SRNS–STI–2012–00200

Savannah River Site

Environmental Report for 2011

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To Our Readers

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 2011 (SRNS-STI-2012-00200) is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 2011 - including the Site's performance against applicable standards and requirements. Details are provided on major programs such as the Environmental Management System (EMS) and permit compliance. Information for the 2011 report was compiled and prepared by the Environmental Compliance and Area Completion Projects (EC&ACP) Department of Savannah River Nuclear Solutions LLC (SRNS), the Site's Management and Operations (M&O) contractor. The "Environmental Monitoring Program Management Plan" (SRS EM Plan, 2010) documents 1) the rationale and objectives for the monitoring program, 2) the frequency of monitoring and analysis, 3) the various sampling locations, and 4) the specific analytical and sampling protocols used. The "Environmental Monitoring Quality Assurance Project Plan" (SRS EM QA Plan, 2010) describes the associated quality assurance requirements.

Complete data tables are included on the CD inside the back cover of this report. The CD also features 1) an electronic version of the report; 2) an appendix of site, environmental sampling location, dose, and groundwater maps; and 3) annual (2011) reports from a number of other SRS organizations. The data tables generally are presented as unformatted Excel spreadsheets; they are not intended to be printed. However, if printing is desired, the user can modify the "Page Setup" parameters in Excel as needed. If printing of the "SRS Maps" on the CD is desired, it is recommended (to ensure clarity) that Figures 1 through 25 be printed 8.5 x 11 inches, Figures 26 through 31 be printed 36 x 32 inches (in.), and Figures 32 through 34 be printed 34 x 33 in.

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

- 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, sample handling and transportation issues, compromise of the samples in the preparation laboratories or counting room.
- Table heading abbreviations may include the following: 1) "N" is number of observations; 2) "SampleCon" is sample concentration; 3) "SampleStd" is standard deviation; and 4) "Sig" is significance, with "Yes" meaning detectable and "No" meaning less than the analytical method detection limit.
- 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 G-1) 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 (50-year committed dose) from internal deposition of radionuclides and to the effective dose attributable to beta/gamma radiation from sources external to the body.

Report Available on Web

Readers can find the
SRS Annual Environmental Report
on the World Wide Web at the following address:
http://www.srs.gov/general/pubs/ERsum/index.html.

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Acronyms and Abbreviations

Note: Sampling location abbreviations can be found on page xvii

A

ACM	Asbestos-Containing Material
ADN	Asbestos Disturbance Notice
AER	Alternate Energy Resources, Inc.
AERMOD	American Meteorological Society/ Environmental Protection Agency Regulatory Model
ALARA	As Low as Reasonably Achieveable
ANS	Academy of Natural Sciences
ARRA	American Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers

B

BCG	Biota Concentration Guide
BGN	Burial Ground North
BJWSA	Beaufort-Jasper Water and Sewer Authority
BPMP	Business Process Modernization Project
BTU/GSF	British Thermal Units per Gross Square Foot

C

C&D	Construction and Demolition
CA	Composite Analysis
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAB	Citizens Advisory Board
CAP	Consolidated Audit Program
CD	Compact Disk
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
CMC	Chemical Management Center
CMIR/RACRs	Corrective Measures Implementation Report/Remedial Action Completion Reports
CO	Carbon monoxide
COE	Corps of Engineers
COR	Challenges, Opportunities, and Resolution
CPT	Cone Penetrometer Technology
CRMP	Cultural Resources Management Plan
CSI	Compliance Sampling Inspection
CSRA	Central Savannah River Area
CWA	Clean Water Act
CY	Calendar Year
CX	Categorical Exclusion

D

DCG	Derived Concentration Guide
DEAR	DOE Acquisition Regulations
DOD	U.S. Department of Defense
DOE	Department of Energy
DUS	Dynamic Underground Stripping
DWS	Drinking Water Standards

E

EA	Environmental Assessment
EB	Existing Building
EC&ACP	Environmental Compliance and Area Completion Projects
ECODS	Early Construction and Operational Disposal Site
EDAM	Environmental Dose Assessment Manual
EDP	Economic Development Partnership

EEC	Environmental Evaluation Checklist
EIS	Environmental Impact Statement
EM	Environmental Monitoring
EML	Environmental Monitoring Laboratory
EMS	Environmental Management System
EMS	Environmental Monitoring System
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferred Product
eQUEST	The Quick Energy Simulation Tool
EQMD	Environmental Quality Management Division
ESA	Endangered Species Act
ESEC	Environmental Science Education Cooperative
ESPC	Energy Savings Performance Contract
EStar	Environmental Sustainability

F

FEIS	Final Environmental Impact Statement
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FFCAct	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIMS	Flow Injection Mercury System
FMP	Fish Monitoring Plan
FONSI	Finding of No Significant Impact
ft	Feet / Foot
ft^2	Square Feet
ft^3	Cubic Feet
FTF	F-Tank Farm
FY	Fiscal Year

G

GDNR	Georgia Department of Natural Resources
GHG	Greenhouse Gases
GSA	General Services Administration
GPS	Global Positioning System
GTCC LLW	Greater-Than-Class-C Low-Level Radioactive Waste

H

HANM	H-Area New Manufacturing
HFC	Hydrofluorocarbon
HPSB	High Performance Sustainable Building
HQ	Headquarters
HSWA	Hazardous and Solid Waste Amendments
HVAC	Heating, Ventilation and Air Conditioning

I

I&D	Industrial and Domestic
IAPCR	Interim Action Post Closure Report
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICRP	International Commission on Radiological Protection
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization

K

Kg	Kilogram

L

lb	Pound
LDR	Land Disposal Restrictions
LEED®	Leadership in Energy and Environmental Design
LWO	Liquid Waste Operations

M

M&O	Management and Operating
MACT	Maximum Achievable Control Technology
MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act of 1918
MCL	Maximum Contaminant Levels

MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MEI	Maximally Exposed Individual
MFFF	Mixed Oxide Fuel Fabrication Facility
mi	Mile
mi^2	Square Mile
MOX	Mixed Oxide
mrem	Millirem
MRF	Material Recovery Facility
mSv	Millisievert
MT	Metric Ton
MW	Mixed Waste
MWMF	Mixed Waste Management Facility

N

NADP	National Atmospheric Deposition Program
NBN	No Building Number
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NNSA	National Nuclear Security Administration
NOAVs	Notices of Alleged Violation
NOI	Notice of Intent
NOVs	Notices of Violation
NOx	Oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPEP	National Partnership for Environmental Priorities
NPL	National Priority List
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NWPs	Nationwide Permits

O

O&M	Operations and Maintenance
OFI	Opportunities For Improvement
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration

P

P2	Pollution Prevention
PA	Performance Assessments
PC	Personal Computers
PCB	Polychlorinated biphenyl
PCR	Post-Construction Report
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
PGP	General Permit for Discharges of Application of Pesticides
pH	Measure of the hydrogen ion concentration in an aqueous solution (acidic solutions, pH from 0 to 6; basic solutions, pH > 7; and neutral solutions, pH = 7)
PM	Particulate Matter
PPE	Personal Protection Equipment
ppm	Parts Per Million
PQL	Practical Quantification Limit

Q

QA	Quality Assurance
QC	Quality Control

R

RCRA	Resource Conservation and Recovery Act
RFI/FI	RCRA Facility Investigation/Remedial Investigation
RHA	Rivers and Harbors Act
RM	River Mile
RMP	Risk Management Program
ROD	Record of Decision
RQ	Reportable Quantity
RUP	Restricted-Use Pesticide

S

SA	Supplement Analysis
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control

SCEEP	South Carolina Environmental Excellence Program
SDF	Saltstone Disposal Facility
SDWA	Safe Drinking Water Act
SE	Site Evaluation
SEER	Seasonal Energy Efficiency Ratio
SEIS	Supplemental Environmental Impact Statement
SEMC	Senior Environmental Managers Council
SPD	Surplus Plutonium Disposition
SO_2	Sulfur dioxide
SRARP	Savannah River Archaeological Research Program
SREL	Savannah River Ecology Laboratory
SRIT	SRS Regulatory Integration Team
SRR	Savannah River Remediation
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
SRSFD	SRS Fire Department
STP	Site Treatment Plan
STAR	Site Tracking, Analysis and Reporting
SVE	Soil Vapor Extraction
SWDF	Solid Waste Disposal Facility

T

TBD	To Be Determined
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TEF	Tritium Extraction Facility
TER	Technical Evaluation Report
TLD	Thermoluminescent Dosimeter
TRI	Toxics Release Inventory
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority

U

UNF	Used Nuclear Fuel
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS-SR	United States Forest Service–Savannah River
USGS	U.S. Geological Survey
UST	Underground Storage Tanks

V

VEGP	Vogtle Electric Generating Plant
VOC	Volatile Organic Compound

W

WQC	Water Quality Certification
WIPP	Waste Isolation Pilot Plant

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
4MB	Fourmile Branch (Four Mile Creek)
4MC	Four Mile Creek
BDC	Beaver Dam Creek
BG	Burial Ground
EAV	E-Area Vaults
FM	Four Mile
FMB	Fourmile Branch (Four Mile Creek)
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 (Augusta Lock and 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
VEGP	Vogtle Electric Generating Plant (Plant Vogtle)

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
Four Mile Creek–3A; Four Mile Creek at Road C
Lower Three Runs–2; Lower Three Runs at Patterson Mill Road
Lower Three Runs–3; Lower Three Runs at Highway 125
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 8–1
Upper Three Runs–3; Upper Three Runs at Road C
Highway 17 Bridge; Houlihan Bridge
Stokes Bluff; Stokes Bluff Landing

Executive Summary

The Savannah River Site Environmental Report for 2011 *(SRNS-STI-2012-00200) is prepared for the U.S. Department of Energy (DOE) according to requirements of DOE Order 231.1 B, "Environment, Safety and Health Reporting.*

The annual SRS Environmental Report has been produced for more than 50 years. Several hundred copies are distributed each year to government officials, universities, public libraries, environmental and civic groups, news media, and interested individuals. The report's purpose is to

- *present summary environmental data that characterize site environmental management performance*
- *describe compliance status with respect to environmental standards and requirements*
- *highlight significant programs and efforts*

Minimal Impact

The Savannah River Site (SRS) maintained its record of environmental excellence in 2011, as its operations continued to result in minimal impact to the public and the environment. The site's radioactive and chemical discharges to air and water were well below regulatory standards for environmental and public health protection; its air and water quality met applicable requirements; and the potential radiation dose from its discharges was less than the national dose standards.

The largest radiation dose that an offsite, hypothetical, maximally exposed individual could have received from SRS operations during 2011 was estimated to be 0.21 millirem (mrem)–0.032 mrem from air pathways plus 0.084 mrem from liquid pathways other than air, and 0.092 from irrigation pathways (mrem is a standard unit of measure for radiation exposure). The 2011 SRS dose is just 0.21 percent of the DOE all-pathway dose standard of 100 mrem per year, and far less than the natural average dose of approximately 300 mrem per year (according to Report No. 160 of the National Council of Radiation Protection and Measurements) to people in the United States. This 2011 all-pathway dose was approximately 9 percent more than the 2010 dose of 0.11 mrem. The newly reported irrigation pathway dose contributed to an 84% increase.

Extensive Monitoring; Documented Compliance Rate of 100 Percent

Environmental monitoring is conducted extensively within a 2,000-square-mile network extending 25 miles (mi) from SRS, with some monitoring performed as far as 100 miles from the site. The area includes neighboring cities, towns, and counties in Georgia and South Carolina. Thousands of samples of air, rainwater, surface water, drinking water, groundwater, food products, wildlife, soil, sediment, and vegetation are collected by SRS and state authorities and analyzed for the presence of radioactive and nonradioactive contaminants.

Compliance with environmental regulations and with DOE orders related to environmental protection provides assurance that onsite processes do not impact the public or the environment adversely. Such compliance is documented in this report.

SRS had a National Pollutant Discharge Elimination System (NPDES) compliance rate of 100 percent in 2011, with zero of the 5,176 sample analyses performed exceeding permit limits – a compliance record that has been attained only two other times (2007 and 2010). The NPDES program protects streams, reservoirs, and other wetlands by limiting the release of nonradiological pollution into surface waters. Discharge limits are set for each facility to ensure that SRS operations do not negatively impact aquatic life or degrade water quality.

Introduction

CHAPTER 1

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Environmental Compliance and Area Completion Projects

This report was prepared in accordance with U.S. Department of Energy (DOE) Order 231.1B "Environment, Safety and Health Reporting," to present summary environmental data for the Savannah River Site (SRS) for the purpose of

- *highlighting significant site programs and efforts*
- *summarizing environmental occurrences and responses reported during the calendar year*
- *describing compliance status with respect to environmental standards and requirements*
- *characterizing the site's environmental management performance*

This report is the principal document that demonstrates compliance with the requirements of DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and is a key component of DOE's effort to keep the public informed of environmental conditions at SRS.

Missions

In September 2011, SRS announced and began to implement its Strategic Plan for 2011 through 2015. As described in the Strategic Plan, Enterprise•SRS will use the site's nuclear materials workforce, knowledge, and assets to help the nation address its critical needs in environmental stewardship, clean energy, and national security.

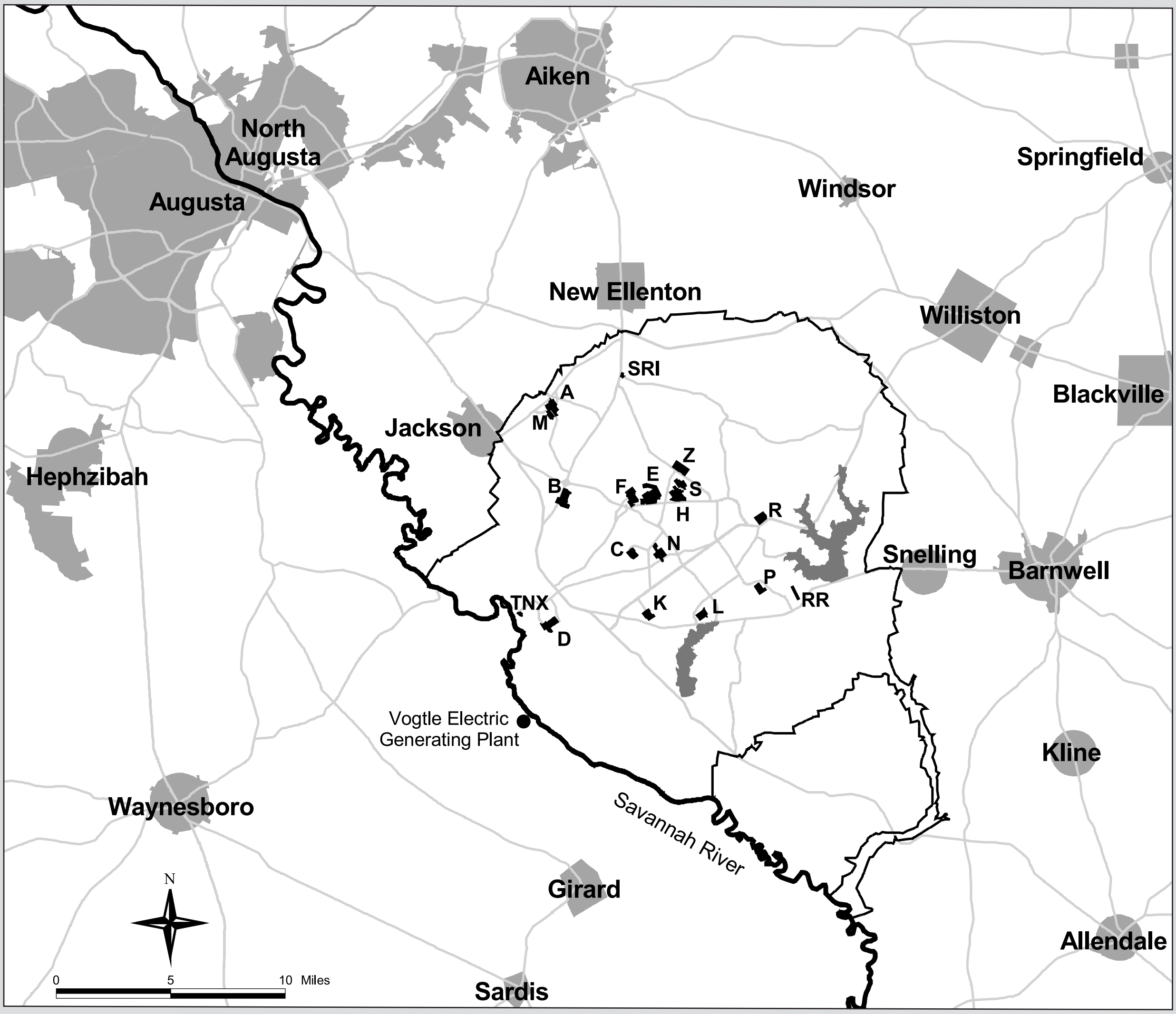
SRS has three primary mission areas that support activities of the DOE-Environmental Management (EM) program, National Nuclear Security Administration (NNSA) and the needs of the nation and the region:

- **Environmental Stewardship** – Focused on reducing the environmental legacy of nuclear materials and radioactive waste at SRS through initiatives such as groundwater restoration, deactivation and decommissioning of excess contaminated facilities, and radioactive waste disposition
- **National Security** – Focused on enhancing national security through innovative solutions to safely manage nuclear materials, including the disposition of surplus nuclear materials, tritium supply, and nuclear stockpile maintenance and evaluation
- **Clean Energy** – Focused on research and development to accelerate technology development through public and private partnerships to sustainably provide regional energy while protecting environmental health

In addition to these three mission areas, the SRS Strategic Plan also describes twelve strategic initiatives that will be pursued to ensure unique resources are effectively employed.

Site Location, Demographics, and Environment

SRS, a DOE complex facility, was constructed during the early 1950s to produce materials (primarily plutonium-239 and tritium) used in nuclear weapons. The Savannah River Nuclear Solutions, LLC (SRNS) is the SRS Management and Operating contractor. Savannah River Remediation (SRR) is the site's Liquid Waste Operations contractor. The site, which borders the Savannah River, covers about 310 square miles in the South Carolina counties of Aiken, Allendale, and Barnwell. SRS is about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia (figure 1-1).



SRNL Map

Figure 1–1 The Savannah River Site

SRS is located in South Carolina, about 12 miles south of Aiken, South Carolina, and about 15 miles southeast of Augusta, Georgia. The Savannah River flows along a portion of the site's southwestern border. The capital letters within the SRS borders identify operations areas referenced throughout this report.

Based on the U.S. Census Bureau's 2010 decennial data, the population within a 50-mile radius of the center of SRS is about 781,060 which is an increase of 9.6 percent over the 2000 population in this area. This translates to an average population density of about 104 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area.

Water Resources

SRS is bounded on its southwestern border by the Savannah River for about 35 river miles and is about 160 river miles from the Atlantic Ocean. The nearest downriver municipal facility that uses the river as a drinking water source (Beaufort-Jasper Water and Sewer Authority's Purrysburg Water Treatment Plant) is about 90 river miles from the site. The river also is used for commercial and sport fishing, boating, and other recreational activities.

According to officials with South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR) no known large-scale uses of the river exist for irrigation by farming operations downriver of the site.

The groundwater flow system at SRS consists of four major aquifers. Groundwater 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. SRS groundwater is used on site both for industrial processes and for drinking water.

Geology

SRS is on the southeastern Atlantic Coastal Plain, part of the larger Atlantic Plain that extends south from New Jersey to Florida. The center of SRS is about 25 miles southeast of the geological Fall Line that separates the Coastal Plain from the Piedmont. Characterization of regional earthquake activity is dominated by the catastrophic Charleston Earthquake of 1886 (est. magnitude of 7.0 on the Richter scale). With nearly three centuries of available historic and contemporary seismic data, the Charleston/Summerville area remains the most seismically active region of South Carolina and the most significant seismogenic region affecting SRS. Ongoing studies by University of South Carolina seismologists suggest a recurrence interval of 500–600 years for magnitude 7.0 or greater earthquakes (similar to the 1886 event) near Charleston. (Taiwani 2001) Earthquake activity occurring within the upper Coastal Plain of South Carolina, where the majority of SRS is located, is characterized by occasional small shallow events associated with strain release near small-scale faults and intrusives. Levels of seismic activity within this region are very low, with magnitudes or sizes generally less than or equal to 3.0.

Land and Forest Resources

About 90 percent of SRS land area consists of natural and managed forests, planted, maintained, and harvested by the U.S. Department of Agriculture (USDA) Forest Service–Savannah River (USFS-SR). The site contains four major forest types: mixed pine-hardwoods, sandhills pine savanna, bottomland hardwoods, and swamp floodplain forests. More than 345 Carolina bays exist on SRS. Carolina bays are relatively small, shallow depressions that provide important wetland 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 mission-oriented facilities. The remainder is maintained in healthy, diverse ecosystems. SRS is home to about 1,500 species of plants, more than 100 species of reptiles and amphibians, some 50 species of mammals, nearly 100 species of fish, and provides habitat for more than 250 species of birds. Nearly 600 species of aquatic insects can be found in SRS streams and wetlands. The site also provides habitat for a number of protected species including the wood stork, the red-cockaded woodpecker, the pondberry, and the smooth purple coneflower (all federally listed as endangered) and at least 40 plant species of state or regional concern.

Primary Site Activities

Nuclear Materials Stabilization Project

In the past, the separations facilities, located in the core area of the SRS, processed special nuclear materials and used fuel from site reactors to produce materials for nuclear weapons and isotopes for medical and National Aeronautics and Space Administration applications. The end of the Cold War in 1991 brought a shift in the mission of these facilities to stabilization of nuclear materials from onsite and offsite sources for safe storage or disposition.

F-Canyon, one of the site's two primary separations facilities, was deactivated in 2006. The other facility, H-Canyon, continues to operate. An important part of H-Canyon's mission is the conversion of weapons-usable, highly enriched uranium to low-enriched uranium. The uranium is then used in the manufacturing of commercial reactor fuel, which is a key function of the nation's nuclear nonproliferation program. During 2011, SRS began to use H-Canyon and HB-Line to prepare surplus plutonium materials for disposition at the Waste Isolation Pilot Plant (WIPP) in New Mexico.

Used Nuclear Fuel Storage

SRS's used nuclear fuel (UNF) facilities receive and store fuel elements from a variety of foreign and domestic research reactors. The mission of the UNF program is to safely and cost effectively receive and store used fuel elements from foreign and domestic research reactors, pending disposition in support of nuclear research and the Global Threat Reduction Initiative.

Tritium Processing

SRS Tritium Facilities are designed and operated to supply and process tritium, a radioactive form of hydrogen gas that is a vital component of nuclear weapons. These facilities are part of the NNSA's Defense Programs operations at SRS.

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

Liquid Waste Operations

SRR continued to manage the SRS Liquid Waste Operations (LWO) facilities in 2011 and to support the integrated high-activity waste program and tank closure process. This work included dispositioning waste from tanks in the site's F-Area and H-Area tank farms. Dispositioning of the waste included operation of the Defense Waste Processing Facility (DWPF), which immobilizes high-level waste in glass; the Saltstone Production and Disposal Facilities (SPDF), which process and dispose low-activity salt waste in a grout form; and the salt waste processing facilities, known as the Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit, which decontaminate the salt waste and send it to SPDF.

Solid Waste Management

SRNS is responsible for managing transuranic, low-level, hazardous, mixed and sanitary waste at SRS. Wastes generated site-wide are treated, stored and disposed to meet environmental and regulatory requirements. The site also emphasizes waste minimization and recycling as a way to reduce the volume of waste that must be managed. More information about radioactive and nonradioactive solid waste management is included on the compact disk (CD) housed inside the back cover of this report.

Area Completion Projects

Past operations at SRS have resulted in the release of hazardous and radioactive substances to soil and groundwater, with contamination levels exceeding regulatory thresholds. The mission of Area Completion Projects (ACP) is to deactivate and decommission contaminated facilities and remediate (if necessary) soils, groundwater, surface water, and sediments to levels that comply with established regulatory thresholds and that protect human health and the environment.

Numerous technologies have been pioneered to increase the effectiveness of ACP's remediation efforts and to reduce hazardous risk across the site. ACP utilizes a Green Remediation approach to reduce greenhouse gas emissions and other negative environmental impacts that might occur during characterization or remediation of hazardous waste sites. Green Remediation is the practice of (1) considering all the environmental effects of remedy implementation and (2) incorporating options to minimize the environmental footprints of cleanup actions. Natural remedies used at SRS include phytoremediation (augmented natural vegetative processes), bioremediation (augmented naturally occurring microbial processes), and natural remediation (natural processes to address contamination). These technologies are proving to be a cost-efficient means of reducing risk to human health and the environment and have been successful in expediting cleanups.

Cleanup decisions are reached through implementation of a core team process with the U.S. Environmental Protection Agency (USEPA) Region 4 and SCDHEC. In reaching such decisions, the public's and stakeholders' (such as the Citizens Advisory Board [CAB]) input is solicited and considered. ACP uses a streamlined cleanup strategy to accelerate work and reduce overall lifecycle costs. During 2011, ACP completed final remediation of P- and R-Areas, which included the in-situ decommissioning of the P- and R-Reactor buildings.

More information about ACP's 2011 operations is included on the CD accompanying this report.

Effluent Monitoring and Environmental Surveillance

The general purpose of the effluent monitoring and environmental surveillance programs is to

- demonstrate compliance with applicable environmental regulations, DOE orders, and commitments made in environmental documents
- manage SRS effluents and their treatment and control practices
- identify, characterize, quantify, trend, and report the effects (if any) of SRS operations on the public and on the environment in and around the site

SRS sampling locations, sample media, sampling frequency, and types of analysis are selected based on environmental regulations, exposure pathways, public concerns, and measurement capabilities. The selections also reflect the site's commitment to (1) safety, (2) protecting human health, (3) meeting regulatory requirements, (4) reducing the risks associated with past, present, and future operations, and (5) improving cost effectiveness.

Research and Development

Savannah River National Laboratory

Savannah River National Laboratory (SRNL) is SRS's applied research and development laboratory. SRNL "puts science to work" to create and implement practical, high-value, cost effective technology solutions in the areas of Environmental Stewardship, National Security, and Clean Energy. SRNL provides technical leadership and key support for future SRS missions. More information can be obtained by viewing SRNL's website at http://srnl.doe.gov.

Savannah River Ecology Laboratory

The Savannah River Ecology Laboratory (SREL) is a research unit of The University of Georgia that has been conducting ecological research at SRS for more than 60 years.

The facility's overall mission is to acquire and communicate knowledge of ecological processes and principles. SREL conducts fundamental and applied ecological research, as well as education and outreach programs, under a cooperative agreement with DOE. More information can be obtained by viewing the laboratory's website at www.srel.edu. Also, SREL's technical progress report for 2011 is included on the CD accompanying this document.

US Department of Agriculture Forest Service–Savannah River (USDA USFS-SR)

The USDA USFS-SR, a unit of the Southern Region of the U.S. Department of Agriculture, manages an estimate of 170,000 acres of natural resources at SRS. USFS-SR operates under an interagency agreement with DOE-Savannah River Operations Office and implements the SRS Natural Resources Management Plan for a variety of natural resources. More information can be obtained by viewing the USFS-SR website at www.fs.usda.gov/savannahriver. Also, USFS-SR's 2011 report is included on the CD accompanying this document.

Savannah River Archaeological Research Program

The Savannah River Archaeological Research Program (SRARP) provides cultural resource management guidance to DOE to ensure fulfillment of compliance commitments. SRARP also serves as a primary facility for the investigation of archaeological research problems associated with cultural development within the Savannah River valley, using the results to help DOE manage more than 1,300 known archaeological sites at SRS. More information can be obtained by viewing the SRARP website at www.srarp.org. Also, SRARP's 2011 report is included on the CD accompanying this document.

CHAPTER 2

Environmental Management System

Kim Cauthen
Environmental Compliance and Area Completion Projects

Compliance with environmental statutory and other legal regulatory requirements is a fundamental responsibility of all federal agencies. In 2011, Savannah River Site (SRS) continued to meet or exceed performance expectations with respect to the management of environmental protection activities related to air, water, land, and other important resources.

This chapter focuses on the SRS Environmental Management System (EMS) as implemented by U.S. Department of Energy (DOE) Order 450.1A, "Environmental Protection Program," and corresponding Executive Orders.

A management system is a tool established by an organization to manage its operations and activities in the pursuit of its policies and goals. In the case of EMS, it is not a stand-alone environmental program or a data management program. Implementation of the EMS enables SRS to clearly identify and establish environmental goals, develop and implement plans to meet the goals, determine measurable progress toward the goals, and take steps to ensure continuous improvement.

DOE promulgated Order 436.1, "Departmental Sustainability," in May 2011 that re-established the objectives in Order 450.1A and furthered those goals by adding additional greenhouse gas monitoring and reporting requirements. DOE Order 436.1 was not yet incorporated into contracts of SRS tenant organizations at the end of 2011. Modification of these contracts to include this Order is under evaluation.

SRS EMS Implementation

The EMS at SRS is implemented by multiple contractors using documents, programs and strategies tailored to organization-specific resources. DOE-SR oversees the implementation of each strategy to ensure a consistent and integrated Site program. The implementation strategy for Savannah River Nuclear Solutions (SRNS), as the M&O contractor, and Savannah River Remediation (SRR), managing Liquid Waste Operations (LWO), is documented in the "Environmental Management System Description Manual" (G-TM-G-00001). This manual can be viewed via the following Internet link: http://irmsrv02.srs.gov/general/pubs/envbul/documents/ems_manual.pdf.

Integration of the SRS EMS within ISMS

Figure 2-1 depicts the processes by which environmentally impacting activities performed at SRS are integrated into the Integrated Safety Management System (ISMS). This approach, rolling environmental regulatory requirements into implementing programs and procedures, is followed by all SRS organizations according to specific work scope, resources, and potential for environmental impact.

Environmental Policy

The commitment to good environmental stewardship is expressed in the SRS Environmental Policy which is a statement of the Site's intent to implement sound stewardship practices that protect the air water, land, and other natural and cultural resources at SRS.

The policy is reviewed, updated annually, communicated throughout the Site, and posted on http://irmsrv02.srs.gov/general/pubs/envbul/documents/env_mgt_sys_policy.pdf for availability to the communities surrounding SRS.

Objectives, Targets, and Programs

Through EMS, each tenant organization sets goals and targets on an annual basis in support of DOE environmental objectives which include:

- Reduction in energy usage
- Increase in renewable energy usage
- Reduction in water usage
- Purchasing of "green" products and services
- Reduction in solid waste generation
- Reduction in hazardous chemical usage
- Increase in the number of sustainable buildings
- Reduction in fleet and petroleum usage
- Use of energy compliant electronic devices
- Maintenance of compliance with requirements

Thirteen specific objectives and targets were established for Fiscal Year (FY) 2011. A summary is provided in table 2-1.

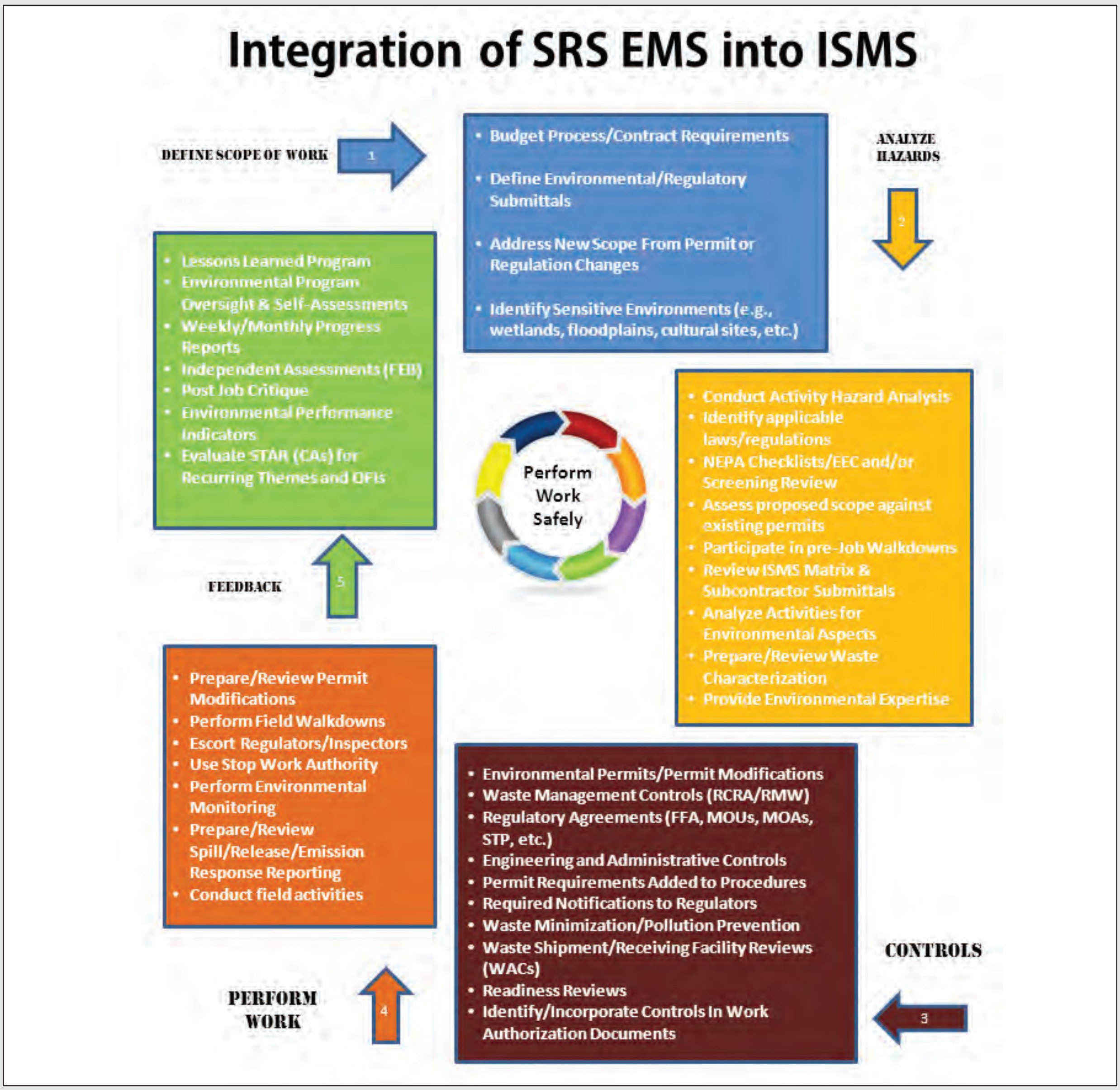


Figure 2-1 Environmental Management System Integration

Table 2-1 FY2011 SRS EMS Goals (Summary)

EMS Goal/Objective	Status
Reduce building energy intensity (British Thermal Units per Gross Square Foot, BTU/GSF) by 3% annually or by 30% by the end of FY2015	Energy intensity decreased by about 2.5% in FY2011 versus FY2010. The Site remains ahead of the FY2015 30% reduction goal with energy intensity having been reduced by 22.5% through FY2011 versus the FY2003 baseline. Planned High Performance Sustainable Building (HPSB) activities such as energy audits and American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) evaluations in thirteen facilities, installation of chilled water BTU meters in six B-Area facilities, and electric meters in four facilities were completed.
Purchase 3% of facility electrical energy from renewable sources, 50% of which is from renewable sources placed into service after 1/1/1999	To meet this goal, SRS has been constructing biomass plants onsite. Construction of the Biomass Cogeneration Facility is on schedule for first quarter FY2012 completion. The 20 MW plant will assist SRS in meeting this goal.
Reduce water consumption by 2% annually or by 16% by the end of FY2015	Process water use was decreased by nearly 19% in FY2011 versus FY2010 due to a well shutdown in K-Area and subsequent extension of the domestic water system in K-Area. Potable water consumption was reduced by 5% during FY2011, contributing to a cumulative reduction of 10.2% since FY2000. Water Conservation Reports (indoor and outdoor) were completed and submitted to DOE in FY2011.
Expand purchases of environmentally preferred products	The Business Process Modernization Project (BPMP) has entailed the incorporation of a mapping process for tracking of Environmentally Preferred Products (EPPs), which will allow tracking from a systems perspective starting FY2012. The BPMP was completed and functional as of October 1, 2011. SRS achieved success in the acquisition of EPP products in the area of custodial products (towels, cleaners, and trash bags), office products (toner, cartridges, and paper) and construction materials (lighting and adhesives).
Reduce the use of hazardous materials and toxic chemicals by 1. Reducing the volume of hazardous and radioactive generated waste by 10% (357 m^3) 2. Achieving a minimum of 35% recycle rate for routine sanitary waste 3. Reducing the purchase of chemicals with hazard rating 3 or 4 by 5%	Almost 2,009 cubic meters (m^3) of waste generation was avoided with an associated cost avoidance of roughly $2.4 million. SRS achieved a 35.5% recycle rate for the routine sanitary waste stream in FY2011. The Chemical Management Center (CMC) reduced the number of high-hazard chemical procurements; from 2,526 procurements in FY2010 to 2,358 procurements in FY2011, a reduction of 6.65% versus a goal of a 5%. The CMC distributed for reuse more than 35,300 pounds (lb) of chemicals in FY2011, avoiding more than $234,000 in chemical acquisition and waste management costs.
Construct or renovate buildings in accordance with sustainability strategies Incorporate sustainable practices in 15% of existing federal capital asset building inventory by 2015	SRS's Mixed Oxide (MOX) Fuel Fabrication Facility administration facility received U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Gold certification in 2010. MOX will be seeking LEED® Gold certification for the Technical Services Building and the Secure Warehouse Building that are currently under construction. No existing onsite buildings meet all of the Guiding Principles for HPSB. SRS has identified specific buildings in which to focus incorporation of sustainable practices. Evaluation of the buildings against the Guiding Principles was initiated in FY2010 and continued through FY2011.
Reduce consumption of petroleum products by 2% annually through 2015	The Site continues to maximize use of E85 as much as possible. The Site was directed by HQ to lease over 70 electric hybrid vehicles in place of E85 vehicles in FY2011. Also, the site took action in September 2011 to utilize gasoline in ethanol pumping stations in an effort to clean ethanol residue out of the equipment. These two major factors increased petroleum consumption and reduced E85 use. FY2011 vs FY2010 resulted in a decrease in E85 use of 19%. However, it should be noted that FY2010 saw an increase in E85 due to ARRA activities. A portion of the decreased use of ethanol in FY2011 is due to this reason. Combined ethanol and gasoline consumption was down in FY2011 approximately 50K gallons versus FY2010.

