR 761.

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 critical habitats on which such species depend.

Several threatened and endangered species exist at SRS, including the wood stork, the red-cockaded woodpecker, the bald eagle, the shortnose sturgeon, the pondberry, and the smooth purple coneflower. Programs designed to enhance the habitat and survival of such species are in place.

Five biological assessments and/or biological evaluations were prepared for SRS in 2004, of which two were for NEPA documents for new projects at SRS. The projects covered the Burma Road II Borrow Pit and NPDES Outfall Permit compliance. In addition, to ensure protection of threatened and endangered species, three biological assessments and biological evaluations were conducted to evaluate potential impacts of forestry related activities. None of these activities was found to have had any significant potential impact on threatened and endangered species.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, Section 106, governs the protection and preservation of archaeological and historical resources. SRS ensures that it is in compliance with the NHPA through several processes. The Cold War Programmatic Agreement was signed in July 2004; the SRS Cold War Built Environment Cultural Resource Management Plan is in its final stages of drafting; and the implementation of these documents is under way. The Artifact Selection team, which includes DOE, WSRC, and the University of South Carolina Savannah River Archaeological Research Program (SRARP), meets monthly and is responsible for overseeing the selection, collection, and curation of Cold War-era artifacts from buildings prior to D&D activities.

In addition, the site helps ensure that it remains in compliance with NHPA through its Site Use Program. All sites being considered for activities such as construction are evaluated by SRARP personnel to ensure that archaeological or historic sites are not impacted. Reviews of timber compartment prescriptions include surveying for archaeological resources and documenting areas of importance with regard to historic and prehistoric significance.

SRARP personnel reviewed 48 site-use packages during 2004, of which six proposed land modifications resulted in the need to survey 365 acres. The remainder of the site-use packages were found to have no activities of significant impact in terms of the NHPA. SRARP personnel also surveyed 1,316 acres in 2004 in support of onsite forestry activities.

The surveys of the 1,681 total acres resulted in 80 site investigations of 71 new archaeological sites and in revisits to nine previously recorded sites for cultural resources management.

To comply with NHPA, Site 38AK155 was excavated as mitigation in anticipation of construction at the Surplus Plutonium Disposition Facilities site. The excavation was completed in November 2004.

Floodplains and Wetlands

Under 10 CFR, Part 1022 ("Compliance with Floodplains and Wetlands Environmental Review Requirements") DOE establishes policies and procedures for implementing its 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.

A floodplains/wetlands assessment was conducted in 2004 for the F&H-Area Underground Barrier Wall/Base Injection System. Also, a wetland assessment was conducted in the inner swamp at TNX to document a wetland that is to be remediated under CERCLA.

Executive Order 11988

Executive Order 11988 ("Floodplain Management") was established to avoid long- and short-term impacts associated with the occupancy and modification of floodplains. The 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, the USDA Forest Service–Savannah River and the Savannah River Ecology Laboratory (SREL), as well as by professionals from other organizations.

Executive Order 11990

Executive Order 11990 ("Protection of Wetlands") was established to mitigate adverse impacts to wetlands caused by the 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 individual—including scientists from SRNL, SREL, and the Environmental Services Section—review site-use applications to ensure that proposed projects do not impact wetlands.

Environmental Release Response and Reporting

Response to Unplanned Releases

Environmental Monitoring and Analysis (EMA) personnel respond to unplanned environmental releases, both radiological and nonradiological, upon request by area operations personnel. No unplanned environmental releases occurred at SRS in 2004 that required the sampling and analysis services of EMA.

Occurrences Reported to Regulatory Agencies

Federally permitted releases comply with legally enforceable licenses, permits, regulations, or orders. If a nonpermitted release to the environment of a reportable quantity or more of a hazardous substance (including radionuclides) occurs, CERCLA requires notification of the National Response Center. Also, the CWA requires that the National Response Center be notified if an oil spill causes a "sheen" on navigable waters, such as rivers, lakes, or streams. Oil spill reporting was reinforced with liability provisions in the CERCLA National Contingency Plan.

SRS had no CERCLA-reportable releases in 2004. This performance compares with zero releases reported during 2000, 2001, 2002, and 2003; one release in 1999; and one in 1998.

Four notifications, not required by CERCLA, were made by the site to regulatory agencies during 2004. Three were the result of an agreement to notify SCDHEC about sewage reaching waters of the state. During a thunderstorm, three portable toilets were dislodged, and sanitary waste reached wet-weather ditches. The fourth was the result of discharging well-development water onto the ground prior to characterization.

EPCRA (40 CFR 355.40) requires that reportable releases of extremely hazardous substances or CERCLA hazardous substances be reported to any local emergency planning committees and state emergency response commissions likely to be affected by the release. No EPCRA-reportable releases occurred in 2004.

Site Item Reportability and Issues Management Program

The Site Item Reportability and Issues Management (SIRIM) program, mandated by DOE Order 232.1A ("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."

Of the 242 SIRIM-reportable events in 2004, the following were categorized as environmental:

- Portable toilets were discovered tipped over by high winds during a thunderstorm. Sewage reached storm sewers and water of the state (two events).
- Approximately 5,360 gallons of well-development water was discharged directly to the ground. It was determined that this water contained trichloroethylene (TCE) in a concentration that exceeded toxicity characteristic leaching procedure (TCLP) levels and was classified as a hazardous waste.
- A SeaLand container leaked radioactive liquid onto a truck bed and the ground. A total of 21,000 disintegrations per minute per 100 square centimeters (cm^2) of tritium were detected.
- A leak in a chromate cooling-water system released sodium chromate into the environment below a reportable quantity.
- A lab sample containing 911 mg/L of mercury was poured down a laboratory drain erroneously. The lab sample exceeded the 260-mg/L Land Disposal Restriction limit threshold.

Assessments/Inspections

The SRS environmental program is overseen by a number of organizations, both outside and within the DOE complex. In 2004, the WSRC environmental appraisal program consisted of self and independent assessments. The program ensures the recognition of noteworthy practices, the identification of performance deficiencies, and the initiation and tracking of associated corrective actions until they are satisfactorily completed. The primary objectives of the WSRC assessment program are to ensure compliance with regulatory requirements and to foster continuous improvement. The program is an integral part of the site's Safety Management System and supports the SRS Environmental Management System, which continues to meet the standards of International Organization for Standardization (ISO) 14001. (ISO 14000 is a family of voluntary environmental management standards and guidelines.)

WSRC conducted several environmental program-level assessments in 2004. The topics included

- NEPA Implementation
- Toxic and Chemical Materials: Asbestos
- Environmental Monitoring: Sample Management
- Environmental Radiation Protection: Dose Calculation
- Air Quality Protection: Ozone-Depleting Substances
- Surface Water Quality: NPDES Implementation
- Biological Monitoring Programs

During 2004, personnel from DOE–SR's Environmental Quality and Management Division continued to perform direct oversight and evaluation of WSRC's self-assessment program. Completed DOE assessments have met with positive results; routine assessments have promoted improvement and helped ensure the adequacy of environmental programs and operations at SRS.

SCDHEC and EPA personnel also performed external inspections of the SRS environmental program for regulatory compliance. Agency representatives performed several comprehensive compliance inspections in 2004, as follows:

- *RCRA Compliance Evaluation Inspection* – The annual compliance evaluation inspection was conducted by EPA and SCDHEC. As of December 31, 2004, no results or deficiencies had been reported.

- *Annual Air Compliance Inspection* – SCDHEC conducted the annual air compliance inspection of operating SRS permitted sources. In general, the site was found to be in compliance with each source's respective permit condition and requirement.
- *Annual Underground Storage Tank Inspection* – SCDHEC inspected the site's 19 underground storage tanks. All were found to be in compliance with applicable regulations.
- *Annual NPDES 3560 Compliance Audit* – SCDHEC conducted the annual 3560 environmental audit of the site's NPDES-permitted outfalls. As of December 31, SRS had not received the final audit report, so the final rating for the site was not known.
- *Quarterly Inspections of SRS Bottled Water Facility* – SCDHEC conducted quarterly inspections of the SRS Bottled Water Facility. The facility was found to be in compliance.
- *Burma Road C&D Landfill, Burma Road Structural Fill, 632–G C&D Landfill, 288–F Industrial Waste Landfill, and Saltstone Inspection* – SCDHEC conducted quarterly inspections, and all the sites were found to be satisfactory, with no observed deficiencies.
- *Interim Sanitary Landfill* – SCDHEC personnel conducted an annual post-closure inspection, and the site was found to be satisfactory, with no observed deficiencies.
- *Groundwater Comprehensive Monitoring Evaluation* – SCDHEC conducted an unannounced RCRA inspection of SRS's groundwater program. No deficiencies or permit violations were cited.

Environmental Training

The site's environmental training program identifies training activities to teach job-specific skills that protect the employee and the environment, in addition to satisfying regulatory training requirements. Regularly scheduled classes in this program at SRS include such topics as Environmental Laws and Regulations, Hazardous Waste Worker, Hazardous and Radiological Waste Characterization, and the Environmental Compliance Authority course. A self-taught Environmental Laws and Regulations course is available on SHRINE for technical staff and is updated by ESS annually. More than 60 environmental program-related training courses are listed in the site training database, and individual organizations schedule and perform other facility-specific, environment-related training to ensure that operations and maintenance personnel, as well as environmental professionals, have the knowledge and skills to perform work safely and in a manner that protects the environment.

Environmental Permits

SRS had 403 construction and operating permits in 2004 that specified operating levels for each permitted source. Table 2–4 summarizes the permits held by the site during the past five years. These numbers reflect only permits obtained by WSRC for itself and for other SRS contractors that requested assistance in obtaining permits. It also should be noted that these numbers include some permits that were voided or closed some time during the calendar year (2004). The continued reduction in the number of environmental permits reflects site efforts to (1) close permits as facilities are deactivated or decommissioned and (2) consolidate and streamline facility permits to help improve operating and administrative efficiency.

Table 2–4 SRS Construction and Operating Permits, 2000–2004

Type of Permit	Number of Permits				
	2000	2001	2002	2003	2004
Air	199	172	150	2[a]	3
U.S. Army Corps of Engineers 404	0	0	0	0	0
Army Corps of Engineers Nationwide Permit	1	5	5	5	3
Domestic Water	203	203	203	202	203
Industrial Wastewater	77	70	66	60	56
NPDES Discharge	1	1	1	1	1
NPDES General Utility	1	0	0	0	0
NPDES No Discharge	1	1	1	1	1
NPDES Stormwater	2	2	2	2	2
RCRA	1	1	1	1	1
Sanitary Wastewater	133	133	133	109	104
SCDHEC 401	1	1	0	0	0
SCDHEC Navigable Waters	0	1	1	0	0
Solid Waste	5	4	2	3	4
Underground Injection Control	23	20	18	19	18
Underground Storage Tanks	7	7	7	7	7
Totals	655	621	590	412	403

[a] This number was revised to reflect the Title V Operating Permit, which includes all SRS air emission sources and one construction permit.

Editor's note: The "Environmental Compliance" chapter is unique in that the number of contributing authors is far greater than the number for any other chapter in this report. Space/layout constraints prevent us from listing all of them on the chapter's first page, so we list them here instead. Their contributions, along with those of the report's other authors, continue to play a critical role in helping us produce a quality document—and are very much appreciated.

Brent Blunt, FSSB,
Paul Carroll, FSSBU
Carl Cook, FSSBU
John Cook, CBU
Keith Dyer, FSSBU
Tim Faugl, FSSBU
Natalie Ferguson, OBU
Linn Liles, FSSBU
Jeff Lintern, FSSBU
Nancy Lowry, FSSBU
Bill Maloney, FSSBU
Al Mamatey, FSSBU
Bart Marcy, FSSBU
Tim McCormick, CBU
Hal Morris, FSSBU
Jeff Newman, CBU
Vernon Osteen, FSSBU
Paul Rowan, FSSBU
Stuart Stinson, FSSBU

Chapter 6

Groundwater

Dan Wells
Environmental Services Section
Bob Hiergesell
Waste Disposal and Environmental Development

GROUNDWATER protection at the Savannah River Site (SRS) has evolved into a program with the following primary components:

- Protect groundwater by good practices in managing chemicals and work.
- Monitor groundwater to identify areas of contamination.
- Remediate contamination as needed.
- Use groundwater wisely to conserve.

SRS operations have contaminated groundwater around certain waste disposal facilities. Extensive monitoring and remediation programs are tracking and cleaning up the contamination. Remediation includes (1) the closing of waste sites to reduce the migration of contaminants into groundwater and (2) the active treatment of contaminated water.

No offsite wells have been contaminated by the migration of SRS groundwater.

This chapter describes SRS's groundwater environment and the programs in place for investigating, monitoring, remediating, and using the groundwater.

Groundwater at SRS

SRS is underlain by sediment of the Atlantic Coastal Plain. The Atlantic Coastal Plain consists of a southeast-dipping wedge of unconsolidated sediment that extends from its contact with the Piedmont Province at the Fall Line to the edge of the continental shelf. The sediment ranges from Late Cretaceous to Miocene in age and comprises layers of sand, muddy sand, and clay with subordinate calcareous sediments. It rests on crystalline and sedimentary basement rock.

Water flows easily through the sand layers but is retarded by less permeable clay beds, creating a complex system of aquifers. Operations during the life of SRS have resulted in contamination migrating into groundwater at various site locations, predominantly in the central areas of the site. The ongoing movement of water into the ground, through the aquifer system, and then into streams and lakes—or even into deeper aquifers—continues to carry contamination along with it, resulting in spreading plumes.

The hydrostratigraphy of SRS has been subject to several classifications. The hydrostratigraphic classification established in Aadland et al., 1995, and in Smits et al., 1996, is widely used at SRS and is regarded as the current SRS standard. This system is consistent with the one used by the U.S. Geological Survey (USGS) in regional studies that include the area surrounding SRS [Clarke and West, 1997]. Figure 6–1 is a chart that indicates the relative position of hydrostratigraphic units and relates hydrostratigraphic units to corresponding lithologic units at SRS and to the geologic time scale. This chart was modified from Aadland et al., 1995, and Fallaw and Price, 1995

The hydrostratigraphic units of primary interest beneath SRS are part of the Southeastern Coastal Plain Hydrogeologic Province. Within this sequence of aquifers and confining units are two principal subcategories, the overlying Floridan Aquifer System and the underlying Dublin-Midville Aquifer System. These systems are separated from one another by the Meyers Branch Confining System. In turn, each of the systems is subdivided into two aquifers, which are separated by a confining unit.

In the central to southern portion of SRS, the Floridan Aquifer System is divided into the overlying Upper Three Runs Aquifer and the underlying Gordon Aquifer, which are separated by the Gordon Confining Unit. North of Upper Three Runs Creek, these units are collectively referred to as the Steed Pond Aquifer, in which the Upper Three Runs Aquifer is called the M-Area Aquifer zone, the Gordon Aquifer is referred to as the Lost Lake Aquifer zone, and the aquitard that separates them is referred to as the Green Clay confining zone unit within which the water table usually occurs at SRS; hence, it is referred to informally as the "water table" aquifer. The water table surface can be as deep as 160 feet below ground surface (bgs), but intersects the ground surface in seeps along site streams. The top of the Gordon Aquifer typically is encountered at depths of 150–250 feet bgs. The Dublin-Midville Aquifer System

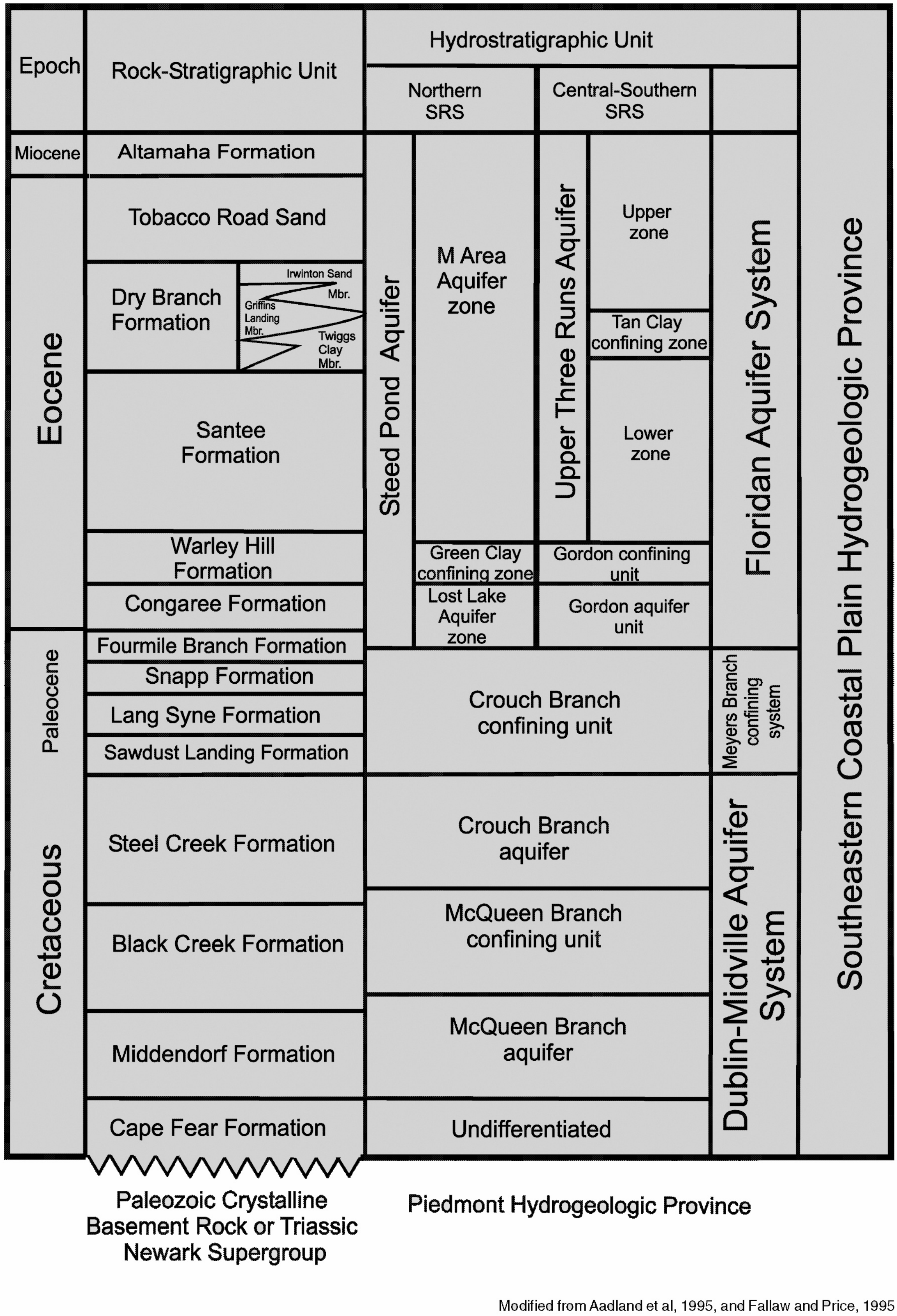


Figure 6–1 Hydrostratigraphic Units at SRS.

is divided into the overlying Crouch Branch Aquifer and the underlying McQueen Branch Aquifer, which are separated by the McQueen Branch Confining Unit. The Crouch Branch Aquifer and McQueen Branch Aquifer are names that originated at SRS [Aadland et al., 1995]. These units are equivalent to the Dublin Aquifer and the Midville Aquifer, which are names originating with the USGS [Clarke and West, 1997]. The top of the Crouch Branch Aquifer typically is encountered at depths of 350–500 feet bgs. The top of the McQueen's Branch Aquifer typically is encountered at depths of 650–750 feet bgs.

Figure 6–2 is a three-dimensional block diagram of the hydrogeologic units at SRS and the generalized groundwater flow patterns within those units. These units are from shallowest to deepest: the Upper Three Runs/Steed Pond Aquifer (or water table aquifer), the Gordon/Lost Lake Aquifer, the Crouch Branch Aquifer, and the McQueen Branch Aquifer.

Groundwater recharge is a result of the infiltration of precipitation at the land surface; the precipitation moves vertically downward through the unsaturated zone to the water table. Upon entering the saturated zone at the water table, water moves predominantly in a horizontal direction toward local discharge zones along the headwaters and midsections of streams, while some of the water moves into successively deeper aquifers. The water lost to successively deeper aquifers also migrates laterally within those units toward the more distant regional discharge zones. These typically are located along the major streams and rivers in the area, such as the Savannah River. Groundwater movement within these units is extremely slow when compared to surface water flow rates. Groundwater velocities also are quite different between aquitards and aquifers, ranging at SRS from several inches to several feet per year in aquitards and from tens to hundreds of feet per year in aquifers.

Monitoring wells are used extensively at SRS to assess the effect of site activities on groundwater quality. Most of the wells monitor the upper groundwater zone, although wells in lower zones are present at the sites with the larger groundwater contamination plumes. Groundwater in some areas contains one or more constituents at or above the levels of the drinking water standards of the U.S. Environmental Protection Agency (EPA). These areas can be seen in figure 16 of the "SRS Maps" appendix on the CD accompanying this report.

Groundwater Protection Program at SRS

The SRS groundwater program was audited by both the U.S. Department of Energy (DOE) and WSRC during 2000 and 2001. Findings of these assessments have resulted in an ongoing evaluation of the goals and priorities of the site groundwater program. It has been determined that a groundwater protection program designed to meet federal and state laws and regulations, DOE orders, and site policies and procedures should contain the following elements:

- investigating site groundwater
- using site groundwater
- protecting site groundwater
- remediating contaminated site groundwater
- monitoring site groundwater

SRS identified specific program goals in each of these areas to maintain its commitment to a groundwater program that protects human health and the environment. Groundwater monitoring is a key tool used in each of the first four elements, and monitoring results form the basis for evaluations that are reported to site stakeholders.

Investigating SRS Groundwater

An extensive program is in place at SRS to acquire new data and information on the groundwater system. This program is multifaceted and is conducted across departmental boundaries at the site because of the different charters and mandates of these organizations. Investigations include both the collection and analysis of data to understand groundwater conditions on regional and local scales at SRS. Research efforts at the site generally are conducted to obtain a better understanding of subsurface processes and mechanisms or to define new approaches to subsurface remediation.

Investigative efforts focus on the collection and analysis of data to characterize the groundwater flow system. Characterization efforts at SRS include the following activities:

- collection of geologic core material and performance of seismic profiles to better delineate subsurface structural features
- installation of wells to allow periodic collection of both water levels and groundwater samples at strategic locations
- development of water table and potentiometric maps to delineate the direction of groundwater movement in the subsurface
- performance of various types of tests to obtain *in situ* estimates of hydraulic parameters needed to estimate groundwater velocities

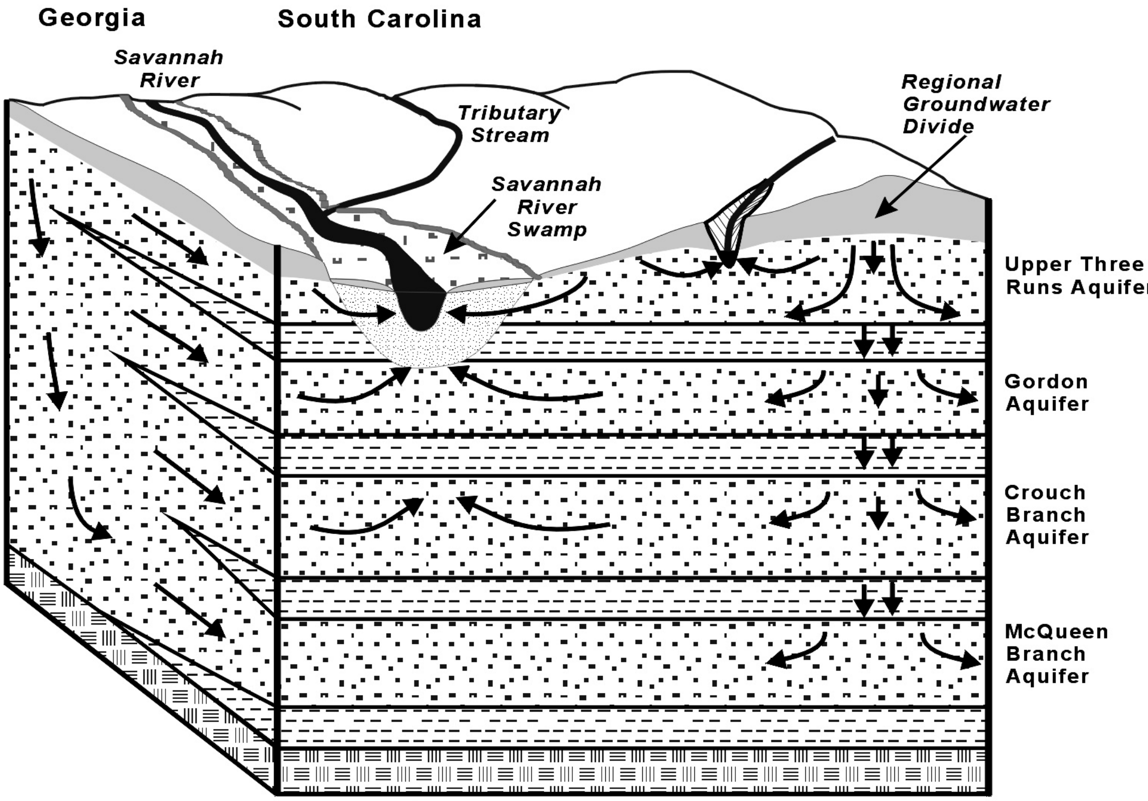


Figure 6–2 Groundwater at SRS
The groundwater flow system at SRS consists of four major aquifers separated by confining units. Flow in recharge areas generally migrates downward as well as laterally—eventually either discharging into the Savannah River and its tributaries or migrating into the deeper regional flow system.

Modified from Clarke and West, 1997

Analysis of data on the regional scale is needed to provide a broad understanding of groundwater movement patterns at SRS that can be used as a framework to better understand the migration of contaminants at the local scale near individual waste units. Surface water flow characteristics also are defined at the site on the regional scale and are significant to risk analyses because perennial streams are the receptors of groundwater discharge—some of which contains contaminants from SRS waste units. Because the site boundary does not represent a groundwater boundary, regional studies are helpful in understanding the movement of groundwater both onto the site from the surrounding area and vice versa.

The collection and analysis of data describing subsurface hydrogeologic conditions at or near individual waste units are needed to design effective remediation systems. Characterization embraces both traditional and innovative technologies to accomplish this goal. The installation of monitoring wells and piezometers is a traditional investigative method to allow the collection of (1) water levels, which are used to define flow directions, and (2) groundwater samples, which are analyzed to monitor contaminant plume migration within the groundwater flow system. Electric logs acquired during well installation are used to delineate the subsurface hydrostratigraphy. Examples of newer technologies include the use of

- direct-push technology, such as the cone penetrometer, to collect one-time groundwater samples at investigation sites and to help establish hydrostratigraphic contacts

- the “rotosonic” method for bore holes to collect cores and install wells

Models have been used extensively as analytical tools at SRS for both regional and local investigations. Models have been utilized for a variety of reasons, but primarily to (1) define the regional groundwater movement patterns at SRS and the surrounding areas, (2) enhance the understanding of contaminant migration in the subsurface, and (3) support the design of remediation systems. At SRS, major groundwater modeling efforts have focused on A/M-Area, F-Area, H-Area, the Burial Ground Complex, and several of the reactor areas where the most extensive subsurface contamination is known to exist.

Research on groundwater issues is conducted at SRS to obtain a better understanding of subsurface mechanisms, such as (1) the interaction of contaminants with the porous media matrix, and (2) the factors that impact the rate of migration of contaminants within the groundwater flow system. Research to address relevant issues often is conducted through cooperative studies with investigators at various public universities and private companies, while other efforts are conducted exclusively by SRS employees.

Using SRS Groundwater

SRS derives its own drinking and production water supply from groundwater. The site ranks as South Carolina’s largest self-supplied industrial consumer of groundwater, utilizing approximately 5.3 million gallons per day. SRS domestic and process water systems are supplied from a network of approximately 40 wells in widely scattered locations across the site, of which eight supply the primary drinking water system for the site. Treated well water is supplied to the larger site facilities by the A-Area, D-Area, and K-Area domestic water systems. Each system has wells, a treatment plant, elevated storage tanks, and distribution piping. The wells range in capacity from 200 to 1,500 gallons per minute.

These three systems supply an average of 1.1 million gallons per day of domestic water to customers in these areas. The domestic water systems supply site drinking fountains, lunchrooms, restrooms, and showering facilities with water meeting state and federal drinking water quality standards. Process water is used for equipment cooling and facility washdown water, and as makeup water for site cooling towers and production processes.

The South Carolina Department of Health and Environmental Control (SCDHEC) periodically samples the large- and small-system wells for Safe Drinking Water Act contaminants. An unscheduled biannual SCDHEC sanitary survey also is performed.

In 1983, SRS began reporting its water usage annually to the South Carolina Water Resources Commission (and later to SCDHEC). Since that time, the amount of groundwater pumped on site has dropped by more than 50 percent—from 10.8 million gallons per day during 1983–1986 to 4.8 million gallons per day in 2004. The majority of this decrease is attributable to the consolidation of site domestic water systems, which was completed in 1997. Thirteen separate systems, each with its own high-capacity supply wells, were consolidated into three systems located in A-Area, D-Area, and K-Area. This greatly reduced the amount of excess water being pumped to waste. Site facility shutdowns and reductions in population also were contributing factors.

The new systems draw water from the Crouch Branch and McQueen’s Branch Aquifers. The amount of groundwater pumped at SRS has had only localized effects on water levels in these aquifers, and it is unlikely that water usage at the site ever will cause drawdown problems that could impact surrounding communities.

The process water systems in A-Area, F-Area, H-Area, K-Area, L-Area, S-Area, and TNX-Area meet site demands for boiler feedwater, equipment cooling water, facility washdown water, and makeup water for cooling towers, fire storage tanks, chilled-water-piping loops, and site test facilities. These systems are supplied from dedicated process water wells ranging in capacity from 100 to 1,500 gallons per minute. In K-Area, the process water system is supplied from the domestic water wells. At some locations, the process water wells pump to ground-level storage tanks, where the water is treated for corrosion control. At other locations, the wells directly pressurize the process water distribution piping system without supplemental treatment.

The site groundwater protection program integrates information learned about the properties of SRS aquifers with site demand for drinking and process water. SRS ensures a high level of drinking water supply protection by (1) monitoring above and beyond SCDHEC requirements and (2) periodically evaluating production wells. Additional protection will be realized under a site wellhead protection program that meets the requirements of the South Carolina Source Water Assessment Program described below.

Protecting SRS Groundwater

SRS is committed to protecting the groundwater resource beneath the site. A variety of activities contribute to this goal, including

- construction, waste management, and monitoring efforts to prevent or control sources of groundwater contamination
- monitoring programs (both groundwater and surface water) to detect contamination
- a strong groundwater cleanup program through the Soil and Groundwater Closure Projects (SGCP) Department

Monitoring around known waste disposal sites and operating facilities provides the best means to detect and track groundwater contamination. To detect contamination from as-yet undiscovered sites, SRS depends on a sitewide groundwater monitoring and protection effort—the site Groundwater Surveillance Monitoring Program (GSMP). This program is an upgraded replacement of the site screening program.

Monitoring wells and production wells that no longer are needed should be properly abandoned. In 2004, SRS abandoned 54 monitoring wells, six deep rock borings (approximately 2,000 ft deep), and four production wells. A larger abandonment program is planned for 2005.

One goal of the GSMP is to protect potential offsite receptors from contamination by detecting contamination in time to apply appropriate corrective actions. SRS is a large site, and most groundwater contamination is located in its central areas. However, the potential for offsite migration exists, and the consequences of such an outcome are serious enough to warrant a comprehensive prevention program.

SRS has evaluated flow in each aquifer and determined where there is potential for flow across the site boundary. This gives a conservative indication of where offsite contamination might be possible and allows for a focused monitoring effort in those few areas. Another pathway for existing groundwater contamination to flow offsite is by discharge into surface streams and subsequent transport into the Savannah River. SRS monitors site streams for contamination, and new wells have been installed in recent years along several site streams to detect contamination before it enters the stream and to assess its concentration in groundwater.

Sample Scheduling and Collection

The Geochemical Monitoring group and the Environmental Services Section schedule groundwater sampling either in response to specific requests from SRS personnel or as part of their 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.

Constituents that may be analyzed are commonly imposed by permit or work plan approval. These include metals, field parameters, suites of herbicides, pesticides, volatile organics, and others. Radioactive constituents that may be analyzed by request include gross alpha and beta measurements, gamma emitters, iodine-129, strontium-90, radium isotopes, uranium isotopes, and other alpha and beta emitters.

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

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

Deviations (caused by dry wells, inoperative pumps, etc.) from scheduled sampling and analysis for 2004 were entered into the site's groundwater database and issued in appropriate reports.

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 DOE directives
- provide data to identify and monitor constituents in the groundwater
- permit characterization of new facility locations to ensure that they are suitable for the intended facilities
- support basic and applied research projects

The groundwater monitoring program at SRS includes two primary components: (1) waste site/remediation groundwater monitoring, overseen by the Geochemical Monitoring group of SGCP, and (2) groundwater surveillance monitoring, conducted by the Environmental Services Section. To assist other departments in meeting their responsibilities, personnel of both organizations provide the services for installing monitoring wells, collecting and analyzing samples, and reporting results.

The *WSRC Environmental Compliance Manual* (WSRC 3Q) provides details about the following aspects of the groundwater monitoring program:

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

Monitoring data are evaluated each year to identify unexpected results in any site wells that might indicate new or changing groundwater contamination.

Remediating Contaminated SRS Groundwater

SRS has maintained an environmental restoration effort for many years. SGCP personnel manage cleanup of contaminated groundwater associated with Resource Conservation and Recovery Act (RCRA) hazardous waste management facilities or Federal Facility Act units. Their mission is to aggressively manage the inactive waste site and groundwater cleanup program so that

- schedules for environmental agreements are consistently met
- the utilization of financial and technology resources are continually improved
- the overall risk posed by existing contaminated sites is continually reduced

The SGCP strategy revolves around developing an appropriate regulatory framework for each waste site, assessing the degree and extent of contamination, and remediating the contaminated groundwater to its original beneficial use. Remedial technologies being used include pump and treat, *in situ* pH adjustment, steam injection, phytoremediation, and barrier wall construction. In cases where remediation to background quality is impractical, the intent is to prevent plume migration and exposure and to evaluate alternate methods of risk reduction.

Groundwater Monitoring Results

The first priority of the groundwater monitoring program at SRS is to ensure that contamination is not being transported from the site by groundwater flow. Contaminated groundwater at SRS discharges into site streams or the Savannah River. Nowhere have offsite wells been contaminated by groundwater from SRS, and only a few site locations have groundwater with even a remote chance of contaminating such wells.

One of these locations is near A-Area/M-Area, the site of a large chlorinated solvent plume. This area's groundwater monitoring program uses more than 200 wells, and some of the contaminated wells lie within a half-mile of the site boundary. While it is believed that the major component of groundwater flow is not directly toward the site boundary, flow in the area is complex and difficult to predict. For this reason, particular attention is paid to data from wells along the site boundary and from those between A-Area/M-Area and the nearest population center, Jackson, South Carolina (figure 21 in the "SRS Maps" appendix on the CD accompanying this report). During 2004, no chlorinated organics were detected in any of these wells.

Another part of the SRS perimeter that has received special monitoring attention is across the Savannah River in Georgia's Burke and Screven counties. Since 1988, there has been speculation that tritiated groundwater from SRS could flow under the river and find its way into Georgia wells. Considerable effort has been directed at assessing the likelihood of transriver flow, and 44 wells have been drilled by the USGS and the Georgia Department of Natural Resources (figure 22 in the "SRS Maps" appendix on the CD accompanying this report). To this point, those efforts have failed to identify any plausible mechanism by which transriver flow could have contaminated Georgia wells. In fact, mathematical modeling indicates that transriver contamination of Georgia wells is virtually impossible.

However, SRS continues to maintain and sample the Georgia monitoring wells annually. In 2004, the maximum concentration of tritium detected was 795 pCi/L—well below EPA's maximum contaminant level of 20,000 pCi/L, and consistent with rainfall data.

Although contaminated groundwater in most SRS areas does not threaten the site boundary, it does have the potential to impact site streams. For this reason—and because of the need to meet the requirements of various environmental regulations—extensive monitoring is conducted around SRS waste sites and operating facilities, regardless of their proximity to the boundary.

Table 6–1 presents a general summary of the most contaminated groundwater conditions at SRS, based on 2003 and 2004 monitoring data. The table shows the 2004 maximum concentrations for major constituents in the SRS areas that have contaminated groundwater—and how these concentrations compare to the drinking water standards and the 2003 maximums. As shown in the table, the two major contaminants of concern in groundwater are (1) common degreasers (trichloroethylene and perchloroethylene) and (2) radionuclides (tritium and gross alpha and nonvolatile beta emitters). In most cases, the maximum concentrations did not change significantly between 2003 and 2004.

Table 6–1 also shows where the contaminated water most likely will outcrop. It should be noted that by the time the groundwater reaches a stream, it generally is much less contaminated because of natural attenuation processes like dilution and biodegradation. As stated above, results in the table are *maximum values* generally associated with wells very close to contaminant source areas, where little attenuation has taken place.

For details about this monitoring and the conditions at individual sites, one should refer to site-specific documents, such as RCRA corrective action reports or RCRA/Comprehensive Environmental Response, Compensation, and Liability Act RCRA facility investigation/remedial investigation reports.

Table 6–1
Summary of Maximum Groundwater Monitoring Results for Major Areas Within SRS, 2003–2004

Location	Major Contaminants	Units	2004 Maximum	MCL	2003 Maximum	Likely Outcrop Point
A-Area/M-Area	TCE PCE	ppb ppb	37,300 142,000	5 5	38,300 125,000	Tims Branch/Upper Three Runs Creek in East; Crackerneck Swamp in West
C-Area	TCE Tritium	ppb pCi/L	1,611 6,230,000	5 20,000	8.330 6,020,000	Tributaries of Fourmile Branch
D-Area	TCE Tritium	ppb pCi/L	395 1,030,000	5 20,000	425 1,340,000	Savannah River Swamp
E-Area	Tritium TCE	pCi/L ppb	82,300,000 606	20,000 5	105,000,000 372	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
F-Area	TCE Tritium Gross alpha Beta	ppb pCi/L pCi/L pCi/L	25.3 1,190,000 89.4 283	5 20,000 15 4 mrem/yr	32.4 1,570,000 109 1380	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
F-Area Seepage Basins	Tritium Gross alpha Beta	pCi/L pCi/L pCi/L	8,599,078 784 3,280	20,000 15 4 mrem/yr	10,500,000 1100 2,640	Fourmile Branch
H-Area	Tritium TCE Gross alpha Beta	pCi/L ppb pCi/L pCi/L	93.048 undeteted 24.1 146	20,000 5 15 4 mrem/yr	128,000 13. 16.3 694	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
H-Area Seepage Basins	Tritium Gross alpha Beta	pCi/L pCi/L pCi/L	9,250,000 239 1,540	20,000 15 4 mrem/yr	8,590,000 204 1,870	Fourmile Branch
R-Area	Tritium	pCi/L	164,000	20,000	121,000	Mill Creek in Northwest; tributaries of PAR Pond elsewhere
K-Area	Tritium TCE[a]	pCi/L ppb	1,560,971 12.7	20,000 5	59,922,000 42.7	Indian Graves Branch
L-Area	Tritium TCE	pCi/L ppb	1,250,000 13	20,000 5	1,052,910 41.6	L Lake
P-Area	Tritium[a] TCE	pCi/L ppb	523,000 8,460	20,000 5	2,840,000 14,800	Steel Creek in North; Meyer's Branch in South
Sanitary Landfill	TCE Vinyl chloride	ppb ppb	14.1 28.4	5 2	10.4 80.1	Upper Three Runs Creek
TNX	TCE	ppb	680	5	1,660	Savannah River Swamp
CMP Pits	TCE	ppb	713	5	1,090	Pen Branch

[a]Some data from K-Area and P-Area in 2003 and 2004 are not directly comparable because of differences in sampling methods/locations.

Chapter 5

Potential Radiation Doses

Timothy Jannik, Patricia Lee, Doug Martin, and Ali Simpkins
Savannah River National Laboratory

THIS chapter presents the potential doses to offsite individuals and the surrounding population from the 2004 Savannah River Site (SRS) atmospheric and liquid radioactive releases. Also documented are potential doses from special-case exposure scenarios—such as the consumption of deer meat, fish, and goat milk.

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

Descriptions of the effluent monitoring and environmental surveillance programs discussed in this chapter can be found in chapter 3, "Effluent Monitoring," and chapter 4, "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, 2001]. All potential dose calculation results are presented in data tables on the CD accompanying this report.

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

Calculating Dose

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

- hypothetical maximally exposed individual living at the SRS boundary (see definition below)
- population living within an 80-km (50-mile) radius of SRS

Because the U.S. Department of Energy (DOE) has adopted dose factors only for adults, SRS calculates maximally exposed individual and collective doses as if the entire 80-km population consisted of adults [DOE, 1988]. For the radioisotopes that contribute the most to SRS's estimated maximum individual doses (i.e., tritium and cesium-137), the dose to infants would be approximately two to three times more than to adults. The dose to older children becomes progressively closer to the adult dose.

SRS also uses adult consumption rates for food and drinking water and adult usage parameters to estimate intakes of radionuclides. These intake values and

Dose to the Hypothetical 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 as follows:

1) **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
2) **For liquid releases:** Someone who lives downriver of SRS (near River Mile 118.8) 365 days per year, drinks 2 liters of untreated water per day from the Savannah River, consumes a large amount of Savannah River fish, and spends the majority of time on or near the river

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

parameters were developed specifically for SRS based on a regional survey [Hamby, 1991].

For dose calculations, unspecified alpha releases were conservatively assigned the plutonium-239 dose factor, and unspecified beta releases were assigned the strontium-90 factor.

Dose Calculation Methods

To calculate annual offsite doses, SRS uses transport and dose models developed for the commercial nuclear industry [NRC, 1977]. The models are described in SRS EM Program, 2001.

Meteorological Database

To show compliance with DOE environmental orders, potential offsite doses from releases of radioactivity to the atmosphere were calculated with quality-assured meteorological data for A-Area, K-Area (used for releases from C-Area, K-Area, and L-Area) and H-Area (used for releases from all other areas). The meteorological databases used were for the years 1997–2001, reflecting the most recent 5-year compilation period.

To show compliance with U.S. Environmental Protection Agency (EPA) regulations, only the H-Area database was used in the calculations because the EPA-required dosimetry code is limited to a single release location. The H-Area meteorological database is provided on the CD accompanying this report.

Population Database and Distribution

Collective (population) doses from atmospheric releases are calculated for the population within an 80-km radius of SRS. Within this radius, the total population was 713,500, based on 2000 census data.

Some of the collective doses resulting from SRS liquid releases are calculated for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant, near Port Wentworth, Georgia, and by the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water Treatment Plants, near Beaufort, South Carolina. According to the treatment plant operators, the population served by the Port Wentworth facility during 2004 was 26,344 persons, while the population served by the BJWSA Chelsea facility was 74,821 persons and by the BJWSA Purrysburg facility, 42,827 persons.

River Flow Rate Data

Although flow rates are recorded at a gauging station near River Mile 118.8 (U.S. Highway 301 bridge), these data are not used directly in dose calculations. This is because weekly river flow rates fluctuate widely (i.e., short-term dilution varies from week to week). Used instead are "effective" flow rates, which are based on the annual average tritium concentrations measured at River Mile 118.8 and at the three downriver water treatment plants.

The use of effective river flow rates in the dose calculations is more conservative than the use of measured flow rates because it accounts for less dilution of other radionuclides.

For 2004, the River Mile 118.8 calculated (effective) flow rate of 6,150 cubic feet per second (cfs) was used. For comparison, the 2004 measured annual average flow rate was 8,778 cfs. The 2004 effective flow rate was about 45 percent less than the 2003 flow rate of 11,138 cubic feet per second because of substantially less rainfall during 2004 than 2003.

The effective flow rate was 8,245 cfs for the Port Wentworth facility, 8,033 cfs for the BJWSA Chelsea facility, and 6,664 cfs for the BJWSA Purrysburg facility. (The flow rate at the new Purrysburg plant, which began operations in February 2004, is prorated.) The significant difference between the flow rates is because the Purrysburg facility is located directly on the Savannah River, and is not affected by dilution. The Port Wentworth plant, meanwhile, is subject to tidal effects because of its location near the Atlantic Ocean, and thus experiences dilution. Similarly, the Chelsea plant is located at the end of a long inlet canal, which experiences groundwater infiltration/dilution.

Dose Calculation Results

Liquid Pathway

Liquid Release Source Terms

The 2004 radioactive liquid release quantities used as source terms in SRS dose calculations are discussed in chapter 3 and shown by radionuclide in table 5–1.

The total curies of tritium released is based on the measured tritium concentration at River Mile 118.8. This total (3,630 curies) includes contributions from Georgia Power Company's Vogtle Electric Generating Plant (1,200 curies).