Table 2-1 FY2011 SRS EMS Goals (Summary) *continued*

EMS Goal/Objective	Status
Purchase at least 95% of electronic products that meet Electronic Product Environmental Assessment Tool (EPEAT) standards	EPEAT standards currently apply to computers and monitors. All laptop computers and desktop monitors acquired for use by SRNS meet EPEAT standards and are listed on the EPEAT website. Current copier lease agreements utilize Energy Star models.
Increase fleet non-petroleum-based fuel consumption by 10% annually while decreasing total consumption of petroleum-based fuels	The Site continues to maximize use of ethanol fuel, E85, as much as possible, although a reduction in usage was experienced in FY2011. Adding electric hybrid vehicles to the fleet (which cannot utilize E85 fuel) and temporarily using gasoline in ethanol pumping stations to clean ethanol residue from the equipment contributed to this reduction in E85 usage.
Evaluate planned work and conduct environmental studies to ensure off-site impacts from SRS activities are minimized	Off-site monitoring to assess impacts, if any, continued during FY2011. The program is continuously reviewed to ensure the appropriate environmental media are sampled and reported. NEPA evaluations and decisions concerning planned activities at SRS were completed in 2011 and are discussed in detail in Chapter 3 of this report.
Prevent occurrence of and minimize severity of spills through proper handling and controls for radioactive and hazardous materials and wastes	No reportable spills occurred during 2011. Details of the spill response program are provided in Chapter 3.

Competence, Training, and Awareness

General environmental awareness training is provided to all SRS employees. Training in specialized environmental and waste management topics is developed and offered by SRS subject matter experts.

Regularly scheduled classes in the environmental training program offer environmental program-related training courses 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 in and around SRS.

Resources, Roles, and Responsibilities

All SRS employees have specific roles and responsibilities in key areas, including environmental protection. Environmental and waste management technical support personnel assist Site operating organizations with identifying and meeting their environmental responsibilities. SRS maintains detailed manuals on resources, roles, responsibilities, and authority to assist employees in performing their duties.

Communications

SRS continues to maintain and improve internal and external communications on environmental issues. SRS solicits input from interested parties such as community members, activists, elected officials, regulators and community members. As an example, the SRS Citizens Advisory Board (CAB) provides advice and recommendations to DOE in many areas of Site operations including environmental matters.

Additional forums associated with environmental issues include:

- Senior Environmental Managers Council (SEMC), composed of senior-level environmental managers (from all SRS contractors) who share information on environmental concerns and regulatory matters
- DOE-Savannah River (SR) Environmental Quality Management Division (EQMD), which convenes regular meetings with SRS contractors and the DOE environmental oversight staff to discuss issues relevant to environmental protection and compliance
- SRS Regulatory Integration Team (SRIT), consisting of DOE-SR, the U.S. Environmental Protection Agency (USEPA) Region 4, and South Carolina Department of Health and Environmental Control (SCDHEC) representatives who address issues that are crosscutting and require high-level agency collaboration
- Challenges, Opportunities, and Resolution (COR) Team, consisting of regulatory compliance representatives of SRNS and other major SRS contractors who discuss (1) emerging compliance or implementation challenges and (2) opportunities to develop and coordinate resolutions

Operational Controls

Operational controls help ensure that environmental policy-related activities of regulatory compliance, pollution prevention, and continuous improvement are in place and implemented. From an environmental protection perspective, one of the more significant operational controls is the consistent use of the Environmental Evaluation Checklist (EEC) process. When a new process or activity is considered and when a change to an existing operation is proposed, an EEC is initiated. The EEC process ensures that regulatory requirements and potential impacts on the environment are identified in a timely manner.

Emergency Preparedness and Response

Emergency plans are established, implemented, and maintained as documented in the SRS Emergency Plan. The Emergency Plan specifies procedures to facilitate the identification of emergency situations and accidents with the potential to impact the environment and provides definitions of appropriate responses and reporting criteria.

Monitoring and Measurement

Air emissions and liquid discharges from SRS operations are examined regularly. This includes effluent monitoring (radiological and nonradiological), compliance assessment, performance assessment, and equipment/facility monitoring (e.g., calibration of instruments). Additional information on environmental monitoring, environmental surveillance, and groundwater monitoring is in Chapter 4 (“Effluent Monitoring”), Chapter 5 (“Environmental Surveillance”), and Chapter 7 (“Groundwater”), respectively, of this site environmental report.

Evaluation of Compliance

Specific environmental laws and regulations are evaluated and assessed on a program- or facility-specific basis. SRS has established a process for evaluating its compliance with relevant environmental regulations. Periodically, environmental support organizations conduct regulatory assessments in selected topical areas to verify compliance. Finally, external regulatory agencies and/or technical experts may perform independent compliance audits. Additional information on environmental compliance is in Chapter 3 of this site environmental report.

Nonconformance; Corrective and Preventive Actions

Nonconformance and corrective and preventive actions include EMS nonconformance as a part of the site’s Quality Assurance (QA) Program. Instances of nonconformance identified by assessments and evaluations are recorded and dispositioned according to established procedures. Additional QA information is in Chapter 8 (“Quality Assurance”) of this environmental report.

Control of Records and Documents

The identification, maintenance, and disposition of environmental records and documents, required by environmental regulations and DOE directives, are reflected in the SRS EMS. The site’s records management program satisfies the requirement for environmental records.

Internal Audits

SRS audits are incorporated into the DOE and contractor assessment programs to verify that the site’s EMS is functioning as intended. Performance assessments include performance objectives and criteria for management system review. Self-assessments are conducted in accordance with senior management-approved assessment plans. SRS utilizes a Facility Evaluation Board to conduct independent performance-based assessments of site programs to satisfy contractual and regulatory obligations.

Management Review

The SRS EMS Policy requires periodic evaluations of EMS effectiveness. Guidelines are intended to focus the management review on continuous improvement. Oversight of SRS’s annual EMS review is the responsibility of DOE-SR’s EQMD. Senior management reviews the EMS to ensure its continuing suitability, adequacy, and effectiveness. Reviews include assessing (1) opportunities for improvement and (2) the need for changes to the EMS. Records of management reviews are retained in accordance with applicable procedures.

EMS Implementation

In accordance with the requirements of DOE Order 450.1A[1], an audit of the EMS was conducted by a qualified outside party, culminating in a June 23,

1 DOE promulgated Order 436.1 in May 2011 to replace DOE Order 450.1A. DOE Order 436.1 was not yet incorporated into contracts of SRS tenant organizations at the end of 2011. Modification of these contracts to include this Order is under evaluation.

2009, "declaration of conformance." The next audit is scheduled for 2012.

Sustainability Accomplishments

Pollution Prevention / Waste Minimization

SRS's primary objective with respect to pollution prevention (P2) and waste minimization is to prevent or reduce pollution and waste generation at its source whenever feasible. In FY2011, the site's 10 percent waste reduction goal for hazardous and radioactive waste equated to 357 m^3, based on forecast generation rates. During the year, P2 projects were documented, resulting in 2,009 m^3 of hazardous and radioactive waste avoidance or diversion. Annual cost avoidance resulting from the projects is nearly $2.5 million. Table 2-2 shows a summary of the FY2011 P2 and waste minimization contributions.

Concurrently, SRS annually establishes a recycle performance target for its routine sanitary waste stream. A routine sanitary waste recycle target of 35% was established for FY2011. SRS documented a recycle rate of 35.5% for this stream, equal to 813 metric tons of routine sanitary waste diverted to recycle markets. SRS diverted 107 metric tons of shredded wood waste, 889 metric tons of scrap metal, 63 metric tons of scrap electronics, 165 metric tons of metal from spent transformer recycle, 20 metric tons of transformer oils, and 103 metric tons of scrap furniture. Additionally, the Chemical Management Center (CMC) distributed for reuse more than 35,300 lbs. of chemicals in FY2011, thus avoiding more than $234,000 in chemical acquisition and waste management costs.

Table 2–2 2011 SRS Pollution Prevention Activities (Summary)

Description	Waste Type Prevented	Life Cycle Savings
Bagging Reactor Process Water De-Ionizers for Disposal	Low Level Waste (LLW)	$95,850
Lead Blanket Reuse	Mixed LLW	$6,499
Used Oil Declared Non-Hazardous	Haz RCRA	$943
Liquid Waste Operations Pre-Fab Hut Use	LLW	$661,610
Rollback of CLE Storage in E-Area	LLW	$402
Recycle Lithium Batteries K-Area	Haz RCRA	$920
Lead Recycle K-Area	Haz RCRA	$8,680
Acid Recovery Unit Column Abatement Waste Avoidance	LLW	$10,816
Lead Recycle H-Canyon	Haz RCRA	$7,400
H-Canyon Rollbacks of the Dinky Charging Station, Shack and 3rd Level Section 11	LLW	$57,660
Unconditional Release of 2 Large Lead Acid Batteries out of Contamination Area for Recycle	Mixed LLW	$840
In situ Disposal of LLW at 105-P	LLW	$930,800
In situ Disposal of LLMW lead at P-Area	LLW	$5,060
In situ Disposal of LLW at 105-R	LLW	$560,400
In situ Disposal of LLMW lead at R-Area	Mixed LLW	$20,500
Brass Fillings Recycle Versus Disposal	HW	$1,625
Oily Water Treatment	Sanitary	$2,785
Segregation of Tritiated Job Control Waste	LLW	$82,050
Radiological Area Rollbacks in K-Area	LLW	$9,303
Reactor Viewing Window In situ Disposal	LLW	$5,475

Energy Intensity

DOE Order 450.1A requires a 30% reduction in energy intensity (energy consumption per gross square foot of building space, including industrial and laboratory facilities) by FY2015 compared to the FY2003 baseline year. SRS is on track to meet or exceed the 30% goal, having realized a 22.5% decrease from FY2003 through FY2011. The 22.5% decrease includes a decrease of 2.4 % from FY2010 to FY2011. Figure 2-2 illustrates this comparison against the current baseline. As SRS's MOX Fuel Fabrication Facility and Salt Waste Processing Facility become operational, the site's efforts to meet the energy intensity goal will be challenged. SRS conducted many activities in FY2011 that impacted energy intensity, including the following notable accomplishments:

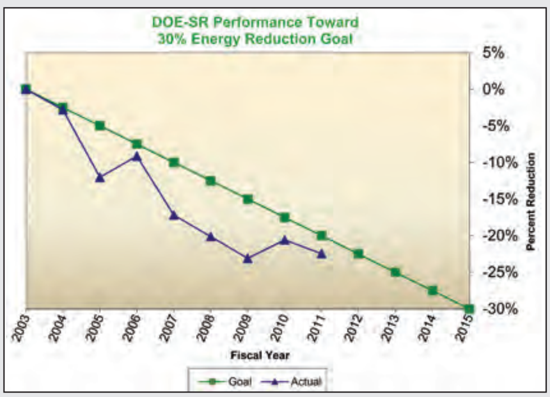


Figure 2–2 DOE–SR Energy Reduction Performance

- Completed start-up of new K-Area & L-Area biomass plants and utilized the new units for the winter heating season
- Completed the installation of about 100 heating, ventilating and air conditioning (HVAC) units with new, higher Seasonal Energy Efficiency Ratio (SEER) units
- Improved operation of A-Area biomass plant to reduce fuel oil use
- Conducted energy audits and building commissioning evaluations in 13 buildings as part of sustainable building efforts
- Installed new chilled water BTU meters in six buildings as part of HPSB
- Installed new electrical meters in four buildings as part of HPSB requirements
- Replaced the A-Area cooling tower associated with the chilled water plant
- Utilized cool roofs on roof replacements
- Continued with D-Area steam plant enhancements and operated the plant as efficiently as possible
- Replaced air compressors and dryers in Building 775-A
- Issued the SRS Metering Plan

The Tritium Facilities (in H-Area) made notable progress in reducing energy intensity in FY2011. An Energy Manager (engineer) role was specifically created in recent years to enhance energy intensity reductions and sustainability, and many benefits have consequently been realized:

- Completed construction of new Tritium Programs Project Support Building that allowed deactivation of inefficient Building 232-1H and relocation of engineering personnel from trailers. The new building is expected to lower Tritium Programs energy intensity with the additional 11,200 square feet of more energy efficient space
- Completed construction of new Tritium Extraction Facility (TEF) warehouse. The new warehouse is expected to lower Tritium Programs energy intensity with the additional 6,000 square feet and low energy consumption
- Evaluated energy reduction idea of right-sizing 218-H secondary chilled water pumps. The initiative replaces existing 200 horsepower pump motors with 150 horsepower (or lower)
- Cleaned 750-ton HVAC chiller evaporator and condenser tubes to improve heat exchanger efficiencies
- Confirmed blowdown for cooling towers meets industry standards. This was a water conservation measure
- Cleaned condenser tubes associated with 264-6H HVAC chillers (three each) to improve heat exchanger efficiency
- Cleaned condenser tubes associated with 264-6H Process chillers (two each) to improve heat exchanger efficiency
- Issued a feasibility study for piloting installation of ice storage chilled system supporting 234-7H and began engineering scope development of this effort
- Replaced rooftop HVAC units for Building 246-H for improved efficiency and reliability
- Initiated project to install electricity meters for two 248-H data centers and the H-Area New Manufacturing facility (HANM) tritium (T2) switchgear

- Repaired steam leaks at HANM and in the area's high pressure steam line
- Created energy models for four administrative buildings using Quick Energy Simulation Tool (eQUEST)

Renewable Energy

SRS has three biomass steam plants in permanent operation to service A-Area and the Savannah River National Laboratory (SRNL), L-Area and K-Area. Construction of a new Biomass Cogeneration Facility near F-Area continued, with start-up expected in FY2012. The new Biomass Cogeneration Facility will generate an estimated 77,500 MW-hours of electricity in its first year of operation. This production rate will be well above the 7.5% statutory goal for energy consumption that must come from renewable energy sources for FY2013 and thereafter.

Use of renewable energy at the SRS is being prioritized at the highest levels. In October 2008, the design and construction of a new steam plant for A-Area and the SRNL were completed and the facility placed online. The new thermal-only steam plant utilizes biomass as the primary fuel source. Early 1950's vintage coal-fired boilers were replaced with new state-of-the-art boilers and emission controls while maintaining steam availability around-the-clock at minimum cost. This new plant was installed utilizing the existing Energy Savings Performance Contract (ESPC) in place at the site. The total cost of the project is $13.8 million and the annual savings average over $1.5 million. The facility will be paid for (term of the contract) in nine years.

The renewable and environmental aspects of the project are plentiful:

- Utilization of coal is being reduced by over 12,000 tons annually
- Utilization of biomass is being increased by nearly 27,000 tons annually
- Particulate emissions are being reduced. Particulate Matter (PM) from 411 tons/year to 7.36 tons/year and PM-10 microns from 300 tons/year to 4.38 tons/year)
- Sulfur dioxide (SO_2) emissions are being reduced from 1,836 tons/year to 4.38 tons/year
- Oxide of nitrogen (NO_x) emissions are being reduced from 256.7 tons/year to 35 tons/year
- Carbon monoxide (CO) emissions are being reduced from 120.8 tons/year to 105.1 tons/year
- Ash generation and disposal are being reduced

A-Area Biomass Steam Plant

- Compliance with Clean Air Act and Clean Water Act standards are achieved

Ameresco Federal Solutions will complete construction and start-up of two new biomass plants at the Biomass Cogeneration Facility in 2012 and will be reimbursed from actual cost savings generated during the 15-year debt service payback period. The energy savings result from replacement of the site's old and inefficient coal-fired plant with a high-tech biomass facility, switching from coal to biomass as the fuel source, locating the new facility closer to the end users, and experiencing improved operational efficiencies with new equipment better matched to site load requirements. The community also receives the health and environmental benefits associated with the reduction in greenhouse gas emissions.

Aerial View of the Ameresco Biomass Cogeneration Facility

Some of the benefits of this major renewable energy project include:

- Reducing over 161,000 tons of annual coal consumption and 300,000 gallons of fuel oil consumption
- Utilizing 322,000 tons of biomass and bio-derived fuels
- Reducing emissions:
    - o 400 tons/yr - particulate matter
    - o 3,500 tons/yr - SOx
    - o 2,500 tons/yr - NOx
    - o 100,000 tons/yr - carbon dioxide (CO_2)
- Reducing over one billion gallons of water from the Savannah River annually
- Reducing greenhouse gas emissions by about 100,000 tons per year, significantly decreasing the carbon footprint of SRS (due to coal, a major contributor to greenhouse gases, being completely eliminated while maximizing the burning of wood)
- Meeting and exceeding all SRS renewable energy goals in federal directives, (serving as a key project for assisting DOE with achieving complex-wide renewable goals)
- Helping SCDHEC to continue with local "Attainment Status"
- Supporting DOE Initiative to be the Lead Federal Agency in Renewable Energy Goals
- Allowing SRS to permanently deactivate inefficient coal-fired boilers in the SRS D-Area

Greenhouse Gas Reduction

SRS is committed to reducing Greenhouse Gases (GHG) Scope 1 & 2 emissions by 28% by FY2020 from a FY2008 baseline. Scope 1 consists of direct emissions such as onsite combustion of fossil fuels or fugitive GHG emissions, whereas Scope 2 consists of indirect emissions associated with the consumption of electricity, heat, or steam. Sites are expected to aggressively strive toward the overall Departmental goal of a 28% reduction, particularly when cost-effective and prudent to do so. Actual targets are being defined by DOE taking into account new mission growth and other factors.

The site has seen progress in FY2011 on GHG emission reductions primarily by considering potential impacts that these reductions will have in future Site operations. The combining of GHG data associated with the various impact sources, such as Site energy use and vehicle/equipment use, is being organized, thus allowing for development of a comprehensive inventory and subsequent management of it.

Scope 1 and 2 GHG emissions are currently generated and inventoried from the following source types at SRS:

- Coal (although FY2012 is anticipated to be the last year of this source)
- Purchased electricity
- Wood (biomass)
- Fuel oil
- Propane
- Hydrofluorocarbon (HFC) fugitive emissions
- Gasoline
- Diesel fuel
- E85 (ethanol) fuel
- Jet fuel

SRS will greatly reduce GHG emissions via the new biomass projects either already completed or currently being constructed. This is primarily a result of transferring to a biomass-based energy supply versus the previous coal-based supply. Construction and start-up of the major new Biomass Cogeneration Facility will be completed and the plant will become fully operational in FY2012. The Site has a transition plan whereby the existing coal-fired facility will continue to operate on a limited basis until the new biomass plant has proven to be reliable. Consequently, the FY2013 and following fiscal years will see even greater GHG benefit than will be realized in FY2012 while both plants are operating.

Water Management

Potable water consumption was reduced by 10.2 percent through FY2011 as compared with the baseline year of FY2000, and nearly 5 percent between FY2010 and FY2011. The following summarizes FY2011 accomplishments:

- Conducted walk-downs in 13 facilities (see Water Conservation description in section 3.1) to determine the number, type and water usage requirements for existing plumbing fixtures in each of the buildings
- Determined water consumption for each building utilizing the LEED-EB water calculator
- Identified actions to reduce water usage to achieve HPSB or LEED-EB goals, such as installing more efficient commodes or urinals or retrofitting sinks with flow restricting aerators
- Performed cost and payback period calculations to determine the cost effectiveness of potential modifications

Transportation/Fleet Management

The primary DOE transportation and fleet management goals are to decrease fleet petroleum consumption by 2 percent annually by FY2020 from a FY2005 baseline and increase alternative fuel consumption by 10 percent annually by FY2015 relative to a FY2005 baseline.

The use of alternative fuels at SRS has increased dramatically in recent years as shown in Figure 2-3. Approximately 80% of vehicles in the light duty fleet currently utilize E85 or are gasoline hybrids. The site works to ensure the use of alternative fuels remains high by prioritizing use of flex fuel and hybrid vehicles. In FY2011, this consumption total rose to over 321,000 gallons (see Figure 2-4).

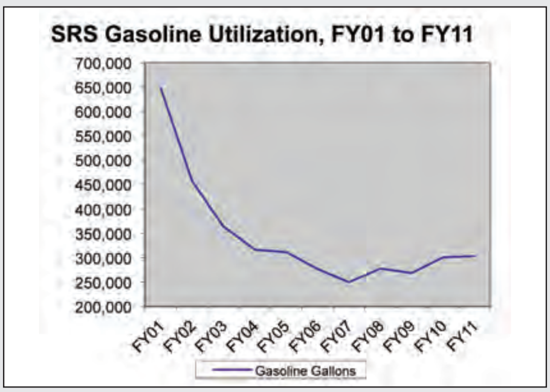


Figure 2–3. SRS Gasoline Reduction Performance

Contracts & Concession Agreements

SRS encourages acquisitions that comply with environmental requirements as evidenced through various contract-related documents, including (but not limited to) the "Terms and Conditions" document (the paragraph entitled "Environmental Compliance") and the "Request for Proposal" document (the paragraph entitled "Environmentally Preferred Products"). Additionally, internally published procedures are documented in the site's Procurement Specifications Manual and Chemical Management Manual, and a number of procurement requirement documents are available on the SRS external website to facilitate understanding of SRS environmentally friendly requirements by current and/or potential vendors and subcontractors. As of the end of 2011, most EPP procurement initiatives have yielded success, primarily in the acquisition of janitorial support and safety functions.

The Procurement Department has not implemented a dedicated campaign to complete a comprehensive evaluation of existing contracts. Rather, its timeline is to address emergent environmental requirements as the contract(s) come up for renewal or rebid while reviews of defined roles and responsibilities are routinely conducted during the course of services delivery.

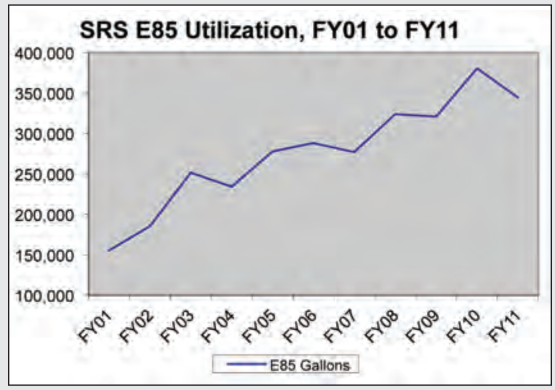


Figure 2–4. Increased E85 Usage at SRS

High-Performance Sustainable Buildings – New Construction

DOE Order 430.2B ("Departmental Energy, Renewable Energy, and Transportation Management") stipulates that all new buildings and major renovations in the stages of pre-project planning (approval of mission need) through conceptual design (approval of preliminary baseline range) that have not obtained preliminary design approval and that have a value exceeding $5 million must achieve the U.S. Green Building Council's LEED® Gold certification. Also, to the extent possible and in consideration of life-cycle cost factors, such buildings must meet the Guiding Principles for Federal Leadership in HPSBs. Any buildings below or equal to the $5-million threshold also must meet the Guiding Principles.

Support for these objectives is evident in the MOX Fuel Fabrication Facility administration building, which received LEED® Gold certification in FY2010. This marks a major milestone, and the facility is the first at SRS to achieve this certification status. Additionally, the MOX-associated technical support building for entry control/security and administration associated with the primary process building is in the design stage and is incorporating LEED®-Gold certification requirements as part of its design.

Ameresco Federal Solutions is currently constructing the administration facility portion of the new Biomass Cogeneration Facility with the intent of achieving LEED® certification following completion. Design features for the new office space include a 6,000 gallon rainwater storage tank to reduce potable water usage for flushing fixtures and irrigation, permeable pavers in the parking lot to help control the volume of storm water runoff, and the specification of materials containing recycled content to improve the building's green footprint. Energy savings will be realized through efficient lighting and equipment, a variable speed drive for the water pump, and increased building insulation.

Electronic Assets Management

SRS continued to purchase EPEAT and other energy efficient electronic products during the year. Leasing of many of the personal computers allows for the return and redeployment of devices no longer needed at SRS. In 2011, excess personal computers (PCs) were distributed to schools throughout the local region. Purchased by SRS, many of these computers were provided directly to schools in Aiken, SC; Martinez, GA; Lincolnton, GA; and Waynesboro, GA.

A new process was put into place during 2011 to allow excess PC assets to be accounted for and redeployed quickly to end users as demand dictates. This will provide better physical accountability of assets and quicker delivery times to the end user as well as reduce waste associated with "searching" and "retrieving" single PCs scattered across the SRS areas.

EMS Best Practices / Lessons Learned

Sustainability Campaign

In August of 2011, a campaign "One Simple Act of Green," was introduced at SRS that targeted specific items of sustainability and environmental stewardship that promote individual action by connecting SRS employees to information, tools and programs that make a difference to our environment. During FY2011 several specific recommendations were provided to SRS employees including:

- Using reusable shopping bags
- Reporting leaky faucets
- Using energy efficient light bulbs
- Reducing emails printed
- Turning off lights in unused rooms

Additional ideas and recommendations will be provided in 2012.

Chemical Management Center (CMC)

The Chemical Management Center provides centralized control of chemical materials procurement and of excess chemical materials management with goals to reduce the volume and toxicity of chemical procurements, reduce chemical inventories and waste, and improve tracking and communication of chemicals currently in on-site inventory. Hazardous and nonhazardous chemicals are reutilized onsite, returned to vendors when possible, sold through sealed bid sales to approved vendors, and donated to local government institutions to promote good community service while reducing waste generation. The CMC distributed for reuse more than 35,300 lbs. of chemicals in FY2011, avoiding more than $234,000 in chemical acquisition and waste management costs.

Awards and Recognitions

SRS believes that significant contributions to site missions that positively impact the local and surrounding environment should be recognized. As such, site activities and projects across the site are evaluated for noteworthy practices, implementation of new and emerging technologies, and insightful approaches to resolving environmental stewardship issues.

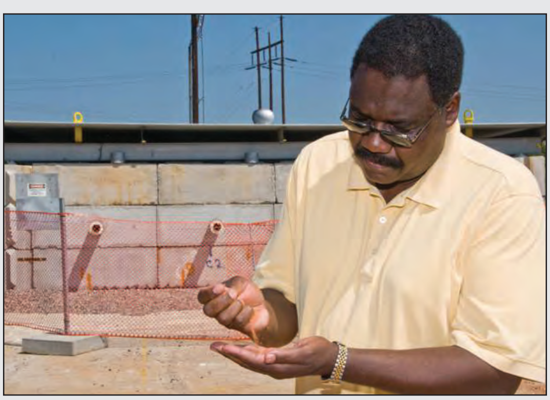
SRS received Environmental Sustainability (EStar) awards for two projects growing out of technology research, development and application at SRNL. One award, for Renewable Technology Development, Deployment and Education in South Carolina, is a collaboration between SRNL and the Economic Development Partnership (EDP) of South Carolina. SRNL has shared expertise and knowledge of renewable energy technologies with the EDP, which in turn has leveraged existing relationships with industry to identify and evaluate specific opportunities. The results have ranged from emissions reductions (through deployment and staging of hydrogen and wind energy technology) to community education programs.

The second award recognized a project to remediate tritium-contaminated debris in an innovative, cost-effective way by using a high heat source called a "thermal detritiation unit." The treated soil and concrete debris can be disposed at an onsite excavation site rather than sent offsite for disposal, reducing transportation, packaging and disposal costs. Over $1.6 million in transportation cost savings and an avoidance of 400,000 truck miles were realized from the deployment.

Additionally, Shaw AREVA MOX Services was recognized by the SCDHEC for outstanding environmental leadership with its recent acceptance into the organization's South Carolina Environmental Excellence Program (SCEEP). Shaw AREVA MOX Services is responsible for the design and construction of NNSA's MOX Fuel Fabrication Facility at SRS.

SCEEP is a voluntary program recognizing South Carolina facilities that have demonstrated environmental performance through P2, energy and resource conservation, and the use of an environmental management system. Shaw AREVA MOX Services was invited and accepted into the program because of its effective implementation of a strong environmental management system and the absence of any violations from environmental regulators during the more than five years of the site work and construction of the MOX project.

SRS received the Information Management Conference Technical Excellence Award for the Green Information Technology Initiative, which reduced the Site's carbon footprint by decreasing energy consumption in the Central Computing Facility more than 30% by reducing space requirements for hardware and improving energy use.



SRS Employee Showing the Finished Product of the Detritiation Unit, With the Unit in The Background

Ongoing Environmental Enhancement Projects

SRS Vehicle Energy and Emissions Reduction

SRS has been successfully implementing multiple fleet management fuel reduction and inventory strategies since the mid-1990s and has surpassed reduction goals from previous baselines. Various approaches have been undertaken and will continue in FY2012 to reduce petroleum consumption, increase alternative fuel use, and increase the number of alternative fuel vehicles. The Site will realize sizeable petroleum reductions over the upcoming years due to a reduction plan that will result in significantly fewer vehicles. SRS has submitted a "Vehicle Reduction Plan, FY2012 – FY2015" with a targeted reduction of 35% (consisting of 15% by the end of FY2012, 10% by the end of FY2013, and 10% by the end of FY2014) that has been established based on the defined baseline of FY2005. Petroleum consumption will continue to decrease unless mandates require less use of E85 fuel.

Computer Acquisition

SRS continued to purchase energy efficient computer products in 2011. Most Site computers are provided to employees via lease agreements, which are leveraged for the needs of multiple Site companies and specifically state that all computers must be Energy Star compliant and must meet low standby power requirements. While most models being leased have been EPEAT compliant since FY2007, the final model became compliant in FY2009. The power reduction features of the personal computers and monitors are set to efficient levels upon receipt of the equipment.

SRNL Filter Design Reduces Waste Treatment Costs

The redesign of a filtration system by SRNL is expected to help DOE drastically reduce cost and infrastructure for the treatment and permanent disposal of its inventory of high level radioactive waste. Removing solids would allow large quantities of radioactive salt waste to be decontaminated for disposal and also concentrate the solids, leaving a much smaller volume requiring expensive treatment and disposal as high-level waste.

Redesigned Rotary Microfilter

SRNL examined different filtration methods and found that a rotary microfilter patented by SpinTek offered filtration rates that were higher than those of a traditional cross-flow filter. As originally designed, however, the rotary microfilter was not suited for use with radioactive waste, so SRNL adapted the system for deployment within the DOE complex.

The redesign consolidates internal parts of the system, allowing an entire stack of 25 filter disks and other parts to be removed as a single piece.

The initial need for the filtration system was to treat the SRS salt waste solutions. SRNL, in collaboration with Oak Ridge National Laboratory and the SRS's liquid waste operations contractor, Savannah River Remediation (SRR), designed a module that allows two or four rotary microfilter systems to be inserted into an existing waste tank. This module eliminates the need to construct a new facility for the filtration process. As the system filters the waste, the liquid filtrate is transferred out of the tank for treatment and disposal, and the concentrated solids are returned to the tank.

EMS Benefits to Agency Mission

Although methods of execution vary from site to site and contractor to contractor, implementation of an EMS provides an understood and recognized structure to standardize the evaluation of, preparation for, and execution of activities and projects having environmental implications within distinct and separate organizations engaging in activities and projects with overlapping interests. More specific instances in which an EMS can benefit DOE's mission are below.

- Policy development and program planning facilitate integration of environmental compliance programs
- Promotion of environmental stewardship throughout the project planning cycle (cradle to grave)
- Solid waste offsite contract evaluation to ensure that best management practices and appropriate stewardship protocols are built into contracts
- Enabling a clear and consistent flow down of expectations and compliance framework in contracting documents
- Clear articulation of DOE complex-wide EMS requirements to promote consistency in contract specifications and environmental management expectations

For Further Information Should additional information be required relative to this chapter, contact Kim Cauthen at kim.cauthen@srs.gov.

CHAPTER 3

Compliance Summary

Michele Wilson
Environmental Compliance & Area Completion Projects

It is the policy of the U S Department of Energy (USDOE) that all activities at the Savannah River Site (SRS) will fully comply 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 safe operations at SRS.

The purpose of this chapter is to report the status of SRS compliance with applicable statutes and programmatic documents. Key federal environmental regulations with which SRS must comply are listed in table 3-1.

The chapter is divided into five separate sections: Compliance Status, Other Environmental Issues/Actions, Continuous Release Reporting, Unplanned Releases, and Permits.

The Compliance Status section identifies the various environmental laws, regulations, and DOE orders with which SRS must comply, and the status of the site's compliance programs.

The Other Environmental Issues/Actions section provides information on any Notices of Violation (NOVs) or Notices of Alleged Violation (NOAVs) issued to SRS in 2011 by the U.S. Environmental Protection Agency (EPA) or the South Carolina Department of Health and Environmental Control (SCDHEC). NOVs/NOAVs are the formal regulatory notices that allege violations of an organization's permits, or of environmental laws or regulations. SRS was in compliance with environmental laws and regulations and received no NOVs or NOAVs in 2011.

No releases required reporting to local emergency planning committees, as noted in the Continuous Release Reporting and Unplanned Releases sections.

Compliance Status

This section includes discussions of compliance with applicable environmental laws and regulations, DOE orders, and agreements with regulators. It addresses environmental remediation, waste management, radiation protection, air and water quality and protection, and other environmental statutes and DOE orders.

Environmental Restoration and Waste Management

Remediation/Cleanup

SRS was placed on the National Priority List (NPL) in December 1989, under the legislative authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The site was added to the NPL because there have been releases or threatened releases of hazardous substances, pollutants, or contaminants, which EPA evaluated through a hazard ranking system on the likelihood that a release occurred, on the characteristics of the waste, and on the environment affected by the releases. Placement on the NPL indicated SRS warranted further investigation to assess the nature and extent of the public health and environmental risks associated with the releases, and to determine the appropriate remedial action(s), if any. DOE, EPA Region 4, and SCDHEC in accordance with Section 120 of CERCLA, entered into the Federal Facility Agreement (FFA) that became effective August 16, 1993, and which directs the comprehensive environmental remediation of the site. The FFA, which integrates CERCLA and Resource Conservation

Table 3-1 Key Federal Environmental Laws and Regulations Applicable to SRS

Legislation	What it Requires
Atomic Energy Act of 1954, 42 U.S.C. § 2011 et seq., (1954)	The AEA provides authority to the DOE to develop applicable standards (DOE Orders) for protecting the environment from radioactive materials. DOE Order 435.1, and implementing Manual 435.1-1, Radioactive Waste Management, provide requirements for high level and low level radioactive waste management, waste characterization, storage, treatment, and disposal, and closure.
CAA Clean Air Act (1970)	The establishment of air quality standards for criteria pollutants, such as sulfur dioxide and particulate matter, and of hazardous air emissions, such as radionuclides and benzene.
CAAA Clean Air Act Amendments of 1990	The establishment of a national permit program, and of provisions for addressing acid rain, ozone depletion, and toxic air pollution
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. The Federal Facility Agreement (FFA) (WSRC–OS-94-42) between EPA, DOE, and SCDHEC integrates CERCLA and RCRA requirements to achieve a comprehensive remediation of SRS. The FFA governs the corrective/remedial action process, sets annual work priorities, and establishes milestones for activities. The agreement also coordinates administrative and public participation requirements.
CWA Clean Water Act (1977)	The regulation of liquid discharges at outfalls (e.g., drains or pipes) that carry effluents to streams (NPDES, Section 402); regulation of dredge and fill of U.S. waters (Section 404) and associated water quality for those activities (WQC, Section 401).
EPCRA Emergency Planning and Community Right-to-Know Act (1986)	The reporting of SRS hazardous substances (and their releases) to EPA, state emergency commissions, and local planning units.
ESA Endangered Species Act (1973)	The protection of critically imperiled species from extinction
FFCA Federal Facility Compliance Act (1992)	Federal Agencies must comply with all substantive and procedural requirements of federal, state, and local solid/hazardous waste laws—in the same manner as any private party. Requires DOE to have a plan known as a Site Treatment Plan, for the development of treatment capacities and technologies to treat all of the mixed wastes at SRS and a Consent Order requiring compliance with such plan. The Act also requires EPA and authorized states to conduct annual RCRA inspections of all federal facilities.
FIFRA Federal Insecticide, Fungicide, and Rodenticide Act (1947)	The regulation of restricted-use pesticides through a state-administered certification program
MBTA Migratory Bird Treaty Act (1918)	Provides protection for migratory birds, including their eggs and nests.
NEPA National Environmental Policy Act (1969)	The evaluation of the potential environmental impacts of proposed federal activities and alternatives
NHPA National Historic Preservation Act (1966)	The preservation of historical and archaeological sites.

Legislation	What it Requires
RCRA Resource Conservation and Recovery Act (1976) amended by Hazardous and Solid Waste Amendments (1984)	The management of hazardous and non hazardous solid wastes and of underground storage tanks containing hazardous materials and wastes.
RHA Rivers and Harbors Act of 1899, Section 10	The regulation of construction over or obstruction of navigable waters of the U.S.
Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), Section 3116(a), Pub. Law 108-375, (2005)	Section 3116 allows the Secretary of Energy, in consultation with the Nuclear Regulatory Commission, to determine that certain waste from reprocessing is not high level radioactive waste if it meets the criteria set forth in Section 3116(a).
SDWA Safe Drinking Water Act (1974)	The protection of drinking water and public drinking water resources.
TSCA Toxic Substances Control Act (1976)	The regulation of PCBs, radon, asbestos, and lead, as well as evaluation and notification to EPA of new chemicals and significant new uses of existing chemicals

and Recovery Act (RCRA) requirements to achieve a comprehensive remediation of SRS, governs the corrective/remedial action process, sets annual work priorities, and establishes milestones for activities. The agreement also requires coordination of administrative and public participation requirements.

SRS has 515 waste units in the Area Completion Projects program, including RCRA/CERCLA units, Site Evaluation Areas, and facilities covered under the SRS RCRA permit. At the beginning of FY2011, surface and groundwater cleanup of 386 of these units were complete or in the remediation phase (373 complete and 13 in the remediation phase). At the end of FY2011, 400 units were complete or in the remediation phase (380 complete and 20 in remediation). A summary of the FFA Milestones for FY2011 follows.

RCRA Facility Investigation/Remedial Investigation (RFI/RI) Field Starts were initiated for the following units:

- C Area Operable Unit
- Pen Branch Integrator Operable Unit [Including Indian Grave Branch] (Third Phase II)
- Wetland Area at Dunbarton Bay (No Building Number)

Remedial Actions were initiated at the following units:

- C-, K-, and L-Reactor Complexes (Early Action)
- P-Area Operable Unit
- R-Area Operable Unit

Remedial Actions were completed and Post-Construction Reports (PCRs) or Post-Construction Report/Corrective Measures Implementation Report/Remedial Action Completion Reports (PCR/CMIR/RACRs) or CMIR/RACRs were submitted for the following units:

- C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit Operable Unit (Effectiveness Monitoring Report with PCR Data)
- E-Area Low Level Waste Disposal Facility, 643-26E (Slit Trench Disposal Units 1 – 5) (Interim PCR)
- Early Construction and Operational Disposal Site (ECODS) L-1, N-2, P-2, and R-1A, -1B, -1C (CMIR/RACR)

A Record of Decision (ROD) was submitted for the following unit:

- L-Area Northern Groundwater

A ROD or Early Action ROD was approved for the following units:

- D-Area Operable Unit (Early Action)
- Gunsite 012 Rubble Pile, Rubble Pile Across from Gunsite 012, and Early Construction and Operational Disposal Site G-3
- L-Area Northern Groundwater

RODs or Early Action RODs were issued for the following units:

- D Area Operable Unit (Early Action)
- Gunsite 012 Rubble Pile, Rubble Pile Across from Gunsite 012, and ECODS G-3
- Gunsite 218 Rubble Pile (631-23G)
- L-Area Northern Groundwater
- R Area Operable Unit

Section X ("Site Evaluations") of the FFA requires SRS to submit Site Evaluation (SE) reports to EPA and SCDHEC for (1) those areas with potential or known releases of hazardous substances not identified before the effective date of the Agreement (referred to as Removal SE Reports), and (2) those areas listed in Appendix G.1 of the Agreement (referred to as Remedial SE Reports). SRS did not submit any Remedial SE Reports in 2011.