Table 5–1
2004 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to EPA's Drinking Water Maximum Contaminant Levels (MCL)

		12-Month Average Concentration (pCi/mL)				
Nuclide	Curies Released	Below SRS[a]	BJWSA Chelsea[b]	BJWSA Purrysburg[b]	Port Wentworth[c]	EPA MCL
H-3	3.63E+03	6.61E-01	5.06E-01	6.10E-01	4.93E-01	2.00E+01
Sr-90	9.23E-02	1.68E-05	1.29E-05	1.55E-05	1.25E-05	8.00E-03
Tc-99	4.86E-03	8.85E-07	6.77E-07	8.17E-07	6.60E-07	9.00E-01
I-129	7.82E-02	1.42E-05	1.09E-05	1.31E-05	1.06E-05	1.00E-03
Cs-137	6.77E-02	1.23E-05	9.44E-06	1.14E-05	9.19E-06	2.00E-01
U-234	2.71E-04	4.93E-08	3.78E-08	4.55E-08	3.68E-08	1.87E+02
U-235	8.74E-06	1.59E-09	1.22E-09	1.47E-09	1.19E-09	6.48E-02
U-238	3.27E-04	5.95E-08	4.56E-08	5.49E-08	4.44E-08	1.01E-02
Pu-238	2.13E-04	3.88E-08	2.97E-08	3.58E-08	2.89E-08	1.50E-02
Pu-239	6.29E-05	1.15E-08	8.77E-09	1.06E-08	8.54E-09	1.50E-02
Am-241	4.33E-05	7.88E-09	6.04E-09	7.28E-09	5.88E-09	1.50E-02
Cm-244	1.52E-05	2.77E-09	2.12E-09	2.55E-09	2.06E-09	1.50E-02
Alpha	1.47E-02	2.68E-06	2.05E-06	2.47E-06	2.00E-06	1.50E-02
Beta	5.57E-02	1.01E-05	7.76E-06	9.36E-06	7.56E-06	8.00E-03

[a] Near Savannah River Mile 118.8, downriver of SRS at the U.S. Highway 301 bridge
[b] Beaufort-Jasper, South Carolina, drinking water
[c] Port Wentworth, Georgia, drinking water

Radionuclide Concentrations in Savannah River Water, Drinking Water, and Fish

For use in dose determinations and model comparisons, the concentrations of tritium in Savannah River water and cesium-137 in Savannah River fish are measured at several locations along the river. The amounts of all other radionuclides released from SRS are so small that they usually cannot be detected in the Savannah River using conventional analytical techniques.

Radionuclide Concentrations in River Water and Treated Drinking Water The measured concentrations of tritium in the Savannah River near River Mile 118.8 and at the Port Wentworth and BJWSA water treatment facilities are shown in table 5–1, as are the calculated concentrations for the other released radionuclides.

The 12-month average tritium concentration measured in Savannah River water near River Mile 118.8 (0.661 pCi/mL) was 12 percent less than the 2003 concentration of 0.749 pCi/mL. The concentrations at the BJSWA Chelsea (0.506 pCi/mL) and Port Wentworth (0.493 pCi/mL) water treatment plants remained below the EPA maximum contaminant level (MCL) of 20 pCi/mL. The new BJSWA Purrysburg facility began operation in February 2004, and the prorated 12-month average concentration was estimated to be 0.610 pCi/mL, which is below the tritium MCL.

The MCL for each radionuclide released from SRS during 2004 is provided in table 5–1. The table indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at River Mile 118.8, were below the MCLs.

Because more than one radionuclide is released from SRS, the sum of the fractions of the observed concentration of each radionuclide to its corresponding MCL must not exceed 1.0.

The sum of the fractions was 0.0390 at the BJSWA Chelsea facility, 0.0469 at the BJSWA Purrysburg facility, and 0.0379 at the Port Wentworth facility. These are below the 1.0 sum-of-the-fractions requirement.

For 2004, the sum of the fractions at the River Mile 118.8 location was 0.0509. This is provided only for comparison because River Mile 118.8 is not a community water system location.

Radionuclide Concentrations in River Fish At SRS, an important dose pathway for the maximally exposed individual is from the consumption of fish.

Fish exhibit a high degree of bioaccumulation for certain elements. 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 the concentration of cesium found in the water in which the fish live [Carlton et al, 1994].

Because of this high bioaccumulation factor, cesium-137 is more easily detected in fish flesh than in river water. Therefore, the fish pathway dose from cesium-137 normally is based directly on the radioanalysis of the fish collected near Savannah River Mile 118.8, which is the assumed location of the hypothetical maximally exposed individual. However, in 2004, the calculated concentration of cesium-137 in fish, which is based on measured effluent releases, was determined to be more than the actual measured concentrations in fish.

To be conservative, the higher calculated cesium-137 concentrations were used in the 2004 dose determinations.

Dose to the Maximally Exposed Individual

As shown in table 5–2, the highest potential dose to the maximally exposed individual from liquid releases in 2004 was estimated at 0.09 mrem (0.0009 mSv). This dose is 0.09 percent of the DOE Order 5400.5 ("Radiation Protection of the Public and the Environment") 100-mrem all-pathway dose standard for annual exposure and is 25 percent less than the 2003 dose of 0.12 mrem.

Approximately 42 percent of the dose to the maximally exposed individual resulted from the ingestion of cesium-137, mainly from the consumption of fish, and about 36 percent resulted from the ingestion (via drinking water) of tritium.

Drinking Water Pathway Persons downriver of SRS may receive a radiation dose by consuming drinking water that contains radioactivity as a result of liquid releases from the site. In 2004, tritium in downriver drinking water represented the majority of the dose (about 68 percent) received by persons at the three downriver water treatment plants.

The maximum potential drinking water dose during 2004 was determined to be about 0.04 mrem (0.0004 mSv) for the new BJWSA Purrysburg facility—the same as the maximum 2003 dose.

As shown in table 5–2, the maximum dose of 0.04 mrem (0.0004 mSv) is 1.0 percent of the DOE standard of 4 mrem per year for public water supplies. For comparison, in table 5–1, the BJWSA Purrysburg facility sum of the fractions equated to 4.7 percent of the EPA MCLs. The difference between the DOE and EPA drinking water standards is explained in the "Potential Dose" section of appendix A.

Table 5–2
Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 2004

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard
Maximally Exposed Individual			
Near Site Boundary (all liquid pathways)	0.09	100[a]	0.09
At BJSWA Chelsea (public water supply only)	0.03	4[b]	0.75
At BJSWA Purrysburg (public water supply only)	0.04	4[b]	1.00
At Port Wentworth (public water supply only)	0.03	4[b]	0.75

[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)

Collective (Population) Dose

The collective drinking water consumption dose is calculated for the discrete population groups served by the BJWSA and Port Wentworth water treatment plants. The collective dose from other pathways is calculated for a diffuse population that makes use of the Savannah River. However, this population cannot be described as being in a specific geographical location.

In 2004, the collective dose from SRS liquid releases was estimated at 3.1 person-rem (0.031 person-Sv). This was 7 percent more than the 2003 collective dose of 2.9 person-rem (0.029 person-Sv). This increase was due to the increased population served by the BJWSA and Port Wentworth water treatment facilities.

Potential Dose from Agricultural Irrigation

Based on surveys of county agricultural extension agencies, there are no known large-scale uses of river water downstream of SRS for agricultural irrigation purposes. However, the potential for irrigation does exist, so potential doses from this pathway are calculated for information purposes only but are not included in calculations of the official maximally exposed individual or collective doses.

For 2004, a potential offsite dose of 0.08 mrem (0.0008 mSv) to the maximally exposed individual and a collective dose of 5.6 person-rem (0.056 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. It is assumed that all the food produced on the 1,000-acre parcels is consumed by the 80-km population of 713,500.

Air Pathway

Atmospheric Source Terms

The 2004 radioactive atmospheric release quantities used as the source term in SRS dose calculations are discussed in chapter 3.

Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required, for demonstrating compliance with NESHAP regulations.

Atmospheric Concentrations

Calculated radionuclide concentrations are used for dose determinations instead of measured concentrations. This is because most radionuclides released from SRS cannot be measured, using standard methods, in the air samples collected at the site perimeter and offsite locations. However, the concentrations of tritium oxide at the site perimeter locations usually can be measured and are compared with calculated concentrations as a verification of the dose models, as shown in data tables on the CD accompanying this report.

Dose to the Maximally Exposed Individual

In 2004, the estimated dose from atmospheric releases to the maximally exposed individual was 0.06 mrem (0.0006 mSv), which is 0.6 percent of the DOE Order 5400.5 air pathway standard of 10 mrem per year. This dose was slightly less than the 2003 dose of 0.07 mrem (0.0007 mSv). This decrease is attributed to a reduction in releases from H-Area, caused by reduced operations in H-Canyon during 2004. Table 5–3 compares the maximally exposed individual's dose with the DOE standard.

Tritium oxide releases accounted for about 74 percent of the dose to the maximally exposed individual. Iodine-129 emissions accounted for 10 percent of the maximally exposed individual dose, and unspecified alpha emissions accounted for 4 percent. Nearly all the unspecified alpha releases were estimated to be from diffuse and fugitive sources (chapter 3).

The potential dose to the maximally exposed individual residing at the site boundary for each of the 16 major compass point directions around SRS can be found in the "Maps" appendix (figure 12) on the CD accompanying this report. For 2004, the due-north sector of the site was the location of the highest dose to the maximally exposed individual.

The major pathways contributing to the dose to the maximally exposed individual from atmospheric releases were inhalation (43 percent) and the consumption of vegetation (39 percent), cow milk (11 percent), and meat (4 percent).

Additional calculations of the dose to the maximally exposed individual were performed substituting goat milk for the customary cow milk pathway. The potential dose using the goat milk pathway was estimated at 0.06 mrem (0.0006 mSv).

Collective (Population) Dose

In 2004, the collective dose was estimated at 2.9 person-rem (0.029 person-Sv)—less than 0.01 percent of the collective dose received from natural sources of radiation (about 214,000 person-rem).

Tritium oxide releases accounted for about 77 percent of the collective dose. The 2004 collective dose was 22 percent less than the 2003 collective dose of 3.6 person-rem (0.036 person-Sv).

NESHAP Compliance

To demonstrate compliance with NESHAP regulations, maximally exposed individual and collective doses were calculated, and a percentage of dose contribution from each radionuclide was determined using the CAP88 computer code [EPA, 1999a].

The CAP88 code estimates a higher dose for tritium oxide than do the MAXDOSE–SR and POPDOSE–SR codes, which are used for showing compliance with DOE environmental orders [SRS EM Program, 2001]. 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 MAXDOSE–SR and POPDOSE–SR codes use 50-percent equilibrium values, as recommended by the Nuclear Regulatory Commission [NRC, 1977]. A site-specific study indicated that the 50-percent value is correct for the atmospheric conditions at SRS [Hamby and Bauer, 1994].

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

The maximally exposed individual dose was estimated at 0.06 mrem (0.0006 mSv), which is 0.6 percent of the 10-mrem-per-year EPA standard, as shown in table 5–3. Tritium oxide releases accounted for about 93 percent of this dose.

The CAP88-determined collective dose was estimated at 6.8 person-rem (0.068 person-Sv). Tritium oxide releases also accounted for about 94 percent of this dose.

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 2004, the potential maximally exposed individual all-pathway dose was 0.15 mrem (0.0015 mSv)—0.06 mrem from airborne pathways plus 0.09 mrem from liquid pathways—and was 0.15 percent of the 100-mrem-per-year DOE dose standard. This dose was 21 percent less than the 2003 all-pathway dose of 0.19 mrem (0.0019 mSv).

Figure 5–1 shows a 10-year history of SRS's all-pathway doses (airborne pathway plus liquid pathway doses to the maximally exposed individual).

Sportsman Dose

DOE Order 5400.5 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem per year 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.

In addition to deer, hog, and fish consumption, the following exposure pathways were considered for an offsite hunter and an offsite fisherman—both on Creek Plantation, a privately owned portion of the Savannah River Swamp, which was contaminated by SRS operations in the 1960s (chapter 4):

Table 5–3
Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 2004

	MAXDOSE–SR	CAP88 (NESHAP)
Calculated dose (mrem)	0.06	0.06
Applicable standard (mrem)	10[a]	10[b]
Percent of standard	0.6	0.6

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

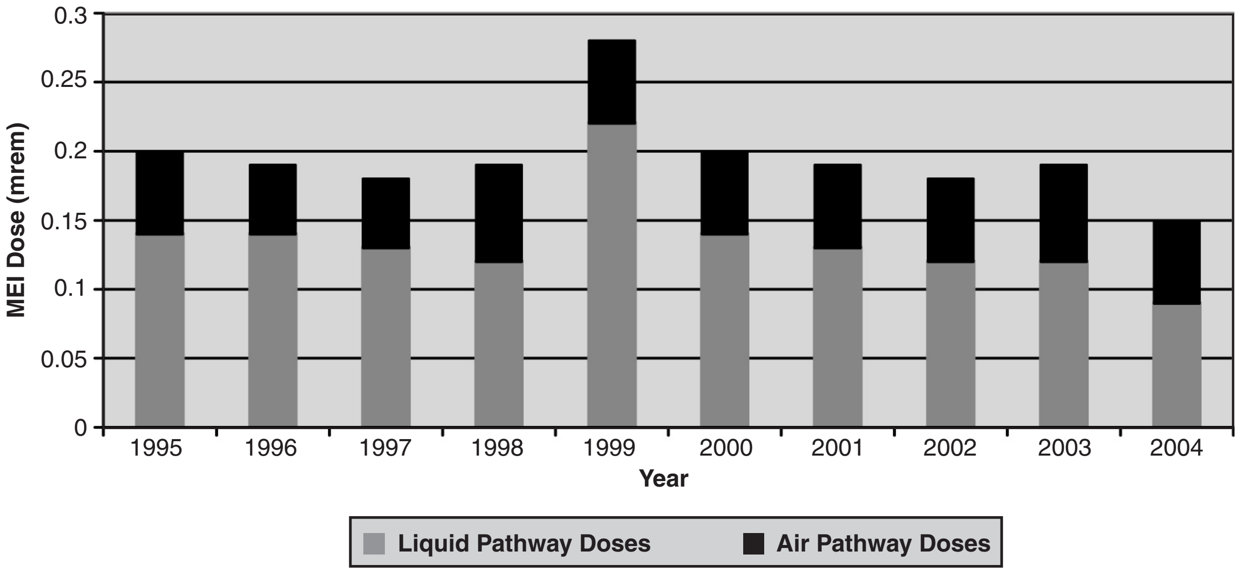


Figure 5–1 Ten-Year History of SRS Maximum Potential All-Pathway Doses

- External exposure to contaminated soil
- Incidental ingestion of contaminated soil
- Incidental inhalation of resuspended contaminated soil

Onsite Hunter Dose

Deer and Hog Consumption Pathway The estimated dose from consumption of the harvested deer or hog meat is determined for every onsite hunter.

During 2004, the maximum potential dose that could have been received by an actual onsite hunter was estimated at 70.8 mrem (0.708 mSv), or 70.8 percent of DOE's 100-mrem all-pathway dose standard (table 5–4). This dose was determined for a prolific hunter who in fact harvested five deer during the 2004 hunts. The hunter-dose calculation is based on the conservative assumption that this hunter individually consumed the entire edible portion—approximately 111 kg (244 pounds)—of the deer he harvested from SRS.

Offsite Hunter Dose

Deer and Hog Consumption Pathway The deer and hog consumption pathway considered was for hypothetical offsite individuals whose entire intake of meat during the year was either deer or hog meat. It was assumed that these individuals harvested deer or hogs that had resided on SRS, but then moved off site.

Based on these low-probability assumptions and on the measured average concentration of cesium-137 in all deer (5.26 pCi/g) and hogs (3.14 pCi/g) harvested from SRS during 2004, the potential maximum doses from this pathway were estimated at 17.3 mrem (0.173 mSv) for the deer hunter and at 8.67 mrem (0.0867 mSv) for the hog hunter.

A background cesium-137 concentration of 1 pCi/g is subtracted from the onsite average concentrations before calculating the doses. The background concentration is based on previous analyses of deer harvested 80 km from SRS (table 33, *SRS Environmental Data for 1994,* WSRC–TR–95–077).

Savannah River Swamp Hunter Soil Exposure Pathway The potential dose to a recreational hunter exposed to SRS legacy contamination in Savannah River Swamp soil on the privately owned Creek Plantation in 2004 was estimated using the RESRAD dosimetry code (DOE Order 5400.5). It was assumed that this recreational sportsman hunted for 120 hours during the year (8 hours per day for 15 days) at the location of maximum radionuclide contamination.

Using the worst-case radionuclide concentrations from the most recent comprehensive survey—conducted in 2000—the potential dose to a hunter from a combination of (1) external exposure to the contaminated soil, (2) incidental ingestion of the soil, and (3) incidental inhalation of resuspended soil was estimated to be 4.4 mrem (0.044 mSv).

As shown in table 5–4, the offsite deer consumption pathway and the Savannah River Swamp hunter soil exposure pathway were conservatively added together to obtain a total offsite hunter dose of 21.7 mrem (0.217 mSv). This potential dose is 21.7 percent of the DOE 100-mrem all-pathway dose standard.

Offsite Fisherman Dose

Creek Mouth Fish Consumption Pathway For 2004, radioanalyses were conducted of fish taken from the mouths of five SRS streams, and the subsequent estimated doses were calculated. As shown in table 5–4, the maximum potential dose from this pathway was estimated at 0.97 mrem (0.0097 mSv) from the consumption of bass collected at the mouth of Four Mile Creek. This hypothetical dose is based on the low-probability scenario that, during 2004, a fisherman consumed 19 kg of bass caught exclusively from the mouth of Four Mile Creek. About 98 percent of this potential dose was from cesium-137.

Savannah River Swamp Fisherman Soil Exposure Pathway The potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately owned Creek Plantation in 2004 was estimated using the RESRAD dosimetry code. It was assumed that this recreational sportsman fished on the South Carolina bank of the Savannah River near the mouth of Steel Creek for 250 hours during the year.

During the comprehensive survey of the Savannah River Swamp conducted in 2000, the location on Creek Plantation that was closest to the South Carolina bank of the Savannah River and the mouth of Steel Creek was on trail 1, at a distance of 0 feet from the Savannah River.

Using the radionuclide concentrations measured at this location, the potential dose to a fisherman from a combination of (1) external exposure to the contaminated soil, (2) incidental ingestion of the soil, and (3) incidental inhalation of resuspended soil was estimated to be 0.54 mrem (0.0054 mSv).

As shown in table 5–4, the maximum Steel Creek mouth fish consumption dose (0.17 mrem) and the Savannah River Swamp fisherman soil exposure pathway were conservatively added together to obtain a

Table 5–4
2004 Maximum Potential All-Pathway and Sportsman Doses Compared to the DOE All-Pathway Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard
Maximally Exposed Individual Dose			
All-Pathway (Liquid Plus Airborne Pathway)	0.15	100	0.15
Sportsman Doses			
Onsite Hunter	70.8	100	70.8
Creek Mouth Fisherman[b]	0.97	100	0.97
Savannah River Swamp Hunter			
Offsite Deer Consumption	17.3		
Offsite Hog Consumption	8.67		
Soil Exposure[c]	4.4		
Total Offsite Deer Hunter Dose	21.7	100	21.7
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.17		
Soil Exposure[d]	0.54		
Total Offsite Fisherman Dose	0.71	100	0.71

[a] All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)
[b] In 2004, the maximum fisherman dose was caused by the consumption of bass from the mouth of Four Mile Creek.
[c] Includes the dose from a combination of external exposure to—and incidental ingestion and inhalation of—the worst-case Savannah River Swamp soil
[d] Includes the dose from a combination of external exposure to—and incidental ingestion and inhalation of—Savannah River Swamp soil near the mouth of Steel Creek

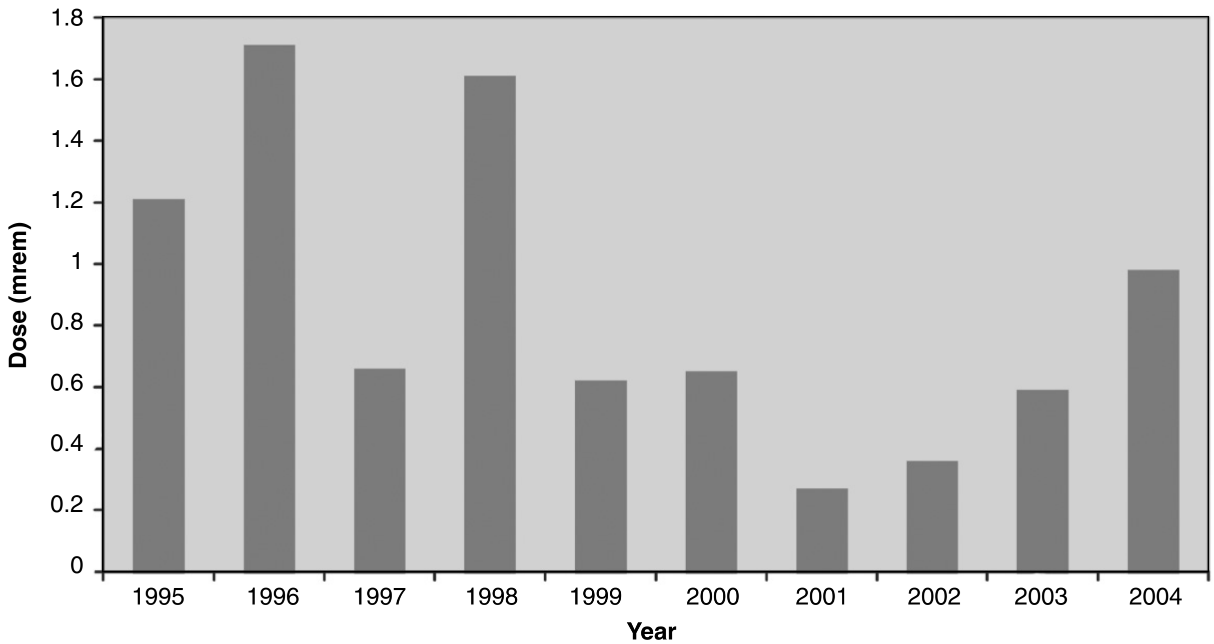


Figure 5–2 Ten-Year History of SRS Creek Mouth Fisherman's Dose

total offsite creek mouth fisherman dose of 0.71 mrem (0.0071 mSv). This potential dose is 0.71 percent of the DOE 100-mrem all-pathway dose standard.

Potential Risk from Consumption of SRS Creek Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed—in conjunction with EPA, the Georgia Department of Natural Resources, and the South Carolina Department of Health and Environmental Control—the *Westinghouse Savannah River Company/Environmental Monitoring Section Fish Monitoring Plan*, which is summarized in SRS EM Program, 2001. Among the reporting requirements of this plan are (1) assessing radiological risk from the consumption of Savannah River fish and (2) presenting a summary of the results in the annual *SRS Environmental Report*.

Risk Comparisons For 2004, the maximum potential radiation doses and lifetime risks from the consumption of SRS creek mouth fish for 1-year, 30-year, and 50-year exposure durations are shown in table 5–5 and are compared to the radiation risks associated with the DOE Order 5400.5 all-pathway dose standard of 100 mrem (1.0 mSv) per year.

The potential risks were estimated using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 [EPA, 1999b].

For 2004, the maximum recreational fisherman dose was caused by the consumption of bass collected at the mouth of Four Mile Creek.

Figure 5–2 shows a 10-year history of the annual potential radiation doses from consumption of Savannah River fish. No apparent trends can be discerned from these data. This is because there is large variability in the annual strontium-90 and cesium-137 concentrations measured in fish from the same location due to differences in

- the size of the fish collected each year
- their mobility and location within the stream mouth from which they are collected
- the time of year they are collected
- the amount of strontium-90 and cesium-137 available in the water and sediments at the site stream mouths—caused by annual changes in stream flow rates (turbulence) and water chemistry

As indicated in table 5–5, the 50-year maximum potential lifetime risk from consumption of SRS creek mouth fish was 3.6E-05, which is below the 50-year risk (3.7E-03) associated with the 100-mrem-per-year dose standard. According to EPA practice, if a potential lifetime risk is calculated to be less than 1.0E-06 (i.e., one additional case of cancer over what would be expected in a group of 1,000,000 people), then the risk is considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is more than 1.0E-04 (one additional case of cancer in a population of 10,000), then some form of corrective action or remediation usually is required. However, if a calculated risk falls between 1.0E-04 and 1.0E-06, which is the case with the maximum potential lifetime risks from the consumption of Savannah River fish, then the risks are considered acceptable if they are kept as low as reasonably achievable (ALARA).