SRS submitted one Revision Removal SE Report:

- C-Area Process Sewer Line as Abandoned

The FFA requires, by January 1 of each year, submittal of an annual removal action report describing all removal actions performed during the previous fiscal year. On December 13, 2011, SRS submitted the report to the EPA and SCDHEC. The FY2011 report described 18 active removal actions areas and 43 maintenance activities.

A listing of all 515 waste units at SRS can be found in Appendices C ("RCRA/CERCLA Units List") and G ("Site Evaluation List") of the FFA (http://www.srs.gov/general/programs/soil/ffa/ffa.pdf).

DOE Order 435.1

SRS manages low-level, high-level and TRU waste in compliance with DOE Order 435.1, "Radioactive Waste Management," within a number of storage and disposal units. The 2011 annual review of the Performance Assessments (PA) and Composite Analysis (CA) (Reference: Savannah River Site DOE 435.1 Composite Analysis, Volumes I and II, SRNL-STI-2009-00512, Rev.0, June 10, 2010) showed that operations in FY2011 were within the performance envelope analyzed in the PAs, CA, and Special Analyses.

Liquid Radioactive Waste Tank Closure

Liquid radioactive waste is generated at the SRS as byproducts from the processing of nuclear materials for national defense, research and medical programs, and stored in 51 underground tanks in the F- and H-Area Tank Farms on site. Forty-four of these tanks currently store approximately 38 million gallons. Of the other seven, two tanks (17F and 20F) were stabilized with grout and closed in 1997; two tanks (18F and 19F) are prepared for closure in 2012; two tanks (5F and 6F) are empty and undergoing preparations for closure. Tank 16H leaked soon after construction in the 1960's and was emptied. As seen in table 3-1, tank closures at SRS have key Federal requirements, as well as requirements under the Federal Facility Agreement (FFA) for the Savannah River Site, an agreement between DOE, South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (EPA)[WSRC-OS-94-43].

The F- and H-Area Tank Farms are permitted under the SCDHEC Industrial Wastewater Regulations through the provisions of Section IX, High-Level Radioactive Waste Tanks System(s), of the FFA, and the SCDHEC industrial wastewater treatment facility construction program [Regulation R.61-67]. Section IX.E of the FFA requires DOE to submit a waste removal plan and schedule for the old style waste tank systems. In addition, DOE is required to remove the tanks from service according to the approved plan and schedule. Once the tanks are emptied and cleaned, they are prepared for closure and then closed with grout (i.e., a cement-like material).

Closure of these tanks is overseen by SCDHEC and EPA through the protocols DOE has established in the Industrial Wastewater General Closure Plans for both the F-Area and H-Area Tank Farms. In January 2011, the General Closure Plan for the F-Area Tank Farm, which describes the general waste removal and closure strategy for the old style high level radioactive waste tank systems, was approved by the State of South Carolina. As described in the General Closure Plan, Closure Modules are developed to describe the specific history, waste removal efforts, and closure strategy for each tank. Closure activities can only begin after the dispositing of the waste in the tanks. The Closure Module describes the waste removal and tank closure phases culminating in grouting. These processes are Bulk Waste Removal efforts, Mechanical Heel Removal, Chemical Cleaning, Cooling Coil and Annulus Cleaning, Final Sampling, Isolation and Stabilization by Grouting.

The Atomic Energy Act of 1954 (table 3-1) provides authority to the DOE to implement DOE Order 435.1, Radioactive Waste Management, for the protection of the environment from defense related radioactive materials. Under Manual 435.1-1, Radioactive Waste

Management, DOE is required to perform risk-informed assessments to evaluate the potential impacts of tank closures to the public. The risk-informed assessments, called Performance Assessments (PAs), are reviewed by the U.S. Nuclear Regulatory Commission (NRC), SCDHEC, EPA and the public. A PA was previously developed for the F-Tank Farm (FTF PA) to provide the technical basis and evaluation needed to demonstrate compliance with DOE Order 435.1 and the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), Section 3116(a). The FFA required DOE to submit the PA for the H-Area Tank Farm to SCDHEC and EPA by March 30, 2011. On March 23, 2011, Revision 0 of the H-Tank Farm PA was issued to SCDHEC, EPA and the NRC for comment and review.

As described in table 3-1 above, NDAA Section 3116(a) allows the Secretary of Energy, in consultation with the NRC, to determine that certain waste from reprocessing is not high level radioactive waste if it meets the criteria set forth in Section 3116(a). The Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site demonstrates compliance with the Section 3116(a) requirements and provides the basis for the Secretary of Energy's determination on the residual waste in the FTF Tanks. The Basis for Section 3116 Determination was previously submitted to the NRC and DOE received NRC recommendations in October 2011. NRC provided their review results and recommendations in accordance with NDAA Section 3116(a) to DOE.

In 2011, as tank closure documentation progressed, so did the field activities described in these documents. Eleven liquid radioactive waste tanks in both F- and H-Area Tank Farms underwent at least one phase in waste removal or tank cleaning. Bulk waste removal efforts were completed on three tanks, final sampling took place in two tanks (Tanks 5F and 6F), and four tanks were isolated from the mechanical, electrical and transfer systems (Tanks 18F, 19F, 5F and 6F). Grout preparations commenced on two tanks (Tanks 18F and 19F).

Resource Conservation and Recovery Act

Congress enacted the RCRA in 1976. RCRA established a system for managing hazardous and nonhazardous solid wastes in an environmentally sound manner. Specifically, it provides for the management of hazardous wastes from the point of origin to the point of final disposal ("cradle to grave"). RCRA also promotes resource recovery and waste minimization.

The Hazardous and Solid Waste Amendments (HSWA) of 1984 expanded the scope and increased the requirements of RCRA. HSWA addressed congressional concern about the adequacy of existing requirements to prevent uncontrolled releases of hazardous constituents or hazardous wastes from hazardous waste management units. Three of the HSWA initiatives were especially noteworthy in preventing or addressing hazardous waste/ constituent releases:

- Congress directed EPA to develop what is now known as the Land Disposal Restrictions (LDR) Program-under which the land disposal of untreated wastes is prohibited.
- Facilities are required to satisfy minimum technology requirements (i.e., liners and leachate collection systems) for surface impoundments, waste piles, land treatment units, and landfills to prevent hazardous wastes and/or constituents from migrating into the groundwater and to allow releases to be detected when they occur.
- When a facility seeks a RCRA permit, EPA is granted the authority to require corrective action for releases of hazardous waste and hazardous constituents from any solid waste management unit, regardless of when the waste was placed in the unit.

Nineteen SRS underground storage tanks contain petroleum products, as defined by CERCLA and are regulated under Subtitle I of RCRA. These tanks require an annual compliance certificate from SCDHEC. The SCDHEC inspection and audit on October 6, 2011 found all 19 tanks to be in compliance, marking nine straight years without a violation.

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

SRS received final certification from SCDHEC on September 21, 2011, for the RCRA closures of the N-Area Permitted Facilities (Buildings 645-N, 645-2N and 645-4N, Solid Waste Storage Pads 1-3) and Building 710-B. The closure plan for the Transuranic Waste Pad 1 (TRU Waste Pad 1) was submitted to regulators August 1, 2011. Closure activities for this facility continued throughout 2011.

Mixed Waste Management

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) (WSRC-

TR-94-0608) consent order (95-22-HW, as amended) was obtained and implemented in 1995, as required by the FFCAct. A Statement of Mutual Understanding for Cleanup Credits was executed by SCDHEC in October 2003, allowing SRS to earn credits for certain accelerated cleanup actions. Credits then can be applied to the STP commitment schedules. SRS submitted the 2010 annual update (SRNS-TR-200800101, Rev 2) of the approved STP to SCDHEC in November 2010 and it was approved on May 26, 2011. The update identifies changes in mixed waste treatment and inventory.

On July 7, 2011 DOE requested a revision to the annual frequency for updating the STP. SCDHEC agreed that DOE shall submit an Annual STP Update to SCDHEC for 2011 and thereafter follow a 5-year frequency of preparing future updates, with the next document being due in 2016. A meeting with SRS and SCDHEC staff will be held annually to discuss the status of the STP.

The STP 2011 Update documents storage of 146,262.03 m^3 of mixed waste as of July 1, 2011 versus 142,901.34 m^3 stored in 2010. The volumes on hand are summarized in Volume II Chapter 11 with additional details for transuranic (TRU) and High Level Waste (HLW) included in Chapters 4 and 5, respectively.

Previous volumes for Waste Stream SR-W009 (silver-coated packing material) reported the volume of the containment culvert and not the primary waste container itself. SRS has implemented refinements in accounting practices and now will only report the primary waste container volume instead of the containment. No SR-W009 waste was shipped.

The Volume II Chapter 5 update also revised the language for discussions concerning the status of facility, regulatory and budget issues and uncertainties that exist.

Table 3–2 Summary of SRS-Related NEPA Reviews in 2011

Type of NEPA Review	Number
Categorical Exclusion Determinations	296
“All No” EEC Determinations[a]	77
Actions Tiered to Previous NEPA Reviews	26
Environmental Impact Statements[b]	3
Supplement Analysis[c]	2
Interim Action	3
Revised FONSI	0
Environmental Assessments[d]	1
Total SRS-Related NEPA Reviews	**408**

[a] Proposed actions that require no further NEPA review

[b] DOE/EIS-0283-S2 (in progress) DOE/EIS-0375(in progress) DOE/EIS-0423 (in progress)

[c] SA for SRS Spent Nuclear Fuel Management FEIS DOE/EIS-0279 (in progress), SA for the Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement DOE/EIS-0303-SA-01

[d] DOE/EA-1606

National Environmental Policy Act

The National Environmental Policy Act (NEPA) is the federal government’s basic charter for ensuring the protection and wise use of the “human environment.” NEPA procedures require that federal agencies identify and consider the potential environmental consequences of their proposed actions early in the planning process so they can make informed, environmentally sound decisions regarding project design and implementation. The NEPA process at SRS is initiated by completing an Environmental Evaluation Checklist (EEC). The EEC is used to characterize the proposed action, identify any potential environmental concerns, and determine which level of NEPA review (if any) will be required; i.e., categorical exclusion (CX) determination, environmental assessment (EA), or environmental impact statement (EIS)]. A total of 408 SRS-related NEPA reviews were conducted in 2011 (see table 3-2). For additional information on SRS NEPA activities visit the NEPA webpage, http://www.srs.gov/general/pubs/envbul/nepa1.htm. The following is a listing of major NEPA reviews conducted during 2011, some of which are scheduled to be completed in 2012:

- *Supplement Analysis (SA) for the Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement (DOE/EIS-0303-SA-01)* - In this SA, DOE is reviewing the use of current technologies and the waste determination process legislated by Congress to implement DOE’s decision to stabilize tanks by filling them with grout. Publication of the SA is expected in 2012. An amended ROD is not required however an environmental bulletin and a *Federal Register* notice will be published in 2012.
- *Surplus Plutonium Disposition (SPD) Supplemental EIS (DOE/EIS-0283-S2)* - In this ongoing Supplemental EIS (SEIS) DOE and National Nuclear Security Administration (NNSA) evaluated alternatives for disposition of surplus non-pit plutonium and surplus clean metal and oxide plutonium materials.

The Tennessee Valley Authority (TVA) is a cooperating agency, and the SEIS will evaluate the impacts of using mixed oxide fuel in TVA reactors. Additional alternative studies were begun in May 2011 and concluded in October 2011. These studies have identified additional reasonable alternatives, and DOE will issue an Amended Notice of Intent and conduct additional public scoping. DOE anticipates that a ROD for the SPD SEIS would be approved in the first or second quarter of FY2013.

- *EIS for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC LLW) (DOE/EIS-0375)* - In this EIS, DOE will evaluate the impacts of disposing GTCC LLW in a geologic repository, in intermediate-depth boreholes, or in enhanced near-surface disposal facilities. Candidate DOE sites still being considered at the end of 2010 for these disposal facilities included SRS, Idaho National Laboratory, Los Alamos National Laboratory, WIPP, Nevada Test Site, Oak Ridge, Hanford, and Yucca Mountain. DOE also will consider generic commercial disposal of GTCC LLW at arid and humid locations. Disposal alternatives being considered for SRS include an intermediate-depth borehole facility and an enhanced near-surface facility. The draft EIS was published February 2011. The final EIS is scheduled for December 2012. The ROD schedule is uncertain.
- *SA: SRS Spent Nuclear Fuel Management FEIS (DOE/EIS-0279)* - In this SA, DOE is summarizing the environmental impacts of managing aluminum-clad spent nuclear fuel from foreign and domestic reactors by processing in H-Canyon rather than using the Melt-and-Dilute process. DOE would issue an amended ROD to document the decision. No projected approval dates had been established for the SA or amended ROD by the end of 2011.
- *Environmental Assessment for the Proposed Use of SRS Lands for Military Training (DOE/EA-1606)* - In this EA, DOE evaluated the potential impacts associated with the use of SRS lands for non-live-fire tactical maneuver training by the U.S. Departments of Defense and Homeland Security. The purpose of the action is to provide the referenced agencies with greater flexibility in developing training missions and strategies in response to rapidly changing world conditions. The EA and Finding of No Significant Impact (FONSI) were published in December 2011.
- *EIS for the Storage and Management of Elemental Mercury (DOE/EIS-0423)* -As directed by the Mercury Export Ban Act of 2008, DOE evaluated seven sites (including SRS) for the long-term storage of elemental mercury. DOE issued the final EIS in January 2011. DOE has not issued a ROD. The Waste Control Specialists facility near Andrews, Texas, is the preferred alternative site listed in the final EIS.
- *Amended Interim Action Determination for the Disposition of Plutonium Materials from the DOE Standard 3013 Surveillance Program at SRS* – DOE is preparing the SPD SEIS (DOE/EIS-0283-S2). In December 2008, DOE-SR approved an Interim Action Determination, *Processing of Plutonium Materials from the DOE Standard 3013 Surveillance Program in H-Canyon at the Savannah River Site*. This Amended Interim Action Determination amends the 2008 Determination by adding a second alternative, disposition as transuranic waste at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, for up to about 95 kilograms of plutonium from the 3013 surveillance program.
- *Interim Action for the Flexible Manufacturing Capability for the Mixed Oxide Fuel Fabrication Facility (MFFF) at the Savannah River Site* – DOE is preparing the SPD SEIS (DOE/EIS-0283-S2). This Interim Action Determination provides DOE and Shaw-Areva MOX Services (the MFFF contractor) the capability to manufacture fuel suitable for the variety of reactor technologies that exist in the current nuclear power reactors, and the flexibility to manufacture fuel for the next generation of power reactors.
- *Interim Action Determination for Disposition of Certain Plutonium Materials Stored at the Savannah River Site* – DOE is preparing the SPD SEIS (DOE/EIS-0283-S2). In order to reduce storage requirements and reduce the risk inherent in storing nuclear materials, DOE will prepare and ship up to 500 kilograms of plutonium-contaminated materials to the WIPP. These materials currently are within the scope of the SPD SEIS. However, because of the small quantity involved relative to the six metric tons of non-pit plutonium materials being evaluated in the SPD SEIS, and because this material does not lend itself to disposition using the other SPD SEIS alternatives, disposal of this material as TRU waste would not affect DOE's ultimate selection of disposition alternatives. This action will result in about 880 cubic meters of TRU waste and 120 shipments to WIPP. DOE estimates that this process would take place over a period of approximately three years.

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 site policies.

The site's 2010 PCB document log was completed in full compliance with 40 CFR 761, and the 2010 annual report of onsite PCB disposal activities was submitted to EPA Region 4 in July 2011, meeting applicable requirements. The disposal of nonradioactive PCBs routinely generated at SRS is conducted at EPA-approved facilities within the regulatory period which is one year from the date of generation. In 2011, SRS decommissioned 35 large oil filled circuit breakers and 19 transformers that previously were used in various electrical power distribution substations on site. PCB components such as insulators (bushings) and bushing potential devices were present in many of these items. This resulted in the generation of a significant volume of non-radioactive PCB waste, all of which was shipped for disposal at appropriately permitted facilities.

For some forms of radioactive PCB wastes, specifically those contaminated with TRU radionuclides, disposal capacity is not immediately available. Such wastes must remain in long-term storage pending necessary processing and packaging that will allow them to be shipped for disposal to the Waste Isolation Pilot Plant (WIPP) in New Mexico. These wastes are held in TSCA-compliant storage facilities in accordance with 40 CFR 761. In 2011, SRS made 67 shipments to WIPP that included containers of PCB/TRU waste. Additional containers of PCB/TRU waste will be processed and shipped to WIPP in 2012.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the application of restricted-use pesticides (RUPs) at SRS through a state-administered certification program. All pesticides applied on site are approved by the SRS Pesticide Use Task Group and the SRNS Chemical Management Center (CMC). Usage is documented in the Pesticide Activity Report database, which allows Environmental Compliance (EC) personnel to monitor application practices as well as to report total annual chemical inventories or usage to meet Emergency Planning and Community Right-to-Know Act (EPCRA) reporting responsibilities.

On October 31, 2011, the South Carolina legislative stay delaying the implementation of the National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Application of Pesticides (PGP) was lifted. As a result, the PGP, which is designed to cover application of pesticides (pesticides, herbicides, biocides) in, over, and at water's edge as well as right–of–way treatments of intrusive vegetation, became immediately effective. While it is not believed SRS will exceed reporting thresholds that would necessitate the submission of a SCDHEC Notice of Intent (NOI), SRNS will monitor applicable pesticide applications for all organizations on site in 2012. Following the enactment of the PGP, SRNS revised the Pesticide Activity Report database, which is used by SRNS personnel to capture all on-site pesticide applications, to distinguish PGP-related applications.

Radiation Protection

DOE Order 5400.5/458.1

DOE Order 5400.5, "Radiation Protection of the Public and the Environment," was replaced with DOE Order 458.1, "Radiation Protection of the Public and the Environment," in February 2011. DOE Order 458.1 was not incorporated into the SRNS contract until November 2011. Development of a Compliance Assessment and Implementation Report will be completed in 2012.

This DOE Order specifies radiation dose standards for individual members of the public. The dose standard to the general public of 100 millirem (mrem) (1 millisievert (mSv)) per year includes doses a person receives from routine DOE operations through all exposure pathways. To demonstrate compliance with the all-pathway dose standard, SRS conservatively combines the airborne pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations.

The highest potential dose to the maximally exposed individual from all pathways (liquid and atmospheric) in 2011 was 0.21 mrem (0.0021 mSv). This dose is 0.21 percent of the DOE dose standard. The 2011 all-pathway dose is about 91 percent more than the reported 2010 dose of 0.11 mrem (0.0011 mSv). Most of the increase is caused by the addition of the irrigation pathway dose. Without the irrigation pathway, the 2011 all-pathway dose would have been 0.12 mrem (0.0012 mSv), which is just 9 percent more than the 2010 comparable all-pathway dose.

Nontypical exposure pathways, which are not included in the standard calculations of the doses to the maximally exposed individual, are considered and quantified separately 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. During 2011, the maximum dose that could have been received by an actual onsite hunter was estimated at 14.7 mrem (0.147 mSv), or 14.7 percent of DOE's 100-mrem all-pathway dose standard.

A detailed discussion of this subject may be found in Chapter 6, "Radiological Dose Assessments."

Air Quality and Protection

Clean Air Act

The Clean Air Act (CAA) of 1970 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 all 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 CAA 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 CAA Part 70 Operating Permit Program. SCDHEC's Bureau of Air Quality issued SRS its Part 70 Air Quality Permit (TV-0080-0041), February 19, 2003, with an effective date of April 1, 2003. The Title V Operating Permit, which initially expired March 31, 2008, was extended with the September 18, 2007, submittal of an application for renewal, as required by SC R61-62.70. The site expects to receive the new Part 70 Air Permit in 2012. Until SCDHEC renews the permit, SRS will continue to operate in accordance with requirements of the extended permit.

The Part 70 Air Quality Permit regulates both radioactive and nonradioactive toxic and criteria pollutant emissions from 19 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 approximately 500 SRS sources that are exempt based on insignificant emission levels, or on equipment size or type.

In 2007, DOE-SR proposed replacement of the existing D-Area Powerhouse prior to its current Title V permit expiring June 20, 2012. Construction of the new plant continued in 2011. Construction and start-up of the biomass cogeneration facility at Burma Road under the SCDHEC issued construction permit No. 0080-0144CA (November 12, 2008) requires permanent removal from operation the existing coal-fired boilers at the D-Area Powerhouse. On November 8, 2011 Ameresco Federal Solutions supplied electricity to SRS facilities, triggering transition and closure activities at the D-Area facility. On December 19, 2011, DOE SR issued the Final Acceptance Certificate for the completion of construction of the DOE Savannah River Site Biomass Cogeneration Facility installed under an energy savings performance contract (ESPC) awarded to Ameresco Federal Solutions in May 2009. Following a series of performance tests on the newly operational plant, the 20-megawatt (MW), 34 acre, renewable energy facility is on-schedule to provide the necessary process steam to the site as well as provide approximately 30% of the power for the site once fully operational in 2012. After more than 60 years of operation, the D-Area Powerhouse will be removed from service prior to expiration of the Title V Permit, May 6, 2012. No revision to the D-Area Powerhouse Part 70 Air Quality Permit was issued in 2011.

MFFF, a part of the SRS Nuclear Nonproliferation Program, was issued an air construction permit (00800139CA) on August 22, 2006. Construction of the MFFF, which began August 1, 2007, continued throughout 2011. Compliance with the SRS Part 70 Air Quality Permit conditions last was evaluated by SCDHEC March 15, 2010.

Accidental Release Prevention Program

Under Title III of the CAA, 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 threshold values must develop a risk management program (RMP). The list of chemicals and their threshold quantity can be found in 40 CFR Part 68.130. The RMP establishes methods that will be used for the containment and mitigation of large chemical spills.

SRS maintains hazardous and extremely hazardous chemical inventories below the threshold value. 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). No reportable 112(r)-related hazardous or extremely hazardous chemical releases occurred at SRS in 2011.

Ozone-Depleting Substances

The CAA mandates air quality standards for the protection of stratospheric ozone. The CAA Title V operating permit program (TV-00800041, Condition 4.B.6) requires that SRS comply with the standards for recycling and emissions reduction pursuant to 40 CFR 82. The permit specifies compliance with the requirements of Subpart B ("Servicing of Motor Vehicle Air Conditioners"), Subpart E ("The Labeling of Products Using Ozone-Depleting Substances"), and Subpart G ("Significant New Alternatives Policy Program"). Accordingly, all large (greater than or equal to 50-pound charge) heating, ventilation, and air conditioning/chiller systems leak repair data are reported monthly. Incidental discharges from refrigerant sources at SRS during 2011 totaled 3,435 pounds.

Additionally, the Title V operating permit also specifies that SRS comply with the requirements of halon emissions reduction and recycling found in 40 CFR 82, Subpart H ("Halon Emissions Reduction"). Halon is used as a fire suppression agent in some facilities at SRS. The SRS Fire Department (SRSFD) maintain and recharge halon-containing equipment, and manage the national halon repository (Savannah River Halon Repository). Halon is maintained at this repository to support existing missions at SRS for the life of the missions. The repository also maintains halon supplies for other sites in the DOE complex.

According to the SRS Halon Management Plan (F-ESR-G-00120, November 16, 2005), all halon systems in service at SRS are scheduled to remain in service for the life of SRS's existing missions. As missions cease, halon will be recovered, recycled, and stored at the SRS repository in support of continuing missions. When stored halon exceeds the amount needed for support of SRS and other DOE sites, the excess is shipped to the U.S. Department of Defense (DOD), or offered to the General Services Administration as excess. SRS continues to phase out its use of halon as part of an overall goal to eliminate halon use in the United States.

The SRSFD details the total halon inventory at SRS in its annual "Halon Report" to DOE. As of December 31, 2011 there were approximately 52,144 pounds in the SRS inventory, including 19,704 pounds in 85 installed fire suppression systems, and 7,075 pounds of unprocessed halon stored in original containers. The balance, 25,365 pounds of halon, has been processed and is stored on site in 1-ton bulk containers. In addition to the SRS inventory, halon totaling 31,690 pounds is maintained in the national halon repository at SRS.

Air Emissions Inventory

SCDHEC Regulation 61-62.1, Section III ("Emissions Inventory"), requires compilation of an air emissions inventory to locate all sources of air pollution and to define and characterize the various types and amounts of pollutants. To demonstrate compliance, SRS personnel conducted the initial comprehensive air emissions inventory in 1993, which identified approximately 5,300 radiological and nonradiological air emission sources. Source operating data and calculated emissions from 1990 were used initially to establish the SRS baseline emissions and to provide data for air dispersion modeling.

Regulation 61-62.1, Section III, was revised in 2010 to require annual reporting of air inventories, beginning with 2010, by March 30 for the previous calendar year. Both SRS operating permits, TV0080-0041 (SRS general) and TV-0300-0036 (D-Area Powerhouse) 2010 emissions were submitted on March 28, 2011. EPA created the National Emissions Inventory as a comprehensive and detailed estimate of air emissions of both criteria and hazardous air pollutants from all air emissions sources, including SRS. The most recent information can be found at the following EPA website, http://www.epa.gov/ttn/chief/eiinformation.html.

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 hazardous air pollutants, such as radionuclides, benzene, and asbestos.

NESHAP Radionuclide Program

The current list of 187 hazardous 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. DOE-SR and EPA Region

4 signed a Federal Facility Compliance Agreement (FFCA) on 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 on May 10, 1995. Subpart H was revised by EPA on 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. SRS is required under Subpart H to determine the highest effective dose to any member of the public at an offsite point. The site must report this information annually by June 30 to both EPA headquarters and the regional office. SRS transmitted the SRS Radionuclide Air Emissions Annual Report for 2010" on June 3, 2011 to EPA, SCDHEC, and DOE Headquarters (HQ).

During 2011, the maximally exposed individual effective dose equivalent, calculated using the NESHAP-required CAP88 computer code, was estimated to be 1.53E-02 mrem (1.53E-04 mSv), which is 0.00153 percent of the 10 mrem per year (0.10 mSv per year) EPA standard (Chapter 6).

SRS compliance with 40 CFR 61, Subpart H ("National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities") last was evaluated by SCDHEC in June 2008 as part of a Title V radiological NESHAP inspection. SCDHEC did not conduct a Subpart H inspection at SRS in 2011.

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. EPA in December 1993 issued a final list of hazardous air pollutant-emitting source categories potentially subject to maximum achievable control technology (MACT) standards; SRS currently is not impacted by any promulgated MACT standards for source categories.

NESHAP Asbestos Abatement Program

SRS began its asbestos management program in 1988 and continues to manage asbestos–containing material (ACM) by "best management practices." Site compliance for asbestos operations and maintenance (O&M) activities, minor and small jobs as well as building renovations and demolitions falls under SCDHEC and federal regulations, including South Carolina Regulations 61–86.1 (Standards of Performance for Asbestos Projects), 40 CFR 61, Subpart M (National Emission Standards for Hazardous Air Pollutants – Asbestos), and 29 CFR 1926.1101 (Occupational Safety and Health Administration [OSHA] Asbestos Standard). SRS conducted 75 permitted renovations and demolitions in 2011.

Pursuant to the requirements of the SRS Asbestos Abatement Group License, issued annually by SCDHEC, O&M activities, minor and small licensed jobs are managed through the SRS Asbestos Disturbance Notice (ADN) procedure. ADN notifications are issued to each area of the site on a quarterly basis, which allows SRS to report amounts of ACM removed and disposed of during each quarter. SRS issued 62 ADN notifications in 2011. SRS certified personnel removed and disposed of 178 linear feet and 199 square feet of friable (regulated) ACM, and 543 linear feet, 6,835 square feet and 8 cubic feet of nonfriable (unregulated) ACM during 2011. Approximately 200 SRS asbestos specialists received training in 2011 and were certified by SCDHEC in the planner, air sampler, inspector, supervisor, worker, and O&M worker disciplines.

SRS disposed of 325 linear and 1,030 square feet of radiologically contaminated asbestos waste in 2011 at the SRS E–Area low–level vaults, engineered trenches, and slit trenches, which are authorized by SCDHEC as asbestos waste disposal sites. Nonradiological asbestos waste was disposed of at the Three Rivers Solid Waste Authority Landfill and the Construction and Demolition (C&D) Landfill (623-G), both of which are also SCDHEC–approved landfills.

Water Quality and Protection

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 effluents into streams, reservoirs, and wetlands.

SRS had five NPDES permits in 2011:

- Two permits for industrial wastewater discharges (SC0047431, which covered the D-Area Powerhouse, and SC0000175, which covered the remainder of the site).

- Two general permits for stormwater discharges (SCR000000 for industrial and SCR100000 for construction). Permit SCR000000 expired December 31, 2010; renewal of the permit became effective January 1, 2011.
- One General Utility Water Permit Number SC250273 issued May 5, 2011.

The site also had one No-Discharge permit for land application of biosolids (ND0072125). This permit was renewed in 2010 and is applicable for another 10 years. More information about SRS's NPDES permits can be found in Chapter 4.

The results of monitoring for compliance with the industrial wastewater discharge permit at SRS were reported to SCDHEC in the site's monthly discharge monitoring reports, as required by the permit. SRS had no permit limit exceptions during 2011, a compliance record that has been attained only two other times (2007 and 2010).

SCDHEC generally conducts an unscheduled "NPDES 3560 Compliance Sampling Inspection" of the site's permitted outfalls annually. The March 2010 inspection, resulted in a "Satisfactory" rating, the highest achievable. There was no "NPDES 3560 Compliance Sampling Inspection" performed in 2011.

A SCDHEC renewal of the NPDES General Permit for Storm Water Discharges (SCR000000) associated with Industrial Activity became effective on January 1, 2011. The permit requires control measures be selected, installed, implemented, and maintained to ensure that storm water discharges do not result in an exceedance of water quality standards in receiving streams. Although one outfall exceeded benchmark levels and required installation of additional control measures, no violations of this permit were experienced in 2011. Results from sampling of storm water outfalls appear in an effluent monitoring data table 4-9 in the "Environmental Data/ Maps - 2011" section of the CD housed inside the back cover of this report. The SRS Storm Water Pollution Prevention Plan, a requirement under the NPDES Storm Water General Permit, was finalized in March 2011.

One permit for industrial wastewater discharge (Permit No. SC0049107, Outfall G-05) has been issued to Ameresco Federal Solutions for discharges associated with the Biomass Cogeneration Facility. This permit is independent of the site's permits and has not been included in the list of permits held by SRS.

Dredge and Fill; Rivers and Harbors—The CWA, Section 404, "Dredge and Fill Permitting," as amended, and the Rivers and Harbors Act (RHA) of 1899, Sections 9 and 10, "Construction Over and Obstruction of Navigable Waters of the United States," protect U.S. waters from dredging/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 Titles 33 and 40 of the Code of Federal Regulations.

In 2011, SRS had two open permits under the Nationwide Permits (NWPs) program (general permits under Section 404), and one open permit under the RHA of 1899, Section 10, as follows:

- Dam construction on an unnamed tributary to Fourmile Branch for the Mixed Waste Management Facility Groundwater Interim Measures project was completed in 2000 under NWP 38, "Hazardous Waste Cleanup." However, mitigation for the impact to wetlands was still pending in 2011 and must be addressed before the permit can be considered closed. SRNS has requested approval from DOE to use wetland mitigation bank credits to satisfy the mitigation issue and close the permit.
- SRS initiated a project during 2009 to dredge sediments out of the 681-3G and 681-5G pumphouse canals to allow for better flow to the water intake of each pumphouse. An RHA of 1899 Section 10 permit, (SAC-2008-1156) was obtained from the U.S. Army Corps of Engineers (COE) March 24, 2009, to allow the dredging work to begin. Both canals were successfully dredged and returned to their original design. Maintenance dredging of accumulated sediments in the 681-5G canal was conducted in November 2011. The Section 10 permit will remain open until March 31, 2014, to allow for additional maintenance dredging as required.
- Area Completion Projects (ACP) installed three wells under NWP 5-in the Savannah River floodplain wetlands east of T-Area in August 2011 for groundwater sampling activities.

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

A navigable waters permit (P/N 2008-1156-6IJ) was issued to Washington Savannah River Company December 4, 2008, for the sediment dredging project of the 681-3G and 681-5G pumphouse canals. The permit, transferred to SRNS on January 14, 2009, was issued by SCDHEC simultaneously with the WQC, and was extended by SCDHEC in August 2011 to expire on March 31, 2014.

Water Quality Certification (WQC)—Section 401, "Water Quality Certification," of the CWA is administered by SCDHEC to ensure the maintenance of water quality during dredge-and-fill projects.

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 groundwater sources. The A-Area and D-Area drinking water facilities are actively regulated by SCDHEC, while the remaining smaller water systems receive a reduced level of regulatory oversight.

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 2011 met these standards.

Due to a three-year rotating cycle, the water systems were not sampled under the state lead and copper Rule in 2011. The D-Area system will be sampled for lead and copper in 2012 and A-Area is scheduled for 2013.

Other Environmental Requirements

EPCRA/SARA Title III

EPCRA (enacted in 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 EPCRA-mandated Toxic Chemical Release Inventory, i.e., Toxics Release Inventory (TRI), report to include source reduction and recycling activities.

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 appropriate reporting requirements for EPCRA, and incorporates the applicable TRI chemicals into its pollution prevention efforts.

Chemical Inventory Report (Tier II)

Under Section 312 of EPCRA, SRS completes an annual Tier II Chemical 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 electronically by March 1 for the previous calendar year. For 2010 SRS submitted the Tier II on February 22, 2011.

Toxics Release Inventory Report (Form R)

Under Section 313 ("Toxic Chemical Release Inventory") of EPCRA, SRS must file an annual TRI report by July 1 for the previous year. SRS calculates chemical releases to the environment for each regulated chemical and reports the each regulated chemical that exceeds its established threshold value to EPA electronically on Form R of EPCRA Section 313. Threshold values are those quantities of regulated chemicals (as defined by EPCRA Section 313) above which additional reporting is required using Form R.

Form R for 2010 was submitted electronically to EPA on July 1, 2011. SRS reported the following chemicals that exceeded their thresholds: barium, chlorine, chromium, copper, fluorine, formic acid, hydrochloric acid, lead, manganese, mercury, nickel, nitrate, nitric acid, sodium nitrite, sulfuric acid, and zinc. (NOTE: The term "exceeded" in an EPCRA context does not indicate a violation. Per EPA regulations, SARA chemical limits are established, and reporting requirements are based on these threshold values.) Specific details, including release amounts and detailed information about toxic release inventory reporting, can be viewed on the EPA website at http://www.epa.gov/tri/tridata.

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 endangered species exist at SRS, including the wood stork, the red-cockaded woodpecker, the Atlantic sturgeon, the shortnose sturgeon, the pondberry, and the smooth purple coneflower. Although the bald eagle no longer is on the endangered species list, it still is protected under the Bald and Golden Eagle Protection Act. Programs are in place on site to enhance the habitat and survival of such species.

During 2011, implementing the United States Department of Energy Natural Resources Management Plan for the Savannah River Site (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5208304.pdf), the United States Department of Agriculture Forest Service-Savannah River (USFS-SR) personnel developed three biological evaluations for timber-related activities, and one as requested to assist other site missions in the P-Area Ash Basin. The biological evaluations determined that implementation may affect but not adversely affect threatened and endangered species due to beneficial, insignificant, or discountable effects. The implementation may also adversely affect three animal species of conservation concern (Southern hognose snake, Pine snake, and the Gopher frog), but not result in a trend toward federal listing or result in the loss of population viability. Additionally, a biological evaluation was prepared by the Department of the Army in support of DOE/EA-1606, Environmental Assessment for the Proposed Use of Savannah River Site Lands for Military Training, and concluded that the proposed action was not likely to adversely affect endangered species. The U.S. Fish and Wildlife Service concurred with the Army's findings.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, Section 106, governs archaeological and historical resources. SRS ensures that it is in compliance with the NHPA through several processes. The Cold War Programmatic Agreement and "SRS's Cold War Built Environment Cultural Resource Management Plan" are being implemented. The site's artifact selection team, which includes DOE, SRNS, and the University of South Carolina's Savannah River Archaeological Research Program (SRARP) is responsible for overseeing the selection, collection, and curation of Cold War-era artifacts from buildings prior to decommissioning and demolition activities.

The Site Use Program is another process used to ensure compliance with NHPA. All locations 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.

The following information is summarized from the "Annual Review of Cultural Resources Investigations by the Savannah River Archaeological Research Program, Fiscal Year 2011", Savannah River Archaeological Research Program, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, 2011.

Archaeological survey of Site Use Permit Application and Timber Compartment Prescription projects by SRARP staff continued through FY2011. During FY2011, archaeological reconnaissance and survey was conducted on 38 proposed projects through the subsurface inspection of 985 acres with a total of 3,853 Shovel Test Pits excavated. Altogether, 13 new sites were recorded and delineated, and 4 previously recorded sites were revisited during FY2011. Based on the level of survey sampling conducted at all new and previously recorded sites, adequate information was not obtained for most sites to allow National Register of Historic Places (NRHP) eligibility determinations. As such, these sites will be completely avoided by SRS contractors during any land disturbing activities. At the time these sites are due to be impacted by future undertakings, the SRARP will conduct the appropriate level of archaeological investigation to resolve eligibility determinations.

A total of 54 Site Use Permit Applications were received by the SRARP during FY2011. Each permit application underwent review by SRARP management for proposed land modification. Of these, 11 Site Use projects required field reconnaissance or archaeological survey in addition to one ongoing project last fiscal year. These Site Use projects comprised 550 acres (56%) of the total survey coverage in FY2011.

The SRARP management reviews each Timber Compartment Prescription to determine the level of survey required for each timber stand slated for timbering. The review process involves determining the potential for archaeological resources in each timber stand. Surveys of log decks and timber stands were conducted in 24 timber compartments, which involved 435 acres (44%) of the total survey area coverage in FY2011.

As a result of the analysis of artifacts recovered through daily compliance activities and the analysis of artifacts recovered from excavations conducted at the Greene site (38AK953) and Flamingo Bay (38AK469) approximately 19,026 artifacts were curated over the course FY2011. Compliance related excavations conducted throughout the year account for 1,044 of these artifacts. Primary analysis of artifacts from 38AK469 yielded approximately 10,000 artifacts, while analysis of artifacts from 38AK953 totaled 7,982 artifacts.

In addition, SRARP staff maintained continued support to DOE Cold War Cultural Resources Management Plan (CRMP) efforts through participation on DOE's Cold War Artifact Selection Team and at Heritage Tourism Board meetings.

Section 110 of the National Historic Preservation Act requires an inventory of all cultural resources on public lands. As of this report, the SRARP has surveyed approximately 66,055 acres (34.0%) out of a total of 193,276 (97.4%) of SRS acreage suitable for survey (i.e., excluding SRS wetlands and developed areas). In total, the SRS comprises 198,344 acres or 310 sq. mi. These efforts have resulted in the inventory of 1,901 sites (931 prehistoric, 492 historic, and 478 with both prehistoric/historic components) recorded to date.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA) is the domestic law that governs the protection of migratory birds, including eggs and nests. The MBTA prohibits the taking, possession, import, export, transport, selling, purchase, or barter of, or offering for sale, purchase or barter, any migratory bird or its eggs, parts, and nests, except as authorized under a valid permit.

In 2011, several nests protected under the MTBA were found in large mobile equipment located at various site locations. The equipment was either barricaded until the hatchlings fledged or the nests were determined by SRNS, with concurrence by the U.S. Fish and Wildlife Service to no longer be viable, or the nests were relocated to a safer adjacent location.

DOE Orders/Executive Orders for Environmental Systems

Summary of EMS Programs

DOE Orders 450.1A, "Environmental Protection Program," and 430.2B, "Departmental Energy, Renewable Energy and Transportation Management," describe DOE's requirements and responsibilities for implementing Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy and Transportation Management." EO 13423 directs each federal agency to use an Environmental Management System (EMS) as the framework to implement, manage, measure, and continually improve upon sustainable environmental, energy, and transportation practices. Additional information on these and other sustainability programs may be found in Chapter 2 ("Environmental Management System") and in the SRS FY2011 Site Sustainability Plan, issued in December 2010.

DOE Order 436.1/EO13514 Greenhouse Gas Reductions

DOE Order 436.1 was approved to incorporate new requirement in Executive Orders 13514, 13423 and other related statutes, administrative requirements and goals. Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," established greenhouse gas (GHG) reduction goals of 28 percent for Scope 1 and 2 items (power generation facilities) and 13 percent for Scope 3 items (business and employee travel) by 2020 from the 2008 baseline. Reducing energy intensity, completing construction of a Biomass Cogeneration Facility and continuing operation of several satellite biomass plants, and increasing the use of alternative fuels and alternative-fuel vehicles are some of the ways SRS made progress toward this goal in 2011. Details of this progress against sustainability goals are provided in Chapter 2 of this report.

2011 Waste Minimization and Pollution Prevention Program Results and Highlights

The SRS Waste Minimization and Pollution Prevention Program (WMin/P2) continued to achieve significant results in 2011. All required site waste generator organizations demonstrated active participation in the program through documented pollution avoidance and/or direct mission support activities for site recycling. Site employees' P2 awareness was increased through online articles and both general employee and job-specific training.

The WMin/P2 Program met all DOE and regulatory agency reporting requirements. Program accomplishments during 2011 included the following:

- SRS documented 19 P2 projects resulting in a DOE-SR approved annualized avoidance of 2,009 m^3 of hazardous and radioactive waste in FY2011 significantly exceeding the FY2011 P2 Program waste avoidance performance goal of 357 m^3. Annual cost avoidance resulting from the documented P2 projects is approximately $2.5 million.
- SRS won an Environmental Management (EM) Best-in-Class Honorable Mention Award and two 2011 DOE EStar Awards for its nominations: "*Renewable Energy Technology Deployment, and Education in South Carolina - A Collaboration Between Savannah River National Laboratory & Economic Development Partnership of South Carolina*" and "*Savannah River Site Tritiated Debris Remediation Project*". In 2011, only 15 EStar Awards were granted from 186 nominations. SRS was represented at the awards ceremony held at DOE headquarters and shared lessons learned with a presenta-

tion of the award-winning projects to DOE complex staff. SRS submitted 5 nominations in FY2012 documenting FY2011 notable projects.

SRS participates in EPA voluntary P2 Programs by maintaining its EPA Waste Wise and EPA National Partnership for Environmental Priorities (NPEP) memberships. SRS received an award from the NPEP Program recognizing SRNS for achievements in chemical reduction. In total, over 250,000 pounds of DOE radiologically associated lead have been shipped for reprocessing into commercial nuclear products exceeding the SRS NPEP goal by over 600%. The award nomination was submitted in FY2010 and recognized by EPA in FY2011 Recycle provides a cost-effective and an environmental preferable option for this stream versus disposal as a RCRA hazardous and radioactive waste.

SRS continued to support federal government electronics recycle and sustainability program objectives. SRS reported 138,480 pounds of electronics recycled in FY2011 and is in compliance with Department of Energy Acquisition Regulations (DEAR) for Energy Star and Electronic Products Environmental Assessment Tool (EPEAT) electronics procurement.

The Sanitary Waste Program (municipal solid waste) managed over 83,000 metric tons (MT) of materials in FY2011. Thirty-five percent (35.5%) of the routine (i.e. office type waste) municipal solid waste stream was recycled (813 MT) meeting the 35% performance objective for this waste stream established to support Aiken County reporting to SCDHEC. Twenty-two percent (22.5%) of the total routine and industrial streams, excluding C&D waste, was recycled (2,118 MT). Operation of the on-site C&D landfill avoided over $4.3 million in commercial landfill fees.

SRS issued a new subcontract with Three Rivers Material Recovery Facility (MRF) to provide municipal solid waste recycle services beginning in FY2012. This contract provides for recycle services to recover greater than 50% of the routine (i.e. office type waste) municipal solid waste stream and will reduce waste processing and transport costs.

The Pollution Prevention Team supports P2 awareness on site and in the local community.

- On site employee awareness is increased through on-line articles and general employee and job-specific training.
- The Program provided volunteer support and student handouts for the Central Savannah River Area (CSRA) Environmental Science Education Cooperative's (ESEC) EcoMeet event held at Thurmond Lake. The event was a success with 30 middle school teams from Georgia and South Carolina competing in a day-long, hands-on environmental education challenge.
- The Program supported CSRA ESEC Environmental Teacher of the Year Award ceremony held in Augusta, Georgia.
- SRS Earth Day support included: Providing photos with captions for posters that DOE-HQ used to highlight winning Environmental Sustainability projects displayed over Earth Day week and providing four articles to the on-site newsletter to increase employees' environmental awareness.

EO 11988/11990 Floodplain Management/ Wetlands

Under 10 CFR 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 developed in 2010 to support a NEPA evaluation for the installation of a temporary road for access to a portion of the earthen cap over the waste unit on the west side of T-Area. The road also was to provide access for cap maintenance and to a monitoring well in the area. The scope of the project was changed to make the road permanent, and the floodplains/wetlands assessment was revised in 2011 to support this change. The floodplains/wetlands assessment was made final and approved by DOE in September 2011.

Other Environmental Issues/ Actions

Lawsuits

SRS was not involved in any active environmental lawsuits during 2011.

Table 3–3 NOV/NOAV Summary, 2007–2011

Program Area	NOV/NOAV 2011	2010	2009	2008	2007
CAA	0	2	0	1	0
CWA	0	0	0	2	0
RCRA	0	0	0	0	0
CERCLA	0	0	0	0	0
Others	0	0	0	0	0
Total Violations	**0**	**2**	**0**	**3**	**0**

SRS as Potentially Responsible Party in Superfund Cleanup

Alternate Energy Resources, Inc. (AER) operated commercial hazardous waste storage and treatment facility in Augusta, Georgia, until 2000, when the facility was abandoned and the owners declared bankruptcy. The facility was placed on the NPL in 2006. Nonradioactive SRS waste was processed at this facility; as a result, EPA named SRS one of 50 potentially responsible parties in the cleanup of this location. SRS responded to multiple Department of Justice requests regarding documents relevant to AER on October 26, 2010 and June 28, 2011.

Notice of Violation / Notice of Alleged Violation

No NOVs or NOAVs were received in 2011. NOVs/NOAVs received from 2007-2011 are summarized in table 3-3.

Environmental Occurrences

The Occurrence Reporting and Processing System (ORPS), mandated by DOE Order 232.2 ("Occurrence Reporting and Processing of Operations Information"), is designed to ". . .ensure that the DOE and the NNSA are informed about events that could adversely affect the health and safety of the public or workers, the environment, DOE missions, or the credibility of the Department." Also, the ORPS system promotes "organizational learning consistent with DOE's Integrated Safety Management System goal of enhancing mission safety, and sharing effective practices to support continuous improvement and adaptation to change."

Of the 115 ORPS-reportable events at SRS in 2011 (including all contractors), there were no ORPS reportable events within ORPS Group 5 (Environmental) or ORPS Group 9 (Noncompliance Notifications).

Environmental Audits

The SRS environmental program is overseen by a number of organizations, both outside and within the DOE complex. In 2011, the site's environmental appraisal program again 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 assessment program are to ensure compliance with regulatory requirements and to foster continuous improvement. The program, an integral part of the site's Integrated Safety Management System, supports the SRS EMS, which continues to meet the guidelines of International Organization for Standardization Standard 14001. (ISO 14000 is a family of voluntary environmental management standards and guidelines.) The Site Tracking, Analysis, and Reporting (STAR) system is a database used for scheduling self-assessments, as well as for (1) documenting their results and any issues or concerns identified, (2) tracking corrective actions to closure, and (3) trending accumulated data for process improvement. DOE-SR conducted 260 assessments that included aspects of the environmental protection functional area. SRNS conducted 341 environmental protection functional area assessments in 2011.

SRNS also conducted several environmental program-level assessments in 2011. The self-assessment titles, the environmental topical areas (in parentheses), and brief summaries of some of these assessments follow.

- *Surface Water Quality-Facility Permitting (Industrial Wastewater Treatment)* – This self-assessment was conducted from August 11 through September 30, 2010. The purpose was to evaluate the SRS industrial wastewater treatment program against the SCDHEC Industrial Wastewater Permitting Program, including wastewater treatment plant (and associated collection system) design, operation, maintenance, permitting and closeout. The assessment, which included document/procedure reviews and interviews with engineering and environmental compliance personnel, resulted in three findings and five opportunities for improvement (OFIs). Corrective actions, including revisions to site- and facility-level procedures, were identified and completed during 2010 and 2011.

- *Air Quality Protection – Title V Operating Permit, Air Dispersion Modeling*–This self-assessment was conducted from June 1 through 21, 2011. As part of the air permitting process, facilities in South Carolina are required to demonstrate the potential emissions coming from their sources will not cause the violation of any applicable South Carolina air pollution control regulations or standards. Air dispersion modeling is typically used to demonstrate compliance. This self-assessment focused on the modeling associated with Title V activities. The SRS demonstrates the potential emissions coming from its sources will not cause the violation of any applicable South Carolina air pollution control regulations or standards with the use of AERMOD modeling. Modeling input files are generated by EC personnel and Savannah River National Laboratory (SRNL) atmospheric technologies personnel utilize the required AERMOD model to demonstrate the site's compliance with SCDHEC Standards no. 2, 7, and 8. The assessment identified two OFIs to take advantage of the movement of the modeling files being generated in the existing Air Information Reporting System (AIRS) to the new opsAir™ system.
- *Waste Management – Underground Storage Tanks*– This self-assessment was conducted from June 7 through July 20, 2011 to evaluate the SRS underground storage tanks (UST) program and ensure USTs are being managed to minimize the potential for releases to the environment and are compliant with all applicable DOE, federal, state, and local requirements. Inspection records were reviewed to verify that the USTs are inspected annually for tank and line tightness and were completed in the last 12 months. Assessors verified monthly leak detection tests were being conducted and records are available. SRNS staff also verified annual tank permits were up-to-date and that corrosion protection testing of USTs had been completed within the last three years. There were two OFIs and no findings.
- *Groundwater – Data Acquisition, Management, and Reporting* – This self-assessment was conducted from June 1 through 27, 2011. The purpose of this assessment was to confirm that SRS has programs in place to identify sources of groundwater contamination, develop formal plans for their characterization, identify constituents of concern, and define the extent of any groundwater plumes. Recent characterization documents were reviewed and CERCLA, characterization, and engineering personnel were interviewed. The assessment determined that the SRS has well established programs and procedures in all of the subject areas. There were no findings and one OFI related to groundwater assessment of petroleum-related sites. Consolidation of assessment activities under Environmental Compliance and Area Completion Projects has addressed this OFI.
- *Waste Management – Non-hazardous Waste Management* – This self-assessment was conducted from July 18 through 21, 2011 to evaluate solid waste management activities at the 632-G Construction and Demolition (C&D) Landfill. The assessors gathered information for this assessment by document review, interviews of cognizant personnel, and inspection of the 632-G (C&D) debris landfill. The assessors found that the landfill is operated according to Manual Y10.10, procedure 9-38045, Operation, and Inspection of 632-G Landfill and Borrow Pit. There is a program in place to detect prohibited wastes by inspections of loads when deposited and prior to compaction, by trained personnel, and if necessary, by notification of SCDHEC if it is suspected that hazardous waste or PCB waste has been deposited at the landfill. Prohibited waste is removed from the working face (location where new waste is being placed) prior to the end of the working day. Generators who deposit prohibited waste are required to remove it and place it into an appropriate container for disposal. The observed working face did not exceed a slope of 33%. Waste was observed to be spread in uniform layers and compacted to the smallest practical volume. Clean soil from site construction activities was stockpiled to use as cover. Records of clean soil, no less than six inches in depth, being placed over exposed waste at least every 30 days are being maintained. The roles and responsibilities of the landfill first line manager and manager are clearly defined. There were no findings or OFIs.
- *NEPA Compliance* – This self-assessment was conducted from April 21 through May 2, 2011 to evaluate NEPA compliance for the Cell 11 Remediation/Repackaging Program. The assessment evaluated whether a formal program is in place that establishes requirements and responsibilities for the implementation of NEPA regulation and for compliance

with DOE Order 451.1B Chg1; Procedure Manual 3Q ECM 5.1; 10 CFR 1021; MCR-14. Appropriate NEPA documentation was completed and approved as required and the necessary permits were revised as needed to cover the project.

- *Environmental Radiation Protection-Environmental Radiological Surveillance* – This was conducted from August 7 through 31, 2011 to identify the drivers for the aquatic fish program and to examine it for any potential streamlining. The data from the fish program is used to satisfy various DOE Orders and an agreement between SRS, South Carolina Department of Health and Environmental Control and Georgia Department of Natural Resources (GDNR). Electrofishing was observed and was conducted in a safe manner with the correct PPE in use at all times. SRS submitted the 2012-2016 SRS Fish Sampling and Analytical Plan (FMP) to SCDHEC on December 1, 2011. The FMP outlines the methods for sampling, preparing, analyzing and quantifying the radionuclide concentrations in fish collected in streams from the SRS that would flow into the Savannah River. The results obtained from fish sampling are used to assess and calculate the risk and dose to the public from ingestion of fish and to identify and evaluate any impacts from the SRS operations on contaminant levels in fish. SRS clarified the radionuclide sampling requirements for both the edible and non-edible portions of the fish.

SCDHEC and EPA personnel conducted external inspections and audits of the SRS environmental program for regulatory compliance. Routine audits and the resulting noncompliances for the past five years are summarized in table 3-4. Agency representatives performed several comprehensive compliance inspections and audits in 2011, as follows:

- *RCRA Compliance Evaluation Inspection* – The RCRA compliance evaluation inspection was conducted by SCDHEC April 15 through 21, 2011. The May 20, 2011 SCDHEC inspection report letter noted that no violations were found.
- *Annual Underground Storage Tank Inspection* – SCDHEC inspected the site's underground storage tanks (USTs) October 6, 2011. All were found to be in compliance with applicable regulations for the ninth straight year.
- *632-G C&D Landfill, 288-F Ash Landfill, and 488-4D Ash Landfill Inspections* – SCDHEC conducted eleven routine inspections-each of which covered the 632-G C&D, the 288-F Ash, and the 488-4D Ash landfills; the facilities were found to be satisfactory, with no observed deficiencies.
- *Z-Area Saltstone Solid Waste Landfill Inspections* – Saltstone Disposal Facility inspections by SCDHEC continued to be completed weekly or biweekly. Moisture areas were again observed on the walls of the facility's Vault 4, and were reported to SCDHEC in accordance with the facility's contingency plan. (NOTE: "Moisture areas" are areas on the external walls of the facility's cells that appear damp due to a combination of saltstone shrinkage from curing, bleeding, and process water accumulation at the inner cell walls, and from hydrostatic pressure that causes the water to weep through preexisting construction cracks.) For any new moisture areas, facility personnel conduct an engineering evaluation. Saltstone personnel inspected the Vault 4 exterior condition of cells that were in operation

Table 3–4 Routine Environmental External Audit and Inspection Summary

Audit	Frequency	Noncompliances				
		2011	2010	2009	2008	2007
RCRA CEI	Annually	0	0	0	0	0
UST Inspection	Annually	0	0	0	0	0
Landfill Inspection	At least bimonthly	0	0	0	0	0
Saltstone Inspection	Weekly or bi-weekly	0	0	0	0	0
Interim Sanitary Landfill (postclosure)	Annually	0	0	0	0	0
Air Programs Compliance Inspection	Annually	0	0	0	0	*
NPDES CSI Inspection	Annually	0	0	0	0	*
CME Inspection of Groundwater Facilities	Annually	0	0	0	0	0
Small Domestic Water Systems Inspection	Triennially	NA	0	NA	NA	0

*No inspections of these programs conducted in 2007 on a daily basis and communicated the discovery of any new moisture areas to SCDHEC, per the facility contingency plan. SCDHEC performed weekly or biweekly onsite inspections of Vault 4 to observe existing and potential moisture areas. The SCDHEC inspectors detailed the results of their inspections in the Saltstone Disposal Facility Vault 4 Inspection Checklist. SCDHEC has not mandated any additional actions other than monitoring of Vault 4 via the aforementioned inspections. No additional actions are pending.

- *On-Site Laboratory Evaluation of the D-Area Powerhouse Lab* - In support of renewing the laboratory certification, a SCDHEC Office of Environmental Laboratory Certification representative conducted an onsite audit of SRS's D-Area Powerhouse laboratory December 9, 2010. SCDHEC's report of the audit, also issued in December 2010, noted minor deficiencies related to standard operating procedures for laboratory methods. These deficiencies were addressed, and the laboratory certification of the D-Area Powerhouse laboratory was renewed February 4, 2011.
- *Interim Sanitary Landfill* – SCDHEC personnel conducted an annual post-closure inspection of the Interim Sanitary Landfill on September 26, 2011. The landfill was found to be satisfactory (the highest possible rating), with no observed deficiencies.
- *On-site Laboratory Evaluation of the Waste Treatment Plant* – SCDHEC Office of Environmental Laboratory Certification representatives conducted an onsite audit of SRS's Waste Treatment Plant (also known as the Central Sanitary Waste Treatment Facility) on March 10, 2011 in support of renewing the laboratory certification. SCDHEC's report of the audit, issued on May 17, 2011, indicated changes needed on various standard operating procedures and related laboratory records. Additionally, SCDHEC identified that the off-site contract laboratory used by the SRS laboratory was not SCDHEC certified for biosolids preparation of fecal coliform biosolid samples. The off-site contract laboratory became certified for the preparation method and the standard operating procedures and laboratory records were revised. The laboratory certification of the Waste Treatment Plant was renewed on September 2, 2011.
- *Compliance Sampling Inspection (CSI) of NPDES Facilities* – A SCDHEC representative inspected NPDES facilities March 1 through 4, 2011. SRS earned the highest ratings possible in all nine categories evaluated.
- *CSI of D-Area NPDES Facilities* – SCDHEC representatives inspected NPDES wastewater outfalls at the D-Area Powerhouse August 16, 2011. No findings or other concerns were noted.
- *Compliance Air Inspection* – SCDHEC representatives inspected continuous emission monitoring systems at the D-Area Powerhouse on September 29, 2011. The inspection report stated that "No violations of permit requirements or applicable regulations were observed during this evaluation."
- *Comprehensive Monitoring Evaluation* – SCDHEC representatives inspected SRS groundwater facilities-associated with the F-Area and H-Area Seepage Basins, M-Area Settling Basin, Metallurgical Lab Basin, Mixed Waste Management Facility (MWMF) and Sanitary Landfill on March 21 through 22, 2011. The inspection resulted in no findings and one observation of two damaged well signs. One sign was located at the F-Area Seepage Basin and the other at the MWMF. On May 13, 2011, SRS submitted a letter to SCDHEC informing them that the two damaged signs had been replaced with new signs.
- *Domestic Water Systems Inspection* – SCDHEC representatives inspected SRS's A-Area and D-Area domestic water systems March 21, 2011. SCDHEC found these systems to be operating in compliance with the State Primary Drinking Water Regulations.
- *Domestic Water Permit Inspections* – SCDHEC inspectors issued a new operating permit on July 14, 2011 for the domestic water system that serves the new administration building at the Advanced Tactical Training Area Range.
- *Industrial Wastewater Construction Permit Inspections* – Personnel from the SCDHEC Local Office conducted inspections to approve the operation or closure of a variety of industrial wastewater treatment projects including upgrades to the H-12 Outfall Humic Acid Chemical Injection System, the 105-C Disassembly Basin Evaporators, the D-Area Coal Pile Runoff Basin, the Waste Concentrate Hold Tank at the Effluent Treatment Facility, and the Caustic Storage Tank located in the H-Area Tank Farm throughout 2011.

Regulatory Self-Disclosures

Management of Nickel-Cadmium and Lithium batteries at SRNL- During an internal waste management audit at SRNL, several nickel-cadmium (Ni-Cad) batteries that should have been managed as universal waste were found in a storage room. Universal waste regulations streamline hazardous waste management standards for certain widely generated wastes, such as batteries, pesticides, lamps and mercury-containing equipment, enabling collection and recycling. Eight of these batteries were marked as "spent" and exhibited dates more than one year old; dates ranged from August 20, 1999 to November 24, 2009. Also with the Ni-Cad batteries were some lithium (Li) batteries. SRS policy at the time of the audit was to manage Li batteries as hazardous waste. SRS recognizes that all of the Ni-Cad batteries should have been labeled as universal waste, dated, and transported to an off-site reclaiming facility within one year. Subsequent to the discovery, all of the Ni-Cad batteries have been managed as universal waste and are being recycled. The Li batteries were placed into a hazardous waste satellite accumulation area after discovery. SRS also has established a contract to recycle Li batteries, and all Li batteries at SRS are now being managed as universal waste. These battery issues were reviewed on April 19, 2011 by a SCDHEC inspector during the Compliance Evaluation inspection (CEI); the inspector accepted the explanations and actions. Closure on this item was completed when SRNS received the May 20, 2011 letter from SCDHEC documenting successful completion of the CEI.

The Management of a B-12 container in a 90-day Accumulation Area the R-Reactor Building - An audit of the inspection records for a 90-day accumulation area at R-Reactor found that a B-12 container was placed into the area for several days without a properly dated label. On September 2, 2010, the container was labeled and dated with its original start date of August 18, 2010. In addition, the inspection records show that the B-12 container was periodically removed from the 90-day accumulation area and taken back into the reactor building so that additional waste could be placed in the container. The area within the reactor building where the waste was generated was not an established 90-day accumulation area. The container was transported to permitted storage within 90 days of its start date. This 90-day accumulation area issue was reviewed on April 18, 2011 by a SCDHEC inspector during the CEI; the inspector accepted the explanation and actions. Closure on this item was completed when SRNS received the May 20, 2011 letter from SCDHEC documenting successful completion of the CEI.

The Operation of Dynamic Underground Stripping (DUS) Industrial Wastewater Demonstration Project- During a startup review of documentation, it was discovered that the temporary DUS approval had expired. As soon as this was realized, DUS soil vapor extraction and groundwater extraction systems were shut down. Negotiations with SCDHEC resulted in approval to continue to operate the project until December 2012, contingent upon submittal of an Industrial Wastewater Permit Application for the project and summary report of the pilot study within 60 days of completion of the study. SRS submitted the permit application and review is ongoing by SCDHEC.

Continuous-Release Reporting

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. SRS had no EPCRA-reportable releases in 2011.

Unplanned Releases

Federally permitted releases comply with legally enforceable licenses, permits, regulations, or orders. If an unpermitted release to the environment of an amount greater than or equal to a reportable quantity (RQ) of a hazardous substance (including radionuclides) occurs, CERCLA requires notification to the National Response Center. Reportable quantities are those quantities of a hazardous substance greater than or equal to values specified in table 302.4 ("Designation of Hazardous Substances") of 40 CFR 302 ("Designation, Reportable Quantities, and Notification"). SRS had no CERCLA reportable releases in 2011. The CWA requires SRS to notify the National Response Center if an oil spill causes sheen on navigable waters, such as rivers, lakes, or streams. Oil spill reporting has been reinforced with liability provisions in the CERCLA National Contingency Plan.

No SCDHEC required notifications were made in 2011 due to the small quantities involved with each spill. However, one petroleum spill, a ruptured fuel hose that released 25 gallons of diesel fuel at the MOX Project, was reported to the SCDHEC local office in Aiken for informational purposes. The site recorded and cleaned up the following spills that did not require reporting under CERCLA or to SCDHEC, (because they were below the RQ): eight chemical, five sewage, and 80 petroleum product spills. None of the small oil spills that occurred in 2011 required a call to the National Response Center.

No unplanned environmental releases (radioactive and nonradioactive) occurred at SRS in 2011 that required sampling and analytical services.

Permits

SRS had 509 construction and operating permits in 2011 that specified operating levels for each permitted source. Table 3-5 identifies these permits. These numbers, which reflect permits for all primary contractors and tenant organizations at SRS, with the exception of Ameresco, include some permits that were voided or closed during 2011.

Table 3-5 SRS Construction and Operating Permits, 2011

Type of Permit	Number of Permits
Air	9
U.S. Army Corps of Engineers — Section 10, Rivers & Harbors Act of 1899	1
U.S. Army Corps of Engineers Nationwide Permit	2
U.S. Army Corps of Engineers — 404 Permit (Dredge and Fill)	1
Asbestos Demolition/Abatement	20
Domestic Water	222
Industrial Wastewater	76
NPDES Discharge	2
NPDES No Discharge	1
NPDES General Utility Water Permit	1
Stormwater Discharge	1
Construction Stormwater Grading Permit	10
RCRA Hazardous Waste	1
RCRA Solid Waste	5
RCRA Underground Storage Tank	7
Sanitary Wastewater	119
SC Department of Natural Resources Scientific Collecting Permit	1
SCDHEC 401	1
SCDHEC Navigable Waters	1
Underground Injection Control	28
Total	**509**

Note: The "Compliance Summary" chapter is unique in that its 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 and their organizations on the chapter's first page, so we list them here instead. Their contribution, 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.

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Effluent Monitoring

CHAPTER 4

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Effluent monitoring at the Savannah River Site (SRS) is conducted to demonstrate compliance with applicable standards and regulations. Site airborne and liquid effluent monitoring activities are divided into radiological and nonradiological programs. This monitoring is conducted in accordance with specific Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Department of Energy (DOE) sampling and analytical procedures. A summary of data results is presented in this chapter; more detailed data can be found in tables on the CD housed inside the back cover of this report.

Radiological Monitoring

The U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) establish the requirements and limits that regulate radionuclide emissions from facilities owned or operated by the DOE. The methods for estimating and reporting radioactive emissions are detailed in 40 CFR 61 Subpart H. The SCDHEC regulates both radioactive and nonradioactive air pollutant emissions from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the SRS Part 70 Air Quality Permits, with specific limitations and monitoring requirements. This section of the chapter will cover the radioactive emissions.

Radiological effluent monitoring results are a major component in demonstrating compliance with standards for radiological doses to the public established by EPA, SCDHEC and DOE. SRS works to ensure that radiation exposures to employees and releases of radioactivity to the environment are maintained below regulatory limits, and deliberate efforts are taken to further reduce exposures and releases.

SRS airborne and liquid effluents that potentially contain radionuclides are monitored or evaluated at the point of discharge by a combination of direct measurement and/or sample extraction and analysis. Brief summaries of analytical results are presented in this chapter; complete data sets, as well as maps which show sampling locations, can be found in tables on the CD housed inside the back cover of this report. Tables on the CD ("Environmental Data/Maps - 2011") are referred to in this chapter as "data table 4-X." Tables in the chapter itself are referred to simply as "table 4-X."

Data tables 4-1 and 4-2 provide a summary of analytical results for radioactive air and liquid effluent measurements taken at SRS in 2011. Radioactive atmospheric and liquid release data by facility are contained in data tables 4-3 and 4-4.

Unspecified alpha and beta radiation releases in airborne and liquid emissions make up a large percentage of the offsite doses. The unidentified alpha and unidentified beta radiation releases are listed separately in data tables 4-3 and 4-4. They are determined by subtracting the identified individual radionuclides from the measured gross activity. Conservatively, unidentified alpha and unidentified beta releases include small amounts of unidentified manmade radionuclides and also include naturally occurring radionuclides, such as uranium, thorium, and potassium-40. For dose calculations, the unspecified alpha and beta radiation releases were assigned the plutonium-239 and the strontium-90 dose factors, respectively (Chapter 6, "Radiological Dose Assessments").

Airborne Emissions

Process area stacks that release, or have the potential to release, radioactive materials are monitored by an inline system, periodic sampling system or utilize approved calculation methods to estimate the emissions.

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.

Diffuse and Fugitive Sources

Estimates of radionuclide releases from unmonitored diffuse and fugitive sources are calculated on an annual basis and are included in the SRS radioactive release totals contained in data table 4-3. A diffuse source is defined as an area source, such as a pond or disposal area. A fugitive source is defined as an undesignated localized source, such as an open tank or naturally ventilated building.

Diffuse and fugitive releases are calculated using EPA's recommended methods [EPA, 2002a]. Because these methods employ conservative assumptions, they generally lead to overestimates of actual emissions. Though these releases are not monitored at their source, onsite and offsite environmental monitoring stations are in place to quantify unexpectedly large diffuse and fugitive releases (Chapter 5, "Environmental Surveillance").

Monitoring Results Summary

The total amount of radioactive material released to the environment is quantified by using (1) data obtained from monitored airborne effluent release points, (2) estimates of diffuse and fugitive sources, and (3) estimates for unmonitored air sources based on approved EPA calculation methods using periodic sampling and analysis of the source.

Tritium

Tritium in elemental and oxide forms accounted for more than 99 percent of the total radioactivity released to the atmosphere from SRS operations in 2011. The remaining one percent is detailed in data table 4-3. Approximately 28,100 Ci of tritium were released from the site in 2011, compared with approximately 40,500 Ci in 2010. About 94 percent of the releases came from the site's tritium facilities and the remainder is split between the Reactor Areas and the estimated diffuse and fugitive releases from ongoing remediation and restoration activities. A significant reduction in tritium emissions is reported for 2011 as a result of refinement in the calculation methodology for the Mixed Waste Management Facility (MWMF) Phytoremediation project. Historical emissions from this source were conservatively based on a maximum possible throughput of 108 million gallons of water with a tritium concentration at 7,440 pCi/mL. SRS reported a 2011 tritium throughput of 12.7 million gallons and a lower tritium concentration of 5,440 pCi/mL. The change to the less conservative and more accurate calculation method reduces the calculated percent of tritium released due to remediation activities from 32% to approximately 3% of the total site release.

The amount of tritium released from SRS fluctuates because of changes in the site's missions and in the annual Tritium Facility production schedules. For the past 10 years, the amount has ranged between 25,000 to 60,000 Ci per year (Figure 4-1).

<u>Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides</u>

Average concentrations of radionuclides in airborne emissions are calculated by dividing the amount of each radionuclide released annually from each stack by the respective yearly stack-flow volumes. 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 appropriate and effective. DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs are applicable at the point of discharge.

Data table 4-5 provides the 2011 atmospheric effluent annual-average concentrations, comparisons against the DOE DCGs, and the estimated quantities of radionuclides released by monitored discharge point. With the exception of tritium releases, the stack emissions reported in data table 4-5 represent only the emissions that occur during periodic sampling events. The emissions for other periods including any time when continuous tritium monitors malfunction and intervals between stack samples are not included. In addition, any emissions estimated using calculations are not provided in this table. Also, not included in the table are gross alpha and gross beta results.

Official year-end estimates are presented in data table 4-3. These estimates include monitored, fugitive, unidentified alpha and beta, calculated releases, and annual totals based on actual operation time. Data table 4-5 provides the 2011 atmospheric effluent annual average concentrations and their comparisons against the DOE DCGs. This DCG comparison is based on concentrations; therefore, only significant isotopic releases occurring during sampling periods are used to determine representative concentration.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs. However, because of the nature of the operations and the application of DCGs at the release point, tritium DCGs are exceeded routinely at K-Area, L-Area, and the Tritium Facilities. The DCG

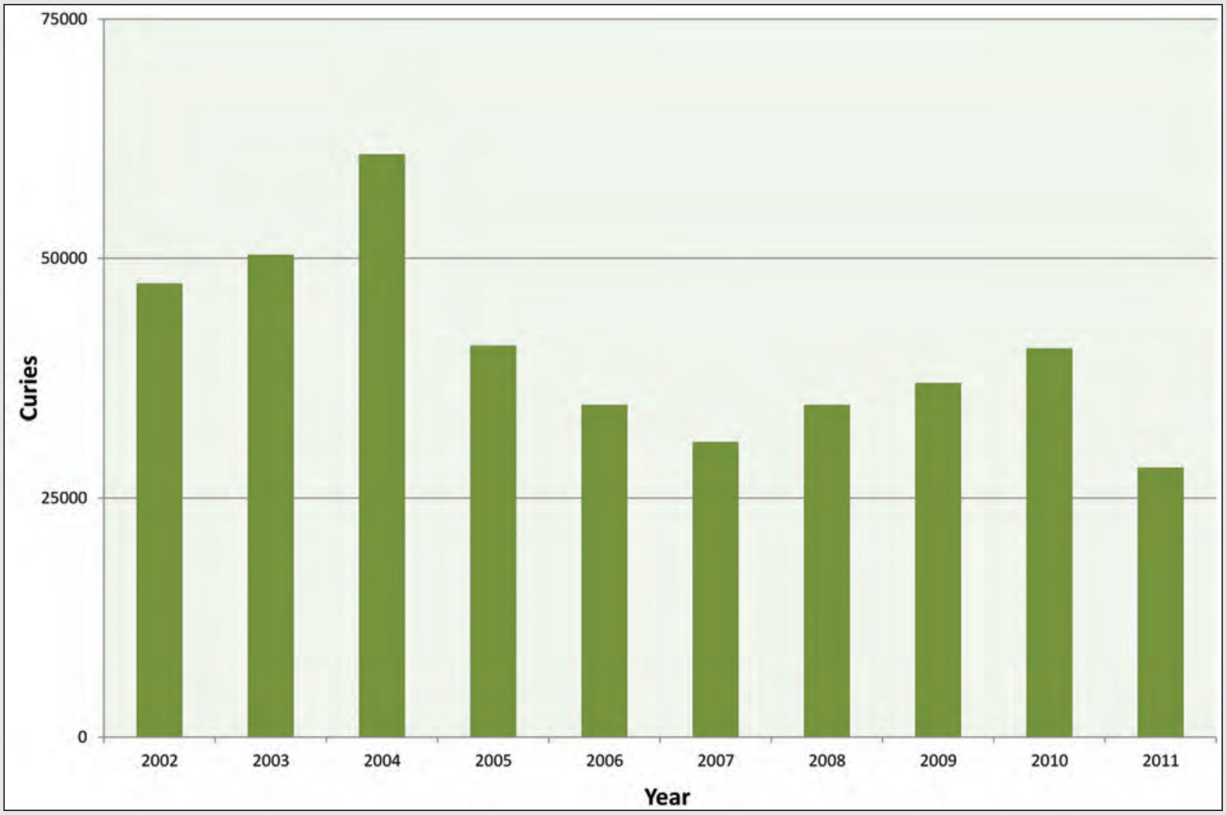


Figure 4-1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

Sum of Fractions (i.e., sum of the fractional DCG values for each radionuclide detectable in the effluent based on rolling twelve-month averages) was exceeded for airborne releases from H-Canyon (291 H) stack in 2011. The H-Canyon exceedance occurred due to releases of Pu-238 and Pu-239 associated with dissolver operations during highly enriched uranium processing and transuranic waste repackaging activities. The offsite dose from all atmospheric releases, however, remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv), as discussed in Chapter 6.

Liquid Effluents

Each process area liquid effluent discharge point that releases, or has potential to release, radioactive materials is sampled routinely and analyzed for radioactivity.

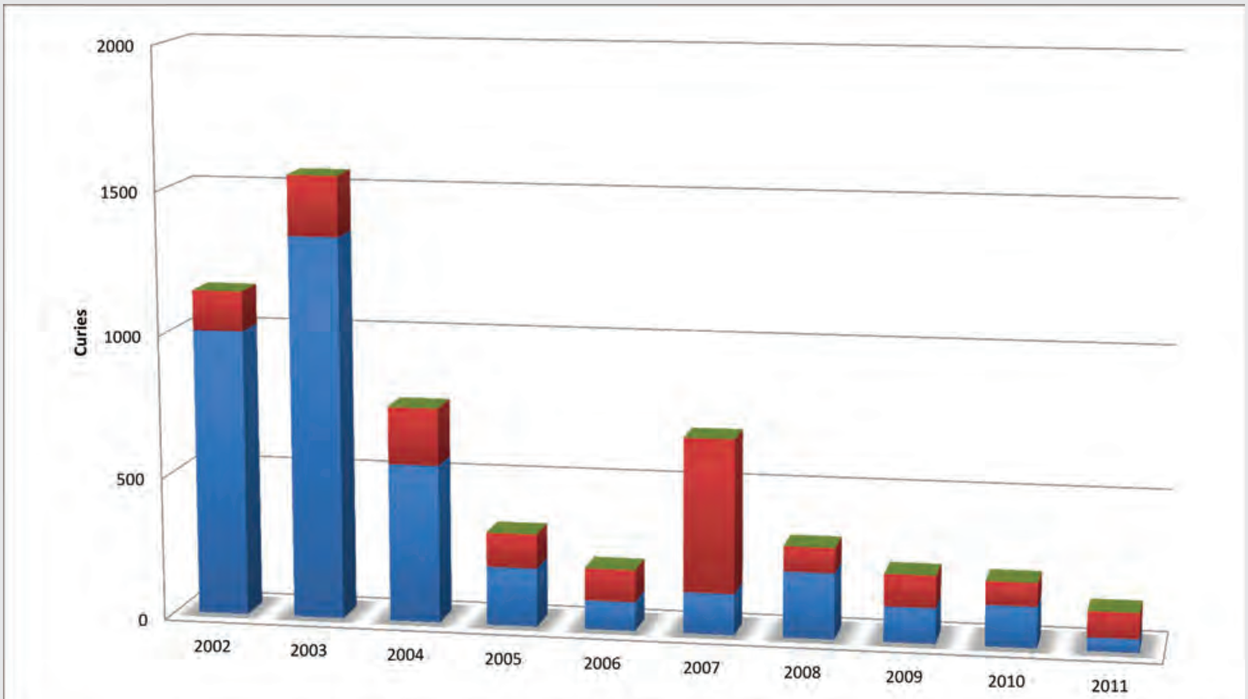
Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that releases are below DOE established limits. Because the instruments have limited detection sensitivity, online monitoring systems are not used to quantify SRS liquid radioactive releases at their current low levels. Instead, samples are collected for more sensitive laboratory analysis.