At SRS, the environmental ALARA program [SRS EM Program, 2001] is in place to ensure that the potential risk from site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) is kept ALARA.

Radiation Dose to Aquatic and Terrestrial Biota

DOE Order 5400.5 establishes an interim dose standard for protection of native aquatic animals. The absorbed dose limit to these organisms is 1.0 rad per day (0.01 Gy per day) from exposure to radioactive material in liquid effluents released to natural waterways.

DOE Biota Concentration Guides

For 2004, a screening of biota doses at SRS was performed using the RESRAD-Biota model, which is based on the DOE standard entitled *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* [DOE, 2002].

The aquatic systems evaluation includes exposures to primary (herbivores) and secondary (predators) aquatic animals, and the biota concentration guides (BCGs) are based on the 1.0-rad-per-day dose limit. Aquatic plants are not considered.

The terrestrial systems evaluation includes exposures to terrestrial plants and animals and is based on a 10-rad-per-day dose limit for plants and a 0.1-rad-per-day dose limit for animals. For the aquatic systems evaluation portion of the BCGs, an initial screening was performed using maximum radionuclide concentration data for the 10 Environmental Monitoring and Analysis (EMA) stream sampling locations from which co-located water and sediment samples are collected. An exception to this was made for sample location FM–2B (located on Four Mile Creek between F-Area and H-Area) because of its historically high cesium and tritium concentration levels. This location was included in the initial screening even though no co-located sediment sample is collected there.

The combined water-plus-sediment BCG sum of the ratios was used for the aquatic systems evaluation. A

Table 5–5
Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards

	Committed Dose (mrem)	Potential Risk[a] (unitless)
2004 Savannah River Fish		
1-Year Exposure	0.96	7.2E-07
30-Year Exposure	28.8	2.2E-05
50-Year Exposure	48.0	3.6E-05
Dose Standard		
100-Mrem/Year All Pathway		
1-Year Exposure	100	7.3E-05
30-Year Exposure	3,000	2.2E-03
50-Year Exposure	5,000	3.7E-03

[a] It should be noted that all radiological risk factors are based on observed and documented health effects to actual people who have received high doses (more than 10,000 mrem) of radiation, such as the Japanese atomic bomb survivors. Radiological risks at low doses (less than 10,000 mrem) are theoretical and are estimated by extrapolating the observed health effects at high doses to the low-dose region by using a linear, no-threshold model. However, cancer and other health effects have not been observed consistently at low radiation doses because the health risks either do not exist or are so low that they are undetectable by current scientific methods.

sum of the ratios less than one indicates the sampling site has passed the initial pathway screen.

For the terrestrial systems evaluation portion of the BCGs, an initial screening was performed using concentration data from the five EMA onsite radiological soil sampling locations. Only one soil sample per year is collected from each location.

For 2004, stream sampling locations R–1 (located adjacent to R-Reactor near the center of SRS), FM–2, and FM–2B failed the initial aquatic systems screen. These locations failed because of relatively high maximum concentrations of cesium-137 in the water and sediment samples. All other locations, including the five soil sampling locations, passed.

For the three locations that failed, an additional assessment was performed using annual average radionuclide concentrations measured in the water and sediment samples. All locations passed this secondary screen (the sum of the ratios of each was less than 1.0).

Chapter 4

Environmental Surveillance

Pete Fledderman, Donald Padgett, and Monte Steedley
Environmental Services Section

Timothy Jannik
Savannah River National Laboratory

Robert Turner
Site Utilities Department

ENVIRONMENTAL surveillance at the Savannah River Site (SRS) is designed to survey and quantify any effects that routine and nonroutine operations could have on the site and on the surrounding area and population. Site surveillance activities are divided into radiological and nonradiological programs.

As part of the radiological surveillance program, routine surveillance of all radiation exposure pathways is performed on all environmental media that could lead to a measurable annual dose at and beyond the site boundary.

Nonradioactive environmental surveillance at SRS involves the sampling and analysis of surface water, drinking water, sediment, groundwater, and fish. Results from the analyses of surface water, drinking water, sediment, and fish are discussed in this chapter. A description of the groundwater monitoring program analysis results can be found in chapter 6, "Groundwater."

The Environmental Services Section's Environmental Monitoring and Analysis (EMA) group and the Savannah River National Laboratory (SRNL) perform surveillance activities. The Savannah River also is monitored by other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC), the Georgia Department of Natural Resources, and the Academy of Natural Sciences (ANS).

A complete description of the EMA surveillance program, including sample collection and analytical procedures, 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). Brief summaries of analytical results are presented in this chapter; complete data sets can be found in tables on the CD accompanying this report.

Radiological Surveillance

Air

Description of Surveillance Program

EMA maintains a network of sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate materials in the air.

Surveillance Results Summary

Except for tritium, specific radionuclides were not routinely detectable at the site perimeter. Both onsite and offsite activity concentrations were similar to levels observed in previous years.

Average gross alpha and beta results were slightly higher in 2004 than in 2003. However, they are consistent with historical results, which demonstrate long-term variability.

No detectable manmade gamma-emitting radionuclides were observed in 2004. These results are consistent with historical results, which indicate only a small number of samples with detectable activity.

Detectable levels of uranium-234 and uranium-238, were observed in all samples in 2004. Also, the SRS Environmental and Bioassay Laboratory (EBL) implemented changes in the method used to determine detectable activity in samples analyzed by alpha spectrometry. This resulted in a greater number of samples indicating detected activity; however, the concentrations of the uranium isotopes were similar to those observed in 2003. Aside from uranium, alpha-emitting radionuclide activity was observed in three samples. Americium-241 was detected at one location on the site perimeter, and curium-244 was detected at two onsite locations. Generally, these concentrations were consistent with historical results. All isotopes at the remaining locations were below detection levels. As observed in previous years, none of the samples showed strontium-89,90 above their minimum detectable concentration (MDC).

Tritium-in-air results for 2004 were similar to those observed in 2003. Tritium was detected at every sampling location, although not every sample from a particular location had detectable tritium. As in previous years, the Burial Ground North location showed average and maximum concentrations significantly higher than those observed at other locations. This was expected because of its proximity to SRS's tritium facilities, which are near the center of the site. Consistent with the SRS source term, tritium concentrations generally decrease with increasing distance from the tritium facilities.

Rainwater

Description of Surveillance Program

SRS maintains a network of rainwater sampling sites as part of the air surveillance program. These stations are used to measure deposition of radioactive materials.

Surveillance Results Summary

Gamma-Emitting Radionuclides No detectable manmade gamma-emitting radionuclides were observed in rainwater samples in 2004.

Gross alpha and gross beta results from 2004 were consistent with those of 2003. The 2004 gross alpha results generally were slightly higher than those of 2003, while the 2004 gross beta results generally were slightly lower. However, no long-term increasing or decreasing trend was evident, which implies that the observed values are natural background and does not indicate any contribution directly attributable to SRS.

Detectable levels of uranium-234 and uranium-238 were present in most samples. Generally, the uranium concentrations were slightly higher than those observed in 2003. As previously documented, this is the result of changes to the processing of alpha spectrometry results by EBL. Except for plutonium-238 at one location, all other actinides were below detection levels in 2004.

As in 2003, no detectable levels of strontium-89,90 were observed in rainwater samples during 2004.

As in previous years, tritium-in-rain values were highest near the center of the site. This is consistent with the H-Area effluent release points that routinely release tritium. Tritium was detected at every sampling location, although not every sample from a particular location had detectable tritium. As with tritium in air, concentrations generally decreased as distance from the effluent release point increased.

Gamma Radiation

Description of Surveillance Program

Ambient gamma exposure rates in and around SRS are monitored by a network of thermoluminescent dosimeters (TLDs).

Surveillance Results Summary

Exposures at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma exposure levels. Exposure rates varied between 54 and 112 mrem per year.

In general, the 2004 ambient gamma radiation monitoring results indicated gamma exposure rates slightly lower than those observed at the same locations in 2003. However, these results generally are consistent with previously published historical results, and indicate that no significant difference in average exposure rates is observed between monitoring networks—except in the case of population centers, where exposure rates are slightly elevated compared to the other monitoring networks.

E-Area Stormwater Basins

Description of Surveillance Program

Stormwater accumulating in the E-Area stormwater basins is monitored because of potential contamination.

Surveillance Results Summary

There are no active discharges to the E-Area stormwater basins. The primary contributor to basin water is rainwater runoff. Rain events did not supply enough water to the E–03 and E–06 basins for sampling purposes in 2004, when the highest E-Area basin mean tritium concentration was 7.06E+04 pCi/L. This activity was detected in basin E–05 and is attributed to operations at the nearby Four Mile Creek phytoremediation project. The concentration is 45-percent lower than 2003's high mean tritium concentration, which occurred at the same location. Mean cobalt-60, cesium-137, gross alpha, gross beta, and actinides concentrations all were below their respective MDCs.

Site Streams

Description of Surveillance Program

Continuous surveillance is used on several SRS streams to monitor downstream of process areas and to detect and quantify levels of radioactivity in liquid effluents transported to the Savannah River.

Surveillance Results Summary

Based on the past 5 years of data, the tritium concentrations for the five major SRS streams continue to remain constant (Steel Creel and Lower Three Runs) or in a downward trend (Upper Three Runs, Four Mile Creek, and Pen Branch).

No significant concentrations of cobalt-60 and cesium-137 were recorded at the farthest downstream locations on each of the five major SRS streams.

All the stream technetium-99 results were below their MDC. Iodine-129 was detected at one Four Mile Creek location, but the result was barely above its MDC.

Uranium-234 was detected at the farthest downstream sampling points on Steel Creek and Upper Three Runs, but the results were lower than in 2003. Uranium-238 was detected at the final sampling points of Four Mile and Upper Three Runs, and likewise the results were lower than 2003's. The uranium-238 detected at Pen Branch was slightly elevated over the previous five years' results, but was similar to historical values. The strontium-89,90 results recorded at the farthest downstream sampling point of Four Mile Creek continue a downward trend. No actinides were detected at the farthest downstream sampling point of Lower Three Runs.

At the U3R–1A control point location, the gross alpha and beta concentrations were elevated over those of 2003. A 2002 investigation proved inconclusive for rising gross alpha and beta concentrations at the control point, and no offsite activities were identified that would have affected the gross alpha and beta results. Cobalt-60 and cesium-137 concentrations were below their MDCs at U3R–1A in 2004, and all tritium concentrations were below detection.

Gross alpha and beta concentrations also were elevated in four of the five major streams. Upper Three Runs was the stream showing the lowest concentrations.

Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, EMA monitored and quantified the migration of radioactivity from site seepage basins and the Solid Waste Disposal Facility (SWDF) in 2004 as part of its stream surveillance program. During 2004, tritium, strontium-89,90, technetium-99, and cesium-137 were detected in migration releases. Measured iodine-129 results, however, all were below their MDC. Therefore, the amount of iodine-129 last measured in 1996, using ultra low-level detection methods, was used for dose calculations.

Figure 4–1 is a graphical representation of releases of tritium via migration to site streams for the years 1995–2004. During 2004, the total quantity of tritium migrating from site seepage basins and SWDF was 1,927 Ci, compared to 2,783 Ci in 2003. This decrease is attributed primarily to the decrease in rainfall in 2004, compared to 2003.

Radioactivity previously deposited in the F-Area and H-Area seepage basins and SWDF continues to migrate via the groundwater and to outcrop into Four Mile Creek and into Upper Three Runs.

Measured migration of tritium into Four Mile Creek in 2004 occurred as follows:

- from F-Area seepage basins, 526 Ci—a 5-percent decrease from the 2003 total of 555 Ci
- from H-Area seepage basin 4 and SWDF, 253 Ci—a 35-percent decrease from the 2003 total of 390 Ci
- from H-Area seepage basins 1, 2, and 3, 211 Ci—a 5-percent increase from the 2003 total of 206 Ci

The measured migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2004 was 215 Ci, a 53-percent decrease from the 2003 total of 462 Ci. (The GSA is in the central part of SRS and contains all waste disposal facilities, chemical separations facilities, associated high-level waste storage facilities, and numerous other sources of radioactive material.)

The total amount of strontium-89,90 entering Four Mile Creek from the GSA seepage basins and SWDF during 2004 was estimated to be 91.5 mCi—similar to the 2003 level of 94.1 mCi. Migration releases of strontium-89,90 vary from year to year but have remained below 100 mCi the past 5 years (see data table on CD accompanying this report).

In addition, a total of 29.2 mCi of cesium-137 was estimated to have migrated from the GSA seepage basins and SWDF in 2004. This was a decrease of 58 percent from the 2003 total of 69.8 mCi.

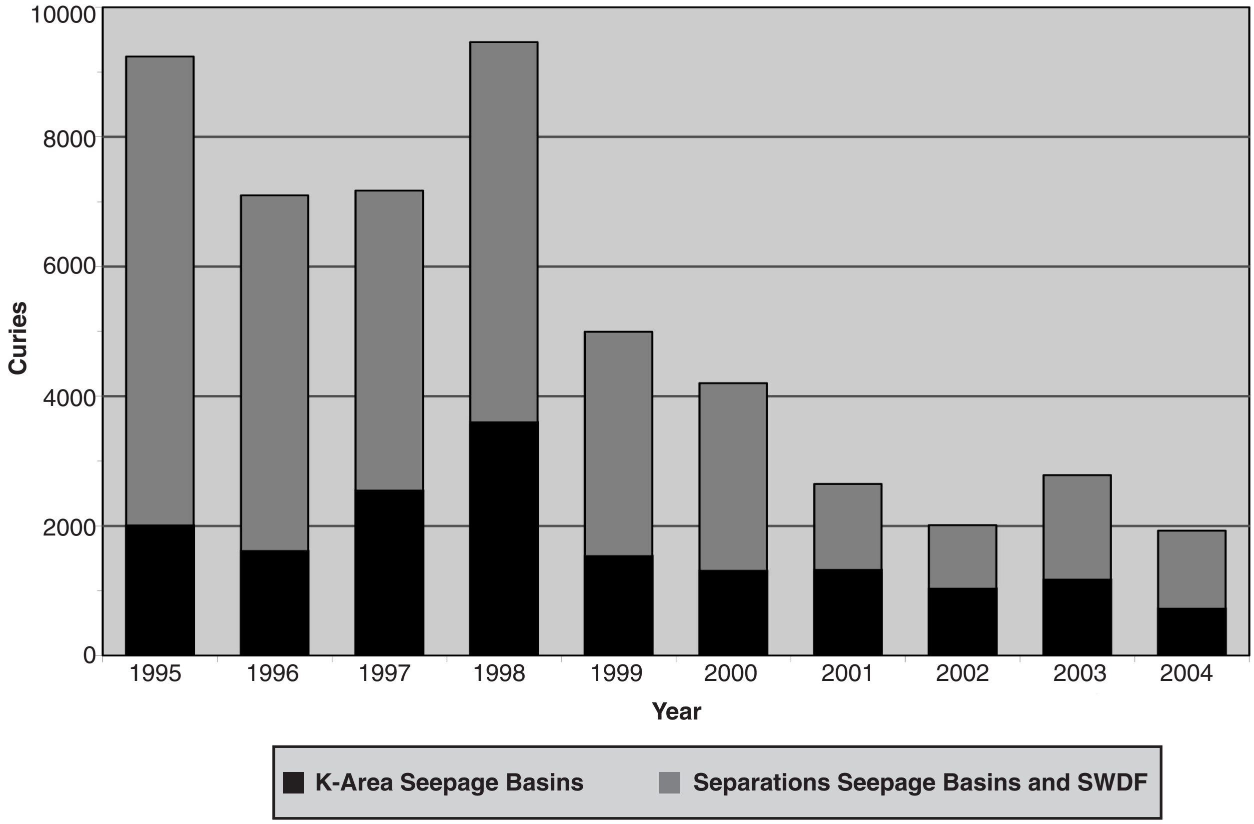


Figure 4–1 Tritium from SRS Seepage Basins and SWDF to Site Streams, 1995–2004

In 2004, 4.86 mCi of technetium-99 was estimated to have migrated into Four Mile Creek. As discussed previously, iodine-129 was not detected in Four Mile Creek during 2004.

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. From 1960 until 1992, purges from the K-Area disassembly basin were discharged to a percolation field below the K-Area retention basin. Tritium migration from the seepage basin and the percolation field is measured in Pen Branch. The 2004 migration total of 722 Ci represents a 38-percent decrease from the 1,170 Ci recorded in 2003.

C-Area, L-Area, and P-Area Seepage Basins Liquid purges from the C-Area, L-Area, and P-Area disassembly basins were released periodically to their respective seepage basins from the 1950s until 1970.

Migration releases from these basins no longer are quantified; however, they are accounted for in the stream transport totals.

Transport of Actinides in Streams

Uranium, plutonium, americium, and curium are analyzed annually from each stream location. Values for 2004 were consistent with historical data.

Savannah River

Description of Surveillance Program

Continuous surveillance is performed along the Savannah River at points above and below SRS and includes the point at which liquid discharges from Georgia Power Company's Vogtle Electric Generating Plant enter the river.

Surveillance Results Summary

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The annual mean tritium concentration at RM–118.8 in 2004 was about 3 percent of the drinking water standard.

The average gross alpha concentrations at all river locations were below the representative MDC in 2004.

The average gross beta concentrations were slightly above the representative MDC, but were similar at all locations, indicating that there was no significant release of beta-emitting nuclides attributable to SRS discharges.

Except for tritium, as indicated above, no manmade radionuclides were detected in Savannah River water.

Tritium Transport in Streams

Tritium is introduced into SRS streams and the Savannah River from former production areas on site. Because 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 and SWDF 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)

The combined tritium releases in 2004 (direct discharges and migration from seepage basins and SWDF) totaled 2,683 Ci, compared to 4,319 Ci in 2003, a decrease of about 60 percent.

During 2004, the total tritium transport in SRS streams decreased by approximately 33 percent (from 4,139 Ci in 2003 to 2,785 Ci in 2004).

EMA has been conducting a study of tritium flux in Lower Three Runs, including sampling on Lower Three Runs tributaries as well as discussions with Chem-Nuclear Systems, LLC (CNS). The result of this study, supported by both EMA and CNS data, indicated a small but measurable amount of tritium entering the Lower Three Runs system from previous CNS operations. This is expected to decline slowly. EMA and CNS will continue to monitor the Lower Three Runs system.

The 2004 measured tritium transport in the Savannah River (3,630 Ci) was more than the stream transport total. Most of this difference is attributed to Plant Vogtle's 2004 tritium releases, which totaled approximately 1,200 Ci.

SRS tritium transport data for 1960–2004 are depicted in figure 4–2, which shows summaries of the past 45 years of direct releases, stream transport, and river transport, as determined by EMA.

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 the determination of water flow rates and of varying transport times.

Domestic and Drinking Water

Description of Surveillance Program

EMA collected domestic and drinking water samples in 2004 from locations at SRS and at water treatment facilities that use Savannah River water. Potable water was analyzed at offsite treatment facilities to ensure that SRS operations did not adversely affect the water supply and to provide voluntary assurance that drinking water did not exceed EPA drinking water standards for radionuclides.

Onsite domestic water sampling consisted of quarterly grab samples at large treatment plants in A-Area, D-Area, and K-Area and annual grab samples at wells and small systems. Collected monthly off site were composite 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

Surveillance Results Summary

All domestic and drinking water samples collected by EMA were screened for gross alpha and gross beta concentrations to determine if activity levels warrant further analysis. No domestic water used for drinking purposes exceeded EPA's 1.50E+01-pCi/L alpha activity limit or 5.00E+01-pCi/L beta activity limit. Also, no onsite or offsite domestic or drinking water samples exceeded the 2.00E+04-pCi/L EPA tritium limit, and no domestic or drinking water samples exceeded the strontium 89,90 MDC.

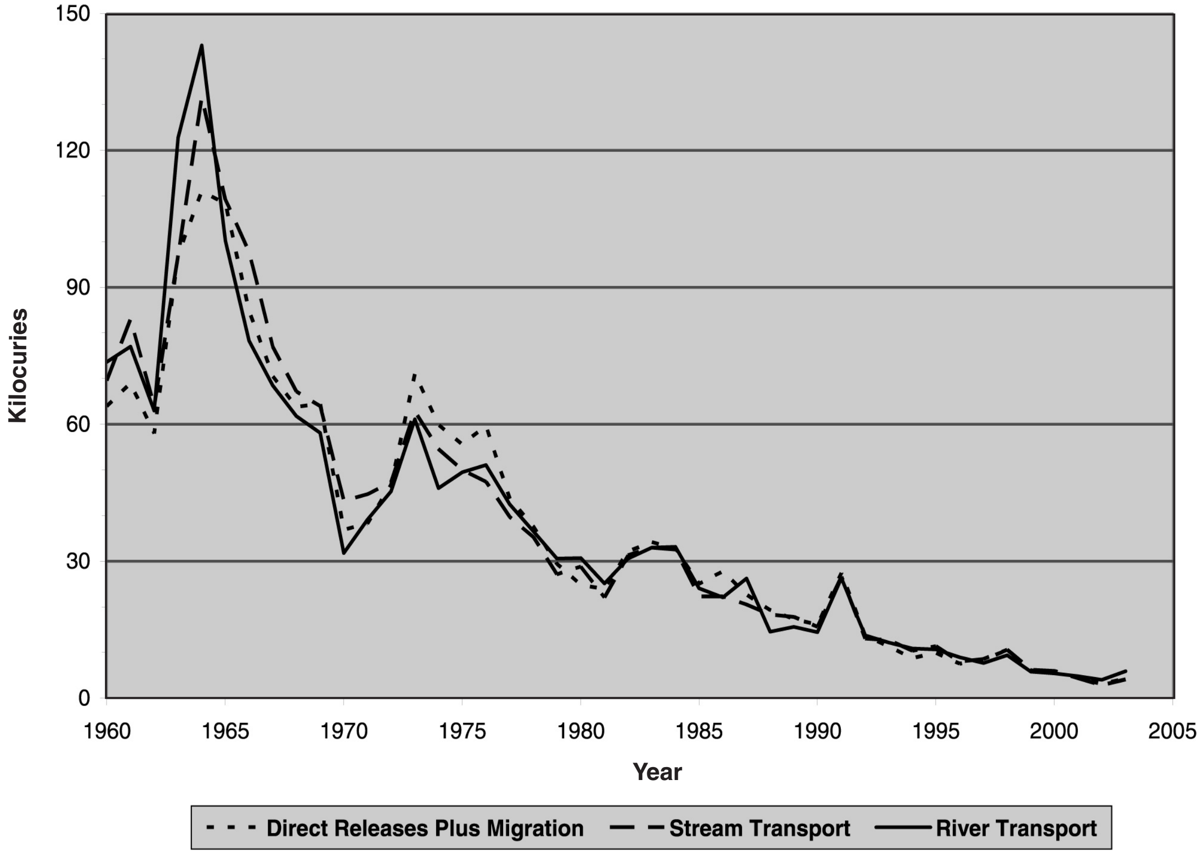


Figure 4–2 SRS Tritium Transport Summary, 1960–2004

SRS has maintained a tritium balance of direct releases plus migration, 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 trend over time is attributable to (1) variations in tritium production at the site (production stopped in the late 1980s); (2) the implementation of effluent controls, such as seepage basins, beginning in the early 1960s; and (3) the continuing depletion and decay of the site's tritium inventory.

No cobalt-60, cesium-137, or plutonium-239 was detected in any domestic or drinking water samples. In general, uranium isotopes, plutonium-238, curium-244, and americium-241 were not detected, although samples from a few locations showed detectable levels of these nuclides.

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). These food products include meat (beef), fruit, and green vegetables (collards). Data from the food product surveillance program are not used to show direct compliance with any dose standard; however, the data can be used as required to verify dose models and determine environmental trends.

Samples of food—including meat (beef), fruit (melons or peaches), and a green vegetable (collards)—are collected from one location within each of four quadrants and from a control location within an extended (to 25 miles beyond the perimeter) southeast quadrant. All food samples are collected annually except milk.

Food samples are analyzed for the presence of gamma-emitting radionuclides, tritium, strontium-89,90, plutonium-238, and plutonium-239.

Surveillance Results Summary

The only manmade gamma-emitting radionuclide detected in food products in 2004 was cesium-137, which was found in collards from five sampling locations, milk at one location, and fruit at one location. Strontium-89,90 was detected in collards at two locations, while tritium was detected in collards and milk at one location. Plutonium-238 was found slightly above its MDC in beef at one location. No other manmade radionuclides were detected in food products.

Tritium in milk and other samples is attributed primarily to releases from SRS. Tritium concentrations in collards and milk were similar to those of previous years. No tritium was detected in any other food sample.

These results are similar to those of previous years.

Aquatic Food Products

Description of Surveillance Program

The aquatic food product surveillance program includes fish (freshwater and saltwater) and shellfish. To determine the potential dose and risk to the public from consumption, both types are sampled.

Nine surveillance points for the collection of freshwater fish are located on the Savannah River—from above SRS at Augusta, Georgia, to the coast at Savannah, Georgia.

Surveillance Results Summary

Cesium-137 was the only manmade gamma-emitting radionuclide found in Savannah River edible composites. Strontium-89,90 and tritium were detected at most of the river locations. No manmade radionuclides were detected in saltwater fish or shellfish. These results were similar to those of previous years.

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, EMA uses portable sodium iodide detectors to perform field analysis for cesium-137. Media samples (muscle and/or bone) are collected periodically for laboratory analysis based on a set frequency, on cesium-137 levels, and/or on exposure limit considerations.

Surveillance Results Summary

A total of 817 deer and 213 feral hogs were taken during the 2004 site hunts. As observed during previous hunts, cesium-137 was the only manmade gamma-emitting radionuclide detected during laboratory analysis. Generally, the cesium-137 concentrations measured by the field and lab methods were comparable. Field measurements from all animals ranged from 1 pCi/g to 48.3 pCi/g, while lab measurements ranged from 1 pCi/g to 32.4 pCi/g. The average field cesium-137 concentration was 1.16 pCi/g in deer (with a maximum of 48.3 pCi/g) and 1.21 pCi/g in hogs (with a maximum of 25.1 pCi/g).

Strontium levels are determined in some of the animals analyzed for cesium-137. Typically, muscle and bone samples are collected for analysis from the same animals checked for cesium-137, and the samples are analyzed for strontium-89,90. As in previous years, strontium-89,90 was not quantified in muscle samples. Lab measurements of strontium-89,90 in bone ranged from a high of 4.75 pCi/g to a low of 3.62 pCi/g.

Turkeys/Beavers

Description of Surveillance Programs

Wild turkeys have been trapped on site by the South Carolina Department of Natural Resources and used to repopulate game areas in South Carolina and other states. The U.S. Department of Agriculture Forest Service–Savannah River harvests beavers in selected areas within the SRS perimeter to reduce the beaver population and thereby minimize dam-building activities that can result in flood damage to timber stands, to primary and secondary roads, and to railroad beds. However, both programs continued to remain inactive in 2004 because of reduced needs.

Soil

Description of Surveillance Program

The SRS soil monitoring program provides

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

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. However, these results may be evaluated over a period of years to determine long-term trends.

Soil samples are collected from four onsite locations, four site perimeter locations and two offsite locations.

Surveillance Results Summary

Radionuclides in soil samples from 2004 were detected as follows:

- cesium-137 at 10 locations (on site/perimeter/offsite)
- uranium-234, 235, and 238 at all locations
- plutonium-238 at 11 onsite, perimeter, and offsite locations
- plutonium-239 at nine locations (onsite/perimeter/off site)
- americium-241 at four onsite and perimeter locations

These results are similar to those of previous years.

Settleable Solids

Description of Surveillance Program

Settleable-solids monitoring in effluent water is required to ensure—in conjunction with routine sediment monitoring—that a long-term buildup of radioactive materials does not occur in stream systems.

DOE limits on radioactivity levels in settleable solids are 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides.

Low total suspended solids (TSS) levels result in a small amount of settleable solids, so an accurate measurement of radioactivity levels in settleable solids is impossible. Based on this, an interpretation of the radioactivity-levels-in-settleable-solids requirement was provided to Westinghouse Savannah River Company (WSRC) by DOE in 1995. The interpretation indicated that TSS levels below 40 parts per million (ppm) were considered to be in *de-facto* compliance with the DOE limits.

To determine compliance with these limits, EMA uses TSS results—gathered as part of the routine National Pollutant Discharge Elimination System monitoring program—from outfalls co-located at or near radiological effluent points. If an outfall shows that TSS levels regularly are greater than 40 ppm, a radioactivity-levels-in-settleable-solids program and an increase in sediment monitoring will be implemented.

Surveillance Results Summary

In 2004, one TSS sample exceeded 40 ppm. This result (44 ppm) occurred at Outfall F–01 because of nearby demolition work. The 2004 TSS results indicate that SRS remains in compliance with the DOE radioactivity-levels-in-settleable-solids requirement.

Sediment

Description of Surveillance Program

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

Sediment samples were collected at eight Savannah River locations and 13 site stream locations in 2004.

Surveillance Results Summary

Cesium-137 and cobalt-60 were the only manmade gamma-emitting radionuclides observed in river and stream sediments. The highest cesium-137 concentration in streams, 3.70E+01 pCi/g, was detected in sediment from R-Canal. The highest level found on the river, 4.35E-01pCi/g, was at River Mile 129; the lowest levels were below detection at several locations. Generally, cesium-137 concentrations were higher in stream sediments than in river sediments. This is to be expected because the streams receive radionuclide-containing liquid effluents from the site. Most radionuclides settle out and deposit on the stream beds or at the streams' entrances to the swamp areas along the river.

Cobalt-60 was detected in sediment from the Four Mile Creek Swamp Discharge and R-Canal locations. The highest cobalt-60 concentration in streams, 7.22E-02 pCi/g, was measured at R-Canal.

Strontium-89,90 was detected in sediment at two stream and no river locations. The maximum value was 1.25E+00 pCi/g, at FM–A7.

Plutonium-238 was detected in sediment at eight stream locations and one river location during 2004, The maximum value was 3.49E+00pCi/g at FM–A7. to below detection at several locations. Plutonium-239 was detected in sediment at most stream and river locations. The maximum value was 1.82E-01 pCi/g—also at FM–A7. Uranium-234, 235, and 238 were detected at all locations.

Concentrations of radionuclides in river sediment during 2004 were similar to those of previous years.

Concentrations of all isotopes generally were higher in streams than in the river. As indicated in the earlier discussion of cesium-137, this is to be expected. Differences observed when these data are compared to those of previous years probably are attributable to the effects of resuspension and deposition, which occur constantly in sediment media.

Grassy Vegetation

Description of Surveillance Program

The radiological program for grassy vegetation is designed to 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 radionuclides and help confirm the dose models used by SRS. Bermuda grass is preferred because of its importance as a pasture grass for dairy herds.

Vegetation samples are obtained from

- locations containing soil radionuclide concentrations that are expected to be higher than normal background levels
- locations receiving water that may have been contaminated

Surveillance Results Summary

Radionuclides in the grassy vegetation samples collected in 2004 were detected as follows:

- tritium at one perimeter location and one onsite location
- cesium-137 (the only manmade gamma-emitting radionuclide detected) at seven perimeter and one offsite location
- strontium-89/90 at 11 locations
- uranium-234 at all locations except Darkhorse, Green Pond, and Patterson Mill Road
- uranium-238 at all locations except Barnwell, Darkhorse, and Patterson Mill Road

These results are similar to those of previous years.

Savannah River Swamp Surveys

Introduction

The Creek Plantation, a privately owned land area located along the Savannah River, borders part of the southern boundary of SRS. In the 1960s, an area of the Savannah River Swamp on Creek Plantation—specifically, the area between Steel Creek Landing and Little Hell Landing—was contaminated by SRS operations. During high river levels, water from Steel Creek flowed along the lowlands comprising the swamp, resulting in the deposition of radioactive material. SRS studies estimated that a total of approximately 25 Ci of cesium-137 and 1 Ci of cobalt-60 were deposited in the swamp.

Comprehensive and cursory surveys of the swamp have been conducted periodically since 1974. These surveys measure radioactivity levels to determine changes in the amount and/or distribution of radioactivity in the swamp. A series of 10 sampling trails—ranging from 240 to 3,200 feet in length—was established through the swamp. Fifty-two monitoring locations were designated on the trails to allow for continued monitoring at a consistent set of locations.

The 2004 survey was identified as a cursory survey, requiring limited media sampling and analysis—as well as exposure rate measurement. A cursory survey had been scheduled for late 2003 but was canceled because of high water in the swamp.

Analytical Results Summary

The sampling portion of the 2004 survey was conducted from February through June. Because of high water levels, samples could not be obtained from the prescribed locations on three trails (6, 7, and 8), but were obtained from alternate established locations on these trails. Similarly, exposure rate determination via TLDs could not be completed because of high water levels during the measurement period.

As anticipated, based on source term information and historical survey results, cesium-137 was the only manmade gamma-emitting radionuclide detected. Cesium-137 was detected in 39 of the 40 soil samples and eight of the 10 vegetation samples. Cesium-137 concentrations in soil varied from nondetectable to approximately 50 pCi/g, while cesium-137 concentrations in vegetation varied from nondetectable to approximately 11 pCi/g. The observed concentration range is consistent with historical results. In general, higher levels of cesium-137 in soil were observed in the shallow samples. As observed in previous surveys, this vertical distribution profile in soil is not as pronounced as it is in undisturbed areas. This indicates some movement (mobilization, movement, and/or redeposition) of contamination in the swamp. cesium-137 was observed in samples as far as approximately five miles from the site boundary (on trail 10).

Cobalt-60 was not detected in any sample. This is consistent with historical survey results, in which cobalt-60 is detected in low concentrations at a relatively small number of sample sites.

Strontium-90 was detected in two of the 50 soil samples and four vegetation samples. The maximum observed concentration in soil was approximately 0.43 pCi/g, while the maximum concentration in vegetation was approximately 0.75 pCi/g. No correlation was observed between soil and vegetation strontium-90 concentrations or between cesium-137 and strontium-90.

Nonradiological Surveillance

Air

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

Surface Water

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

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

Appendix A, "Applicable Guidelines, Standards, and Regulations," provides some of the specific guidelines used in water quality surveillance, but because some of these guidelines are not quantifiable, they are not tracked.

Surveillance Results Summary

At every site, most water quality parameters and metals were detected in at least one sample. Thallium and nitrite were not detected in any samples. Only two samples had detectable pesticides/herbicides: one SC–4 sample showed beta-BHC, while one PB–3 sample showed delta-BHC. These results continue to indicate that SRS discharges are not significantly affecting the water quality of the onsite streams or the river.

Drinking Water

Most of the drinking water at SRS is supplied by three systems that have treatment plants in A-Area, D-Area, and K-Area. The site also has 14 small drinking water facilities, each of which serves populations of fewer than 25 persons.

Surveillance Results Summary

All samples collected from SRS drinking water systems during 2004 were in compliance with SCDHEC and EPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of chapter 2, "Environmental Compliance."

Sediment

The nonradiological sediment surveillance program provides a method to determine the deposition, movement, and accumulation of nonradiological contaminants in stream systems.

Surveillance Results Summary

In 2004, as in the previous five years, no pesticides or herbicides were found to be above the quantitation limits in sediment samples. Metals analyses results for 2004 also were comparable to those of the previous five years.

Fish

EMA personnel analyze the flesh of fish caught from the Savannah River to determine concentrations of mercury in the fish. The fish analyzed represent the most common edible species of fish in the Central Savannah River Area (freshwater) and at the mouth of the Savannah River (saltwater).

Surveillance Results Summary

In 2004, 152 fish were caught from the Savannah River and analyzed for mercury. Concentrations of mercury generally were slightly higher than those observed in 2003, but were similar to those of previous years. The highest concentrations were found in bass at U.S. Highway 17 (2.31 µg/g), bream at Stokes Bluff (2.49µg/g), and catfish at U.S. Highway 301 (1.71µg/g).

The Academy of Natural Sciences River Water Quality Surveys

Description of Surveys

Academy of Natural Sciences (ANS) personnel conducted biological and water quality surveys of the Savannah River from 1951 through 2003, when the EMA personnel assumed this responsibility. The surveys were 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
- patterns of change over seasons or years that indicate improving or deteriorating conditions

Samples collected for the 2003 survey were analyzed by ANS during 2004 and compared to previous years' data. No adverse conditions were identified. EMA conducted the macroinvertbrate and diatom sampling during the spring and fall of 2004. The diatom slides were sent to ANS for archiving. EMA personnel archived the spring macroinverterbrate samples on site and are processing the fall samples.

Chapter 3

Effluent Monitoring

Carl Cook, Pete Fledderman, Donald Padgett, and Monte Steedley
Environmental Services Section

Timothy Jannik
Savannah River National Laboratory

EFFLUENT monitoring at Savannah River Site (SRS) is conducted to demonstrate compliance with applicable standards and regulations. Site effluent monitoring activities are divided into radiological and nonradiological programs. A complete description of sampling and analytical procedures used for effluent monitoring by the Environmental Monitoring and Analysis group of the site's Environmental Services Section 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. A summary of data results is presented in this chapter; more complete data can be found in tables on the CD included with this report.

Radiological Monitoring

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards. SRS management philosophy ensures that potential exposures to members of the public and to onsite workers are kept as far below regulatory standards as is reasonably achievable. This philosophy is known as the "as low as reasonably achievable" (ALARA) concept.

SRS airborne and liquid effluents that potentially contain radionuclides are monitored at their points of discharge by a combination of direct measurement and/or sample extraction and analysis. Each operating facility maintains ownership of and is responsible for its radiological effluents.

Unspecified alpha and beta emissions (the measured gross activity minus the identified individual radionuclides) in airborne and liquid releases are large contributors—on a percentage basis—to offsite doses, especially for the airborne pathway from diffuse and fugitive releases (see definitions below). The unspecified alpha and beta emissions are listed separately in the effluent release tables. Prior to 2000, these emissions were included in the plutonium-239 and strontium-89,90 releases. For dose calculations, the unspecified alpha releases were assigned the plutonium-239 dose factor, and the unspecified beta releases were assigned the strontium-90 dose factor (chapter 5, "Potential Radiation Doses").

Airborne Emissions

Process area stacks that release or have the potential to release radioactive materials are monitored continuously by applicable online monitoring and/or sampling systems [SRS EM Program, 2001].

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

The following effluent sampling and monitoring changes were made during 2004:

- At 292–H, the sampling of charcoal canisters was changed from weekly to every two weeks in July.
- At 244–H, vessel vent sampling was taken out of service in April, with radioactive material inventory removed and sampling discontinued in May.
- At 291–S, Zone 1 sampling was changed from weekly to quarterly in October.

Diffuse and Fugitive Sources

Estimates of radionuclide releases from unmonitored diffuse and fugitive sources also are included in the SRS radioactive release totals. A diffuse source is defined as an area source. A fugitive source is defined as an undesignated localized source.

Diffuse and fugitive releases are calculated using the U.S. Environmental Protection Agency's (EPA's)

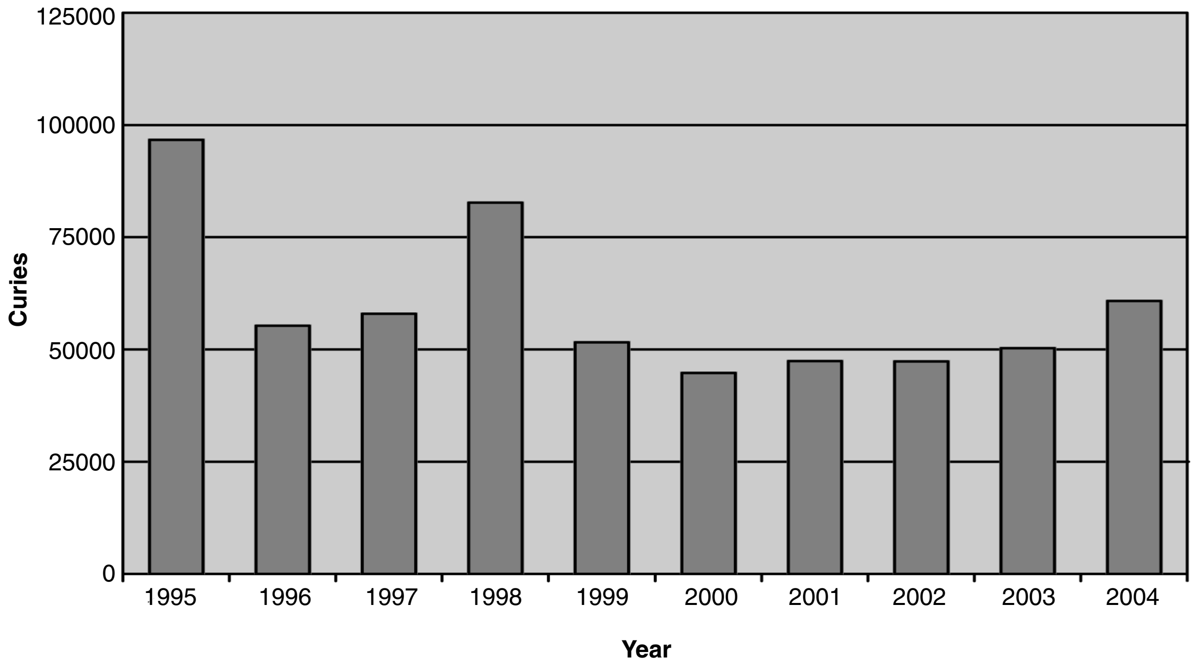


Figure 3–1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

recommended methods [EPA, 1999a]. Because these methods are conservative, they generally lead to overestimates of actual emissions.

Monitoring Results Summary

The total amount of radioactive material released to the environment is quantified by using data obtained from continuously monitored airborne effluent release points and estimates of diffuse and fugitive sources.

Because of greatly reduced operations in H-Canyon, there were no fission product tritium, carbon-14, or krypton-85 releases from the separations areas in 2004. In the past, estimated releases of these unmonitored radionuclides were calculated based on production levels.

Tritium Tritium in elemental and oxide forms accounted for more than 99 percent of the total radioactivity released to the atmosphere from SRS operations. During 2004, about 61,300 Ci of tritium were released from SRS, compared to about 50,000 Ci in 2003.

Because of improvements in facilities, processes, and operations, and because of changes in the site's missions, the amount of tritium (and other atmospheric radionuclides) released generally has declined during the past 15 years at SRS. Since 1995, the total amount of tritium released has fluctuated but has remained less than 100,000 Ci per year because of changes in the site's missions and the existence of the Replacement Tritium Facility (figure 3-1).

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) in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," as a screening method to determine if existing effluent treatment systems are proper and effective. The 2004 atmospheric effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, on the CD accompanying this report.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs. However, certain radionuclides—tritium (in the oxide form) from the reactor (K-Area, C-Area, and L-Area main stacks) and tritium facilities; plutonium-239 from the 291–F and 221–S stacks; and americium-241 from the 244–H vessel vent—were emitted at concentration levels above the DCGs. The offsite dose from all atmospheric releases during 2004, however, remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv) (chapter 5).

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, 2001].

Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that instantaneous releases stay within established limits. Because the instruments have limited detection sensitivity, online monitoring systems are not used to quantify SRS liquid radioactive releases at their current low levels.

Monitoring Results Summary

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. SRS liquid radioactive releases for 2004 are shown by source on the CD accompanying this report. These data are a major component in the determination of offsite dose consequences from SRS operations.

Direct Discharges of Liquid Effluents Direct discharges of liquid effluents are quantified at the point of release to the receiving stream, prior to dilution by the stream. The release totals are based on measured concentrations and flow rates.

Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas—i.e., reactor, separations, Effluent Treatment Facility (ETF)—to site streams during 2004 was 756 Ci, which was 51 percent less than the 2003 total of 1,553 Ci. This decrease was due to the fact that ETF has been processing wastewater with less tritium in it than in previous years.

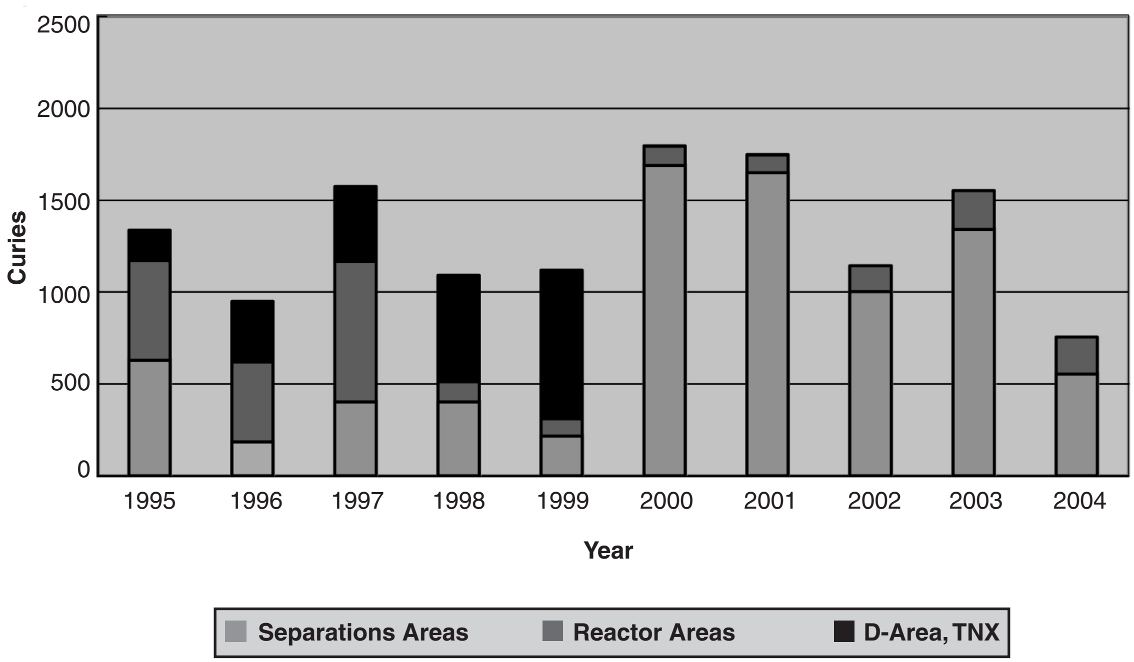


Figure 3–2 Ten-Year History of Direct Releases of Tritium to SRS Streams

Operations at D-Area and TNX were discontinued in 2000 and 2001, respectively. Releases from A-Area represent only a small percentage of the total direct releases of tritium to site streams. The reactor area releases include the overflows from PAR Pond and L Lake.