Environmental Monitoring Field Technician Picks Up a Radiological Sample for Analysis

Monitoring Results Summary

Data from monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release

Figure 4-2 Ten-Year History of Direct Releases of Tritium to SRS Streams



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SRNL	0	1	1	0.495	0	0.33	0	0	0	0.28
Reactor Areas	140	212	201	121	113	540	89	114	83	91.5
Separations Areas	1003	1340	554	205	101	144	231	124	144	46.5

estimates to quantify the total radioactive material released to the Savannah River from SRS operations. Data table 4-4 provides SRS liquid radioactive releases for 2011. This data are a major component in the determination of offsite dose consequences from SRS operations.

Discharges of Liquid Effluents

Discharges of liquid effluents are quantified at the point of release. The release totals are based on measured concentrations and measured flow rates. Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas to site streams during 2011 was 138 Ci. Direct releases of tritium to site streams for the years 2002-2011 are shown in figure 4-2.

Groundwater migration and transport of radionuclides from site seepage basins and the SWDF are discussed in Chapter 5.

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 groundwater 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" (BAT) waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from BAT requirements; however, it is not excluded from the requirement to keep radioactive emissions and external exposures as low as reasonably achievable (ALARA). DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detected in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. Data table 4-6 provides the 2011 liquid effluent annual-average concentrations, the quantities of radionuclides released compared to the DOE DCGs by discharge point.

Nonradiological Monitoring

Airborne Emissions

SCDHEC regulates both radioactive and nonradioactive criteria and toxic air pollutant emissions from SRS sources. Each source of air emissions is permitted, regulated or exempted by SCDHEC in the SRS Part 70 Air Quality operating permit. The permit sets emission limits and monitoring requirements for air emission sources at SRS. This section will cover nonradioactive emissions.

The bases for the limitations and monitoring requirements specified in the Part 70 Air Quality Permits 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 industries, processes, or equipment. However, some standards govern all sources for criteria pollutants and toxic air pollutants. Air pollution control regulations and standards applicable to SRS sources are discussed briefly in Appendix A, "Applicable Guidelines, Standards, and Regulations," of this report. The SCDHEC air standards for toxic air pollutants can be found at http://www.scdhec.gov/environment/baq/Regulation-SIPManagement/reg61-62index.asp.

Monitoring Program

Major nonradiological emissions of concern from SRS facility stacks include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 micrometers and smaller than 2.5 micrometers, volatile organic compounds (VOCs), toxic and hazardous air pollutants. The SRS Part 70 Air Quality Permit has numerous 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 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 SRS processes, however, are unique sources requiring nonstandard, complex calculations. The hourly and total actual annual emissions for each source are then compared against their respective permit limitations.

SRS is required to perform stack compliance tests every two years at the A-Area biomass boiler and D-Area Powerhouse facility. The tests include sampling of boiler exhaust gases to determine particulate matter. In addition, opacity emissions are monitored and recorded during times of operation and a weekly visual inspection is conducted. A compliance stack test was conducted at the A-Area biomass boiler in February 2011, and test results are included in table 4-2. The next test is required prior to March 31, 2013. Only one compliance stack test was required and conducted at the D-Area facility. Boiler #3 was tested in May 2011. Due to permanent shutdown of the D-Area facility in 2012, no additional compliance tests will be performed at the D-Area powerhouse.

Compliance with sulfur dioxide standards is required for all fuel oil fired equipment operated on site. The sulfur content of the fuel oil used at SRS must be below 0.05 percent, and compliance reported to SCDHEC semiannually. Compliance is verified by analysis, and fuel supply vendor certification is required for each delivery. The monitoring of SRS diesel-powered equipment includes 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 are currently reported to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices, such as electrostatic precipitators, baghouse dust collectors, or condensers, which must be monitored continuously or during operation and 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 regional office. The inspections include a review of each permit condition (i.e., daily monitoring readings, equipment calibrations, control device inspections, etc.); SCDHEC performed an air compliance inspection at the D-Area Powerhouse facility in September, 2011 and found no instances of noncompliance. SCDHEC did not perform a general site air compliance inspection in 2011.

Monitoring Results Summary

SRS is required to report its emissions inventory for all site air emission sources annually. Operating data are compiled and emission data are calculated for each calendar year. Data table 4-7 provides a list of the 2007-2011 estimated emissions.

The total SCDHEC air emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in each of the past five years, are provided in table 4-1. A review of the calculated emissions for each source for each calendar year determined that SRS sources had operated in compliance with permitted emission rates. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC are also, by nature, particulate matter or VOCs. As such, the total for VOCs in table 4-1 includes applicable toxic air pollutant emissions.

Four pulverized coal-fired boilers are maintained by SRS at the D-Area Powerhouse facility. Each of the boilers has a steam generation rating of 330,000 lbs per hour (3,960,000 Btu/hr capacity). The D-Area Part 70 Air Quality Permit requires that a biennial stack test be conducted for each of the boilers. D-Area Powerhouse boiler D#3 was source tested in 2011; these test results, as well as the 2010 test results for boilers D#1, D#2, and D#4, are shown in table 4-2. The particulate matter, sulfur dioxide, and visible emissions of these boilers were found to be in compliance with their permitted limits.

SRS also operates a biomass boiler and an oil-fired backup boiler in A-Area. These two boilers are substantially smaller and burn cleaner than the two coal-fired boilers which they replaced. The biomass boiler and oil-fired backup boiler each produce significantly less particulate matter, sulfur dioxide, and nitrogen dioxide emissions than coal-fired boilers.

SCDHEC issued a new Part 70 Air Quality Prevention of Significant Deterioration Construction Permit to Ameresco Federal Solutions to construct two biomass boilers, each rated at a maximum heat input rate of 210 million BTU/hr, and one new oil fired auxiliary boiler rated at 150 million BTU/hr, and two additional biomass boilers rated at 14.9 million BTU/hr. This new equipment will replace the D-Area Powerhouse facility. In November 2011, Ameresco began producing steam for use at SRS and closure of the D-Area Powerhouse was initiated.

The total diesel fuel consumption for portable air compressors, generators, emergency cooling water pumps, and fire water pumps was found to be well below the SRS limit for the entire reporting period. As reported to SCDHEC during 2011, the calculated annual VOC emissions were well below the permit limit for each unit.

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 is conducted as required in the

Table 4–1 SRS Estimated SCDHEC Standard 2 Pollutant Air Emissions, 2007–2011

Pollutant Name	Emissions (Tons/Year)				
	2007	2008	2009	2010	2011
Sulfur dioxide (SO_x)	4,250	4,070	4,000	4,110	4,560
Total particulate matter (PM)	417	459	399	803	329
Particulate matter <10 micrometers (PM_{10})	245	313	264	637	142
Particulate matter <2.5 micrometers ($PM_{2.5}$)	220	265	222	136	427
Carbon monoxide (CO)[a]	76.2	673	40.7	44.6	125
Volatile organic compounds (VOCs) (Ozone Precursors)	16.1	65.3	4.88	4.88	4.60
Gaseous fluorides (as hydrogen fluoride)	12.7	12.2	12.2	12.2	12.3
Nitrogen dioxide (NO_x)	2,630	1,890	1,790	2,060	2,060
Lead (lead components)	0.0191	0.0267	0.034	0.0391	0.0166

[a] Increase in CO emissions attributed to decreased combustion efficiency of D-Area Powerhouse facility

Title V and construction permitting process. Additional information about ambient air quality regulations at the site can be found in Appendix A of this report.

Liquid Effluents

Monitoring Program

NPDES—SRS monitors nonradioactive liquid discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES), as mandated by the Clean Water Act. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES permit program is administered by the State of South Carolina. SCDHEC has issued permits to SRS for discharges to the waters of the United States, including 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.

In 2011, SRS discharged water into site streams under three NPDES permits: two for industrial wastewater, SC0047431 (covers D-Area) and SC0000175 (covers remainder of site), and one for stormwater runoff, SCR000000 (industrial discharge). A fourth 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 2011. SCDHEC reissued SCR000000, which covers 34 individual stormwater outfalls and became effective January 1, 2011.

NPDES samples are collected in the field according to 40 CFR 136 ("Guidelines Establishing Test Procedures for the Analysis of Pollutants"), 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.

Land Application—The sludge from the sanitary wastewater treatment facility is managed under the requirements contained in Permit ND0072125. Sludge generated at the facility is transferred from the

Table 4–2 2010 and 2011 Boiler Stack Test Results

Boiler[a]	Pollutant	Emission Rates lb/10^6 BTU	lb/Hr
A Area Biomass Boiler	Particulate matter[b] Sulfur dioxide[b] Opacity[d]	0.0052 0.0300 Avg. 2.73%	0.306 1.765
D Area Boiler #1	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.2598 1.52 Avg. 13.7%	113.28 413.83
D Area Boiler #2	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.258 1.17 Avg. 13.2%	86.89 336.13
D Area Boiler #3	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.5640 1.56 Avg. 8.83%	269.79 495.33
D Area Boiler #4	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.189 1.54 Avg. 6.3%	95.11 482.00

[a] Boiler #1 source test October 22, 2010; Boiler #2 source test February 3, 2010; Boiler #3 source test May 27, 2011; Boiler #4 source test December 9, 2010

[b] SCDHEC's Title V permitted emission limits are 0.6 lb/million BTU for particulates and 3.5 lb/million BTU for sulfur dioxide.

[c] Opacity limit 40%

[d] Opacity limit 20%

activated sludge basin to the drying bed prior to the land application of the resulting biosolids. One application of approximately 102 cubic yards of the dried sludge was performed from November 29 through December 7, 2011. All sample results were within permit limits for metals and nutrients.

Environmental Monitoring Field Technician Records Data from a Flow Meter at an Industrial Wastewater Outfall

Monitoring Results Summary

SRS reports industrial wastewater analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320-1). Results of 5,176 sample analyses performed during 2011 indicated that no NPDES permit exceptions occurred. Data table 4-8 provides a compilation of industrial wastewater analytical data for 2011.

All industrial stormwater outfalls were monitored per the requirements of the permit. There were no noncompliances. Data table 4-9 provides a compilation of stormwater analytical data for 2011.

CHAPTER 5

Environmental Surveillance

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

As part of the SRS radiological surveillance program, routine surveillance of all applicable radiation exposure pathways is performed on all environmental media (air, rain, surface water, soil, sediment, vegetation, drinking water, food products, wildlife, and aquatic wildlife) that could lead to a measurable annual dose above background at and beyond the SRS boundary. Radionuclides present in and around the SRS environment may be from a number of sources, including (1) natural background, (2) fallout from historical atmospheric testing of nuclear weapons, (3) nuclear power plant operations, and (4) SRS operations. Nonradioactive environmental surveillance at SRS involves the sampling and analysis of surface water, drinking water, air, 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 and analysis results can be found in Chapter 7, “Groundwater.”

The Savannah River is monitored by SRS and other groups, including the South Carolina Department of Health and Environmental Control (SCDHEC), the Georgia Department of Natural Resources, Georgia Power Company’s Vogtle Electric Generating Plant (VEGP, operating in Georgia), and the city of Savannah, Georgia.

Brief summaries of analytical results are presented in this chapter; detailed data sets can be found in tables on the compact disk (CD) (see “Environmental Data/Maps - 2011”) inside the back cover of this report. Also on the CD are maps showing all applicable sampling locations. Tables on the CD are referred to in this chapter as “data table 5-X.” Tables in the chapter itself are referred to simply as “table 5-X.”

References to detectable amounts or levels of radioactivity within this chapter are synonymous with activity greater than the minimum detectable concentration (MDC) for a particular analytical method. The MDC is the smallest amount or concentration that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level. Representative MDC values for radiological analyses can be found in Table 2 (“Representative Minimum Detectable Concentrations for Radiological Analyses”) in the “Sampling” section of the CD.

References to detectable amounts or levels of nonradioactivity within this chapter are synonymous with activity that is greater than either the method detection limit (MDL) or practical quantification limit (PQL) for a particular analytical method. The MDL is the lowest concentration that can be detected by an instrument with correction for the effects of sample matrix and method-specific parameters such as sample preparation. The PQL is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Radiological Surveillance

Air

Description of Surveillance Program

SRS conducts atmospheric air monitoring both onsite and offsite to determine whether airborne radionuclides have reached the environment in measurable quantities of SRS releases and to verify and modify the models used to show compliance with the 10 mrem/year dose limit specified in United States Department of Energy (USDOE) Order 5400.5, “Radiation Protection of the Public and the Environment.” The atmospheric surveillance program is divided into two primary areas, air and rainwater.

The SRS maintains a network of 15 atmospheric (ambient) surveillance sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air. Tritium is the most abundant airborne radionuclide released as part of routine SRS operations, and becomes part of the natural environment. Monitoring ensures that it poses no health risk to the surrounding population. The tritium-in-air surveillance results are used to validate the dose models used for the airborne pathway to the nearby public.

The surveillance stations are placed at the center of the SRS, around the site perimeter, at a regional reference location (assumed to be unimpacted by SRS operations) nearly 25 miles from the SRS, and in population centers 25 and 100 miles from the SRS. Placement on the site boundary was designed to ensure that at least one monitoring station is in every 45-degree sector.

Each air surveillance sampling station consists of the following:

Media	Purpose	Sampling Frequency	Analysis Frequency	Analyses
Glass-Fiber Filter	Airborne Particulate Matter	Biweekly	Biweekly	Gamma-emitting radionuclides, gross alpha/ beta emitting radionuclides
Glass-Fiber Filter	Airborne Particulate Matter	Biweekly	Annually	Total Strontium, Actinides (plutonium, americium, uranium, curium, and neptunium)
Charcoal Canister	Gaseous States of Radioiodine	Biweekly	Annually	Iodine-129, Iodine-131
Silica Gel	Tritiated Water Vapor	Biweekly	Biweekly	Tritium
Rainwater	Tritium in Rainwater	Monthly	Monthly	Tritium
Rain Ion Column	Wet/Dry Deposition	Monthly	Monthly	Gamma-emitting radionuclides, gross alpha/ beta emitting radionuclides, total Strontium, Actinides (plutonium, americium, uranium, curium, and neptunium)

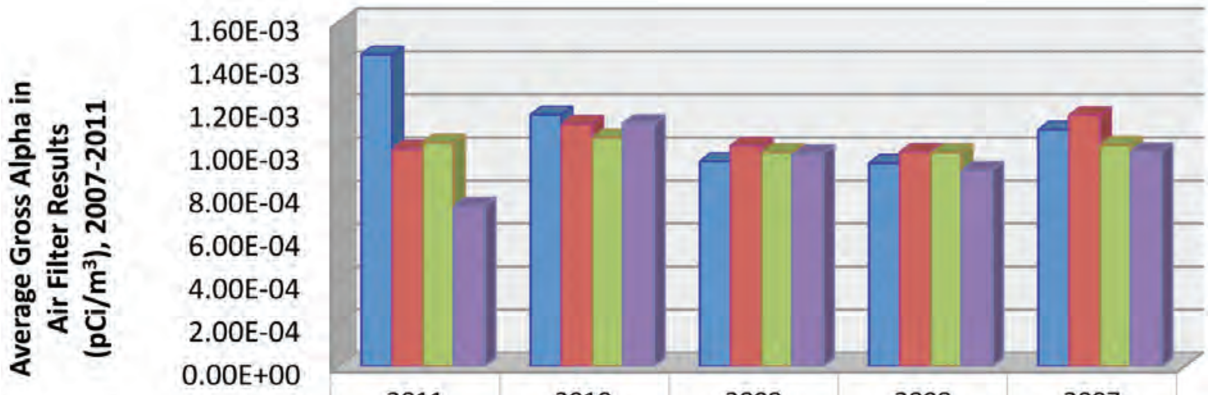
Surveillance Results Summary

For the biweekly analyses at the site perimeter in 2011, only tritium was routinely detectable, greater than the MDC.

During March and April 2011, the Fukishima nuclear incident in Japan following the earthquake and tsunami led to airborne contamination released to the environment. The SRS surveillance program was impacted by this event in that detectable levels of contamination were measured during the routine surveillance. The details will be discussed in Post Fukishima Event Sampling section of Chapter 9.

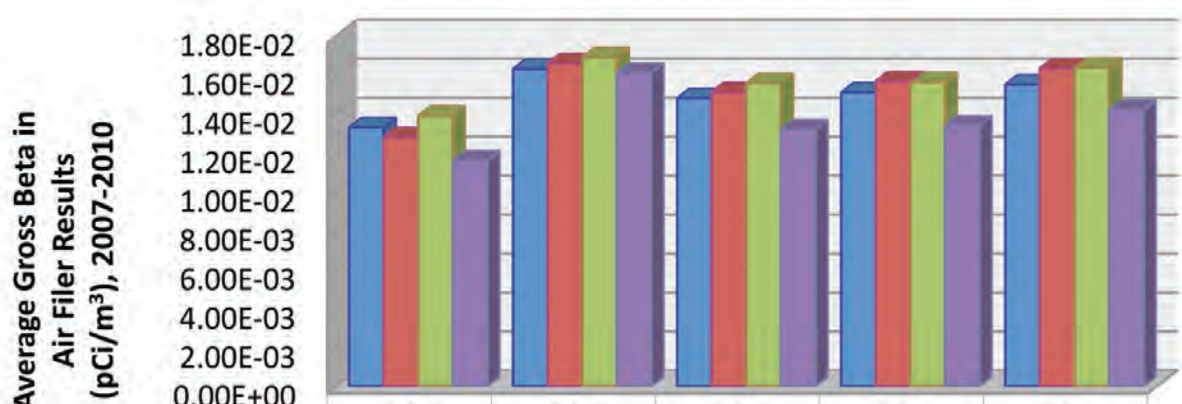
With the exception of the post-Fukishima incident monitoring results, onsite and offsite radionuclide concentrations were similar to levels observed in previous years (see expanded discussion in paragraphs that follow).

Glass-Fiber Airborne Particulates Results—(data table 5-1) Average gross alpha results for 2011 compared to 2010 were generally higher at the onsite Burial Ground North (BGN) location and were generally lower at the site perimeter and beyond the site (figure 5-1). Average gross beta results were generally lower than those of 2010 for all locations (figure 5-2). Gross alpha and beta results were consistent with historical results in demonstrating long-term variability.



	2011	2010	2009	2008	2007
Onsite	1.45E-03	1.17E-03	9.53E-04	9.45E-04	1.10E-03
Perimeter	1.01E-03	1.13E-03	1.03E-03	9.96E-04	1.17E-03
25-mile	1.04E-03	1.06E-03	9.95E-04	9.94E-04	1.03E-03
100-mile	7.46E-04	1.13E-03	9.89E-04	9.12E-04	9.99E-04

Figure 5–1 Five Year Trendchart of Average Gross Alpha in Air Filter Results (pCi/m^3), 2007-2011



	2011	2010	2009	2008	2007
Onsite	1.33E-02	1.63E-02	1.48E-02	1.51E-02	1.55E-02
Perimeter	1.28E-02	1.66E-02	1.51E-02	1.57E-02	1.63E-02
25-mile	1.39E-02	1.69E-02	1.56E-02	1.56E-02	1.64E-02
100-mile	1.16E-02	1.61E-02	1.32E-02	1.34E-02	1.42E-02

Figure 5–2 Five Year Trendchart of Average Gross Beta in Air Filter Results (pCi/m^3), 2007-2011

External Configuration of Air Surveillance Sampling Station

Field Sampling Technician Changes Air Filter Media

As part of SRS routine operations, cesium-137 is released into the atmosphere at quantities well below the Derived Concentration Guide (DCG). One out of 402 filter samples for 2011 contained detectable amounts of the man-made gamma-emitting radionuclide cesium-137, consistent with the historical results.

During 2011, detectable levels of uranium-234 were observed in 14 of 24 air samples, and detectable levels of uranium-238 were observed in 16 of 24 air samples; however, no detectable levels of uranium-235 were observed in any of the 2011 samples. These results are similar to those observed in 2010 and previous years. Uranium is naturally occurring in soil, and therefore expected to be present in low concentrations on some particulate filters. Aside from uranium, the only alpha-emitting radionuclide observed was americium-241 in three of 24 air samples. Generally, these concentrations were consistent with historical results. All other alpha-emitting isotopes were below detection levels.

Charcoal Canister Results—(data table 5-2) Due to the Fukishima nuclear incident in early 2011, additional charcoal samples were taken during March and April 2011. Of the gamma-emitting radionuclides, cesium-137 was detectable in two of 138 samples during 2011. Radioiodine-129 was detected in 21 of 138 charcoal samples and iodine-131 in 29 of 138 samples. These were all around the post Fukishima timeframe and were consistent with other published results around the United States. More details will be provided in Chapter 9.

Silica Gel Tritium-In-Air Results—(data table 5-3) Tritium-in-air results for 2011 were greater than those observed in 2010 but were consistent with the long-term variability of historical results (table 5-1). Tritium-in-air results showed detectable levels in 149 (38%) of the 388 silica gel samples for 2011. As in previous years, the Burial Ground North (BGN) location showed average and maximum concentrations significantly higher than those observed at other locations. BGN concentrations are expected to be higher and more variable because of the location's proximity to both the Tritium Facilities and to the phytoremediation project near the center of the SRS; the concentrations are influenced by operations at these facilities. All (100 percent) of the silica gel samples from the center of the site contained detectable levels of tritium. Beyond the center of the SRS, tritium-in-air was detected in 34-percent of the samples. As expected, tritium concentrations generally decreased with increasing distance from the Tritium Facilities (figure 5-3 and table 5-1).

Table 5-1 2011 Average Tritium-in-Air Results (pCi/m3), 2007 – 2011

Location	2011	2010	2009	2008	2007
Burial Ground North	190 (+/-1.42)	170	233	200	243
Green Pond	7.49(+/-0.673)	6.49	7.90	11.5	4.78
Talatha Gate	9.93 (+/-0.682)	8.15	8.71	13.3	8.64
East Talatha	8.09 (+/-0.683)	6.61	5.36	10.2	6.92
Darkhorse	8.63 (+/-0.701)	6.91	6.30	27.2	6.94
Highway 21/167	7.47 (+/-0.705)	8.48	7.03	13.2	5.43
Barnwell Gate	6.30 (+/-0.671)	7.11	9.04	16.4	4.93
PMR	4.81 (+/-0.694)	5.09	5.97	8.43	3.82
Allendale Gate	4.86 (+/-0.666)	4.93	5.26	7.45	2.79
D-Area	12.6 (+/-0.739)	7.91	15.3	14.7	9.44
Jackson	9.01 (+/-0.749)	7.59	6.88	8.26	6.92
Augusta	5.27 (+/-0.707)	2.03	3.83	14.1	2.60
Aiken Airport	7.71 (+/-0.800)	3.77	6.60	8.44	3.57
Highway 301	5.28 (+/-0.735)	2.99	3.29	5.18	2.54
Savannah, GA	3.86 (+/-0.703)	2.86	3.34	5.24	2.51

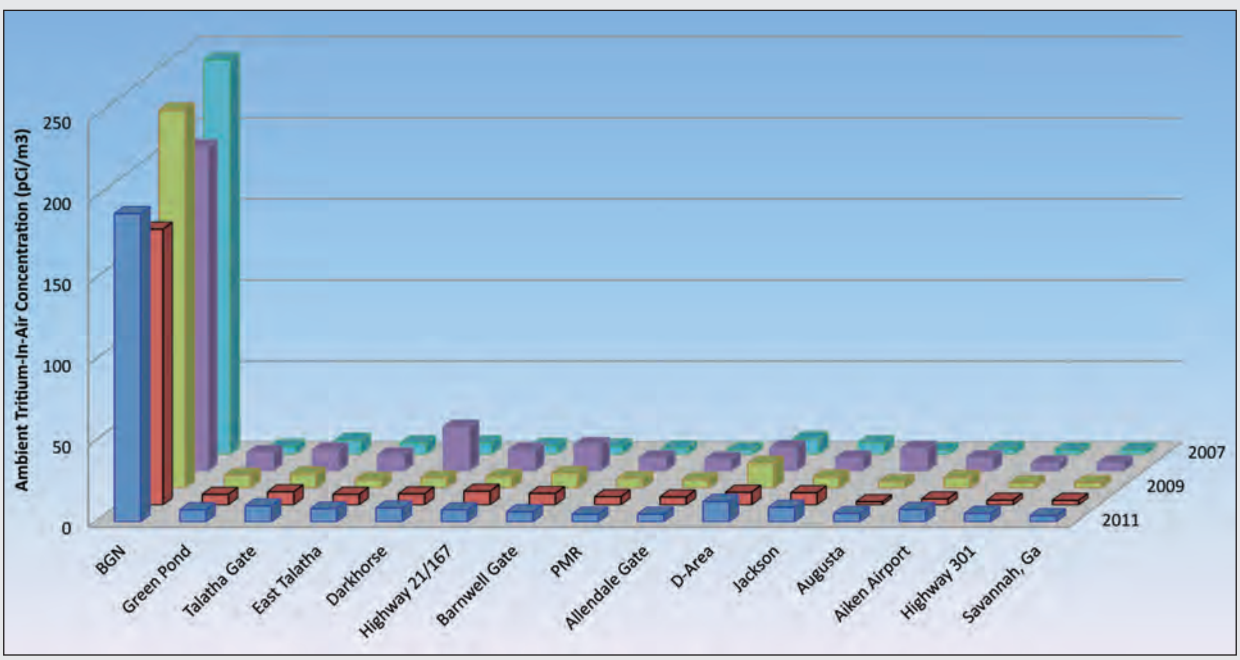


Figure 5-3 Ambient/Atmospheric Tritium-In-Air Concentrations (pCi/m^3), 2007 - 2011

- The tritium-in-air results are well below the concentration equivalent to 1 mrem from inhalation. The NESHAPS limit for airborne pathway is 10 mrem.

Rainwater

Description of Surveillance Program

The atmospheric surveillance program also includes rainwater surveillance, divided into two parts, sampling for tritium in rainwater and sampling for nontritium radionuclides in wet/dry deposition. Rainwater sampling is performed at all 15 locations, while seven of these locations are sampled for wet/dry deposition. The placement of locations for deposition was selected to provide a uniform distribution around the SRS.

Surveillance Results Summary

Other than iodine-131, no other detectable man-made gamma-emitting radionuclides were observed in rainwater samples during 2011 (data table 5-4).

Gross alpha and gross beta results from 2011 were consistent with those of 2010. In 2011, the average gross alpha and gross beta results generally were slightly lower than in 2010. Annual average gross alpha and gross beta concentrations, as well as individual sample results, are consistent with historical results, which demonstrate long-term variability.

Detectable levels of uranium-234 were present in 20 of 99 samples. Detectable levels of uranium-238 were present in 22 of 99 samples. No detectable levels of uranium-235 were in any of the 99 samples. Uranium is naturally occurring in soil and is therefore expected to be present at low concentrations in some deposition samples. Both uranium-234 and uranium-238 results were higher at the D-Area perimeter location than at the other site perimeter locations; they also were higher at the BGN (onsite) location. This is likely attributable to the increased airborne particulate matter (dust) present at these locations because of vehicle traffic on nearby dirt roads and fields. Neither plutonium-238 nor plutonium-239 was observed in any of the 99 samples. Americium-241 was observed in 13 samples (three from the BGN location and 10 at the site perimeter). The average concentration of americium-241 was well below the drinking water standard. Eight strontium-89,90 results were above the MDC (seven at the center of the SRS and one at the D-Area perimeter location). The strontium concentration levels were below regulatory limits.

Tritium in rainwater results showed detectable levels in 31 (16 percent) of the 195 rainwater samples for 2011 (data table 5-5). As in previous years, tritium-in-rain values were highest near the center of the SRS. All rainwater samples from the center of the site contained detectable tritium. This is consistent with the H-Area effluent release points that routinely release tritium. Beyond the center of the site, tritium was detected in 9.89 percent of the rainwater samples. As with tritium-in-air (figure 5-3), concentrations generally decreased as distance from the effluent release points increased.

Gamma Radiation

Description of Surveillance Program

Ambient gamma exposure rates in and around SRS are monitored by an extensive network of dosimeters. SRS uses the thermoluminescent dosimeter (TLD) to quantify integrated gamma exposure on a quarterly basis. The TLD performs this function accurately, reliably, and relatively inexpensively.

SRS has been monitoring ambient environmental gamma exposure rates with TLDs since 1965. The information provided by this program is used primarily to determine the impact (if any) of site operations on the gamma exposure in the environment and to evaluate trends in environmental exposure levels. Other potential uses include support of routine and emergency response dose calculation models.

The SRS ambient gamma radiation monitoring program is divided into four subprograms: site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor potential exposures from Georgia Power's VEGP). All TLDs are exchanged quarterly. Most gamma exposure monitoring is conducted onsite and at the SRS perimeter. Monitoring continues to be conducted in population centers within nearly 15 kilometer (km) (9 mile (mi)) of the site boundary, but only limited monitoring is conducted beyond this distance and at the 40- to 160-km (25- to 100-mi) air surveillance stations.

Surveillance Results Summary

Ambient gamma exposure rates 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 radiation exposure levels. In 2011, ambient gamma exposure rates varied between 56.5 and 125 millirem (mrem)/year (yr) (data table 5-6).

In general, the 2011 ambient gamma radiation monitoring results indicated dose rates very close to those observed at the same locations in 2010. The average annual exposure rate was 82.5 mrem in 2011, compared to 82 mrem in 2010. The total ambient exposure results for the BGN (onsite) location was lower for 2011 (125 mrem/yr) than for 2010 (129 mrem/yr). However, these results generally are consistent

Thermoluminescent Dosimeters Placed in the Field for Ambient Gamma Exposure Monitoring

with previously published historical results and indicate that no significant difference in average annual dose rates is observed between monitoring networks except in the case of population centers. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks, as expected, because of factors such as buildings and roadways, which emit low levels of radiation.

Stormwater Basins

Description of Surveillance Program

Stormwater accumulating in site stormwater basins is monitored monthly for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides.

Analyses for specific radionuclides are determined by the makeup of the previous releases to the basins.

In 2011, monitoring was conducted at five E-Area basins as well as at the Z-Area Basin and F-Area Pond 400.

Surveillance Results Summary

No active discharges to SRS stormwater basins are present. The primary contributor is rainwater runoff. Cesium-137 and gross beta concentration levels in the Z-Area Basin were measured during 2011 and are attributed to storm water runoff from near Saltstone Disposal Facility (SDF) Vault 4 operations. Cesium-137 was greater than the MDC level in 11 of the 12 Z-Area Basin samples during 2011 at an average of 220 (+/-3.57) pCi/L and a maximum of 803 (+/-27.3) pCi/L. These levels are higher than those of 2010 and the historical trend, but below the USDOE DCG of 3,000 pCi/L for cesium-137. The Z-Area basin does not discharge to the environment. SDF management has implemented steps (i.e., installation of weather enclosures, enhanced facility operations, and installation of storm water management controls) for radioactive contamination control. SDF operations and radiological areas are maintained in accordance with SRS radiological practices. SCDHEC performs routine inspections of the SDF. The highest mean tritium concentration in all the basin samples was measured in the E-005 Basin, at 17,400 (+/-124) pCi/L, which was 33% lower than the mean tritium concentration at the same location in 2010. This is consistent with the previous five years of historical results. Cobalt-60 was less than the MDC in all of the basin samples. Other than the Z-Area Basin, cesium-137 was not greater than the MDC in any of the other basin samples. Curium-244 was detected in one basin sample from the Basin North (E-002) but was well within the historical trend for this location. Technetium-99 was detected in 11 of the 12 samples from Z-Area Basin at an average level of 10.0 (+/-0.349) pCi/L, and 10 of the other basin locations, averaging 1.15 pCi/L. Fission products, as well as some actinides, were observed in the basins measuring a mean average of less than 1.00 pCi/L. Gross alpha and gross beta activity were detected in all the basins, and, other than the Z-Area Basin, the concentrations were comparable to those of the previous five years to identify any trends (data table 5-7).

Streams

Description of Surveillance Program

Continuous surveillance monitoring of SRS streams is performed downstream of several process areas to detect and quantify levels of radioactivity in effluents transported to the Savannah River. The five primary streams are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. The frequency and types of analyses performed on each sample are based on potential quantity and types of radionuclides likely to be present at the sampling location.

Surveillance Results Summary

The average 2011 concentrations of gross alpha, gross beta, and tritium in SRS streams are presented in table 5-2. Detectable concentrations of tritium, the predominant radionuclide detected above background

SRS and SCDHEC
Side-by-Side Automated Samplers

Liquid Surveillance
Stream Sampling Location Fourmile-A7

levels in SRS streams, were observed at least once at all stream locations in 2011. When comparing stream tritium averages for 2011 and 2010, some were slightly higher and others were slightly lower; however, no statistically significant differences occurred between the averages of the two years. The ten-year trend chart for the average tritium levels in the streams shows a decreasing trend over time (figures 5-4 and 5-5), which is due to a combination of decreases in site releases and the natural decay of tritium over time. Overall, tritium concentrations in SRS streams during 2011 were consistent with long-term tritium levels.

Cesium-137 was detected in 16 of 272 stream samples (less than 6%) for 2011 from the Upper Three Runs, Fourmile Branch, and Lower Three Runs locations. Gross alpha and gross beta activity was detected in all the streams, but overall average concentrations were

Table 5-2 Average 2011 Concentrations of Radioactivity in SRS Streams

Location	Gross Alpha *(pCi/L)*	Standard Deviation	Gross Beta *(pCi/L)*	Standard Deviation	Tritium *(pCi/L)*	Standard Deviation
Onsite Downstream Locations						
Tims Branch (TB–5)	10.7	0.304	3.50	0.171	409	50.0
Lower Three Runs (L3R–3)	5.61	0.349	3.07	0.231	781	51.1
Steel Creek (SC–4)	3.72	0.196	3.37	0.138	2,900	62.3
Pen Branch (PB–3)	1.57	0.169	1.85	0.182	3,080	160
Fourmile Branch (FM–6)	3.19	0.135	10.4	0.188	3,950	180
Upper Three Runs (U3R–4)	35.8	0.773	12.5	0.420	937	53.7
Onsite Control Location (for comparison purposes)						
Upper Three Runs (U3R–1A)	6.26	0.213	2.20	0.155	261	29.6

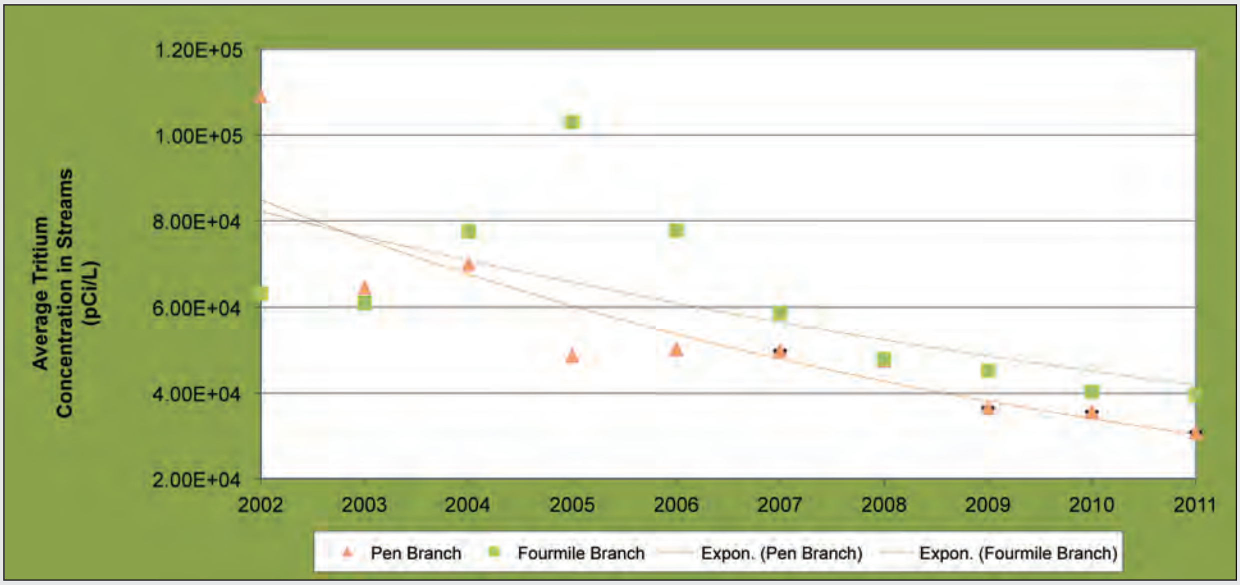
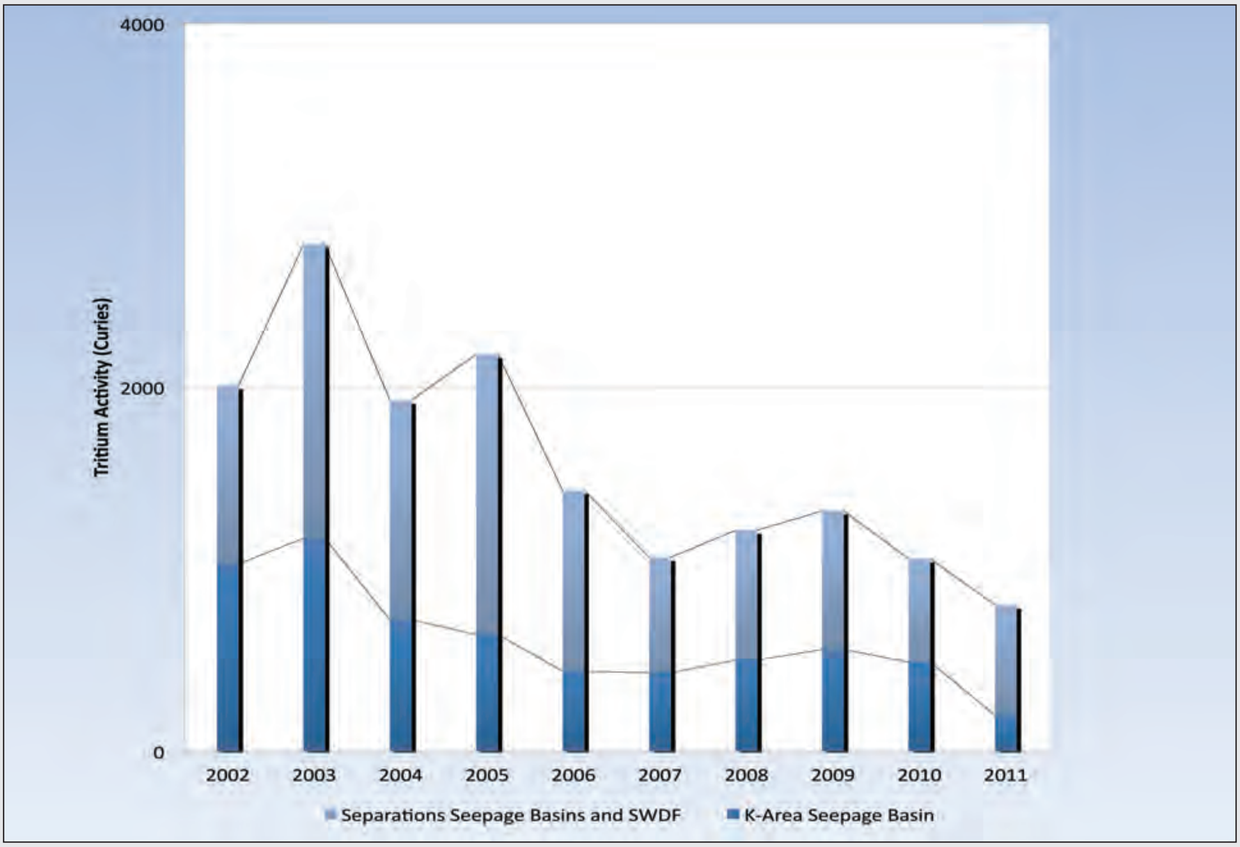


Figure 5-4 Ten-Year Trend of Average Tritium Concentration in Lower Three Runs, Steel Creek, and Upper Three Runs (pCi/L)

Figure 5-5 Ten-Year Trend of Average Tritium Concentration in Pen Branch and Fourmile Branch (pCi/L)

consistent with levels of recent years. Gross alpha levels were higher for the Lower Three Runs-2 and Upper Three Runs-4 locations during the late summer of 2011 due to sedimentation in the samples. The samples were reanalyzed several times to filter out the sedimentation. Isotopic analyses revealed the source to be natural uranium. The levels were accounted for in the radioactivity transport calculations. Strontium-89,90 was detected in all samples from the Fourmile Branch location with an average of 3.74 (+/-0.143) pCi/L, below the Minimum Control Level of 8.00 pCi/L. Other radionuclides were observed at locations throughout the SRS but were consistent with the source of the material and exhibited variations similar to those of previous



Year	K-Area Seepage Basin Curies	Separations Seepage Basins and SWDF Curies	Total Curies
2002	1030	977	2007
2003	1170	1613	2783
2004	722	1205	1927
2005	641	1539	2180
2006	439	993	1432
2007	431	635	1066
2008	500	715	1215
2009	559	762	1321
2010	489	569	1058
2011	197	606	803

Figure 5-6 Estimated Tritium Migration from SRS Seepage Basins and SWDF to Site Streams, 2002-2011

years. No significant trends were observed in 2011 when compared with recent years (data table 5-8), and, in most cases, averages were less than one pCi/L.