Direct releases of tritium to site streams for the years 1995–2004 are shown in figure 3–2. The migration and transport of radionuclides from site seepage basins and the Solid Waste Disposal Facility are discussed in chapter 4 (“Environmental Surveillance”).

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 migration discharges. The DOE order lists DCG values for most radionuclides.

DCGs are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). 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 fractional DCG values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. The 2004 liquid effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, on the CD accompanying this report.

The data show that the U3R–2A ETF outfall at the Road C discharge point exceeded the DCG guide for 12-month-average tritium concentrations during 2004. 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. No other discharge points exceeded the DOE DCGs during 2004.

Nonradiological Monitoring

Airborne Emissions

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates both radioactive and nonradioactive criteria and toxic air pollutant emissions—from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the new SRS Part 70 Air Quality Permit, with specific limitations and monitoring requirements identified. This section will cover only nonradioactive emissions.

The bases for the limitations and monitoring requirements specified in the Part 70 Air Quality Permit are outlined in various South Carolina and federal air pollution control regulations and standards. Many of the applicable standards are source dependent, i.e., applicable to certain types of industry, processes, or equipment. However, some standards govern all sources for criteria pollutants, toxic air pollutants, and ambient air quality. Air pollution control regulations and standards applicable to SRS sources are discussed briefly in appendix A, “Applicable Guidelines, Standards, and Regulations.” The SCDHEC air standards for toxic air pollutants can be found at http://www.scdhec.net/baq on the Internet.

At the beginning of 2004, the SRS Part 70 Air Quality Permit identified 84 nonexempt radiological and nonradiological air emission units. During the year, SCDHEC issued three revisions to the permit in which 35 of the permitted emission units were voided and a new emission unit was added. Of the 35 voided units, eight had been removed from service and 27 were reclassified as exempt sources in the Insignificant Activities List (attachment B of the permit). Of the remaining 50 units, 45 were in operation in some capacity during 2004 and the remaining five sources either were being maintained in a “cold standby” status or were under construction.

Description of Monitoring Program

Major nonradiological emissions of concern from stacks at SRS facilities include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 microns, volatile organic compounds (VOCs), and toxic air pollutants. With the issuance of the new Part 70 Air Quality Permit, SRS has several new continuous and periodic monitoring requirements; only the most significant are discussed below.

The primary method of source monitoring at SRS is the annual air emissions inventory. Emissions from SRS sources are determined during this inventory from standard calculations using source operating parameters, such as hours of operation, process throughput, and emission factors provided in the EPA “Compilation of Air Pollution Emission Factors,” AP–42. Many of the processes at SRS, however, are unique sources requiring nonstandard, complex calculations. The hourly and total annual emissions for each source then can be compared against their respective permit limitations.

At the SRS powerhouses, airborne emission specialists under contract to SRS perform stack compliance tests every two years for each boiler. The tests include sampling of the boiler exhaust gases to determine particulate matter, sulfur dioxide, and visible opacity emissions. The permit also requires a weekly sample and laboratory analysis of coal for sulfur content and, a visible emissions inspection daily to verify compliance with opacity standards.

For the package steam generating boilers in K-Area, fuel oil-fired water heaters in B-Area, and diesel-powered equipment, compliance with sulfur dioxide standards is determined by analysis of the fuel oil purchased from the offsite vendor. Sulfur content of the fuel oil must be below 0.5 percent and must be reported to SCDHEC annually as part of the SRS annual compliance certification report due in April of each year.

Monitoring of SRS diesel-powered equipment consists of tracking fuel oil consumption monthly and calculating a 12-month rolling total for determining permit compliance with a site consumption limit.

SRS has several soil vapor extraction units and two air strippers that are sources of toxic air pollutants and VOCs. These units must be sampled monthly for VOC concentrations, and the total VOC emissions must be calculated for comparison against a 12-month rolling limit. The VOC emissions then are reported to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices—such as multiclone dust collectors, baghouse dust collectors, or condensers—whose parameters must be monitored continuously or whenever the system is operated. The operating parameters must be recorded and compared against specific operating ranges.

Compliance by all SRS permitted sources is evaluated during annual compliance inspections by the local SCDHEC district air manager. The inspections consist of a review of each permit condition, i.e., daily monitoring readings, equipment calibrations, control device inspections, etc.

Monitoring Results Summary

In 2004, operating data were compiled and emissions calculated for 2003 operations for all site air emission sources. Because this process, which begins in January, requires up to 6 months to complete, this report will provide a comprehensive examination of total 2003 emissions, with only limited discussion of available 2004 monitoring results for specific sources.

The 2003 total criteria and toxic air pollutant emissions results for all SRS sources, as determined by the air emissions inventory conducted in 2004, are provided in table 3–1 and on the CD accompanying this report. A review of the calculated emissions for each source for calendar year 2003 determined that SRS sources had operated in compliance with permitted emission rates. Actual 2004 emissions will be compiled and reported in depth in the *SRS Environmental Report for 2005*. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC also are, by nature, VOCs. As such, the total for VOCs in table 3–1 includes toxic air pollutant emissions. This table also includes the emissions for some hazardous air pollutants that are regulated under the Clean Air Act but not by SCDHEC Standard No. 8. These pollutants are included because they are compounds of some Standard No. 8 pollutants.

Table 3–1
2003 Criteria Pollutant Air Emissions

Pollutant Name	Actual Emissions (Tons/Year)
Sulfur dioxide	5.36E+02
Total suspended particulates	3.02E+02
PM_{10} (particulate matter 10 microns)	1.18E+02
Carbon monoxide	2.29E+03
Ozone (volatile organic compounds)	9.33E+01
Gaseous fluorides (as hydrogen fluoride)	1.14E–01
Nitrogen	2.66E+02
Lead	5.58E-01

Two power plants with five overfeed stoker-fed coal-fired boilers are operated by Westinghouse Savannah River Company (WSRC) at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 3–2. Because of an alternating test schedule, only A-Area boiler No. 2 was stack tested in 2004 (February). At that time, the boiler's particulate matter, sulfur dioxide, and visible emissions were found to be in compliance with its permitted limit. Results from the test are shown in table 3–3.

SRS also has two package steam generating boilers in K-Area fired by No. 2 fuel oil. The percent of sulfur in the fuel oil burned during the first quarter of 2004 was certified by the vendor to meet the requirements of the permit.

At SRS, 115 permitted and exempted sources, both portable and stationary, are powered by internal-combustion diesel engines. These sources include portable air compressors, generators, emergency cooling water pumps, and fire water pumps. The total diesel fuel consumption was found to be well below the SRS limit for the entire reporting period.

Table 3–2
SRS Power Plant Boiler Capacities

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

As reported to SCDHEC during 2004, the calculated annual VOC emissions were well below the permit limit for each unit.

In 2004, the annual air compliance inspection was conducted in two phases—the first phase by both SCDHEC and EPA as part of a multimedia inspection and the second by the SCDHEC District Air manager. During these inspections, all SRS permitted sources were found to be in compliance with their respective permit conditions and limits, and all required reports were determined to have been submitted to SCDHEC within specified time limits.

Ambient Air Quality

Under existing regulations, SRS is not required to conduct onsite monitoring for ambient air quality; however, the site is required to show compliance with various air quality standards. To accomplish this, air dispersion modeling was conducted during 2004 for new emission sources or modified sources as part of the sources' construction permitting process. The modeling analysis showed that SRS air emission sources were in compliance with applicable regulations. Additional information about ambient-air-quality regulations at the site can be found in appendix A of this report.

Liquid Discharges

Description of Monitoring Program

SRS monitors nonradioactive liquid discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES), as mandated by the Clean Water Act. As required by EPA and SCDHEC, SRS has NPDES permits in place for discharges to the waters of the United States and South Carolina. These permits establish the specific sites to be monitored, parameters to be tested, and monitoring frequency—as well as analytical, reporting, and collection methods. Detailed requirements for each permitted discharge point can be found in the individual permits, which are available to the public through SCDHEC's Freedom of Information office at 803–734–5376.

Table 3–3
Boiler Stack Test Results (A-Area)

Boiler	Pollutant	Emission Rates lb/10^6 Btu	Emission Rates lb/hr
A #2	Particulates[a]	0.204	17.43
	Sulfur dioxide[a]	1.52	NC[b]
	Opacity[c]	Avg. 10.6%	

[a] The compliance level is 0.6 lb/million Btu for particulates and 3.5 lb/million Btu for sulfur dioxide
[b] Not calculated
[c] Opacity limit 40%

In 2004, SRS discharged water into site streams and the Savannah River under two NPDES permits: one for industrial wastewater (SC0000175) and one for stormwater runoff—SCR000000 (industrial discharge). A third permit, SCR100000, does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site; SCDHEC did not request such sampling in 2004. The public comment period for draft Permit SCR100000 expired in February 2004, and the submitted comments are under resolution. Upon completion of this process, the new permit will be formally implemented; this is expected in early 2005. Permit ND0072125 is a "no discharge" water pollution control land application permit that regulates sludge application and related sampling at onsite sanitary wastewater treatment facilities.

NPDES samples are collected 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.

Monitoring Results Summary

SRS reports industrial wastewater analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320–1). Results from only seven of the 3,673 sample analyses performed during 2004 exceeded permit limits—a 99.8-percent compliance rate, which is higher than the DOE-mandated 98-percent rate. A list of the 2004 NPDES exceedances appears in table 3–4.

In anticipation of a new stormwater permit in early 2005, 16 additional outfalls were added to the 2004 routine stormwater sampling program on a one-time basis in October to determine the condition of normally unsampled stormwater outfalls. Because of various factors—including rain-event timing, severe weather conditions, increased sampling load, and SRS's large area—only six of the 12 routine outfalls and 12 of the 16 additional outfalls could be sampled in 2004. The remaining samples from the additional outfalls will be collected in early 2005. Complete 2004 analysis results from all the stormwater outfalls can be found in the NPDES stormwater monitoring data table on the CD accompanying this report. In 2004, as in previous years, no permit limits were mandated for SRS stormwater outfalls.

During the fourth quarter of 2004, dewatered sludge was sampled and analyzed for pollutants of concern, and approximately 51 cubic yards of sludge were applied to the land. No sludge was applied during the first, second, or third quarters. The analytical results indicated that pollutant concentrations were within regulatory limits.

Table 3–4
2004 Exceedances of SCDHEC-Issued NPDES Permit Liquid Discharge Limits at SRS[a]

Facility/Division/ Unit	Outfall	Date	Analysis	Possible Cause(s)	Corrective Action(s)
Effluent Treatment Facility	H–16	January 20	TSS	Loss of electrical power at contract laboratory due to ice storm caused a missed hold time; sample declared invalid	Power restored and analysis performed (results received too late to perform additional sampling)
Effluent Treatment Facility	H–16	February 3	BOD	Contract laboratory QA/QC errors due to demo of new automated equipment; sample declared invalid	Automated equipment removed from service
Effluent Treatment Facility	H–16	February 9	BOD	Contract laboratory QA/QC errors due to demo of new automated equipment; sample declared invalid	Automated equipment removed from service
Site Utilities Division	G–10	April 16	pH	Samples required twice a month, but obtained twice on same day and taken too closely for accurate representation of monthly discharge; sample declared invalid	SUD committed to ensuring that samples are taken in separate weeks; SUD also sends data review sheet to ESS early in each month for review
Site Utilities Division	G–10	April 16	DO	Samples required twice a month, but obtained twice on same day and taken too closely for accurate representation of monthly discharge; sample declared invalid	SUD committed to ensuring that samples are taken in separate weeks; SUD also sends data review sheet to ESS early in each month for review
Closure Business Unit	F–01	July 14	TSS (44 mg/L – exceeded daily average of 20 mg/L)	Runoff from D&D activities; the changing footprint of the area	Best management practices for D&D activities strengthened and maintained for longer duration
Closure Business Unit	F–01	July 14	TSS (44 mg/L – exceeded daily maximum of 40 mg/L)	Runoff from D&D activities; the changing footprint of the area	Best management practices for D&D activities strengthened and maintained for longer duration

Key: TSS – Total Suspended Solids; BOD – Biological Oxygen Demand; DO – Dissolved Oxygen

[a]The DOE-mandated NPDES compliance rate is 98 percent; SRS's compliance rate for 2004 was 99.8 percent.

Chapter 7

Quality Assurance

Moheb Khalil
Environmental Bioassay Laboratory

Donald Padgett and Monte Steedley
Environmental Services Section

Rick Page and Mike Boerste
Geochemical Monitoring Group

[Editors note: During 2004, responsibility for the environmental Quality Assurance (QA) program was divided among three groups—the Environmental Monitoring Laboratory (EML), the Environmental Monitoring and Analysis group (EMA), and the Geochemical Monitoring group (GM)].

SRS's environmental QA program is conducted to verify the integrity of data generated by onsite and subcontracted environmental laboratories.

The program's objectives are to ensure that samples are representative of the surrounding environment and that analytical results are accurate.

This chapter summarizes the 2004 QA program. Guidelines and applicable standards for the program are referenced in appendix A, "Applicable Guidelines, Standards, and Regulations."

Tables containing the 2004 QA data and the nonradiological detection limits can be found on the CD accompanying this report.

A more complete description of the QA program can be found in *Savannah River Site Environmental Monitoring Program* (WSRC–3Q1–2, Section 1100) and in the *Savannah River Site Environmental Monitoring Section Quality Assurance Plan* (WSRC–3Q1–2, Section 8000).

The 2004 QA data and program reviews demonstrate that the data in this annual report are reliable and meet applicable standards.

QA for EMA Laboratories

Internal Quality Assurance Program

Field Sampling Group

EMA and EML personnel routinely conduct a blind sample program for field measurements of pH to assess the quality and reliability of field data measurements.

EMA personnel also measure total residual chlorine, dissolved oxygen, and temperature in water samples; but because of the difficulties in providing field standards, these measurements are not suitable for a blind sample program.

During 2004, blind pH field measurements were taken for 24 samples. All field pH measurements except one outlier were within the U.S. Environmental Protection Agency's (EPA's) suggested acceptable control limit of ± 0.4 pH units of the true (known) value. The pH meter for the outlier has been recalibrated and tested to ensure that it will produce accurate pH data.

Chemistry and Counting Laboratories

Blind Tritium Samples Blind tritium samples provide a continuous assessment of laboratory sample preparation and counting. During 2004, 10 blind samples were analyzed for tritium; all the results were within the control limits.

Laboratory Certification EML is certified by the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Laboratory Certification for the following analytes:

- under the Clean Water Act (CWA) – chemical oxygen demand, total suspended solids, field pH, total residual chlorine, temperature, and 26 metals
- under the Resource Conservation and Recovery Act (RCRA) – 50 volatile organic compounds (VOCs) and 27 metals

External Quality Assurance Program

In 2004, EML participated in the U.S. Department of Energy (DOE) Quality Assurance Program (QAP), an interlaboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE by its contractors.

For a radiological laboratory intercomparison in 2004, the analysis of 42 isotopes was completed in March on the 60th set of QAP samples. A performance rating of 100-percent acceptable was achieved on the 60th set. This rating was calculated by dividing the "acceptables" and the "acceptable with warnings" by the total number of results. Environmental QA personnel consider 80 percent to be the minimum acceptance rating in this program.

Detailed QAP intercomparison study results can be found in the data tables section of the CD accompanying this report.

QA for Subcontracted Laboratories/EMA Laboratories

Subcontracted environmental laboratories providing analytical services must have a documented QA program and meet the quality requirements defined in the *WSRC Quality Assurance Manual* (WSRC 1Q).

An annual Department of Energy Consolidated Audit Program evaluation of each subcontracted laboratory is performed to ensure that all 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. Reports of the findings and recommendations are provided to each laboratory, and follow-up evaluations are conducted as necessary.

Nonradiological Liquid Effluents

Effluent samples are analyzed by three onsite laboratories and one subcontracted laboratory. Laboratories must be certified by SCDHEC for all National Pollutant Discharge Elimination System (NPDES) analyses.

Interlaboratory Program

During 2004, EMA- and GM-subcontracted laboratories participated in the Environmental Resource Associates (ERA) WatR™ Pollution Proficiency Testing (PT) Studies, which include various InterlaB WatR™ Supply Water Pollution (WP) Performance Evaluation Programs.

EPA uses PT results to certify laboratories for specific analyses. As part of the recertification process, EPA requires that subcontracted laboratories investigate the outside-acceptance-limit results and implement corrective actions as appropriate.

General Engineering Laboratory (GEL), participated in the WP 114 study and reported acceptable results for 218 of 222 parameters; Lionville Laboratory, participated in the WP 108 study and reported acceptable results for 219 of 223 parameters; Severn Trent Laboratory (STL), St Louis, participated in the WP 114 study and reported acceptable results for 158 of 179 parameters.

Laboratories (commercial and government) that analyze NPDES samples participate in the Discharge Monitoring Report–Quality Assurance (DMR–QA) study or the WP study. Under this program, the laboratories obtain test samples from ERA. This provider, as required by EPA, is accredited by the National Institute of Standards and Technology. For the 2004 DMR–QA study, Shealy Environmental Services, Inc. (SES) participated in the WP 113 and 115 studies, and EMA, Environmental Bioassay Laboratory (EBL), and the WSRC Site Utilities Division (SUD) participated in the WP 113 study.

SES reported acceptable results for 12 of 13 NPDES parameters; EMA reported acceptable results for one of one parameter; EBL reported acceptable results for 11 of 11 parameters; and SUD reported acceptable results for three of three parameters.

The initial zinc concentration reported by SES was found to be "not acceptable" by the limits published by ERA for WP 113. The most probable cause for this failure was a high bias by the instrument. As a corrective action, SES analyzed zinc from WP 115. This result passed.

Intralaboratory Program

The environmental monitoring intralaboratory program also reviews laboratory performance by analyzing duplicate and blind samples throughout the year.

SES, EBL, and EMA combined analyzed a total of 94 duplicate samples during 2004. Zero-difference results were reported for 49 of these samples. Percent-difference calculations showed that three of the 94 duplicate samples analyzed were outside ± 20 percent of the relative difference.

SES, EML, and EMA combined analyzed a total of 99 blind samples during 2004. Zero-difference results were reported for 53 of these samples. Percent-difference calculations showed that 12 of the 99 blind samples analyzed were outside ± 20 percent of the relative difference.

Results for the duplicate and blind sampling programs met expectations, with no indications of consistent

Table 7–1 Subcontract-Laboratory Performance on Mixed-Analyte Performance Evaluation Program (MAPEP)

Laboratory	MAPEP–04–GrW12 (Water Std)	MAPEP–04–MaW12 (Water Std)	MAPEP–04–MaS12 (Soil Std)
General Engineering	100%	97%[a]	88%[b, c]
Severn Trent	100%	100%	94%[d]
Lionville	100%	100%	94%[e]
Eberline	100%	97%[f]	87%[g]

[a] Results for uraniuim-233/234 were not acceptable.
[b] Results for technetium-99 and uranium-238 were acceptable with warning.
[c] Results for antimony, uranium-233/234, and uranium-238 were not acceptable.
[d] Results for antimony, plutonium-239/240, strontium-90, and uranium-233/234 were not acceptable.
[e] Results for iron-55 were not acceptable.
[f] Results for technetium-99 were not acceptable, and results for uranium-238 were acceptable with warning.
[g] Results for antimony and dieldrin were not acceptable.

problems in the laboratories. In some cases, the exceptions might be related to analytical variances, sample contamination, or sampling techniques.

Stream and River Water Quality

SRS's water quality program requires checks of 10 percent of the samples to verify analytical results. Duplicate grab samples from SRS streams and the Savannah River were analyzed by SES and EMA in 2004. Most results were within the ± acceptance limits. Detailed stream and Savannah River water quality duplicate sample results can be found in the data tables section of the CD accompanying this report.

Groundwater

Groundwater analyses at SRS are performed by subcontracted laboratories. During 2004, Severn Trent Laboratories, Inc., Eberline Services Oak Ridge Lab, and Lionville Laboratory, Inc., were the primary subcontractors. MicroSeeps, Inc., was subcontracted to perform special analyses. In addition to the subcontracted laboratories, the SRS Environmental Bioassay Laboratory performed analytical analyses on site.

Internal QA

During 2004, approximately five percent of the samples collected (radiological and nonradiological) for the RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) programs were submitted to the primary laboratory for analysis as blind duplicates and to a different laboratory as a QA check. The laboratories' results were evaluated on the basis of the percentage within an acceptable concentration range.

Generally, results for all QA evaluations were found to be within control limits in 2004. Full results for all QA evaluations can be obtained by contacting the EMA manager at 803–952–6931.

External QA

During 2004, Soil and Groundwater Closure Projects (SGCP) discontinued the use of its internal performance evaluation program and began participation in the Mixed-Analyte Performance Evaluation Program (MAPEP). The Radiological and Environmental Sciences Laboratory (RESL), under the direction of DOE–HQ Environmental Safety and Health (ES&H), administers the MAPEP.

MAPEP samples include water, soil, air filter, and vegetation matrices with environmentally important stable inorganic, organic, and radioactive constituents.

Results from the laboratories for the MAPEP–04–MaS12 Soil Standard and the MAPEP–04–GrW12 and MAPEP–04–MaW12 Water Standards are summarized in table 7–1. The results show that all the laboratories exceeded the expected 80-percent-acceptable-results level for both the soils and groundwater standards.

Soil/Sediment

Environmental investigations of soils and sediments, primarily for RCRA/CERCLA units, are performed by subcontracted laboratories. Data from 2004 were validated by SGCP according to EPA standards for analytical data quality, unless specified otherwise by site customers.

The environmental validation program is based on two EPA guidance documents, *Guidance for the Data Quality Objectives Process for Superfund* (EPA–540–R–93–071) and *Data Quality Objectives Process for Hazardous Waste Sites (G–4HW)* (EPA–600/R–00–007). These documents identify QA issues to be addressed, but they do not formulate a procedure for how to evaluate these inputs, nor do they propose pass/fail criteria to apply to data and documents. Hence, the validation program necessarily contains elements from—and is influenced by—several other sources, including

- *Guidance on Environmental Data Verification and Data Validation (QA/G–8)*, EPA–240/R–02/004
- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, EPA–540/R–99/008
- *USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/ Furan Data Review*, EPA–540/R–02/003
- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA–540/R–01/008
- T*est Methods for Evaluating Solid Waste*, EPA, November 1986, SW–846, Third Edition
- *DOE Quality Systems for Analytical Services,* Revision 1, April 2004

Relative-percent difference for the soil/sediment program is calculated for field duplicates and laboratory duplicates. Generally, results for all QA evaluations were found to be within control limits in 2004. A summary of this information is presented in each project report prepared by SGCP personnel.

Data Review

The QA program's detailed data review for groundwater and soil/sediment analyses is described in WSRC–3Q1–2, Section 1100.

In 2004, the major QA issues discovered and addressed in connection with these programs for soil/ sediment and groundwater analyses included the following:

- Observed calibration instability in soils volatile analyses due to the standard preservative requirement and revised preservation protocol for a single Appendix IX compound required by SCDHEC
- Inconsistent reporting of results (primarily MDLs) from labs
- Uncertified analytes reported without flagging
- Samples exceeding both technical holding and regulatory reporting times due to mismatches with acceptance criteria
- Problems with validation packages submitted by labs
- Various data reporting issues for all laboratories as new contract requirements and electronic EDD formats were introduced

Previously identified items that are still being addressed include the following:

- Data recording problems (cooler number and temperature, field measurements, collection date/ times, legible corrections) on chains-of-custody by field samplers
- Inability to demonstrate the absence of spectral interference for liquid-scintillation counter radioisotopes at one subcontracted laboratory
- Inconsistent application of the laboratory portion of the qualification policy from all laboratories due to a newly implemented qualification policy

These findings illustrate that, although laboratory procedures are well defined, analytical data quality does benefit from technical scrutiny. A corrective action plan has been put into place to address these issues, which are expected to be resolved during 2005.

Appendix A

Applicable Guidelines, Standards, and Regulations

Jack Mayer
Environmental Services Section

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) Order 5400.5, "Radiation Protection of the Public and the Environment"; in the Clean Air Act [Standards of Performance for New Stationary Sources, also referred to as New Source Performance Standards (NSPS), and the National Emission Standards for Hazardous Air Pollutants (NESHAP)]; in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA—also known as Superfund); in the Resource Conservation and Recovery Act (RCRA); in the Clean Water Act (i.e., National Pollutant Discharge Elimination System—NPDES); and in the National Environmental Policy Act (NEPA). Compliance with environmental requirements is assessed by DOE–Savannah River Operations Office (DOE–SR), the South Carolina Department of Health and Environmental Control (SCDHEC), and the U.S. Environmental Protection Agency (EPA).

The SRS environmental monitoring program's objectives incorporate recommendations of

- the International Commission on Radiological Protection (ICRP) in *Principles of Monitoring for the Radiation Protection of the Population,* ICRP Publication 43
- DOE Order 5400.5
- DOE/EH–0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance"

Detailed information about the site's environmental monitoring program is documented in Section 1100 (SRS EM Program) of the *SRS Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1. This document is reviewed annually and updated every 3 years.

SRS has implemented and adheres to the SRS Environmental Management System Policy. Implementation of a formal Environmental Management System (EMS), such as that described in the International Organization for Standardization (ISO) 14001 standard, is an Executive Order 13148 ("Greening the Government Through Leadership in Environmental Management") and DOE Order 450.1 ("Environmental Protection Program") requirement. SRS maintains an EMS that fully meets the requirements of ISO 14001. The full text of the SRS EMS Policy is included at the end of this appendix.

Drinking water standards (DWS) can be found at http://www.epa.gov/safewater/standards.html on the Internet, and maximum allowable concentrations of toxic air pollutants can be found at http://www.scdhec.net/baq/. More information about certain media is presented in this appendix.

Air Effluent Discharges

DOE Order 5400.5 establishes Derived Concentration Guides (DCGs) for radionuclides in air. DCGs, calculated by DOE using methodologies consistent with recommendations found in ICRP publications 26 (*Recommendations of the International Commission on Radiological Protection*) and 30 (*Limits for Intakes of Radionuclides by Workers*), are used as reference concentrations for conducting environmental protection programs at DOE sites. DCGs are not considered release limits. DCGs for radionuclides in air are discussed in more detail on page 71.

Radiological airborne releases also are subject to EPA regulations cited in 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H ("National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities").

Regulation of radioactive and nonradioactive air emissions—both criteria pollutants and toxic air pollutants—has been delegated to SCDHEC. Therefore, SCDHEC must ensure that its air pollution regulations are at least as stringent as federal regulations required by the Clean Air Act. This is accomplished by SCDHEC

Regulation 61–62, “Air Pollution Control Regulations and Standards.” As with many regulations found in the Code of Federal Regulations (CFR), many of SCDHEC’s regulations and standards are source specific. Each source of air pollution at SRS is permitted or exempted by SCDHEC, with specific emission rate limitations or special conditions identified. The bases for the limitations and conditions are the applicable South Carolina air pollution control regulations and standards. In some cases, specific applicable CFRs also are cited in the permits issued by SCDHEC. The applicable SCDHEC regulations are too numerous to discuss here, so only the most significant are listed.

Two SCDHEC standards, which govern criteria and toxic air pollutants and ambient air quality, are applicable to all SRS sources. Regulation 61–62.5, Standard No. 2, “Ambient Air Quality Standards,” identifies eight criteria air pollutants commonly used as indices of air quality (e.g., sulfur dioxide, nitrogen dioxide, and lead) and provides allowable site boundary concentrations for each pollutant, as well as the measuring intervals. Compliance with the various pollutant standards is determined by conducting air dispersion modeling for all sources of each pollutant, using EPA-approved dispersion models and then comparing the results to the standard. The pollutants, measuring intervals, and allowable concentrations are provided in Table A–1. The standards are in micrograms per cubic meter, unless noted otherwise.

A total of 258 toxic air pollutants and their respective allowable site boundary concentrations are identified in Regulation 61–62.5, Standard No. 8, “Toxic Air Pollutants.” As with Standard No. 2, “Ambient Air Quality Standards,” compliance is determined by air dispersion modeling. Toxic air pollutants can be found at http://www.scdhec.net/baq/.

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, SRS powerhouse coal-fired boilers are regulated by Regulation 61–62.5, Standard No. 1, “Emissions from Fuel Burning Operations.” This standard specifies that for powerhouse stacks built before February 11, 1971, the opacity limit is 40 percent. For new sources constructed after this date, the opacity limit typically is 20 percent. The standards for particulate and sulfur dioxide emissions are shown in table A–2.

Regulation 61–62.5, Standard No. 4, “Emissions from Process Industries,” is applicable to all SRS sources except those regulated by a different source-specific standard. For some SRS sources, particulate matter emission limits depend on the weight of the material being processed and are determined from a table in the regulation. For process and diesel engine stacks in existence on or before December 31, 1985, emissions shall not exhibit an opacity greater than 40 percent. For new sources, where construction began after December 31, 1985, the opacity limit is 20 percent.

As previously mentioned, some SRS sources have both SCDHEC and CFRs applicable and identified in their permits. For the package steam generating boilers in K-Area and two portable package boilers, both SCDHEC and federal regulations are applicable. The standard for sulfur dioxide emissions is specified in 40 CFR 60, Subpart Dc, “Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units,” while the standard for particulate matter is found

Table A–1 Criteria Air Pollutants

Pollutant	Interval	$\mu g/m^{3}$ [a,b]
Sulfur Dioxide	3 hours	1300[c]
	24 hours	365[c]
	annual	80
Total Suspended Particulates	annual geometric mean	75
PM_{10}	24 hours	150[d]
	annual	50[d]
Carbon Monoxide	1 hour	40 mg/m^3
	8 hours	10 mg/m^3
Ozone	1 hour	0.12 ppmd
	8 hours	0.08 ppmd
Gaseous Fluorides (as HF)	12-hour average	3.7
	24-hour average	2.9
	1-week average	1.6
	1-month average	0.8
Nitrogen Dioxide	annual	100
Lead	calendar quarterly mean	1.5

[a] Arithmetic average except in case of total suspended particulate matter
[b] At 25°C and 760 mm Hg
[c] Not to be exceeded more than once a year
[d] Attainment determinations will be made based on the criteria contained in 40 CFR 50, appendices H, I, K, and N.

Table A–2 Airborne Emission Limits for SRS Coal-Fired Boilers

Sulfur Dioxide	3.5 lb/10^6 Btu[a]
Total Suspended Particulates	0.6 b/10^6 Btu
Opacity	40%

[a] British thermal unit

in Regulation 61–62.5, Standard No. 1. Because these units were constructed after applicability dates found in both regulations, the opacity limit for the units is the same in both regulations. The emissions standards for these boilers are presented in table A–3.

Another federal regulation, 40 CFR 60, Subpart Kb, "Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for which Construction, Reconstruction, or Modification Commenced after July 23, 1984," specifies types of emission controls that must be incorporated into the construction of a source. In this regulation, the type of control device required depends on the size of the tank and the vapor pressures of the material being stored. The regulation is applicable to several sources at SRS, such as the two 30,000-gallon No. 2 fuel oil storage tanks in K-Area and the four mixed solvent storage tanks in H-Area. However, because of the size of these tanks and the vapor pressures of the materials being stored, the tanks are not required to have control devices. The only requirements applicable to SRS storage tanks are those for record keeping. In October 2003, EPA revised this regulation to eliminate the record-keeping requirements for those tanks with vapor pressures below certain limits. In September 2004, SCDHEC also incorporated this revision into the SCDHEC air pollution control regulations, and the SRS Title V Permit was modified to remove these tanks and the requirements accordingly.

Table A–3 Airborne Emission Limits for SRS Fuel Oil-Fired Package Boilers

Sulfur Dioxide	0.5 lb/10^6 Btu[a]
Total Suspended Particulates	0.6 b/10^6 Btu
Opacity	20%

[a] British thermal unit

(Process) Liquid Effluent Discharges

DOE Order 5400.5 establishes DCGs for radio-nuclides in process effluents. (DCGs for radionuclides in liquid are discussed in more detail on page 71.) DCGs were calculated by DOE using methodologies consistent with recommendations found in ICRP, 1987 and ICRP, 1979 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

DOE Order 5400.5 exempts aqueous tritium releases from best available technology requirements but not from ALARA (as low as reasonably achievable) considerations.

Three NPDES permits are in place that allow SRS to discharge water into site streams and the Savannah River: one industrial wastewater permit (SC0000175) and two stormwater runoff permits (SCR000000 for industrial discharges and SCR100000 for construction discharges).

A fourth permit (ND0072125) is a no-discharge water pollution control land application permit that regulates sludge generated at onsite sanitary waste treatment plants.

Detailed requirements for each permitted discharge point—including parameters sampled for, permit limits for each parameter, sampling frequency, and method for collecting each sample—can be found in the individual permits, which are available to the public through SCDHEC's Freedom of Information Office at 803–898–3882.

Site Streams

SRS streams are classified as "Freshwaters" by South Carolina Regulation 61–69, "Classified Waters." Freshwaters are defined in Regulation 61–68, "Water Classifications and Standards," 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 the survival and propagation of a balanced indigenous aquatic community of fauna and flora
- industrial and agricultural uses

Table A–4 provides some of the specific guides used in water quality surveillance, but because some of these guides are not quantifiable, they are not tracked in response form (i.e., amount of garbage found).

Savannah River

Because the Savannah River is defined under South Carolina Regulation 61–69 as a freshwater system, the river is regulated in the same manner as are site streams (table A–4).

Table A–4
South Carolina Water Quality Standards for Freshwaters[a]

Parameters	Standards
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.
pH	Range between 6.5 and 8.5
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 more details, see E.10, Regulation 61–68, "Water Classifications and Standards" (November 28, 2001).
Dissolved oxygen	Daily average not less than 5.0 mg/L, with a low of 4.0 mg/L.
Garbage, cinders, ashes, sludge, or other refuse	None allowed.
Treated wastes, toxic wastes, deleterious substances, colored or other wastes, except those in (e) above	None alone or in combination with other substances of 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.
Ammonia, chlorine, and toxic pollutants listed in South Carolina Regulation 61–68, "Water Classifications and Standards"	See Appendix: Water Quality Numeric Criteria for the Protection of Aquatic Life and Human Health, Regulation 61–68, "Water Classifications and Standards" (November 28, 2001)

[a] This is a partial list of water quality standards for freshwaters.

SOURCE: SCDHEC, 2001

Drinking Water

The federal Safe Drinking Water Act—enacted in 1974 to protect public drinking water supplies—was amended in 1980, 1986, and 1996.

SRS drinking water systems are tested routinely by SRS and SCDHEC to ensure compliance with SCDHEC State Primary Drinking Water Regulations (R61–58) and EPA National Primary Drinking Water Regulations (40 CFR 141).

SRS drinking water is supplied by 17 separate systems, all of which utilize groundwater sources. The A-Area, D-Area, and K-Area systems are actively regulated by SCDHEC, while the remaining 14 site water systems receive less frequent regulatory inspections.

Under the SCDHEC-approved, ultrareduced monitoring plan, the A-Area consolidated system was sampled for lead and copper in 2004 and did not exceed the respective action levels. The A-Area system will be resampled for lead and copper in 2007. Both D-Area and K-Area were sampled in 2003 for lead and copper, and neither system exceeded the lead and copper action levels. These systems are not required to be sampled again until 2006.

The B-Area Bottled Water Facility no longer is listed by SCDHEC as a public water system, as its source water is provided by the A-Area water system. SCDHEC's Division of Food Protection will continue to conduct periodic inspections of this facility. Results from quarterly bacteriological and annual complete chemical analyses performed in 2004 met SCDHEC and FDA water quality standards.

DWS for specific radionuclides and contaminants can be found on the Internet at http://http://www.epa.gov/safewater/standards.html.

Groundwater

Groundwater is a valuable resource and is the subject of both protection and cleanup programs at SRS. More than 1,000 wells are monitored each year at the site for a wide range of constituents. Monitoring in the groundwater protection program is performed to detect new or unknown contamination across the site, and monitoring in the groundwater cleanup program is performed to meet the requirements of state and federal laws and regulations. Most of the monitoring in the cleanup program is governed by SCDHEC's administration of RCRA regulations.

The analytical results of samples taken from SRS monitoring wells are compared to various standards. The most common are final federal primary DWS—or other standards if DWS do not exist. The DWS are considered first because groundwater aquifers are defined as potential drinking water sources by the South Carolina Pollution Control Act. DWS can be found at http://www.epa.gov/safewater/mcl.html on the Internet. Other standards sometimes are applied by regulatory agencies to the SRS waste units under their jurisdiction. For example, standards under RCRA can include DWS, groundwater protection standards, background levels, or alternate concentration limits.

SRS responses to groundwater analytical results require careful evaluation of the data and relevant standards. Results from two constituents having DWS—dichloromethane and bis (2–ethylhexyl) phthalate—are evaluated more closely than other constituents and are commonly dismissed. 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 detailed groundwater monitoring results that can be obtained by contacting the manager of the Westinghouse Savannah River Company (WSRC) Environmental Monitoring and Analysis group at 803–952–6931. Also, the SCDHEC standard used for lead is 50 µg/L. The federal standard of 15 µg/L is a treatment standard for drinking water at the consumer's tap.

The regulatory standards for radionuclide discharges from industrial and governmental facilities are set under the Clean Water Act and Nuclear Regulatory Commission and DOE regulations. In addition, radionuclide cleanup levels are included in the site RCRA permit under the authority of the South Carolina Pollution Control Act. 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.

Many potential radionuclide contaminants are beta emitters. 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 considered is the activity per liter that would, if only that isotope were present, exceed the dose equivalent. Similarly, the standards for alpha emitters are calculated to present the same risk at the same rate of ingestion.

The element radium has several isotopes of concern in groundwater monitoring. Although radium has a DWS of 5 pCi/L for the sum of radium-226 and radium-228, the isotopes have to be measured separately, and the combined numbers may not be representative of the total. Radium-226, an alpha emitter, and radium-228, a beta emitter, cannot be analyzed by a single method. Analyses for total alpha-emitting radium, which consists of radium-223, radium-224, and radium-226, are compared to the standard for radium-226.

Four other constituents without DWS are commonly used as indicators of potential contamination in wells. 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
- pH at values equal to or less than 6.5 or equal to or greater than 8.5.

The selection of these values as standards for comparison is somewhat arbitrary; however, the 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 also may indicate leaching of the grouting material used in well construction, rather than degradation of the groundwater.

Potential Dose

The radiation protection standards followed by SRS are outlined in DOE Order 5400.5 and include 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 40 CFR 61, Subpart H, is adopted in DOE Order 5400.5.

These dose standards are based on recommendations of the ICRP and the National Council on Radiation Protection and Measurements.

The DOE dose standard enforced at SRS for drinking water 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).

In 2000, EPA promulgated 40 CFR, Parts 9, 141, and 142, "National Primary Drinking Water Regulations; Radionuclides; Final Rule." This rule, which is applicable only to community drinking water systems, finalized maximum contaminant levels (MCLs) for radionuclides, including uranium. In essence, it reestablishes the MCLs from EPA's original 1976 rule. Most of these MCLs are derived from dose conversion factors that are based on early ICRP–2 methods.

However, when calculating dose, SRS must use the more current ICRP–30-based dose conversion factors provided by DOE. Because they are based on different methods, most EPA and DOE radionuclide dose conversion factors differ. Therefore, a direct comparison of the drinking water doses calculated for showing compliance with DOE Order 5400.5 to the EPA drinking water MCLs cannot be made.

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 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, 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 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 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. Because of security controls and the considerable distances between most SRS operating facilities and the site boundary, this scenario is highly improbable, if not impossible.

For each SRS facility that releases radioactivity, the site's Environmental Monitoring and Analysis group compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs.

Environmental Management

SRS began its cleanup program in 1981. Two major federal statutes provide guidance for the site's environmental restoration and waste management activities—RCRA and CERCLA. RCRA addresses the management of hazardous waste and requires that permits be obtained for facilities that treat, store, or dispose of hazardous or mixed waste. It also requires that DOE facilities perform appropriate corrective action to address contaminants in the environment. CERCLA (also known as Superfund) addresses the uncontrolled release of hazardous substances and the cleanup of inactive waste sites. This act establishes a National Priority List of sites targeted for assessment and, if necessary, corrective/remedial action. SRS was placed on this list December 21, 1989 [Fact Sheet, 2000]. In August 1993, SRS entered into the Federal Facility Agreement (FFA) with EPA Region IV and SCDHEC. This agreement governs the corrective/remedial action process from site investigation through site remediation. It also describes procedures for setting annual work priorities, including schedules and deadlines, for that process [FFA under section 120 of CERCLA and sections 3008(h) and 6001 of RCRA].

Additionally, DOE is complying with Federal Facility Compliance Act requirements for mixed waste management—including high-level waste, most transuranic waste, and low-level waste with hazardous constituents. This act requires that DOE develop and submit site treatment plans to the EPA or state regulators for approval.

The disposition of facilities after they are declared excess to the government's mission is managed by Site Decommissioning and Demolition (D&D)—formerly Facilities Disposition Projects. The facility disposition process is conducted in accordance with DOE Order 430.1A, "Life Cycle Asset Management," and its associated guidance documents. The major emphases are (1) to reduce the risks to workers, the public, and the environment, and (2) to reduce the costs required to maintain the facilities in a safe condition through a comprehensive surveillance and maintenance program.

Quality Assurance/Quality Control

DOE Order 414.1B, "Quality Assurance," sets requirements and guidelines for departmental quality assurance (QA) practices. To ensure compliance with regulations and to provide overall quality requirements for site programs, WSRC developed its *Quality Assurance Management Plan, Rev. 13* (WSRC–RP–92–225). The plan's requirements are implemented by the *WSRC Quality Assurance Manual* (WSRC 1Q).

The *SRS Environmental Monitoring Section Quality Assurance Plan* (WSRC–3Q1–2, Volume 3, Section 8000), was written to apply the QA requirements of WSRC 1Q to the environmental monitoring and surveillance program. The EMA WSRC–3Q1 procedure series includes procedures on sampling, radiochemistry, and water quality that emphasize the quality control requirements for EMA.

QA requirements for monitoring radiological air emissions are specified in 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants." For radiological air emissions at SRS, the responsibilities and lines of communication are detailed in *National Emission Standards for Hazardous Air Pollutants Quality Assurance Project Plan for Radionuclides (U)* (WSRC–IM–91–60).

To ensure valid and defensible monitoring data, the records and data generated by the monitoring program are maintained according to the requirements of DOE Guide 1324.5B, "Implementation Guide for Use with 36 CFR Chapter XII – Subchapter B Records Management," 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 Retention Schedule Matrix* (WSRC–EM–96–00023).

EMA assessments are implemented according to the following documents:

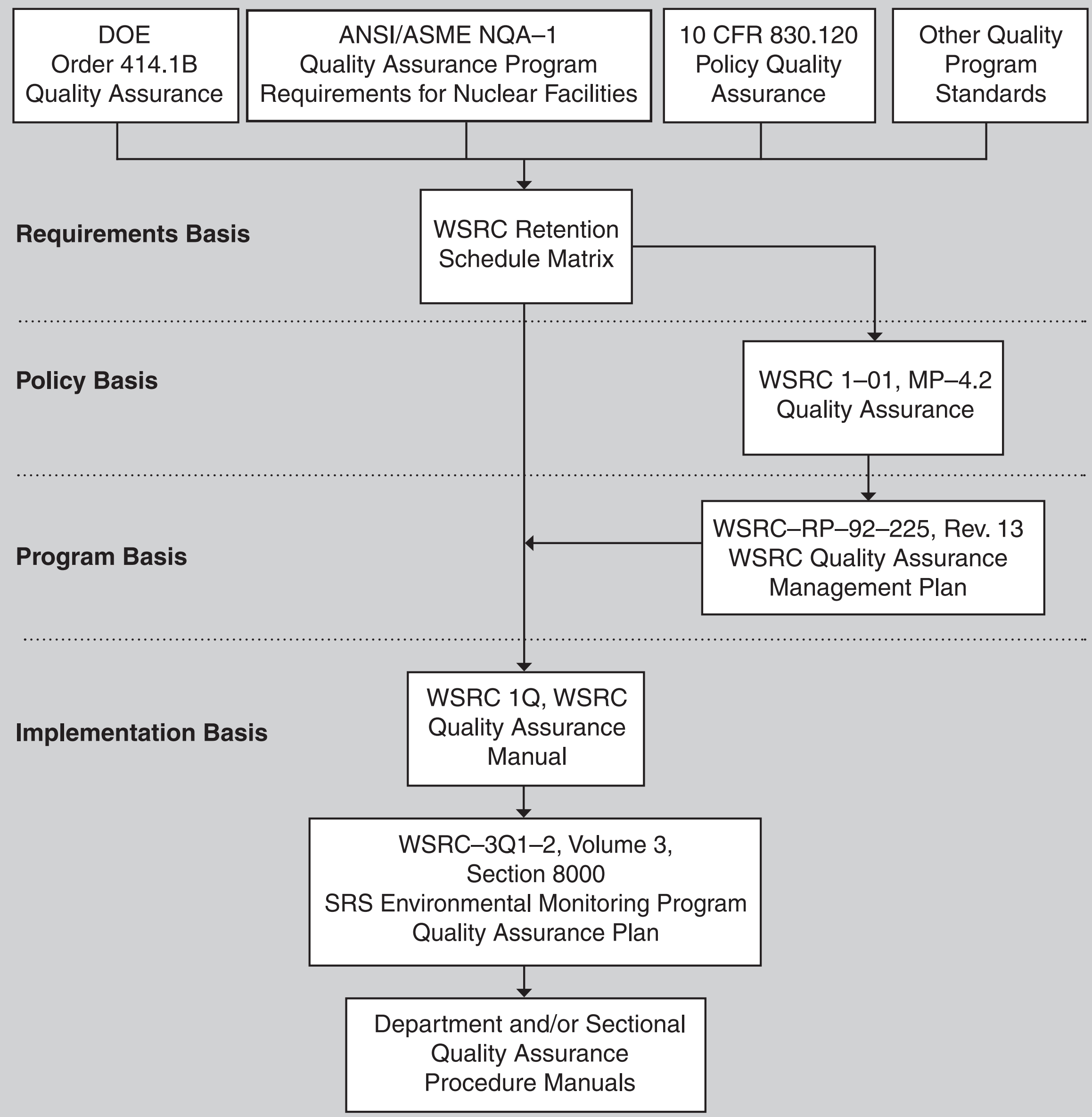
- DOE Order 414.1B
- DOE/EH–0173T
- DOE Environmental Management Consolidated Audit Program (EMCAP)
- WSRC 1Q
- WSRC 12Q, *Assessment Manual*

Figure A–1 illustrates the hierarchy of relevant guidance documents that support the EMA QA/QC program.