Seepage Basin and Solid Waste Disposal Facility Radionuclide Migration

Description of Surveillance Program

To incorporate the migration of radioactivity to site streams into total radioactive release quantities, SRS personnel continued to monitor and quantify the migration of radioactivity from SRS seepage basins and the SWDF in 2011 as part of its stream surveillance program.

Surveillance Results Summary

Tritium, strontium-89,90, technetium-99, iodine-129, and cesium-137 were detected in migration releases (data table 5-9).

Figure 5-6 is a graphical representation of releases of tritium via migration to site streams for 2011. As seen in the figure, migration releases of tritium generally have declined the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall. Accordingly, during 2011, the total quantity of tritium migrating from SRS seepage basins and SWDF was 803 Ci compared to 1,058 Ci in 2010, a 24% decrease.

Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF continues to migrate through the groundwater and to outcrop into Fourmile Branch and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch among locations FM-3A, FM-2B, and FM-A7. Because of their proximity, migration from the SWDF cannot be distinguished from migration from a part of H-Area Basin 4. Estimated migration of tritium into Fourmile Branch in 2011 occurred as follows:

- From F-Area Seepage Basins, 13 Ci, a 62% decrease from the 2010 total of 34 Ci
- From SWDF and a part of H-Area Seepage Basin 4, 457 Ci, a 20% increase from the 2010 total of 381 Ci
- From H-Area Seepage Basins 1, 2, 3, and most of 4, 68 Ci, a 20% decrease from the 2010 total of 85 Ci

The estimated tritium migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2011 was 68.3 Ci, compared with the 2010 total of 69 Ci, a fluctuation consistent with historical results. (The GSA is in the central part of SRS and contains all waste disposal facilities, chemical separations facilities, and associated high-level waste storage facilities along with numerous other sources of radioactive material.)

The total amount of strontium-89,90 entering Fourmile Branch from the GSA seepage basins and SWDF during 2011 was estimated to be 15.2 mCi (table 5-3). Migration releases of strontium-89,90 vary from year to year but have remained below 100 mCi the past nine years. In 2011, 10.6 mCi of technetium-99, 14.8 mCi of iodine-129, and 19.5 mCi of cesium-137 were estimated to have migrated into Fourmile Branch (table 5-3).

Table 5-3 Strontium-89,90, Technetium-99, Iodine-129, and Cesium-137 Migration Estimates

Radionuclide	Total Activity (millicuries [mCi])
Strontium-89,90	15.2
Technetium-99	10.6
Iodine-129	14.8
Cesium-137	19.5

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 annually in Pen Branch. The 2011 estimated migration total of 197 Ci represents a 60% decrease from the 489 Ci recorded in 2010.

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 are accounted for in the stream transport totals (see "Tritium Transport in Streams" section of this chapter).

Migration of Actinides in Streams

Migration of the actinides (uranium, plutonium, americium, and curium) into site streams no longer is quantified because of the historically low levels of these actinides. However, the streams are sampled and analyzed annually for the presence of these actinides. The resulting concentrations are compared to those of previous years to identify any trends. Overall, values for 2011 were consistent with historical data and generally remained at or below the analytical MDC.

The Savannah River

Description of Surveillance Program

Continuous surveillance is performed along the Savannah River at locations above and below SRS tributaries, including a location at which liquid discharges from VEGP enter the river.

Surveillance Results Summary

Five locations along the river continued to serve as environmental surveillance points in 2011. Composite samples are collected weekly at these five river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides (data table 5-10). The average 2011 concentrations of gross alpha, gross beta, and tritium at river locations are presented in table 5-4. The tritium concentration levels are well below the USEPA drinking water standard of 20,000 pCi/L. Detectable levels of gross alpha and gross beta activity were observed at all river sampling locations and were consistent with the averages of the previous five years. Cesium-137 was detected in one out of the 265 weekly composite river samples for 2011.

Based on curies (of activity) released, tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium estimates based on concentration results and average flowrates at Savannah River Mile (RM) 118.8 were 2,090 Ci in 2011 compared to 2,058 Ci in 2010, well within the statistical overlap. In addition to the weekly composite samples referenced above, SRS collects annual grab samples to provide a more comprehensive suite of radionuclides (strontium-89,90, technetium-99 and actinides). Uranium-234, uranium-238 and americium-241 were quantified in all these grab samples from RM 118.8 and several other locations in 2011. Results were consistent with the averages of the previous five years.

River Surveillance Sample Collection from Automated Samper at River Mile 160

Table 5–4 Average 2011 Concentrations of Radioactivity in the Savannah River

Location	Gross Alpha *(pCi/L)*	Standard Deviation	Gross Beta *(pCi/L)*	Standard Deviation	Tritium *(pCi/L)*	Standard Deviation
RM–160	0.346	0.046	2.57	0.094	164	7.13
RM–150.4	0.556	0.056	2.66	0.096	1,480	8.79
RM–150	0.317	0.045	2.53	0.094	402	7.46
RM–141.5	0.487	0.052	2.32	0.092	621	7.78
RM–118.8	0.431	0.050	2.37	0.093	599	7.75

Tritium Transport in Streams

Description of Surveillance Program

Tritium is introduced into SRS streams and the Savannah River from former production areas onsite. Because of the mobility of tritium in water and the quantities of the radionuclide released during the years of SRS operations, a tritium balance comparison at various site stream and Savannah River monitoring locations has been performed annually since 1960. SRS tritium transport data for 1960-2011 are depicted in figure 5-7, which shows the history of direct releases, stream transport, and river transport, as determined by SRS personnel. The history of tritium transport at SRS is documented in data table 5-11. The ten-year trend analysis shows a decreasing trend for the past ten years (figure 5-8). The tritium balance is compared among the following alternative methods of calculation:

- Total direct tritium releases, including releases from (1) facility effluent discharges and (2) measured shallow groundwater migration of tritium from SRS seepage basins and SWDF (direct releases)
- Tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River (stream transport)
- Tritium transport in the Savannah River, measured downriver of SRS (near RM 118.8) after subtraction of any measured contribution above the SRS (river transport)

The general trend over time is attributable to (1) variations in tritium production and processing at the SRS; (2) the implementation of effluent controls, such as seepage basins, beginning in the early 1960s; and (3) the continuing depletion and decay of the SRS's tritium inventory.

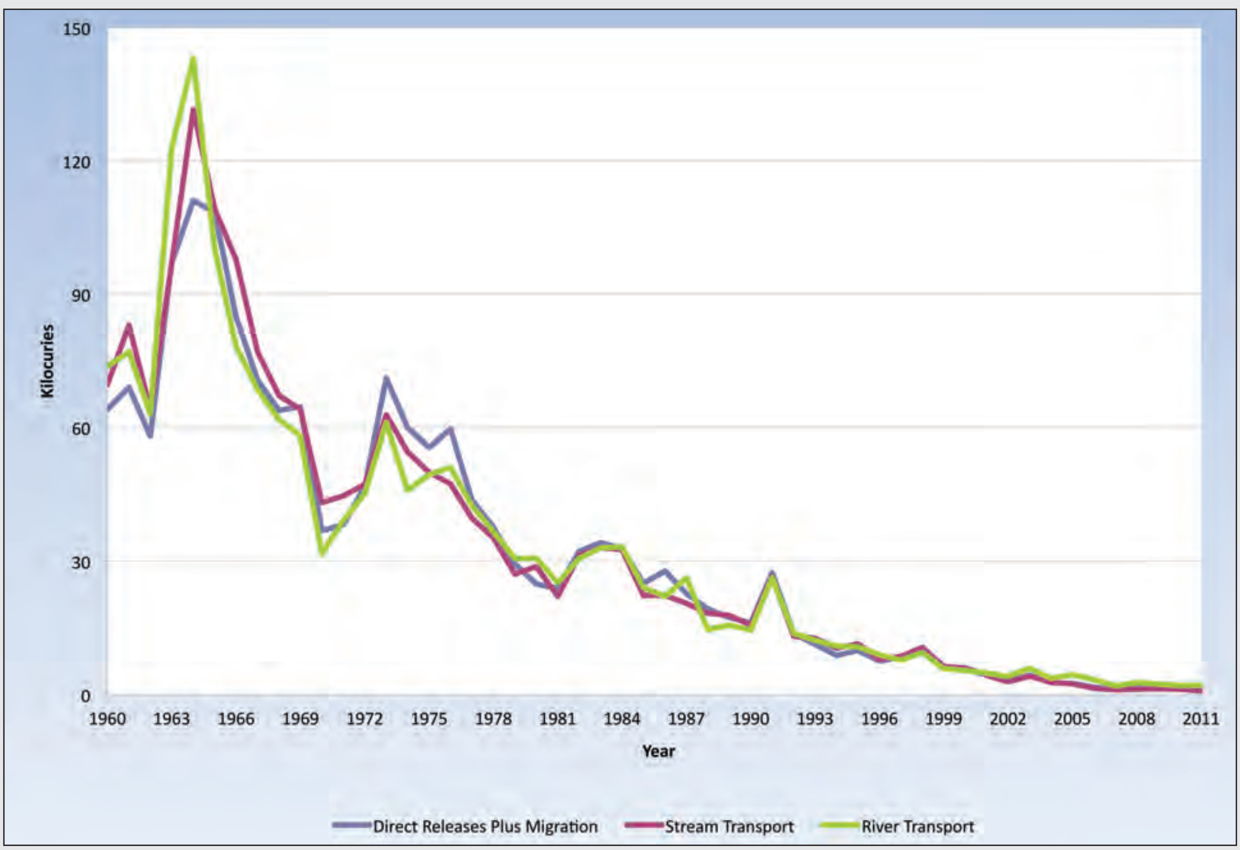


Figure 5-7 SRS Tritium Transport Summary, 1960–2011

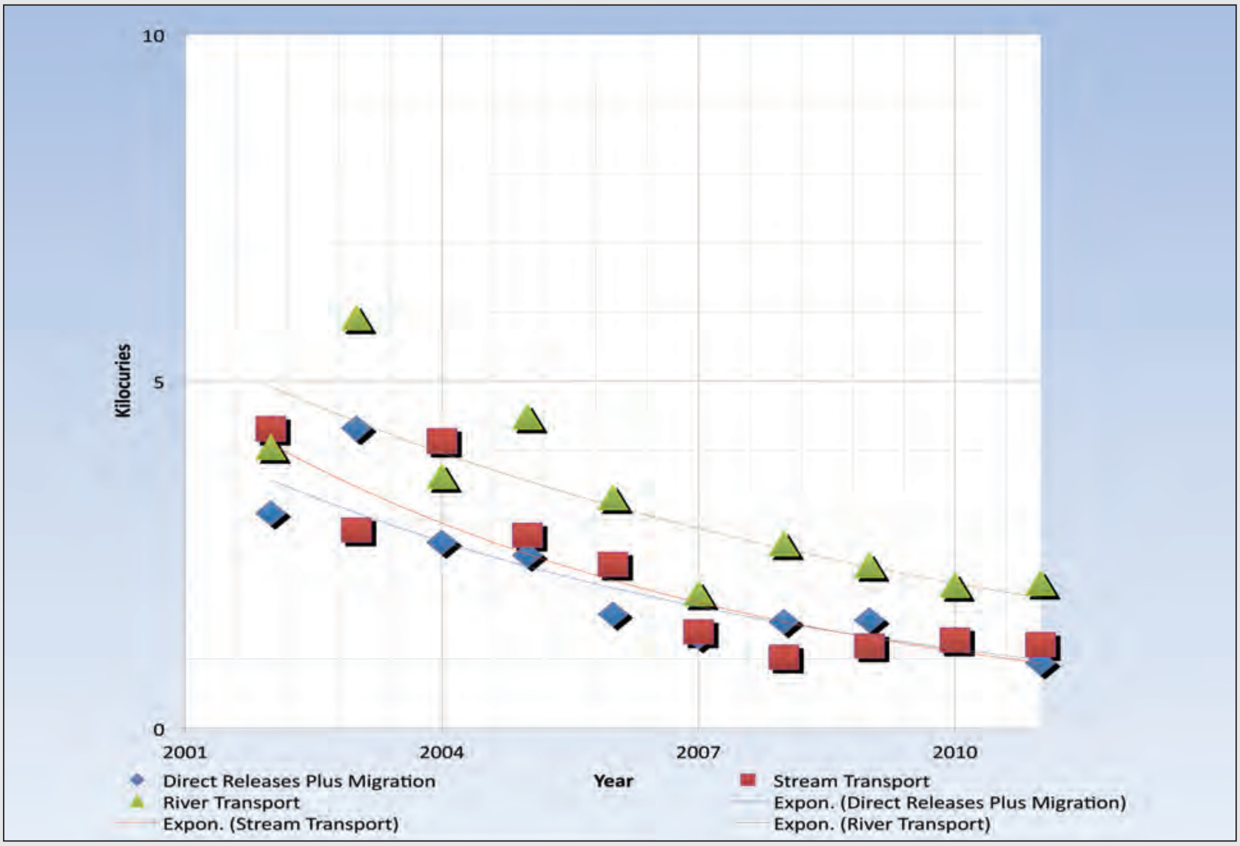


Figure 5-8 Ten-Year Trend of SRS Tritium Transport, 2002-2011

Surveillance Results Summary

The *direct releases* of tritium in 2011 decreased by almost 27% (from 1,285 Ci in 2010 to 942 Ci in 2011).

The *stream transport* of tritium in 2011 decreased by almost 36% (from 1,205 Ci in 2010 to 776 Ci in 2011).

The *river transport* of tritium estimated in the Savannah River in 2011 was 2,090 Ci, compared with 2,058 Ci from the previous year. Both VEGP and SRS contributed to these values. For the 2011 dose calculations, the highest value between the SRS *direct releases* and *stream transport* measurements (which was 942 Ci) is added to the VEGP reported tritium release total of 1,370 Ci to obtain an overall tritium total of 2,312 Ci (see chapter 6).

A small but measurable amount of tritium from earlier EnergySolutions LLC low level waste (LLW) radioactive waste disposal facility operations continued entering the stream system in 2011 as in the past few years. The facility is privately owned and adjacent to SRS. The amount of tritium entering the system is expected to continue a gradual decline over time. EnergySolutions LLC began a program of capping the tritium sources in 1991, thereby reducing the amount of tritium entering the groundwater. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. Environmental Monitoring and EnergySolutions LLC will maintain a monitoring program for Lower Three Runs to evaluate this tritium migration.

Domestic Water

Description of Surveillance Program

SRS personnel collected domestic water samples in 2011 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 USEPA 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. Composite samples were collected monthly off site from

- The Beaufort-Jasper Water and Sewer Authority's Chelsea and Purrysburg Water Treatment Plants
- The city of Savannah Industrial and Domestic Water Supply Plant
- The North Augusta (South Carolina) Water Treatment Plant

Surveillance Results Summary

All onsite and offsite domestic water samples in 2011 were screened for gross alpha and gross beta concentrations to determine if regulatory limits were exceeded. No domestic water exceeded USEPA's 15 picocuries per liter (pCi/L) alpha activity limit or 50 pCi/L beta activity limit. Also, no onsite or offsite domestic water samples exceeded the 20,000 pCi/L USEPA tritium limit or the 8 pCi/L strontium-89,90 MDC.

No cesium-137, strontium-89,90, uranium-235, plutonium-238, plutonium-239, or curium-244 was detected in any domestic water samples in 2011. For the 14 onsite samples, detectable levels greater than the MDC were observed for americium-241 in one sample, uranium-234 in four samples, and uranium-238 in four samples (data table 5-12). The levels were well below the USDOE DCG.

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). The purpose of the foodstuff monitoring program is to determine whether SRS operations are affecting human health through the food chain. Agricultural products, livestock and game animals for human consumption may contain radionuclides. SRS samples foods including milk, meat, fruit, nuts, and green vegetables because of the potential to transport radionuclides to people via the food change. 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 validate dose models and determine environmental trends.

Samples of food, including meat, fruit, and a green vegetable, are collected from one location within each of four SRS quadrants and from a location within an extended (to 25 miles beyond the perimeter) southeast quadrant. All food samples are collected annually except milk, which is collected quarterly from four dairies within a 25-mile radius of the SRS. In general, as part of the foodstuffs surveillance, sampling of meat, fruit, and green vegetables is conducted on a three-year rotating schedule. Beef, collards, peanuts, pecans, and watermelon were sampled in 2011 as part of this program. Additionally, strawberries were collected and analyzed to evaluate elevated iodine-131 levels associated with the Fukushima Daichii Plant nuclear incident in Japan (Chapter 9). Food samples typically are analyzed for the presence of gamma-emitting radionuclides, tritium, strontium-89,90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, americium-241, curium-244, gross alpha activity, and gross beta activity. Technetium-99 was added to the analytical suite in 2009 and neptunium in 2010.

Surveillance Results Summary

Terrestrial food product results for collards, peanuts, pecans, fruit, and beef appear in data table 5-13; results for milk appear in data table 5-14.

Tritium in food products is attributed primarily to releases from SRS. Tritium in peanuts was not analyzed due to inadequate moisture content. Tritium was detected during 2011 as follows:

- Fruit at all four quadrants (0-10 miles from the SRS) at a maximum of 9.70E-02 (+/-2.25E-02) pCi/g
- Beef at the northeast and southeast quadrants (0-10 miles from the SRS) at a maximum of 1.42E-01 (+/-3.93E-02) pCi/g
- Pecans at the southwest quadrant (0-10 miles from the SRS) at a concentration of 6.24E-02 (+/-2.18E-02) pCi/g
- Milk in 5 out of 24 dairy samples at a maximum concentration of 4.38E+02 (+/-8.38E+01) pCi/L

The detectable levels of tritium in milk were confirmed with reprocessing of the samples.

The only gamma-emitting radionuclide detected in food products in 2011 was cesium-137 as follows:

- Collards from the northeast and southeast quadrants (0-10 miles from the SRS) at a maximum of 4.32E-02 (+/-1.21E-02) pCi/g
- Peanuts from the northwest and southeast quadrants (0-10 miles from the SRS) at a maximum of 1.10E-02 (+/-3.01E-03) pCi/g

- Pecans from the northeast quadrant (0-10 miles from the SRS) at a concentration of 1.34E-02 (+/- 3.81E-03) pCi/g
- One milk sample at concentration of 3.49E+00 (+/- 8.67E-01) pCi/L

Strontium-89,90 was detected in beef in the southwest quadrant (0-10 miles from the SRS) at 2.21E-03 (+/- 7.34E-04) pCi/g, in collards at all five locations at a maximum of 1.89E-01 (+/-2.55E-02) pCi/g, and in five milk samples out of 24 milk samples at a maximum of 2.27E+00 (+/-4.08E-01) pCi/L. Uranium-234 and uranium-238 were detected above the MDC for beef and collards at levels within the historical trend. Americium-241 was detected in collards at the northwest quadrant (0-10 miles from the SRS). Technetium-99 was detected in collards at all locations, in beef at the southeast and northwest quadrants 0-10 miles from the SRS, and in peanuts southeast and northeast quadrants 0-10 miles from the SRS. Detectable levels of gross beta activity were observed in all food products, while no detectable levels of gross alpha were observed in any of the food products. The 2011 results appeared to be randomly distributed among the monitoring locations, and no underlying spatial distribution was observed.

All radiological results on terrestrial food products were consistent with those of previous years.

Aquatic Food Products

Description of Surveillance Program

The aquatic food product surveillance program includes fish (freshwater and saltwater) and shellfish. SRS maintains an ongoing program for collecting and analyzing fish from the Savannah River and surrounding freshwater bodies. Various species of fish were also collected off site from streams and tributaries to determine the potential dose and risk to the public from consumption. Because of a die-off attributed to cold weather in December 2010 and January 2011, no spotted sea trout could be collected. Nine surveillance points for the collection of freshwater fish are on the Savannah River from above SRS at Augusta, Georgia, to the coast at Savannah. Composite samples composed of three to five fish of a given species are prepared for each species from each location. Freshwater fish are grouped into one of three categories: bass, panfish (bream), or catfish. Saltwater fish include composites of sea trout, red drum (spottail bass), and mullet. The fish are selected for sampling because they are the most sought-after fish in the Savannah River. Composites are divided into edible (meat and skin only) and nonedible (scales, head, fins, viscera, bone) portions; however, catfish are skinned,

Field Sampling Technicians Collect Fish at Steel Creek River Mouth

Striped Bass Collected at Steel Creek River Mouth

and the skin becomes part of the nonedible composite. Analyses conducted on edible and nonedible composites include tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, technetium-99, iodine-129, and the actinide series.

Surveillance Results Summary

Aquatic food product results for saltwater fish are in data table 5-15; for freshwater fish, data table 5-16; and for shellfish, data table 5-17.

Gross alpha results were below the MDC for all edible and nonedible fish composites of saltwater and freshwater fish. Gross beta activity was detectable in all edible saltwater and freshwater fish composites at maximum concentrations of 3.14 (+/-0.362) pCi/g and 5.27 (+/-0.451) pCi/g, respectively, and was also detected in some of the nonedible saltwater and freshwater fish composites at all locations. This is most likely attributed to the naturally occurring radionuclide potassium-40. Iodine-129 was greater than the MDC in one freshwater fish composite from West Bank Landing at 2.27E-02 (+/-8.11E-03) pCi/g and not detected (or less than the MDC) in saltwater and shellfish composites. Cesium-137 was detectable in 33% of the freshwater edible fish composites at a maximum of 1.40E-01 (+/-1.88E-02) pCi/g, and 17% of the freshwater nonedible fish composites at a maximum of 1.25E-01 (+/-2.34E-02) pCi/g. No man-made gamma-emitting radionuclides were found in Savannah River edible and nonedible fish composites during 2011.

Strontium-89,90 was greater than the MDC in 39% of the nonedible freshwater fish composites at a maximum of 9.65E-03 (+/-1.80E-03) pCi/g and 99% of the nonedible fish composites at a maximum of 4.38E-01 (+/-2.89E-02) pCi/g. Uranium-234, uranium-238, and tritium were detected in freshwater and saltwater fish composites at concentrations similar to those of previous years. For the edible and nonedible saltwater fish composites, technetium-99 was below the MDC. For the freshwater fish composites, 29% of the edible composites contained detectable levels of technetium-99 at a maximum of 1.05E-01 (+/-2.64E-02) pCi/g. No Plutonium-239 or plutonium-238 was detectable in any of the edible freshwater and saltwater fish composites. Uranium-234 and uranium-238 were detected in saltwater and freshwater fish at levels consistent with the historical trends.

Gross alpha and gross beta were detected in shellfish at an average concentration of 6.41E-01 (+/-2.31E-01) pCi/g and 1.17 (+/-0.267) pCi/g, respectively. These levels were within the historical statistical trends. Strontium-89,90, uranium-234, uranium-235, and uranium238 were detected in shellfish at levels similar to those of previous years. No detectable levels of iodine-129, plutonium-238, plutonium-239, americium-241, and curium-244 greater than the MDC were present in shellfish.

Calculations of risk from the consumption of fish from the Savannah River can be found in Chapter 6 ("Potential Radiation Doses").

Wildlife Monitoring of Deer, Hogs, and Coyote

Description of Surveillance Program

Annual game animal hunts, open to members of the general public, are conducted at SRS to control the SRS's deer and feral hog populations and to reduce animal-vehicle accidents. Prior to releasing any animal to a hunter, SRS personnel use portable sodium iodide detectors to perform field analyses for cesium-137. In 2011, Cs-137 concentrations in deer (muscle and bone) samples were periodically collected for laboratory analysis based on (1) a set frequency, (2) the cesium-137 levels, or (3) exposure limit considerations. Cesium-137 is chemically analogous to potassium in the environment and behaves similarly. It has a half-life of about 30 years and tends to persist in soil, and, if in soluble form, can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations from 1945 to 1980 and has been detected in all environmental media.

SRS established an administrative dose limit of 30 mrem per year in 2006 for the consumption of game animals. This limit, which ensures that no single pathway contributes more than 30 % to the all-pathway dose limit of 100 mrem, is consistent with USDOE guidance. The doses from deer and hog consumption are quantified and reported in Chapter 6.

Surveillance Results Summary

A total of 564 deer, 156 feral hogs, and 30 coyote were harvested and released during the 2011 SRS hunts. As observed during previous hunts, cesium-137 was the only man-made gamma-emitting radionuclide detected in animal flesh during laboratory analysis. Generally, cesium-137 concentrations measured by field detectors and laboratory methods were comparable. Field measurements for cesium-137 from all released animals ranged from the lowest default value of 1.00 pCi/g to 11.5 pCi/g while laboratory measurements ranged from below the MDC to 7.38 (+/-0.495) pCi/g. One hog was disposed of from hunt compartment number 48 with a cesium-137 concentration of 27.8 pCi/g, (equivalent to a dose of 19.4 mrem). This dose did not exceed the release limit of 30 mrem, but the hunter voluntarily decided to dispose of the animal onsite.

Laboratory measurement results are summarized in data tables 5-18 and 5-19 for deer tissue and bone, and in data tables 5-20 and 5-21 for hog tissue and bone. Results of field and laboratory measurements are summarized in table 5-5. The dose impacts to hunters are discussed in Chapter 6.

Table 5-5 2011 Cesium-137 Results for Laboratory and Field Measurements

2011	Number Animals	Field Gross Average Cs-137 *(pCi/g)*	Field Maximum Cs-137 *(pCi/g)*	Lab Average Cs-137 *(pCi/g)*	Standard Deviation
Deer	564	1.46	10.5	2.12	0.018
Hog	156	1.75	11.5*	2.22	0.011
Coyote	30	1.45	5.13	------	------

* One hog measured 27.8 pCi/g but was not released

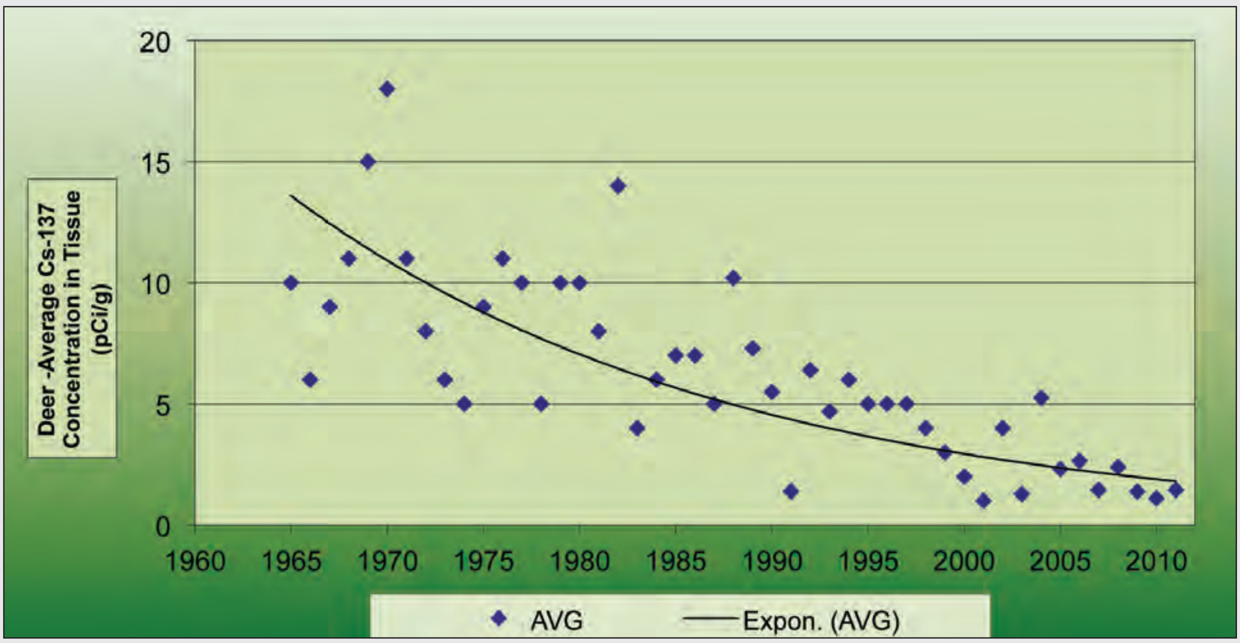


Figure 5-9 Historical Trend of Cesium-137 Concentrations in Deer (pCi/g), 1965-2011

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past ten years. The historical trend analysis is in figure 5-9.

The muscle and bone samples from a subset of the animals returned to the laboratory for cesium-137 analysis also are analyzed for strontium-89,90. Because of its chemistry, strontium is more readily measured in bone than in muscle tissue.

In 2011, all 69 deer bone samples had detectable levels of strontium-89,90 greater than the MDC with an average of 4.14 (+/-0.038) pCi/g and a maximum of 9.03 (+/-0.564) pCi/g. For the deer muscle tissue samples, 20 out of the 97 muscle tissue samples had detectable levels greater than the MDC for strontium-89,90 with a maximum of 8.08E-03 (+/-1.28E-03). Strontium-89,90 was also greater than the MDC in the two hog bone samples at a maximum of 3.89 (+/-0.282) pCi/g and below the MDC for the hog muscle tissue samples. These results are similar to those of previous years.

Turkeys

Description of Surveillance Programs

SRS hosted a special turkey hunt during April 2011 for hunters with mobility impairments. Twenty-eight turkeys were harvested and released.

Surveillance Results Summary

All field measurement results for the 28 turkey harvested had Cs-137 levels at or below the lowest default value of 1.00 pCi/g, which is comparable with the results from previous special hunts.

Beavers

Description of Surveillance Programs

The U.S. Department of Agriculture Forest Service-Savannah River (USFS-SR) harvests beavers in selected areas within the SRS perimeter to reduce the population and thereby minimize dam-building activities that can result in food damage to timber stands, to primary and secondary roads, and to railroad beds.

Surveillance Results Summary

USFS-SR harvested 20 beavers in 2011 from six locations. Because none of these animals were taken from suspect radiological areas, no monitoring was performed, and they were disposed of in an onsite landfill.

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

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. Therefore, a direct comparison of data from year to year is not appropriate. However, the data are available in previous environmental reports and can be evaluated over a period of years to determine and analyze long-term trends.

Hand augers or other similar devices are used in soil sample collection to a depth of three inches. The samples are analyzed for gamma-emitting radionuclides, strontium-89,90, and the actinides.

Surveillance Results Summary

In 2011, radionuclides were detected in soil samples from all 21 sampling locations (five onsite, 12 at the perimeter, and four offsite), as follows:

- Cesium-137 at all locations with the exception of one of the onsite locations near the burial ground
- Uranium-234 at all 21 locations
- Uranium-235 at all 21 locations
- Uranium-238 at all 21 locations
- Plutonium-238 at one location (F-Area location)
- Plutonium-239 at 15 locations (four onsite, nine perimeter, two offsite)
- Strontium-89,90 at two locations onsite
- Americium-241 at seven locations (two onsite, four perimeter, one offsite)
- Curium-244 at four locations (one onsite, three perimeter)

The concentrations at these locations are consistent with historical results (data table 5-22). Uranium is naturally occurring in soil and therefore expected to be present in soil samples.

Settleable Solids

Description of Surveillance Program

Settleable-solids monitoring in effluent water is required to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems.

USDOE 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.

Accurate measurement of radioactivity levels in settleable solids is impractical in small amounts of settleable solids with low Total Suspended Solids (TSS). TSS levels below 40 parts per million (ppm) comply with DOE limits. To determine compliance with these limits, SRS uses TSS results gathered as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near radiological effluent points.

Surveillance Results Summary

In 2011, there were no NPDES TSS sample results which exceeded 40 ppm. The 2011 NPDES 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 variations in sampling locations) but the data obtained can be used to observe long-term environmental trends.

Field Sampling Technician collects sediment at River Mile 151.

Sediment samples were collected at eight Savannah River and 21 onsite stream and basin locations during 2011.

Surveillance Results Summary

Cesium-137 was the only man-made gamma-emitting radionuclide observed in river and stream sediments during 2011. The highest cesium-137 concentration in streams, 64.1 (+/-2.60) pCi/g, was detected in sediment from R-Canal (100-R Location); the lowest levels were below the minimum detectable concentration level at eight locations. The highest level from the river, 9.89E-01 (+/-5.89E-02) pCi/g, was at RM 129; the lowest levels were below detection at three 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 SRS. Most radionuclides settle out and deposit on the stream beds or at stream entrances to swamp areas along the river. Strontium-89,90 was above the MDC in sediment at 12 stream locations in 2011. The maximum detected value was 6.14E-01 (+/-6.94E-02) pCi/g at the Fourmile A-7A (Beaver Pond) location.

Plutonium-238 was detected in sediment during 2011 at ten stream locations and two river locations. The results ranged from below the MDC to a maximum of 3.03 (+/-0.281) pCi/g at FM-2 at Road 4. Plutonium-239 was detected in sediment at 14 stream locations and one river location. The maximum value was 7.24E-01 (+/-7.35E-02) pCi/g at Pond 400. Uranium-234, uranium-235, and uranium-238 were detected at all locations at levels similar to previous years.

The distribution and concentration of radionuclides in river sediment during 2011 were similar to those of previous years (data table 5-23).

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 re-suspension 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 soil and sediment samples to determine the environmental accumulation of radionuclides and to help validate SRS dose models. Vegetation can be contaminated externally by the deposition of airborne radioactive contaminants and internally by uptake from soil or water by the roots. 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
- All air sampling locations

Vegetation samples are analyzed for tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and the actinides.

Surveillance Results Summary

All vegetation surveillance samples are based on dry weight. Radionuclides in the grassy vegetation samples collected during 2011 were detected in all 17 locations (one onsite, 12 at the perimeter, and four offsite), as follows:

- Tritium at six locations (one onsite, four perimeter, and one offsite)
- Cesium-137 at six locations (five perimeter and one offsite)
- Strontium-89,90 at 13 locations (one onsite, eight perimeter, four offsite)
- Uranium-234 at eight locations (one onsite, five perimeter and two offsite)
- Uranium-238 at eight locations (one onsite, five perimeter and two offsite)
- Technetium-99 at all 17 locations
- Gross beta at all 17 locations
- Gross alpha at three SRS perimeter locations

No levels were above the MDC for neptunium-237, plutonium-238, plutonium-239, americium-241, or uranium-235. Average tritium results show a 16% increase from 2010 to 2011 with levels ranging from below the MDC to 1.18 (+/-0.03) pCi/g at the BGN location. Results for the other radionuclides show a slight decrease in concentrations from the past several years but remain consistent with historical results (data table 5-24).

Nonradiological Surveillance

Air Quality

Description of Surveillance Program

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 SRS sources of criteria pollutants and toxic air pollutants in 2011.

Surveillance Results Summary

Air dispersion 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 SRS with current applicable regulations and standards. The states of South Carolina and Georgia continue to monitor ambient air quality near the SRS as part of a network associated with the Clean Air Act.

Mercury in Rainwater and Wet/Dry Deposition

Description of Surveillance Program

SRNL sponsors a monitoring and collection station in support of the National Mercury Deposition Network of the National Atmospheric Deposition Program (NADP). This network provides data on the geographic distributions and trends of mercury in precipitation. It is the only network providing a long-term record of mercury concentrations in North American precipitation. All monitoring sites follow standard procedures and have uniform precipitation collectors and gauges. In the fall of 2010 the mercury collector at the SRNL monitoring station (SC03) was upgraded to a modern precipitation collector that satisfies network collection requirements. In 2011, SRNL installed an electronic rain gage that completed equipment modernization of this station.

Surveillance Results Summary

During calendar year 2010 (the last year for which data is available) the average (volume weighted) concentration of total mercury in precipitation was 10.9 ng/L and the wet deposition rate was 6.5 µg/m^2. Data from 2011 will not be available until the fall of 2012. Additional information on this network is accessible via the following link: http://nadp.sws.uiuc.edu/mdn/.

Weekly Precipitation Sampling in Support of the National Atmospheric Deposition Program

Mercury Deposition Network

The NADP provides a long-term record of wet deposition of mercury from precipitation. SRNL sponsors and operates Station SC03 at SRS.

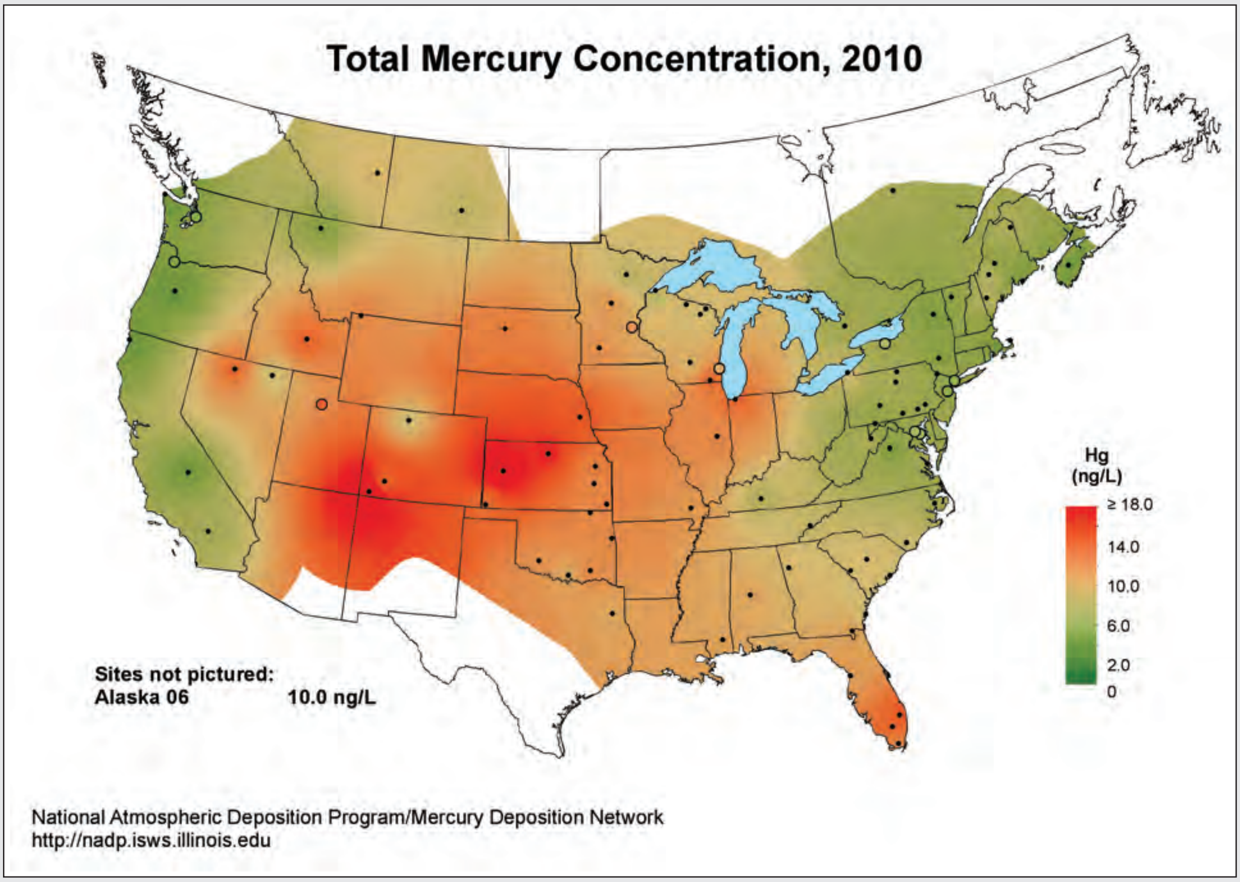


Figure 5-10 2010 Total Mercury in Rainfall Results from the National Atmospheric Deposition Program (NADP)

Surface Water

Description of Surveillance Program

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/propagation of a balanced indigenous aquatic community of fauna and flora
- Industrial and agricultural uses

Appendix A ("Applicable Guidelines, Standards, and Regulations") of this report provides some of the specific standards used in water quality surveillance, but, because not all the standards are quantifiable, they are not tracked at SRS.

Surveillance Results Summary

Water quality parameters were measured at all 16 sampling locations in SRS streams and along the Savannah River during 2011 and metals were detected in at least one sample at each location. With the exception of Endosulfan II detected at SC-4 during July 2011, no samples had detectable pesticides/herbicides. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river (data table 5-25).

Drinking Water

Description of Surveillance Program

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 SRS also has 14 small drinking water facilities, each of which serves populations of fewer than 25 persons.

Water Quality Parameters are Measured in Samples from the Savannah River (pictured)

Surveillance Results Summary

All samples collected from SRS drinking water systems during 2011 were in compliance with SCDHEC and USEPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of Chapter 3, "Environmental Compliance."

Sediment

Description of Surveillance Program

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

The nonradiological sediment program consists of the collection of sediment samples at eight onsite stream locations and three Savannah River locations. Collection is made by either a Ponar sediment sampler or an Emery pipe dredge sampler. The samples are analyzed for various inorganic contaminants (metals) and pesticides/herbicides by the Toxicity Characteristic Leaching Procedure (TCLP). This method analyzes for the soluble constituents in sediment. The program is designed to check for the existence and possible buildup of the inorganic contaminants as well as for pesticides/herbicides.

Surveillance Results Summary

In 2011, as in the previous five years, no pesticides or herbicides were above the quantitation limits in sediment samples. No mercury was detected at any of the locations during 2011 as in previous years. Metals analysis showed some metals with levels greater than the Practical Quantitation Limit for 2011 but were consistent with those seen in soil samples and comparable to those of the previous five years (data table 5-26).

Striped Bass Collected at Steel Creek River Mouth

Fish

Description of Surveillance Program

SRS personnel collected and analyzed the flesh of fish caught from the Savannah and Edisto Rivers to determine concentrations of mercury, arsenic, cadmium, manganese, and antimony in the fish.

Surveillance Results Summary

Mercury analyses were performed in 2011 on 468 fish at 11 locations including site streams, the Savannah River and the Edisto River at West Bank Landing. Concentrations of mercury generally were slightly lower than those observed in 2010 (data table 5-27). The MDL for the mercury in fish analyses was 0.02 µg/g. The highest concentrations were in the Savannah River in bass at the Lower Three Runs Creek Mouth (1.30 µg/g), in catfish at West Bank Landing (0.673 µg/g), in bream at the Augusta Lock and Dam (0.978 µg/g), in red drum at RM 0-8 (0.304 µg/g), and in mullet at RM 0-8 (0.022 µg/g). Review of the surveillance results concluded

- Cadmium levels were below minimum detection limits in all 468 fish samples collected during 2011.

- Arsenic was detected in four fish samples with the highest concentration in bass (0.691 µg/g) from the Stokes Bluff Landing sampling location.
- Antimony also was detected in 22 fish samples, with the highest concentration in catfish (0.458µg/g) at the Upper Three Runs Creek River Mouth. Metal results are lower than those of 2010 and are consistent with the previous 5 years (data table 5-28).
- Manganese was detected at all 11 fish sampling locations, with the highest concentration in bream (3.03 µg/g) at Beaver Dam Creek River Mouth.

River Water Quality Surveys

Description of Surveys

Biological and water quality surveys are conducted to assess the potential effects of SRS contaminants and warm-water discharges on the general health of the river and its tributaries The surveys were designed to assess potential effects of SRS contaminants and warmwater discharges on the general health of the river and its tributaries. This is accomplished by looking for

- Patterns of biological disturbance geographically associated with the SRS
- Patterns of change over seasons or years that indicate improving or deteriorating conditions

Survey Results Summary

In 2011, SRS conducted macroinvertebrate sampling during the spring and fall and diatom sampling monthly. The diatom slides were sent to the Academy for Natural Sciences (ANS) for archiving. No adverse biological impacts have been identified in the Savannah River diatom communities.

Macroinvertebrates collected from river traps during 2011 were similar in species diversity to those documented in surveys during the 1990s. An overall decrease in total populations was observed that likely is associated with low flow in the river and incipient drought conditions. No evidence of adverse biological impacts was found in the observed macroinvertebrate communities.

Radiological Dose Assessments

CHAPTER 6

Timothy Jannik, Eduardo B. Farfan, Wendy W. Kuhne, and Kenneth L. Dixon
Savannah River National Laboratory

This chapter presents the potential doses to offsite individuals and the surrounding population from the 2011 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 (50-year committed dose) from internal deposition of radionuclides and the effective dose attributable to sources external to the body. Use of the effective dose allows doses from different types of radiation and to different parts of the body to be expressed on the same basis.

All dose calculation results are presented in data tables on the compact disk (CD) inside the back cover of this report and are referred to in this chapter as "data table 6-X." Tables provided in this chapter are simply referred to as "table 6-X."

Descriptions of the SRS effluent monitoring and environmental surveillance programs discussed in this chapter can be found in Chapter 4, "Effluent Monitoring," and Chapter 5, "Environmental Surveillance." A complete description of how potential doses are calculated at SRS can be found in the SRS Environmental Dose Assessment Manual (SRS EDAM, 2010), a copy of which is included on the accompanying CD.

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 (MEI) living at the SRS boundary
- Population living within a 50-mile (80-kilometer [km]) radius of SRS (Figure 1 in the "SRS Environmental Data/Maps" section of the CD accompanying this report)

For compliance purposes, SRS calculates MEI and collective doses as if the entire 50-mile population consists of adults. For the radioisotopes that contribute the most to SRS's estimated maximum individual doses (i.e., tritium and cesium-137), the dose to infants can be approximated as two to three times more than the adult dose. The dose to older children becomes progressively closer to the adult dose (International Commission on Radiological Protection [ICRP] 1996).

Dose to the Hypothetical Maximally Exposed Individual

When calculating radiation doses to the public, SRS uses the concept of the hypothetical MEI; 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:

For airborne releases – Someone who lives at the SRS boundary (in the sector that has the highest calculated radionuclide concentrations) 365 days per year and consumes milk, meat, and vegetables produced at that location.

For liquid releases – Someone who lives downriver of SRS (near River Mile 118.8) 365 days per year, drinks two liters of untreated water per day from the Savannah River, consumes 19 kilogram (42 pounds) per year of Savannah River fish, and spends time on or near the river. Beginning in 2011, the irrigation pathway (consumption of food products irrigated with Savannah River water) was added to the MEI dose for liquid releases.

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.

SRS also uses adult consumption rates for food and drinking water and adult usage parameters to estimate intakes of radionuclides. All applicable land- and water-use parameters in the dose calculations are documented in the Land and Water Use Characteristics and Human Health Input Parameters for use in Environmental Dosimetry and Risk Assessments at the Savannah River Site (Jannik et al. 2010). These parameters include local characteristics of food production, river recreational activities, and meat, milk, and vegetable consumption rates, as well as other human usage parameters required in the SRS dosimetry models. In addition, the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations at SRS are documented in this report. The site-specific input parameters that are the most important to the dose calculations are summarized in data tables 6-1 and 6-2.

For dose calculations, unspecified alpha releases were treated as plutonium-239, and unspecified beta releases, as strontium-90. These radionuclides have the highest dose factors of the alpha- and beta-emitters, respectively, commonly measured in SRS waste streams.

Dose Calculation Methods

During routine operations at SRS, radioactive materials are incidentally released to the environment through atmospheric and/or liquid pathways. These releases potentially result in a radiation dose commitment to offsite people. The principal pathways by which people are exposed to releases of radioactivity are:

- Inhalation
- Ingestion
- Skin absorption
- External exposure

Figure 6-1 is a simplified representation of the principal exposure pathways.

At SRS, the potential effects of routine radioactive releases have been assessed annually since operations began. Since 1972, annual offsite dose estimates have been published in site environmental reports made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on codes

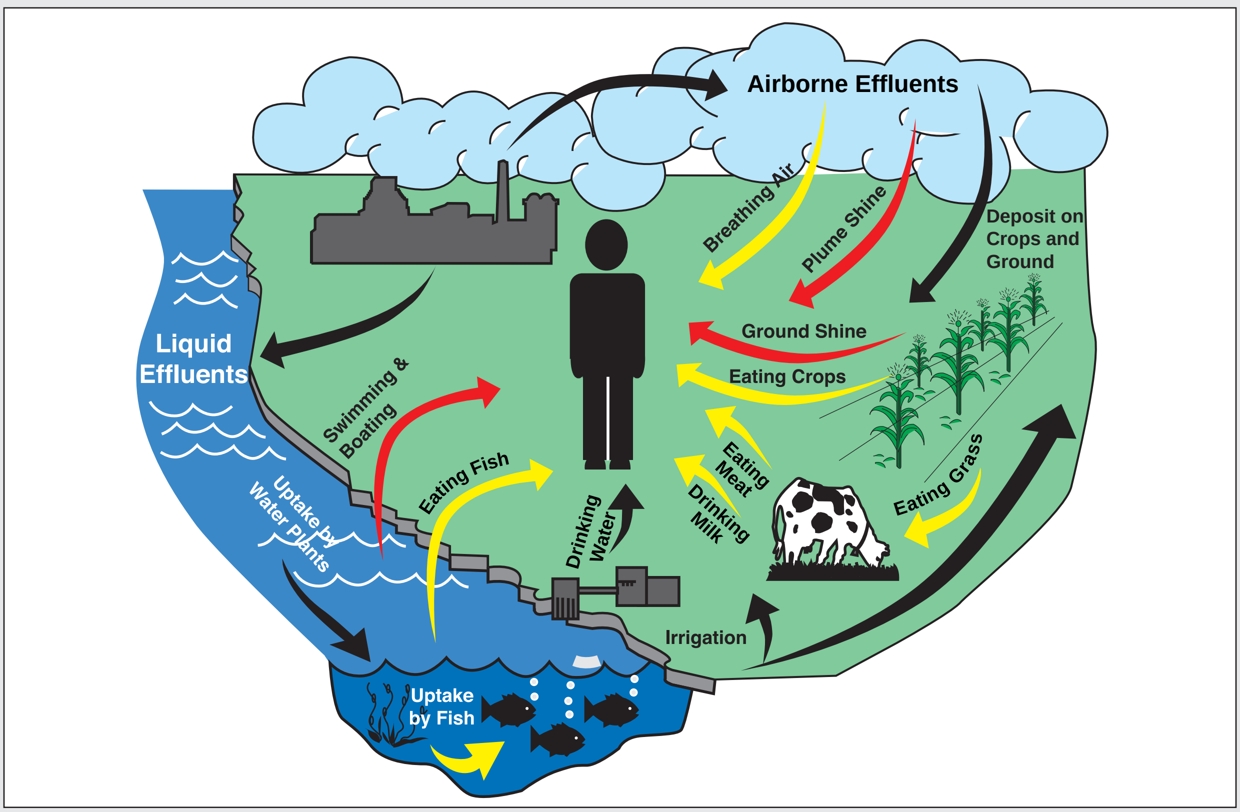


Figure 6-1 Exposure Pathways to Humans from Atmospheric and Aqueous Releases

developed by the Nuclear Regulatory Commission (NRC) (NRC 1977). The NRC based transport models use DOE accepted methods, consider all significant exposure pathways, and permit detailed analysis of the effects of routine operations. At SRS, the MAXDOSE-SR and POPDOSE-SR codes are used for atmospheric releases and LADTAP XL© is used for liquid releases. These models are described in SRS EDAM (2010).

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE [1988]. Beginning in 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72, (ICRP 1996). External dose conversion factors were updated to the dose factors provided in Federal Guidance Report 12, (Environmental Protection Agency [EPA] 1993).

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 (for combined releases from C-Area, K-Area, and L-Area), and H-Area (for combined releases from all other areas). The meteorological databases for the years 2002-2006, reflecting the most recent five-year compilation period, are provided in data table 6-3.

To show compliance with regulations, only the H-Area meteorological database was used in the calculations because the USEPA-required dosimetry code (CAP88 PC [Personal Computer] version 3.0, henceforth referred to simply as CAP88 PC) is limited to a single release location. Refer to the Compliance section for more details on CAP88 PC.

Population Database and Distribution

Collective (population) doses from atmospheric releases are calculated for the population within a 50-mile radius of SRS. Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of the center of SRS is 781,060, an increase of 9.6 percent over the 2000 population in this area. This translates to an average population density of about 104 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area. The population distribution around SRS is provided in data table 6-4.

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 (Savannah I&D), near Port Wentworth, Georgia, and by the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water Treatment Plants, both near Beaufort, South Carolina. According to the treatment plant operators, the population served by the Savannah I&D facility during 2011 was 26,300 persons, while the population served by the BJWSA Chelsea facility was 77,000 persons and by the BJWSA Purrysburg facility, 58,000 persons. The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories: (1) BJSWA water consumers, (2) Savannah I&D water consumers, (3) consumption of fish and invertebrates of Savannah River origin, (4) recreational activities on the Savannah River, and (5) irrigation of food stuffs using river water near River Mile 118.8.

River Flow Rate Data

Savannah River flow rates, recorded at a gauging station near River Mile 118.8 (U.S. Highway 301 bridge), are based on the measured water elevation. The river flow rates measured at this location from 1954 to 2011 are provided in data table 6-5. However, these data are not used directly in the SRS dose calculations. "Effective" flow rates are used instead and they are based on (1) the measured annual release of tritium and (2) the annual average tritium concentrations measured at River Mile 118.8 and at the three downriver water treatment plants. The effective river flow rate calculations are shown in data table 6-6. The use of effective flow rates in the dose calculations generally is more conservative than the use of measured flow rates because it accounts for less dilution.

For 2011, the River Mile 118.8 calculated (effective) flow rate of 4,329 cubic feet per second (cfs) was used in the dose calculations. This flow rate was about 33 percent less than the 2010 effective flow rate of 6,603 cfs. For comparison, the 2011 annual average flow rate, as measured by the U.S. Geological Survey (USGS), was 5,714 cfs. This flow rate is much less than the 2010 mean annual flow rate of 10,144 cfs, indicating 2011 was a severe drought year in the Savannah River basin. The 2011 calculated effective flow rates were 5,188 cfs for the Savannah I&D facility, 5,327 cfs for the BJWSA Chelsea facility, and 5,008 cfs for the BJWSA Purrysburg facility.

Dose Calculation Results

Liquid Pathway

Liquid Release Source Terms

The 2011 radioactive liquid release quantities used as the source term in SRS dose calculations are discussed in Chapter 4 and shown by radionuclide in Table 6-1 and by site streams in data table 6-7. Data table 6-8 provides a five-year history of SRS liquid radioactive releases. Tritium accounts for more than 99 percent of the total amount of radioactivity released from the site to the Savannah River. In 2011, a total of 942 curies of tritium were released from SRS to the river, a 27 percent decrease from the 2010 amount of 1,285 curies. In the past, the total amount of tritium in SRS dose calculations was based on the measured tritium concentration at River Mile 118.8. However, the total from this location includes the tritium releases from Georgia Power Company's Vogtle Electric Generating Plant (VEGP). Since 2006, doses have been calculated and documented in this report using SRS-only releases.

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility migration release measurements to quantify the total tritium released from SRS. A separate dose calculation is performed (for information only) that includes the total amount of tritium (SRS plus VEGP), which in 2011 was 2,312 curies (942 curies from SRS and 1,370 curies from VEGP). This was a 12 percent increase from the 2010 total of 2,058 curies.

Table 6-1 2011 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the USEPA's Drinking Water Maximum Contaminant Levels (MCL)

Nuclide	ActivityReleased (Ci)	12-Month Average Concentration (pCi/L)				
		Below SRS[a]	BJWSA Chelsea[b]	BJWSA Purrysburg[b]	Savannah I&D[c]	USEPA MCL[e]
H-3[d]	2.31E+03	5.98E+02	4.86E+02	5.17E+02	4.99E+02	2.00E+04
C-14	1.11E-02	2.87E-03	2.33E-03	2.48E-03	2.40E-03	2.00E+03
Sr-90	2.94E-02	7.60E-03	6.18E-03	6.57E-03	6.35E-03	8.00E+00
Tc-99	1.07E-02	2.77E-03	2.25E-03	2.39E-03	2.31E-03	9.00E+02
I-129	1.48E-02	3.83E-03	3.11E-03	3.31E-03	3.19E-03	1.00E+00
Cs-137	8.05E-02	2.08E-02	1.69E-02	1.80E-02	1.74E-02	2.00E+02
U-234	7.44E-02	1.92E-02	1.56E-02	1.66E-02	1.61E-02	1.03E+01
U-235	3.50E-03	9.05E-04	7.36E-04	7.83E-04	7.55E-04	4.67E-01
U-238	8.80E-02	2.28E-02	1.85E-02	1.97E-02	1.90E-02	1.00E+01
Np-237	3.56E-06	9.21E-07	7.48E-07	7.96E-07	7.68E-07	1.50E+01
Pu-238	1.03E-03	2.66E-04	2.16E-04	2.30E-04	2.22E-04	1.50E+01
Pu-239	4.39E-05	1.14E-05	9.23E-06	9.82E-06	9.47E-06	1.50E+01
Am-241	4.06E-04	1.05E-04	8.53E-05	9.08E-05	8.76E-05	1.50E+01
Cm-244	3.99E-04	1.03E-04	8.39E-05	8.92E-05	8.61E-05	1.50E+01
Alpha[f]	1.35E-02	3.49E-03	2.84E-03	3.02E-03	2.91E-03	1.50E+01
Beta[g]	3.30E-02	8.54E-03	6.94E-03	7.38E-03	7.12E-03	8.00E+00

[a] Near 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

[d] The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations. They include contributions from VEGP. All other radionuclide concentrations are calculated based on the effective river flow rate.

[e] MCLs for uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

[f, g] For dose calculations and MCL comparisons, unspecified alpha and beta releases are assumed to be Pu-239 and Sr-90, respectively

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

The concentrations of tritium in Savannah River water and cesium-137 in Savannah River fish are measured at several locations along the river for use in dose determinations and model comparisons. 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. Therefore, their concentrations in the river are calculated using the LADTAP XL© code, based on the annual release amounts and on the applicable effective flow rate.

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 Savannah I&D and BJWSA water treatment facilities are in table 6-1, as are the calculated concentrations for the other released radionuclides. These downriver tritium concentrations include tritium releases from SRS and the neighboring VEGP.

In 2011, the 12-month average tritium concentration measured in Savannah River water near River Mile 118.8 (598 picocuries per liter (pCi/L)) was 71 percent more than the 2010 concentration of 349 pCi/L. This increase is mainly attributed to the decrease in river flow from 2010 to 2011 and to increased releases of tritium from VEGP. The 2011 concentrations at the BJSWA Chelsea (486 pCi/L) and Purrysburg (517 pCi/L) facilities and at the Savannah I&D (499 pCi/L) water treatment plant were proportionately higher than in 2010 but remained well below the EPA drinking water maximum contaminant level (MCL) of 20,000 pCi/L. The drinking water MCL for each radionuclide released from SRS during 2011 is in table 6-1. 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 reported concentration of each radionuclide divided by its corresponding MCL must not exceed 1.0. As shown in data table 6-9, the sums of the fractions were 0.0343 at the BJSWA Chelsea facility, 0.0365 at the BJSWA Purrysburg facility, and 0.0352 at the Savannah I&D facility. These are below the 1.0 sum-of-the-fractions requirement.

For 2011, the sum of the fractions at the River Mile 118.8 location was 0.0422. This is provided only for comparison because River Mile 118.8 is not a community drinking water system location.

Radionuclide Concentrations in River Fish — At SRS, an important dose pathway for the MEI 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 3,000. That is, the concentration of cesium 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 detected more easily 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 River Mile 118.8, the assumed location of the hypothetical MEI. However, as shown in data table 6-10, the LADTAP XL dose model calculated concentration of cesium-137 in fish, based on measured 2011 effluent releases, was determined to be more than the actual measured concentration in fish. To be conservative, this higher calculated cesium-137 concentration in fish was used in the 2011 dose determinations.

Dose to the Maximally Exposed Individual

Based on discussions with personnel in the Georgia Department of Natural Resources (GDNR), the South Carolina Department of Health and Environmental Control (SCDHEC), and the U.S. Geological Survey (USGS), no known large-scale uses of Savannah River water downstream of SRS exist for agricultural irrigation purposes. However, the potential for agricultural irrigation does exist, especially for individual garden use. Therefore, beginning in 2011, the doses from the irrigation pathway are included in the totals for the official MEI and collective doses.

As shown in data table 6-12, the 2011 dose to the MEI from all liquid pathways except irrigation was estimated at 0.084 mrem (0.00084 millisievert (mSv)). This dose was 42 percent more than the comparable dose in 2010 of 0.059 mrem (0.00059 mSv). This increase is mainly attributed to the 33 percent decrease in river flow rate from 2010 to 2011. As shown in data table 6-16, the irrigation pathway MEI dose was estimated to be 0.092 mrem (0.00092 mSv). Adding these two doses together leads to a total liquid, all-pathway dose of 0.18 mrem (0.00018 mSv). Table 6-2 shows this total dose is 0.18 percent of the DOE Order 5400.5 all-pathway dose standard for annual exposure of 100 mrem. A five-year history of SRS doses is provided in data table 6-11.

Nearly 52 percent of the 2011 total dose to the MEI resulted from the irrigation pathway (ingestion of meat, milk, and vegetables). The fish consumption pathway accounted for 34 percent and the drinking water pathway, 13 percent. Cesium-137 (36 percent), tritium oxide (13 percent), and uranium-238 (10 percent) were the major radionuclides contributing to the total liquid pathway dose.

Using the 2011 total Savannah River tritium source term (which includes SRS and VEGP releases) of 2,312 curies, the MEI dose (including the irrigation pathway) was calculated to be 0.21 mrem (0.0021 mSv). This dose, provided for information only, is about 17 percent more than the 2010 comparable dose of 0.18 mrem (0.0018 mSv).

Drinking Water Pathway Dose

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. As shown in data tables 6-13 and 6-14, tritium in downriver drinking water represented the majority of the dose (about 51 percent) received by customers of the three downriver water treatment plants.

Based on SRS-only releases, the maximum potential drinking water dose during 2011 was determined to be 0.02 mrem (0.0002 mSv), about the same as the 2010 dose (data table 6-11). As shown in table 6-2, the maximum dose of 0.02 mrem (0.0002 mSv) is 0.5 percent of the DOE standard of 4 mrem per year for public drinking water supplies.

Using the SRS-plus-VEGP total tritium source term of 2,312 curies, the maximum drinking water dose in 2011 was calculated to be 0.035 mrem (0.00035 mSv), which is 0.9 percent of the DOE standard.

Collective (Population) Dose

The collective drinking water consumption dose is calculated for the discrete population groups served by the BJWSA and Savannah I&D water treatment plants. Collective doses from agricultural irrigation were calculated assuming that 1,000 acres of land were devoted to each of the major food types grown in the SRS area (vegetables, milk, and meat). It is assumed that all the food produced on these 1,000-acre parcels is consumed by the population (781,060) within 50 miles of SRS. 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. As shown in data table 6-15, the collective dose from all pathways except irrigation was estimated at 1.8 person-rem (0.018 person-Sv) in 2011. As shown in data table 6-16, the collective dose from the irrigation pathway was 1.3 person-rem (0.013 person-Sv). Adding these two doses together leads to a total all pathway collective dose of 3.1 person-rem (0.031 person-Sv). This is about 8 percent less than the comparable 2010 collective dose of 3.4 person-rem (0.034 person-Sv). This decrease is

Table 6-2 Potential Dose to the Maximally Exposed Individual from SRS Liquid Releases in 2011

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (percent)
Near Site Boundary (all liquid pathways)			
• All Pathways except irrigation	0.084		
• Irrigation Pathways	0.092		
Total Pathways	0.18	100[a]	0.18
At BJSWA Chelsea (public water supply only)	0.019	4[b]	0.48
At BJSWA Purrysburg (public water supply only)	0.020	4[b]	0.50
At Savannah I&D (public water supply only)	0.019	4[b]	0.48

[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)

attributed mainly to decreases in tritium releases from SRS (data table 6-8). Using the SRS-plus-VEGP total tritium source term of 2,312 curies, the collective dose was calculated to be 4.4 person-rem (0.044 person-Sv) in 2011.

Air Pathway

Atmospheric Source Terms

The 2011 radioactive atmospheric release quantities used as the source term in SRS dose calculations are discussed in Chapter 4 and are in data table 6-17. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required, for demonstrating compliance with NESHAP regulations. A five-year history of SRS atmospheric releases is provided in data table 6-18.

Atmospheric Concentrations

Calculated radionuclide concentrations instead of measured concentrations are used for dose determinations because most radionuclides released from SRS cannot be measured (using conventional analytical 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 in data table 6-19.

Dose to the Maximally Exposed Individual

The 2011 estimated dose from atmospheric releases to the MEI (calculated with MAXDOSE-SR) was 0.032 mrem (0.00032 mSv), 0.32 percent of the DOE Order 5400.5 air pathway standard of ten mrem per year. Table 6-3 compares the MEI dose with the DOE standard. The 2011 dose was about 41 percent less than the 2010 dose of 0.05 mrem (0.00054 mSv). This decrease is attributed primarily to the large decrease in the estimated diffuse and fugitive releases of tritium from 2010 to 2011 (see Chapter 4). A five-year history of SRS air pathway doses is in data table 6-11.

The 2011 atmospheric doses by radionuclide and pathway are provided in data table 6-20. Tritium oxide releases accounted for about 74 percent of the dose to the MEI, strontium-90 releases accounted for about 12 percent, and unidentified beta accounted for 6 percent of the dose. No other individual radionuclide accounted for more than 5 percent of the MEI dose. The major pathways contributing to the MEI dose from atmospheric releases were vegetation consumption (42 percent), inhalation (36 percent), and cow milk consumption (16 percent). As shown in data table 6-21 and in Data Map Figure 16, the due north sector of the site was the location of the highest dose to the MEI.

Table 6–3 Potential Dose to the Maximally Exposed Individual from SRS Atmospheric Releases in 2011

	MAXDOSE–SR	CAP88 PC (NESHAP)
Calculated dose (mrem)	0.032	0.015
Applicable Standard (mrem)	10[a]	10[b]
Percent of Standard (%)	0.32	0.15

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

Because of the potential in the SRS area for exposure to goat milk, additional calculations of the dose to the MEI were performed substituting goat milk for the customary cow milk pathway. As shown in data table 6-22, the potential dose to the MEI using the goat milk pathway was estimated to be 0.036 mrem (0.00036 mSv), which is about 13 percent more than “official” MEI dose of 0.032 mrem (0.00032 mSv) using the customary cow milk pathway.

Collective (Population) Dose

The air-pathway collective dose is calculated for the entire 781,060 population living within 50 miles of SRS. The population distribution around SRS is provided in data table 6-4. In 2011, the airborne-pathway collective dose (calculated with POPDOSE-SR) was estimated at 1.2 person-rem (0.012 personSv), less than 0.01 percent of the annual collective dose received from natural sources of radiation (about 234,000 person-rem). The 2011 air-pathway collective doses by radionuclide and pathway are provided in data table 6-23. Tritium oxide releases accounted for about 82 percent of the collective dose. The 2011 collective dose was about 37 percent less than the 2009 collective dose of 1.9 person-rem (0.019 person-Sv). This decrease is again mainly attributed to the decrease in estimated diffuse and fugitive tritium releases from 2010 to 2011.

NESHAP Compliance

To demonstrate compliance with NESHAP regulations (USEPA, 2002a), MEI and collective doses were calculated using (1) the CAP88 PC version 3.0 computer code, (2) the 2011 airborne-release source term (data table 6-24), and (3) site-specific input parameters (data table 6-25).

In 2011, SRS began using the PC version of the CAP88 code. Previously, the mainframe version of the code was used, but a mainframe computer is no longer available for these calculations at SRS. Several major differences occur between the two versions of the CAP88 code, as documented in Farfan and Powell (2012). The main differences are that the PC version uses updated dose conversion factors based on ICRP 72 (ICRP 1996) and updated usage and transfer parameters. Also, differences exist in the food ingestion and external (ground shine) exposure calculations. For SRS, where the major source term is tritium oxide, these differences lead to a reduction in the estimated MEI dose of about 50 percent (Farfan and Powell 2012). Most parameters in CAP88 PC are hard coded in the program and cannot be changed without specific USEPA approval.

For 2011, using the CAP88 PC code, the maximally-exposed-individual dose was estimated at 0.015 mrem (0.00015 mSv), 0.15 percent of the 10-mrem-per-year USEPA standard, as shown in table 6-3. The 2011 doses by radionuclide are provided in data table 6-26. Tritium oxide releases accounted for about 50 percent of this dose and strontium-90 accounted for 43 percent. Strontium-90 became more important on a percentage of dose basis in 2011, as compared to 2010; because (1) the CAP88 PC code uses larger soil-to-plant and plant-to-animal uptake ratios for the element strontium than did the mainframe version and (2) a relatively large increase in the estimated diffuse and fugitive releases of strontium-90 occurred (Chapter 4).

The 2011 NESHAP compliance dose was about 74 percent less than the 2010 dose of 0.057 mrem (0.00057 mSv) in spite of the significant increase in the diffuse and fugitive emissions of strontium-90. This large decrease is attributed mainly to the differences in the CAP88 PC code as compared to mainframe version and to the decrease in diffuse and fugitive releases of tritium oxide discussed previously.

For NESHAP, the dose from diffuse and fugitive releases is required to be reported separately. As shown in data table 6-27, the MEI dose from diffuse and fugitive releases was estimated to be about 0.089 mrem (0.00089 mSv), which accounts for more than half of the total 2011 maximally-exposed-individual dose calculated using CAP88 PC.

The CAP88 PC-determined collective dose for 2011 was estimated at 1.9 person-rem (0.019 person-Sv). Tritium oxide releases accounted for about 58 percent and strontium-90 accounted for about 35 percent of this dose. Comparisons (by pathway and major radionuclides) of the CAP88 PC-determined MEI and collective doses with the MAXDOSE-SR and POPDOSE-SR doses are provided in data tables 6-28 and 6-29, respectively.

All-Pathway Dose

To demonstrate compliance with the DOE Order 5400.5 all-pathway dose standard of 100 mrem (1.0 mSv) per year, SRS conservatively combines the MEI airborne all-pathway and liquid all-pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations. As previously discussed, beginning in 2011, the SRS all-pathway dose includes the irrigation pathway dose estimate.

For 2011, the potential MEI all-pathway dose was 0.21 mrem (0.0021 mSv), 0.032 mrem from air pathways plus 0.084 mrem and 0.092 mrem from the standard liquid pathways and the irrigation pathways, respectively. The all-pathway dose is 0.21 percent of the 100-mrem-per-year DOE dose standard. The 2011 all-pathway dose is about 91 percent more than the reported 2010 dose of 0.11 mrem (0.0011 mSv). Most of the increase is caused by the addition of the irrigation pathway dose. Without the irrigation pathway, the 2011 all-pathway dose would have been 0.12 mrem (0.0012 mSv), which is 9 percent more than the 2010 comparable all-pathway dose.

Figure 6-2 shows a ten-year history of SRS's all-pathway (airborne pathway plus liquid pathway) doses to the MEI.

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 MEI, 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 ("creekmouth fish") 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

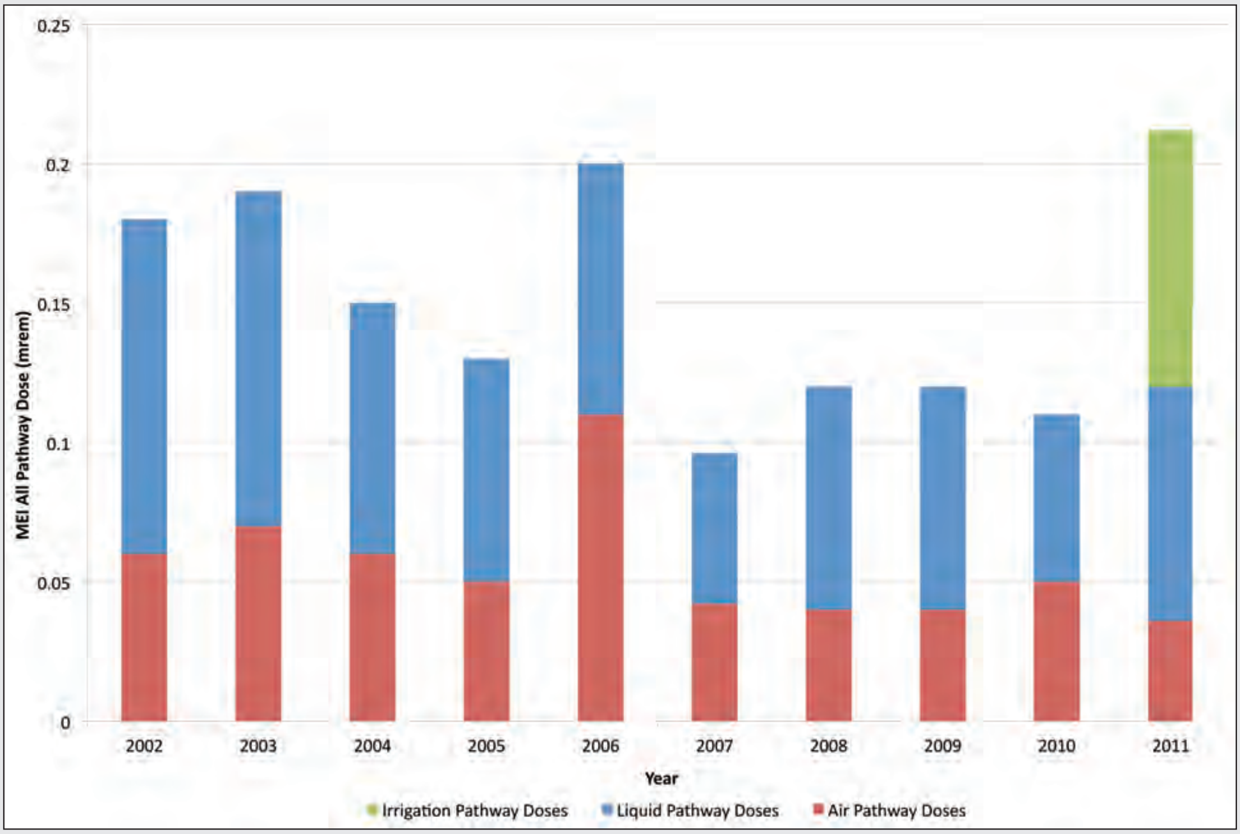


Figure 6–2 Ten-Year History of SRS Maximum Potential All-Pathway Doses

Note: Beginning in 2011, the irrigation pathway dose is included in the liquid pathway dose. Previous years do not include the irrigation pathway dose.