Reporting

DOE Orders 231.1A, "Environment, Safety and Health Reporting," and 5400.5, "Radiation Protection of the Public and Environment," require that SRS submit an annual environmental report.

This report, the *SRS Environmental Report for 2004,* is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 2004.



Other Quality Program Standards and Guidances

- ISO 1996
- ANSI 1995
- ISO 1999

Documents referenced in this figure are as follows:

- ANSI 1989
- DOE 2000
- DOE 2001a
- WSRC 1992
- WSRC 2001a
- WSRC 2001b
- WSRC 2001j
- WSRC 2001i

Figure A–1 SRS EM Program QA/QC Document Hierarchy

This diagram depicts the hierarchy of relevant guidance and supporting documents for the QA/QC program.

ISO 14001 Environmental Management System

ISO 14001 is the EMS standard within the ISO 14000 series of standards, a family of voluntary environmental management standards and guidelines. SRS first achieved ISO 14001 independent certification of its EMS against this standard in 1997 by demonstrating adherence to and programmatic implementation of the SRS Environmental Management System Policy. Beginning in May 2002, the site discontinued independent certification of its EMS program, but it continues to self-evaluate itself against the ISO 14001 standard. A requirement of the standard is maintenance of an environmental policy. The full text of the policy follows.

Savannah River Site Environmental Management System Policy June 14, 2004

Objective

The management of the Savannah River Site (SRS) recognizes its responsibility to conduct its operations in compliance with applicable laws and regulations providing for the protection of the environment, to reduce the use of procedures and processes that produce hazardous wastes, and to seek ways to continually improve the performance of activities protective of the environment.

Directive

Recognizing that many aspects of operations carried out at SRS may impact the environment, the SRS policy is that all employees, contractors, subcontractors, and other entities performing work at SRS shall abide by the directives in this document. This document serves as the primary documentation for the environmental goals and objectives of SRS and shall be available to the public. It shall be centrally maintained and updated as necessary to reflect the changing needs, mission, vision, and goals of SRS. The Department of Energy–Savannah River Operations Office (DOE–SR), Westinghouse Savannah River Company (WSRC), Wackenhut Services Inc.–Savannah River Site (WSI–SRS), Savannah River Ecology Laboratory (SREL), General Services Administration–Savannah River Site (GSA–SRS), National Nuclear Security Administration–Savannah River Site Office (NNSA–SRSO), National Nuclear Security Administration–Fissile Materials Disposition Office (NNSA–FMDO), and the United States Forest Service–Savannah River (USFS–SR) endorse the principles stated in this policy.

- The Environmental Management System pursues and measures continual improvement in performance by establishing and maintaining documented environmental objectives and targets that correspond to SRS's mission, vision, and core values. The environmental objectives and targets shall be established for each relevant function within DOE–SR, NNSA–SRSO, NNSA–FMDO, and all contractors, subcontractors, and other entities performing work at SRS for all activities having actual or potentially significant environmental impacts.
- DOE–SR, NNSA–SRSO, NNSA–FMDO, and all contractors, subcontractors, and other entities performing work at SRS shall

  1. manage the SRS environment, natural resources, products, waste, and contaminated materials so as to eliminate or mitigate any threat to human health or the environment at the earliest opportunity and implement process improvements, as appropriate, to ensure continual improvement of performance in environmental management
  2. implement a pollution prevention program to reduce waste generation, releases of pollutants, and future waste management and pollution control costs, and to promote energy efficiency
  3. conduct operations in compliance with all applicable federal, state, and local laws, regulations, statutes, executive orders, directives, and standards

4. work cooperatively and openly with appropriate local, state, and federal agencies, public stakeholders, and site employees to prevent pollution, achieve environmental compliance, conduct cleanup and restoration activities, enhance environmental quality, and ensure the protection of workers and the public
5. design, develop, operate, maintain, decommission, and deactivate facilities and perform operations in a manner that shall be resource-efficient and will protect and improve the quality of the environment for future generations, and continue to maintain SRS as a unique national environmental asset
6. recognize that the responsibility for quality communications rests with each individual employee and that it shall be the responsibility of all employees to identify and communicate ideas for improving environmental protection activities and programs at the site

Adherence to and programmatic implementation of this policy shall be the responsibility of the DOE–SR, NNSA–SRSO, and NNSA–FMDO managers in coordination with the contractors, subcontractors, and other entities performing work at SRS.

Jeffrey M. Allison, Manager
Savannah River Operations Office

Robert A. Pedde, President
Westinghouse Savannah River Company LLC

Richard W. Arkin, Manager
NNSA Savannah River Site Office

Dr. Lawrence Brede, Jr., General Manager
Wackenhut Services Incorporated – SRS

Sterling Franks, Acting Director
NNSA Fissile Materials Disposition Office

Dr. Paul M. Bertsch, Director
Savannah River Ecology Laboratory

David W. Wilson, Forest Manager
U. S. Forest Service, Savannah River

Merton A. Keith, Environmental Manager
General Services Administration-SRS

Appendix B

Radionuclide and Chemical Nomenclature

Nomenclature and Half-Life for Radionuclides

Radionuclide	Symbol	Half-life[a,b]	Radionuclide	Symbol	Half-life[a,b]
Actinium-228	Ac-228	6.15 h	Mercury-203	Hg-203	46.61 d
Americium-241	Am-241	432.7 y	Neptunium-237	Np-237	2.14E6 y
Americium-243	Am-243	7370 y	Neptunium-239	Np-239	2.355 d
Antimony-124	Sb-124	60.2 d	Nickel-59	Ni-59	7.6E4 y
Antimony-125	Sb-125	2.758 y	Nickel-63	Ni-63	100 y
Argon-39	Ar-39	269 y	Niobium-94	Nb-94	2.0E4 y
Barium-133	Ba-133	10.7 y	Niobium-95	Nb-95	34.97 d
Beryllium-7	Be-7	53.28 d	Plutonium-238	Pu-238	87.7 y
Bismuth-212	Bi-212	2.14 m	Plutonium-239	Pu-239	2.41E4 y
Bismuth-214	Bi-214	19.9 m	Plutonium-240	Pu-240	6560 y
Carbon-14	C-14	5714 y	Plutonium-241	Pu-241	14.4 y
Cerium-141	Ce-141	32.5 d	Plutonium-242	Pu-242	3.75E5 y
Cerium-144	Ce-144	284.6 d	Potassium-40	K-40	1.27E9 y
Cesium-134	Cs-134	2.065 y	Praseodymium-144	Pr-144	17.28 m
Cesium-137	Cs-137	30.07 y	Praseodymium-144m	Pr-144m	7.2 m
Chromium-51	Cr-51	27.702 d	Promethium-147	Pm-147	2.6234 y
Cobalt-57	Co-57	271.8 d	Protactinium-231	Pa-231	3.28E4 y
Cobalt-58	Co-58	70.88 d	Protactinium-233	Pa-233	27.0 d
Cobalt-60	Co-60	5.271 y	Protactinium-234	Pa-234	6.69 h
Curium-242	Cm-242	162.8 d	Radium-226	Ra-226	1599 y
Curium-244	Cm-244	18.1 y	Radium-228	Ra-228	5.76 y
Curium-245	Cm-245	8.50E3 y	Ruthenium-103	Ru-103	39.27 d
Curium-246	Cm-246	4.76E3 y	Ruthenium-106	Ru-106	1.020 y
Europium-152	Eu-152	13.54 y	Selenium-75	Se-75	119.78 d
Europium-154	Eu-154	8.593 y	Selenium-79	Se-79	6.5E5 y
Europium-155	Eu-155	4.75 y	Sodium-22	Na-22	2.604 y
Iodine-129	I-129	1.57E7 y	Strontium-89	Sr-89	50.52 d
Iodine-131	I-131	8.0207 d	Strontium-90	Sr-90	28.78 y
Iodine-133	I-133	20.3 h	Technetium-99	Tc-99	2.13E5 y
Krypton-85	Kr-85	10.76 y	Thallium-208	Tl-208	3.053 m
Lead-212	Pb-212	10.64 h	Thorium-228	Th-228	1.913 y
Lead-214	Pb-214	27 m	Thorium-230	Th-230	7.54E4 y
Manganese-54	Mn-54	312.1 d	Thorium-232	Th-232	1.40E10 y

[a] m = minute; h = hour; d = day; y = year
[b] Reference: Chart of the Nuclides, 15th edition, revised 1996, General Electric Company

Nomenclature and Half-Life for Radionuclides, Continued

Radionuclide	Symbol	Half-life[a,b]	Radionuclide	Symbol	Half-life[a,b]
Thorium-234	Th-234	24.10 d	Uranium-235	U-235	7.04E8 y
Tin-113	Sn-113	115.1 d	Uranium-236	U-236	2.342E7 y
Tin-126	Sn-126	2.5E5 y	Uranium-238	U-238	4.47E9 y
Tritium (Hydrogen-3)	H-3	12.32 y	Xenon-135	Xe-135	9.10 h
Uranium-232	U-232	69.8 y	Zinc-65	Zn-65	243.8 d
Uranium-233	U-233	1.592E5 y	Zirconium-85	Zr-85	7.7 m
Uranium-234	U-234	2.46E5 y	Zirconium-95	Zr-95	64.02 d

[a] m = minute; h = hour; d = day; y = year
[b] Reference: Chart of the Nuclides, 15th edition, revised 1996, General Electric Company

Nomenclature for Elements and Chemical Constituent Analyses

Note: Some of the symbols listed in this table came from various databases used to format the data tables in this report and are included here to assist the reader in understanding the tables.

Constituent	Symbol	Constituent	Symbol
Aluminum	Al (or AL)	Nitrite, Nitrate	NO_2,NO_3 (or NO_2,
Ammonia	NH_3		NO_3, or NO_2/NO_3)
Ammonia as Nitrogen	NH_3-N (or AN)	pH	pH (or PH)
Antimony	Sb (or SB)	Phenol	PHE
Arsenic	As (or AS)	Phosphorus	P
Barium	Ba (or BA)	Phosphate	PO_4 (or PO_4-P or
Biological Oxygen Demand	BOD		PO_4-P)
Beryllium	Be	Polychlorinated Biphenyl	PCB
Boron	B	Potassium	K
Bromide	B-	Selenium	Se (or SE)
Cadmium	Cd (or CD)	Silver	Ag (or AG)
Chemical Oxygen Demand	COD	Sulfate	SO_4 (or SO_4)
Chlorine	Cl (or CHL)	Tetrachloroethene	PERCL
Chromium	Cr (or CR)	Tetrachloroethylene	
Cobalt	Co	(Perchloroethylene)	PERCL
Copper	Cu (or CU)	Trichloroethene	TRICL
Cyanide	CN	Trichloroethylene	TRICL
Dissolved Oxygen	DO	Tin	SN
Iron	Fe (or FE)	Total Dissolved Solids	TDS
Lead	Pb (or PB)	Total Kjeldahl Nitrogen	TKN
Magnesium	Mg (or MG)	Total Organic Carbon	TOC
Manganese	Mn (or MN)	Total Suspended Particulate	
Mercury	Hg (or HG)	Matter	TSP
Molybdenum	Mo	Total Suspended Solids	TSS
Nickel	Ni (or NI)	Total Volatile Solids	TVS
Nitrate	NO_3	Uranium	U
Nitrate as Nitrogen	NO_3-N	Vinyl Chloride	VC
Nitrite as Nitrogen	NO_2-N	Zinc	Zn (or ZN)

Appendix C

Errata

From 2003 Report

The following information was reported incorrectly in the *Savannah River Site Environmental Report for 2003* (WSRC–TR–2004–00015):

Page 10, right column, third full paragraph: SRS's 2003 compliance rate for the NPDES program under the CWA should have been listed as 99.7 percent.

From 2003 Data

The following information was reported incorrectly in the *Savannah River Site Environmental Data for 2003* (WSRC–TR–2004–00015):

Liquid Dose Tables ("MEI Dose - Liquid"): The percent-of-total-dose values for alpha and nonvolatile beta were reversed. The alpha percent of total dose should have been 10 percent and the nonvolatile beta percent of total dose should have been 2 percent. The individual dose values are correct as shown in the table.

Glossary

A

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

actinide - Group of elements of atomic number 89 through 103. Laboratory analysis of actinides by alpha spectrometry generally refers to the elements plutonium, americium, uranium, and curium but may also include neptunium and thorium.

activity - See radioactivity.

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.

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.

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. Functions of the Energy Research and Development Administration eventually were taken over by the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission.

B

background radiation - Naturally occurring radiation, fallout, and cosmic radiation. Generally, the lowest level of radiation obtainable within the scope of an analytical measurement, i.e., a blank sample.

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 management practices - Sound engineering practices that are not 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 U.S. 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 Services 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.

C

calibration - Process of applying correction factors to equate a measurement to a known standard. Generally, a documented measurement control program of charts, graphs, and data that demonstrate that an instrument is properly calibrated.

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.

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.

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 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.

contamination - State of being made impure or unsuitable by contact or mixture with something unclean, bad, etc.

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

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.

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) - 1**0^3 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.

deactivation - The process of placing a facility in a stable and known condition, including the removal of hazardous and radioactive materials to ensure adequate protection of the worker, public health and safety, and the environment—thereby limiting the long-term cost of surveillance and maintenance.

decommissioning - Process that takes place after deactivation and includes surveillance and maintenance, decontamination, and/or dismantlement.

decontamination - The removal or reduction of residual radioactive and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

decommissioning and demolition - Program that reduces the environmental and safety risks of surplus facilities at SRS.

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 U.S. Department of Energy Order 5400.5.

detection limit - See analytical detection limit, lower limit of detection, minimum detectable concentration.

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.

disposal - Permanent or temporary transfer of U.S. Department of Energy control and custody of real property to a third party, which thereby acquires rights to control, use, or relinquish the property.

disposition - Those activities that follow completion of program mission—including, but not limited to, surveillance and maintenance, deactivation, and decommissioning.

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 U.S. Department of Energy program activities.

dosimeter - Portable detection device for measuring the total accumulated exposure to ionizing radiation.

downgradient - In the direction of decreasing hydrostatic head.

drinking water standards - Federal primary drinking water standards, both proposed and final, as set forth by the U.S. Environmental Protection Agency.

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 - Any treated or untreated air emission or liquid discharge to the environment.

effluent monitoring - Collection and analysis of samples or measurements of liquid and gaseous effluents for purpose of characterizing and quantifying the release of contaminants, assessing radiation exposures of members to the public, and demonstrating compliance with applicable standards.

environmental compliance - Actions taken in accordance with government laws, regulations, orders, etc., that apply to site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with regulatory compliance.

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 - U.S. Department of Energy program that directs the assessment and cleanup of inactive waste units and groundwater (remediation) contaminated as a result of nuclear-related activities.

environmental surveillance - Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from U.S. Department of Energy sites and their environs and the measurement of external radiation for purpose of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

exceedance - Term used by the U.S. 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 that takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

exposure pathway - Route that materials follow to get to the environment and then to people.

F

fallout - See worldwide fallout.

Federal Facility Agreement (FFA) - Agreement negotiated among the U.S. Department of Energy, the U.S. 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 Savannah River Site waste units identified for evaluation and, if necessary, cleanup.

feral hog - Hog that has reverted to the wild state from domestication.

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-emitter - Any nuclide that emits a gamma ray during the process of radioactive decay. Generally, the fission products produced in nuclear reactors.

gamma spectrometry - System consisting of a detector, associated electronics, and a multichannel analyzer that is used to analyze samples for gamma-emitting radionuclides.

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).

H

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.

heavy water - Water in which the molecules contain oxygen and deuterium, an isotope of hydrogen that is heavier than ordinary hydrogen.

hydraulic gradient - Difference in hydraulic head over a specified distance.

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.

instrument background - Instrument signal due to electrical noise and other interferences not attributed to the sample or blank.

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.

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.

legacy - Anything handed down from the past; inheritance, as of nuclear waste.

lower limit of detection - Smallest concentration/amount of an 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 U.S. 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 from 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 - 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.

migration - Transfer or movement of a material through the air, soil, or groundwater.

minimum detectable concentration - 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.

moderate - To reduce the excessiveness of; to act as a moderator.

moderator - Material, such as heavy water, used in a nuclear reactor to moderate or slow down neutrons from the high velocities at which they are created in the fission process.

monitoring - Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically to regulate and control potential impacts.

N

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

opacity - The reduction in visibility of an object or background as viewed through the diameter of a plume.

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

parameter - Analytical constituent; chemical compound(s) or property for which an analytical request may be submitted.

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 at a waste source (e.g., a hazardous waste disposal site).

point source - Any defined source of emission to air or water such as a stack, air vent, pipe, channel or passage to a water body.

population dose - See collective dose equivalent under dose.

process sewer - Pipe or drain, generally located underground, used to carry off process water and/or waste matter.

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) - In the Environmental Monitoring System program, QA consists of the system whereby the laboratory can assure clients and other outside entities, such as government agencies and accrediting bodies, that the laboratory is generating data of proven and known quality.

quality control (QC) - In the Environmental Monitoring System program, QC refers to those operations undertaken in the laboratory to ensure that the data produced are generated within known probability limits of accuracy and precision.

R

rad - Unit of absorbed dose deposited in a volume of material.

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 essentially are simultaneous to the event itself.

reforestation - Process of planting new trees on land once forested.

regulatory compliance - Actions taken in accordance with government laws, regulations, orders, etc., that apply to Savannah River Site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with environmental compliance.

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 x the radiation quality factor). Dose equivalent frequently is reported in units of millirem (mrem) which is one-thousandth of a rem.

remediation - Assessment and cleanup of U.S. Department of Energy sites contaminated with waste as a result of past activities. See environmental restoration.

remediation design - Planning aspects of remediation, such as engineering characterization, sampling studies, data compilation, and determining a path forward for a waste site.

replicate - In the Environmental Services 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.

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) 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/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.

routine radioactive release - Planned or scheduled release of radioactivity to the environment.

S

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.

settling basin - Temporary holding basin (excavation) that receives wastewater that subsequently is discharged.

site stream - Any natural stream on the Savannah River Site. Surface drainage of the site is via these streams to the Savannah River.

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.

spent nuclear fuel - Used fuel elements from reactors.

spike - Addition, to a blank sample, of a known amount of reference material containing the analyte of interest.

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.

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

supernate - 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.

thermoluminescent dosimeter (TLD) - Device used to measure external gamma radiation.

total dissolved solids - Dissolved solids and total dissolved solids are terms generally associated with freshwater systems; they consist of inorganic salts, small amounts of organic matter and dissolved materials.

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 suspended particulates - Refers to the concentration of particulates in suspension in the air, irrespective of the nature, source, or size of the particulates.

transport pathway - Pathway by which a released contaminant is transported physically from its point of discharge to a point of potential exposure to humans. Typical transport pathways include the atmosphere, surface water, and groundwater.

transuranic waste - Solid radioactive waste containing primarily alpha-emitting elements heavier than uranium.

trend - General drift, tendency, or pattern of a set of data plotted over time.

turbidity - Measure of the concentration of sediment or suspended particles in solution.

U

unspecified alpha and beta emissions - The unidentified alpha and beta emissions that are determined at each effluent location by subtracting the sum of the individually measured alpha-emitting (e.g., plutonium-239 and uranium-235) and beta-emitting (e.g., cesium-137 and strontium-90) radionuclides from the measured gross alpha and beta values, respectively.

V

vitrify - Change into glass.

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 management - The U.S. Department of Energy uses this term to refer to the safe, effective management of various kinds of nonhazardous, hazardous, and radioactive waste generated on site.

waste unit - An inactive area known to have received contamination or to have had a release to the environment.

water table - Planar, underground surface beneath which earth materials, such as soil or rock, are saturated with 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 attributed 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 wind direction and speed at a location is summarized.

worldwide fallout - Radioactive debris from atmospheric weapons tests that has been deposited on the earth’s surface after being airborne and cycling around the earth.

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Units of Measure		Units of Measure	
Symbol	**Name**	**Symbol**	**Name**
Temperature		*Concentration*	
°C	degrees Centigrade	ppb	parts per billion
°F	degrees Fahrenheit	ppm	parts per million
Time			
d	day	*Rate*	
h	hour	cfs	cubic feet per second
y	year	gpm	gallons per minute
Length			
cm	centimeter	*Conductivity*	
ft	foot	μmho	micromho
in.	inch		
km	kilometer		
m	meter	*Radioactivity*	
mm	millimeter	Ci	curie
μm	micrometer	cpm	counts per minute
		mCi	millicurie
Mass		μCi	microcurie
g	gram	pCi	picocurie
kg	kilogram	Bq	becquerel
mg	milligram		
μg	microgram	*Radiation Dose*	
		mrad	millirad
Area		mrem	millirem
mi^2	square mile	Sv	sievert
ft^2	square foot	mSv	millisievert
		μSv	microsievert
Volume		R	roentgen
gal	gallon	mR	milliroentgen
L	liter	μR	microroentgen
mL	milliliter	Gy	gray

Fractions and Multiples of Units				
Multiple	**Decimal Equivalent**	**Prefix**	**Symbol**	**Report Format**
10^6	1,000,000	mega-	M	E+06
10^3	1,000	kilo-	k	E+03
10^2	100	hecto-	h	E+02
10	10	deka-	da	E+01
10^{-1}	0.1	deci-	d	E–01
10^{-2}	0.01	centi-	c	E–02
10^{-3}	0.001	milli-	m	E–03
10^{-6}	0.000001	micro-	µ	E–06
10^{-9}	0.000000001	nano-	n	E–09
10^{-12}	0.000000000001	pico-	p	E–12
10^{-15}	0.000000000000001	femto-	f	E–15
10^{-18}	0.000000000000000001	atto-	a	E–18

Conversion Table (Units of Radiation Measure)		
Current System	***Systéme International***	**Conversion**
curie (Ci)	becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
rad (radiation absorbed dose)	gray (Gy)	1 rad = 0.01 Gy
rem (roentgen equivalent man)	sievert (Sv)	1 rem = 0.01 Sv

Conversion Table					
Multiply	**By**	**To Obtain**	**Multiply**	**By**	**To Obtain**
in.	2.54	cm	cm	0.394	in.
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
liq qt–U.S.	0.946	L	L	1.057	liq qt–U.S.
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
d/m	0.450	pCi	pCi	2.22	d/m
pCi	10^{-6}	µCi	µCi	10^6	pCi
pCi/L (water)	10^{-9}	µCi/mL (water)	µCi/mL (water)	10^9	pCi/L (water)
pCi/m^3 (air)	10^{-12}	µCi/mL (air)	µCi/mL (air)	10^{12}	pCi/m^3 (air)