River Swamp, contaminated by SRS operations in the 1960s (Chapter 9):

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

Onsite Hunter Dose

Deer and Hog Consumption Pathway — Annual hunts, open to the general public, are conducted at SRS to control the site's deer and feral hog populations and to reduce animal-vehicle accidents. The estimated dose from the consumption of harvested deer or hog meat is determined for every onsite hunter. During 2011, the maximum dose that could have been received by an actual onsite hunter was estimated at 14.7 mrem (0.147 mSv), or 14.7 percent of DOE's 100-mrem all-pathway dose standard (Table 6-4). This dose was determined for an actual hunter who in fact harvested 14 animals (five deer and nine hogs) during the 2011 hunts. The hunter-dose calculation is based on the conservative assumption that this prolific hunter individually consumed the entire edible portion, almost 213 kilogram (kg) (469 pound (lb)) of the animals that this individual harvested from SRS in 2011.

Turkey Consumption Pathway—SRS hosts a special turkey hunt during April for hunters with mobility impairments. Twenty-eight turkeys were harvested in 2011. The dose assigned from each turkey was 1.0 mrem (0.01 mSv), which is the minimum assigned dose to each successful hunter. One of the hunters harvested four turkeys in 2011, so the maximum potential dose from this pathway was 4.0 mrem (0.04 mSv).

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 (assumed to be 81 kg) during the year was either deer or hog meat. It was assumed that these

Table 6-4 2011 Maximally-Exposed-Individual All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Maximally-Exposed-Individual Dose			
All-Pathway (Liquid Plus Airborne Pathway)	0.21	100	0.21
Sportsman Dose			
Onsite Hunter	14.7	100	14.7
Creek-Mouth Fisherman[b]	0.068	100	0.068
Savannah River Swamp Hunter			
Offsite Hog Consumption	1.29		
Offsite Deer Consumption	0.74		
Soil Exposure[c]	2.90		
Total Offsite Deer Hunter Dose	3.64	100	3.64
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.068		
Soil Exposure[d]	0.28		
Total Offsite Fisherman Dose	0.35	100	0.35

[a] All-pathway dose standard: 100 mrem per year (DOE Order 5400.5)
[b] In 2011, the maximum dose to a hypothetical fisherman resulted from the consumption of bass from the mouth of Steel 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

individuals harvested deer or hogs that had resided at SRS but then moved offsite. Based on these low probability assumptions and on the measured average concentration of cesium-137 in all deer (1.19 pCi/g) and hogs (1.33 pCi/g) harvested from SRS during 2011, the potential maximum doses from this pathway were estimated at 0.74 mrem (0.0074 mSv) for the offsite deer hunter and 1.3 mrem (0.013 mSv) for the offsite hog hunter. These dose calculations are provided in data table 6-30.

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 at least 50 miles from SRS (Table 33, SRS Environmental Data for 1994) [SRS Data, 1995].

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 2011 (Chapter 5) was estimated using the RESRAD code (Yu et al., 2001 and SRS EDAM 2010). 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, which was conducted in 2007, 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 2.9 mrem (0.029 mSv).

As shown in table 6-4, 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 3.6 mrem (0.036 mSv). This potential dose is 3.6 percent of the DOE 100-mrem all-pathway dose standard.

Offsite Fisherman Dose

Creek-Mouth Fish Consumption Pathway — For 2011, radioanalyses were conducted of three species of fish (panfish, catfish, and bass) taken from the mouths of the five SRS streams. Three composites of up to five fish of each species are analyzed from each sampling location. The resulting estimated doses are provided in data table 6-31. Beginning in 2011, at least one of the three composites had to have a significant result for an average concentration to be reported. In previous years, to be conservative, all radioanalytical results (even those below the minimum detectable activity) were included in the average radionuclide concentrations. SRS reports the maximum dose from this combination of creek-mouth fish. As shown in table 6-4, the maximum potential dose from this pathway was estimated at 0.068 mrem (0.00068 mSv) from the consumption of bass collected at the mouth of Steel Creek. This hypothetical dose is based on the low probability scenario that, during 2011, a fisherman consumed 19 kg (42 lb) of bass caught exclusively from the mouth of Steel Creek. About 88 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 was estimated using the RESRAD code (Yu et al., 2001). 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.

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 0.28 mrem (0.0028 mSv).

As shown in table 6-4, the maximum Steel Creek fish consumption dose (0.068 mrem) and the Savannah River Swamp fisherman soil exposure pathway were conservatively added together to obtain a total offsite fisherman dose of 0.35 mrem (0.0035 mSv). This potential dose is 0.35 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 a Fish Monitoring Plan in conjunction with EPA, GDNR and SCDHEC. This plan assesses radiological risk from the consumption of Savannah River fish, and presents a summary of the results in the annual SRS environmental report.

Risk Comparisons — For 2011, 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 provided in data table 6-31, and the maximum values 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 in table 6-5. The potential risks were estimated using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (USEPA, 1999a)

For 2011, the maximum recreational fisherman dose was caused by the consumption of bass collected at the mouth of Steel Creek. Figure 6-3 shows a ten-year history of the annual potential radiation doses from consumption of Savannah River fish. Over the past seven years, no apparent trends can be discerned from these data because of large variability in the 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 cesium-137 (and other radionuclides) available in the water and sediments at SRS, and
- the water quality at each SRS stream mouth, caused by annual changes in stream flow rates (turbulence) and water chemistry.

As indicated in table 6-5, the 50-year maximum potential lifetime risk from consumption of SRS creek-mouth fish was 2.8E-06, below the 50-year risk (3.7E-03) associated with the 100-mrem-per-year dose standard.

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, the case with the maximum potential lifetime risks from the consumption of Savannah River fish, then the risk may be deemed acceptable if it is kept as low as reasonably achievable (ALARA), although actions to further reduce this risk can be considered. At SRS, an environmental ALARA program is in place to

Table 6–5 Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards

	Committed Dose (mrem)	Potential Risk[a] (unitless)
2010 Savannah River Fish		
1-Year Exposure	0.068	5.6E-08
30-Year Exposure	2.04	1.7E-06
50-Year Exposure	3.4	2.8E-06
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] 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.

ensure that the potential risk from site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) is kept ALARA (SRS EM Plan, 2010).

Release of Material Containing Residual Radioactivity

No materials containing residual radioactivity were released from SRS during 2011. DOE issued a moratorium in January 2000 prohibiting the release of volume-contaminated metals and subsequently suspended the release of metals for recycling purposes from DOE radiological areas in July 2000. No volume-contaminated metals or metals for recycling purposes were released from SRS in 2011.

DOE approved an SRS request in 2003 to use supplemental limits for releasing material from the site with no further DOE controls. These supplemental release limits, provided in data table 6-32, are dose-based, and are such that if any member of the public received any exposure, it would be less than 1 mrem/year. The supplemental limits include both surface and volume concentration criteria. The surface criteria are very similar to those used in previous years. The volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary facility. In 2011, no material was released from the site using the SRS supplemental release limits volume concentration criteria.

These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 5400.5.

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 gray (Gy) per day) from exposure to radioactive material in liquid effluents released to natural waterways.

DOE Biota Concentration Guides

At SRS, the evaluations of biota doses for aquatic and terrestrial systems are performed using the RESRAD-Biota model (version 1.5) (SRS EDAM 2010), based on the DOE standard, 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 (BCG)s are based on the 1.0-rad-per-day dose limit for aquatic animals and a 0.1 rad-per-day limit for riparian animals. Aquatic plants are not considered. The terrestrial-systems evaluation includes exposures to terrestrial plants and animals and is based on a 1.0-rad-per-day dose limit for plants and a 0.1-rad-per-day dose limit for animals. These two terrestrial dose

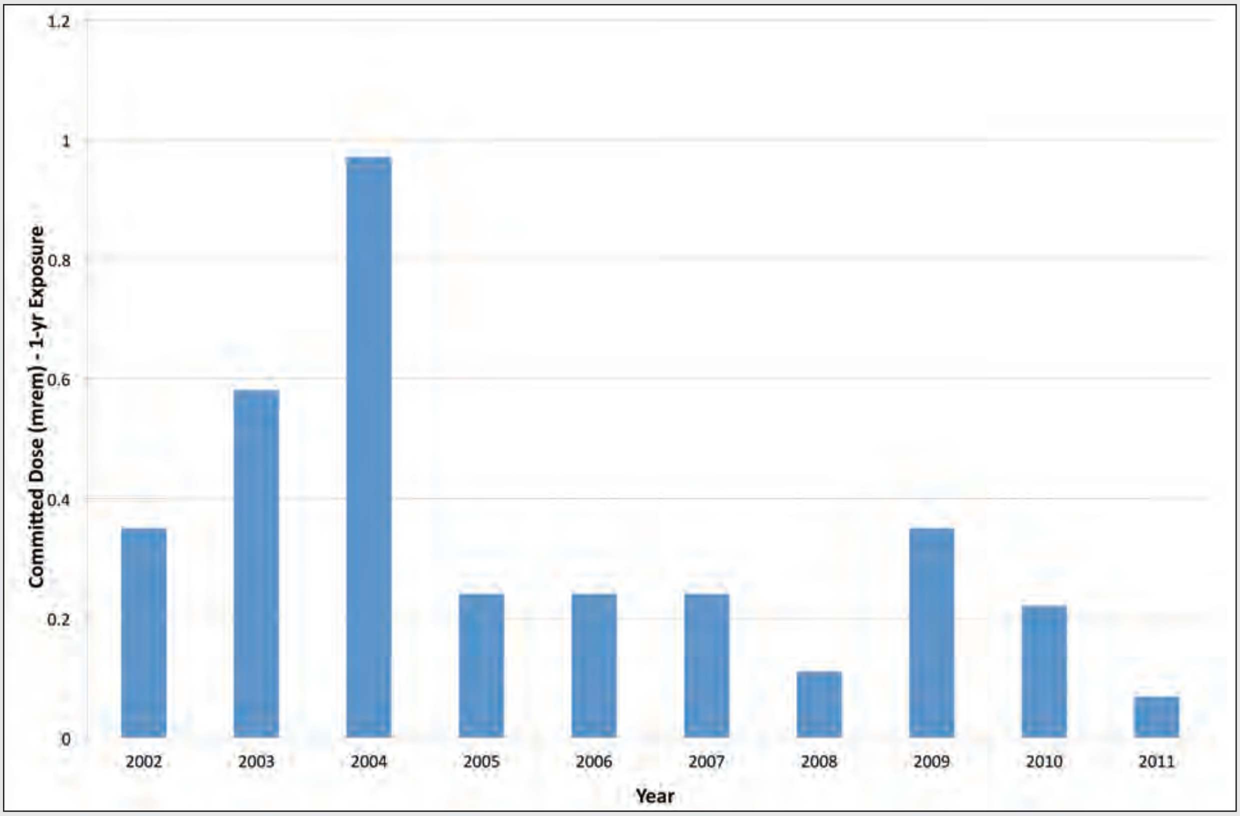


Figure 6–3 Ten-Year History of SRS Creek-Mouth Fisherman's Doses

limits, included as part of the RESRAD-Biota model, are not specified in DOE Order 5400.5. All three biota dose limits are for chronic, long-term exposures to the maximally exposed applicable species.

For the aquatic-systems evaluation, initial screenings were performed in 2011 using maximum radionuclide concentration data from the ten SRS Environmental Monitoring stream sampling locations from which collocated water and sediment samples are collected. An exception to this was made for sample location FM-2B (on Fourmile Branch 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 collocated sediment sample is collected. The combined water-plus-sediment BCG sum of the fractions was used for the aquatic systems evaluation. A sum of the fractions less than 1.0 indicates the sampling site has passed its initial pathway screening.

For the terrestrial-systems evaluation, initial screenings were performed using concentration data from the five environmental monitoring onsite radiological soil sampling locations. Only one soil sample per year is collected and analyzed for radioactivity from each location.

For 2011, all terrestrial locations and all aquatic locations passed their initial pathway screenings. All of the RESRAD-Biota screening results are provided in data table 6-33.

Groundwater

CHAPTER 7

Sadika O'Quinn
Environmental Compliance and Area Completion Projects Engineering

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

- *Protecting groundwater by using best practices in managing groundwater contaminants and implementing sound remediation technologies;*
- *Monitoring groundwater to identify areas of contamination;*
- *Remediating groundwater contamination as needed; and*
- *Conserving groundwater.*

Previous SRS operations have contaminated the groundwater adjacent to and beneath hazardous waste management facilities and operable units. An extensive groundwater monitoring program is in place at SRS and remediation strategies are being implemented. Remediation strategies include closing waste sites to reduce the migration of contaminants into groundwater and actively treating contaminated water.

Groundwater monitoring from wells located off SRS indicate that contaminated groundwater is not migrating off-site.

This chapter describes SRS's groundwater environment and the site-wide 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 sandy layers (aquifers), but is retarded by less permeable clayey beds (confining units). Past SRS operations have resulted in contamination migrating to the groundwater at various site locations, predominantly in the central areas of the site. The continuous movement of water into the subsurface intervals of the aquifer system has the ability to transfer contamination into the groundwater.

The hydrostratigraphy of SRS has been subject to several classifications, as established in Aadland et al. (1995) and Smits et al. (1996). The classifications are used extensively at SRS and regarded as the current site standard. This system is consistent with the U.S. Geological Survey (USGS) standards used in the regional studies that include the area surrounding SRS [Clarke and West 1998]. Figure 7-1 demonstrates the relative position of the SRS hydrostratigraphic units as they relate to their corresponding lithologic units and geologic time scale.

The hydrostratigraphic units beneath SRS are part of the Southeastern Coastal Plain Hydrogeologic Province (figure 7-1). Within this sequence of aquifers/confining units are two principal subcategories: the overlying Floridian Aquifer System and the underlying Dublin-Midville Aquifer System. These systems are separated from each other by the Meyers Branch Confining System. In turn, this system is further subdivided into two aquifers, which are separated by a confining unit. In the northern part of SRS (north of Upper Three Runs), the aquifer system is referred to as the Steed Pond Aquifer and is comprised of the M-Area Aquifer Zone, the Green Clay Confining Zone, and the Lost Lake Aquifer Zone. In the Central and Southern part of SRS, the aquifer system is referred to as the Upper Three Runs and Gordon Aquifers and is comprised

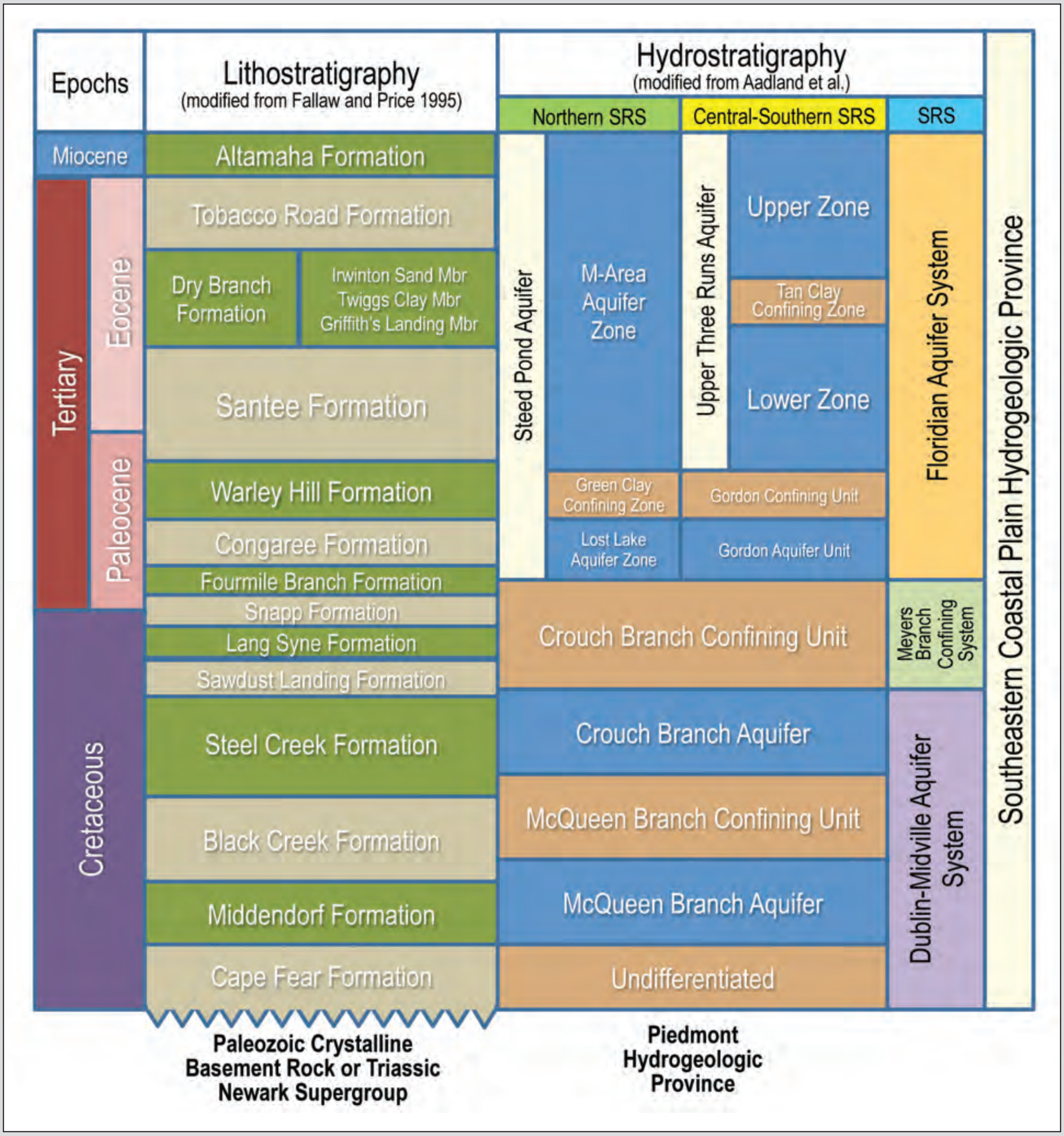
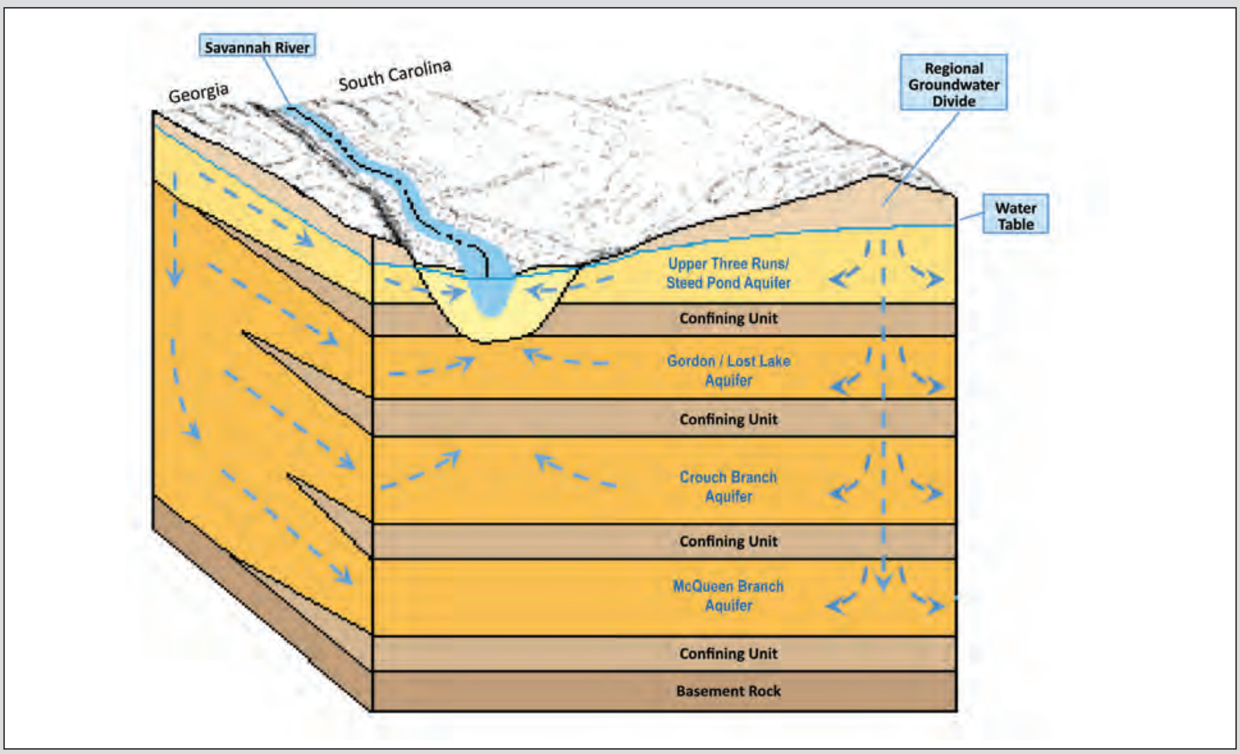


Figure 7–1 Hydrostratigraphic Units at SRS

of the Upper Zone, Tan Clay Confining Zone, Lower Zone, Gordon Confining Unit, and Gordon Aquifer Zone. Figure 7-2 is a three-dimensional block diagram of the hydrogeologic units at SRS and the generalized groundwater flow patterns within those units. The units from the shallowest to the deepest are: 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. Maps of the potentiometric surfaces of these aquifers are presented in figures 19-22, respectively, of the "Environmental Data/Maps - 2011" Appendix located on the accompanying compact disk (CD).

Groundwater recharge is a result of rainwater or other precipitation moving downward through the ground 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 headwaters and midsections of streams. Additionally some water moves into successively deeper aquifers. The water lost to successively deeper aquifers migrates laterally within those units toward the more distant regional discharge zones. These regional zones are typically located along major streams (e.g., Upper Three Runs or Fourmile Branch), or along the Savannah River itself. Groundwater movement within these units is extremely slow as compared to surface water, with groundwater velocities varying between aquitards and aquifers. At SRS, these velocities can range 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 effects of site activities on groundwater quality. Most of the wells monitor the upper groundwater zones (see figure 7-1), although wells are present in the lower zones at the sites with the larger groundwater contamination plumes. Groundwater in some areas contains one or more contaminants at or above the U.S. Environmental Protection Agency (USEPA) drinking water standards (i.e., maximum contaminant levels [MCLs]). These areas can be seen in figure 18 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD. Time-versus- concentration plots for selected wells from various contaminated areas are also included on the accompanying CD. The CD also contains all of the 2011 SRS groundwater monitoring data. Well coordinates have been provided in the data tables and can be used in conjunction with figure 25 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD to find the location of individual wells.



Modified from Clarke and West, 1998

Figure 7-2 Groundwater at SRS
The groundwater flow system at SRS consists of four major aquifers separated by confining units: Upper Three Runs / Steed Pond, Gordon / Lost Lake, Crouch Branch, and McQueen Branch. Groundwater flow in recharge areas generally migrates downward, as well as laterally, and eventually discharges into the Savannah River and its tributaries or migrates into the deeper regional flow system. Additional information concerning hydraulic heads and flow directions may be found in Figures 19–22 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD.

Groundwater Protection Program at SRS

The SRS groundwater protection program is designed to meet federal and state laws/regulations, U.S. Department of Energy (USDOE) orders, and SRS policies and procedures. It contains the following elements:

- Investigating SRS groundwater;
- Using SRS groundwater;
- Protecting SRS groundwater;
- Remediating contaminated SRS groundwater; and
- Monitoring SRS groundwater.

Groundwater monitoring is a key tool used in each of the first four elements, with the results forming the basis for evaluations that are reported to SRS stakeholders.

Investigating SRS Groundwater

An extensive monitoring program is in place at SRS to acquire data and information relating to the groundwater. Groundwater investigations include the collection and analysis of data to understand groundwater conditions on both a regional scale (sitewide) and a local scale (individual waste site) at SRS.

Monitoring efforts at SRS focus on the collection and analysis of data to characterize the groundwater flow and the contaminants present. Characterization efforts at SRS include, but are not limited to, the following activities:

- Collecting soil and groundwater samples using cone penetrometer technology (CPT). Additional information can also be obtained from geologic soil cores or seismic profiles to better delineate subsurface structural features, as warranted;
- Installing wells to allow periodic collection of water level measurements and groundwater samples at strategic locations;
- Developing water table and potentiometric maps to help define the groundwater velocity in the subsurface; and
- Performing various types of tests to obtain in situ estimates of hydraulic parameters in order to estimate groundwater velocities.

Analysis of groundwater characteristics on the regional scale is needed to provide a comprehensive understanding of SRS groundwater movement in order to better understand the migration of contaminants at the local scale (i.e., near individual waste units).

Surface water flow characteristics are also determined on the regional scale at SRS in order to ascertain contaminant risk to perennial streams since they are the receptors of groundwater discharge. Because the SRS boundary does not represent a groundwater boundary, regional studies are useful in understanding the movement of groundwater into SRS from surrounding areas and vice versa.

Groundwater modeling has been used extensively at SRS as an analytical tool for regional and local groundwater investigations. Models have been used to (1) define regional groundwater flow patterns on and off SRS; (2) enhance understanding of contaminant migration in the subsurface; (3) support remedial designs; and (4) provide predictive performance assessments of waste disposal facilities. At SRS, major groundwater modeling efforts have been conducted on A/M-Areas, D/TNX-Areas, F/H Areas, the Burial Ground Complex, and C-, K-, L-, P-, and R-Reactor Areas.

In order to gain a better understanding of the fate and transport processes in groundwater, research is being conducted on many topics, including attenuation processes for inorganics and radionuclides, physical interactions of contaminants with porous media matrices, and biogeochemical factors that influence microbial degradation of organic contaminants in groundwater. Research to address relevant issues at SRS is often conducted through cooperative studies with public universities and private companies or by SRS employees exclusively. Published papers describing the results of the specific research projects may be found at DOE s Office of Scientific and Technical Information website, http://www.osti.gov, and in various technical journals.

Using SRS Groundwater

SRS manages its own drinking and process water supply from groundwater located beneath the SRS. SRS domestic and process water systems are supplied from a network of approximately 40 production wells in widely scattered locations across the site, of which eight wells supply the primary drinking water system for the SRS (figure 14 of the “Environmental Data/Maps - 2011” Appendix found on the accompanying CD). The production wells are the water supply wells that provide water for all the facility operations including domestic water systems. In 1983, SRS began reporting its water usage annually to the South Carolina Water Resources Commission, and later to the South Carolina Department of Health and Environmental Control (SCDHEC). Since that time, the amount of groundwater pumped for SRS

Sample Scheduling and Collection

Approximately 2,000 wells and numerous direct-push holes are sampled each year. Most of the wells are sampled semiannually, but many are sampled quarterly or annually. These groundwater samples provide data for reports required by federal/state regulations, internal monitoring reports, and research projects. The results, which contain over 193,000 lines of data, are included with the CD that accompanies this document.

Nonradioactive constituents that may be required for analysis due to permit or regulatory document requirements include metals, field parameters, herbicides, pesticides, volatile organic compounds (VOCs), and others as needed. Likewise, radioactive constituents that may be required for analysis include gross alpha and nonvolatile beta indicators, gamma emitters, iodine-129, strontium-90, radium isotopes, uranium isotopes, and other alpha and beta emitters.

Groundwater samples are typically collected via pumps or bailers that are dedicated to each individual well to prevent cross-contamination between the wells. Portable sampling equipment can also be used if decontamination procedures are implemented between wells.

Sampling and shipping equipment and procedures are consistent with USEPA, SCDHEC, and U.S. Department of Transportation guidelines. USEPA-recommended preservatives and sample-handling techniques are employed for sample storage and transportation to onsite and offsite analytical laboratories. Potentially radioactive samples are screened for total activity prior to shipment to determine appropriate packaging and labeling requirements. Deviations from scheduled sampling and analysis for 2011 (caused by dry wells, inoperative pumps, etc.) were entered into the SRS groundwater database and issued in appropriate reports.

usage has dropped by more than two thirds from 10.8 million gallons per day during 1983-1986 to 3.3 million gallons per day in 2011. The majority of this decrease is attributed to the consolidation of the SRS domestic water systems, which was completed in 1997. Thirteen separate water systems, each with its own high-capacity supply wells, were consolidated in 1997 into three systems which are located in A-, D-, and K-Areas. In 2009, these three systems were further consolidated into two systems located in A- and D-Areas. This consolidation greatly reduced the amount of excess water being pumped to waste. Site facility shutdowns and reductions in population have also been contributing factors to the decrease in water usage. An increase from 2.7 million gallons per day in 2009 to the 3.3-million gallons per day in 2011 was likely due to the American Recovery and Reinvestment Act that accelerated many SRS projects and required an increase in the workforce through 2011.

Treated water is supplied to the larger SRS facilities by the A-Area and D-Area domestic water systems. Each system is comprised of a treatment plant, distribution piping, elevated storage tanks, and a well network. The wells range in capacity from 200 to 1,500 gallons per minute. The SRS domestic water systems meet state and federal drinking water quality standards. The two systems supply water to site drinking fountains, lunchrooms, restrooms, and showering facilities. The systems are sampled quarterly for chemical analyses by SCDHEC. The A-Area water system is monitored monthly for bacteriological analyses; the D-Area water system is sampled quarterly. SCDHEC performs sanitary surveys every two years on the A-Area and D-Area systems. The much smaller systems are inspected by SCDHEC every three years. All 2011 water samples were in compliance with SCDHEC and EPA water quality standards. Additional information is provided in the Safe Drinking Water Act section of Chapter 3, “Environmental Compliance.”

The process water systems are located in A-, F-, H-, K-, L-, and S-Areas and meet SRS’s 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.

Protecting SRS Groundwater

SRS is committed to protecting the groundwater resources beneath the site. A variety of activities that contribute to this endeavor, include:

- Construction, waste management, and monitoring efforts to prevent or control sources of groundwater contamination;
- Groundwater and surface water monitoring programs to detect contamination; and
- A successful groundwater cleanup program that is managed by Environmental Compliance & Area Completion Projects (EC&ACP).

The main objective of the groundwater monitoring program is to protect potential offsite receptors from groundwater and or surface water contamination that originated at SRS. Monitoring the groundwater around SRS facilities and known waste disposal sites provides the best means to detect and keep track of groundwater contamination so that the appropriate remedial or corrective actions can be implemented before the contamination travels offsite. The majority of SRS's groundwater contamination is located in its central areas. However, the potential for offsite migration does exist. The consequences of offsite contamination occurring are serious enough to warrant a comprehensive groundwater monitoring program.

The SRS groundwater monitoring program also collects groundwater data to determine the effects of site operations on groundwater quality. The program:

- Supports SRS in complying with environmental regulations and USDOE directives;
- Provides contaminant data to evaluate the current status of groundwater plumes;
- Provides water quality data necessary for evaluating the suitability of a new facility location; and
- Supports basic and applied research projects.

The SRS groundwater monitoring program includes two primary components: (1) waste site monitoring associated with remediation, and (2) groundwater surveillance monitoring.

Groundwater monitoring data are evaluated on a regulatory-approved frequency to identify whether new groundwater contamination exists or if current monitoring programs need to be modified in order to maintain an overall optimal monitoring program.

Monitoring wells and production wells that are no longer beneficial are abandoned with approval from SCDHEC, following SRS procedures. A typical abandonment involves placing a smaller diameter pipe ("tremie pipe") near the bottom of the well and pumping cement grout through the tremie pipe until the well is full of grout. This method ensures that grout reaches the bottom of the well. SRS abandoned seven wells in 2011. The Z-Area Saltstone Disposal Facility is planning to abandon seven monitoring wells in 2012.

Remediating Contaminated SRS Groundwater

SRS has maintained an environmental remediation and monitoring effort for more than 20 years. EC&ACP currently manages the remediation and monitoring of contaminated groundwater associated with Resource Conservation and Recovery Act (RCRA) hazardous waste management facilities, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste sites and other hazardous waste sites as specified in the *Savannah River Site Federal Facility Agreement* (FFA) (FFA 1993). The purpose of the FFA is to ensure that

- Schedules for environmental agreements are consistently met;
- Usage of financial and technological resources is continually improved; and
- Overall risk of contamination to human health and ecological receptors from SRS sources is eliminated or reduced.

For each groundwater project, the following actions occur: (1) the appropriate regulatory framework is developed with the regulatory agencies (USEPA and SCDHEC) and USDOE; (2) the degree and extent of contamination is determined through characterization efforts; and, if warranted, (3) a strategy for remediating the contaminated groundwater to its original beneficial use is decided.

Remedial actions are often applied to the groundwater contamination source. For instance, soil vapor extraction (SVE), which is pulling contaminated soil vapor from the subsurface, is widely used at SRS to remove VOCs from the unsaturated (vadose) zone. Other remedial technologies that have been recently deployed to the vadose zone include heating (steam or electrical resistance), chemical oxidation, and enhancing natural biodegradation through nutrient additions. Heating has also been used to volatilize tritium that has sorbed to concrete slabs.

Groundwater remedial technologies that have been and are being implemented at SRS include pump and treat systems, in situ pH adjustments, steam injection, phytoremediation, biodegradation, natural attenuation, and subsurface barriers construction. These technologies are implemented with the intent of managing contaminant flux and reducing contaminant exposure risk to human health and ecological receptors.

Monitoring SRS Groundwater

The objective of the SRS groundwater monitoring program is to ensure that groundwater contamination is not being released offsite. SRS groundwater discharges into various site streams and/or the Savannah River. To date, no offsite wells have been contaminated by groundwater from SRS. Additionally, the majority of the SRS groundwater plumes are located in the center of SRS and do not pose a risk of offsite contamination. A/M Area is the site of a significant VOC plume. The groundwater monitoring program for A/M Area utilizes more than 150 wells for monitoring the plume. Some of these monitoring wells lie within a half-mile of SRS's northwestern boundary. While it is known that the major component of groundwater flow in the area parallels the site boundary, groundwater flow direction can fluctuate. For this reason, particular attention is paid to the groundwater results from the wells located along the site boundary and between A/M Area and the nearest population center, Jackson, South Carolina (figure 23 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD).

In 2009, trichloroethylene (TCE) was detected at well MSB91 at a concentration of 1.6 µg/L which is below the drinking water standard (maximum concentration limit [MCL] is 5 µg/L). As a result, MSB91 was sampled quarterly during 2010. The second quarter groundwater sample had a detection of TCE at 3.92 µg/L, still below the MCL. The other three quarterly samples had results that were below the TCE detection limit (0.25 µg/L). Furthermore, the 2011 sampling events continue to indicate that TCE concentrations are below the detection limit.

Since the early 1990s, considerable effort has been directed at assessing the likelihood of trans-river flow from South Carolina to Georgia. Forty-four wells were drilled by the U.S. Geological Survey (USGS) and the Georgia Department of Natural Resources (figure 24 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD). A groundwater model developed by the USGS indicates there is no mechanism by which trans-river flow could contaminate Georgia wells [Cherry 2006]. Despite the model results, SRS continues to maintain and sample the Georgia monitoring wells on an annual basis. The 2011 sampling results for tritium confirm that none of the Georgia wells are exceeding a concentration of 1,000 pCi/L. Tritium concentrations of 1000 pCi/L or less are consistent with aquifer recharge from rainfall in the SRS area. The MCL for tritium is 20,000 pCi/L.

Although most of the contaminated groundwater plumes at SRS do not approach the site boundary, the potential to impact site streams does exist. Therefore, extensive monitoring is conducted adjacent to and near SRS waste sites and operating facilities, regardless of their proximity to the boundary.

Table 7-1 presents a general summary of the most contaminated groundwater conditions at SRS, based on 2011 monitoring data. The selected wells are from the large plumes at A/M-Area, F/H-Area Seepage Basins, and at the Mixed Waste Management Facility (E Area). The table shows the 2011 maximum concentrations for major constituents in SRS areas that have contaminated groundwater and compares these values to the appropriate drinking water standards. As shown in the table, the two major contaminants of concern in the groundwater are common degreasers (TCE and tetrachloroethylene [PCE]) and radionuclides (tritium, gross alpha, and nonvolatile beta emitters).

All groundwater monitoring results collected during 2011 are included in data table 7-1 of the "Environmental Data/Maps-2011" Appendix located on the accompanying CD. Though it is impractical to provide maps of all wells; Universal Transverse Mercator (UTM) coordinates for each well are included and can be used in conjunction with figure 25 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD to find the approximate locations of the wells. Time-versus-concentration plots for representative wells and contaminants are shown in figure 7-3. The selected wells are from the plumes in A/M-Area, F/H-Areas, and K-Area. As shown in the plots, contaminant concentrations in these wells has decreased through time due to the remedies in place and/or the attenuation process occurring.

TCE contaminant plumes are shown in figures 26-28 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD for various aquifers in A/M-Area. Likewise, tritium contaminant plumes for E- and F/H-areas are shown in figures 29-31 of the "Environmental Data/Maps - 2011" Appendix located on the accompanying CD. Details concerning groundwater monitoring and conditions at individual sites are discussed in SRS site-specific documents, such as RCRA corrective action reports or RCRA/CERCLA facility investigation/remedial investigation reports.

Table 7-1 Summary of Maximum Well Monitoring Results for Major Areas within SRS (2011)

Location	Major Contaminant	Units	2011 Maximum Concentration	Well	MCL[a]	Likely Discharge Point
A/M Area	Trichloroethylene	µg/L	54,000	RWM 1	5	Tims Branch/Upper Three Runs in Swamp in West
	Tetrachloroethylene	µg/L	41,000	MSB101B	5	
C Area	Trichloroethylene	µg/L	2,320	CRW020D	5	Fourmile Branch and Castor Creek
	Tetrachloroethylene	µg/L	25	CRW020D	5	
	Tritium	pCi/mL	2,970	CDB 1	20	
CMP Pits	Tetrachloroethylene	µg/L	643	CMP 10C	5	Pen Branch
	Trichloroethylene	µg/L	707	CMP 10C	5	
	Lindane	µg/L	1.95	CMP 35D	0.2	
D Area	Trichloroethylene	µg/L	286	DCB 62	5	Savannah River Swamp
	Tritium	pCi/mL	231	DCB 26AR	20	
E Area	Tritium	pCi/mL	64,700	BSW 4D2	20	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	Trichloroethylene	µg/L	400	BSW 4D2	5	
F Area	Tritium	pCi/mL	60.6	FSL 15D	20	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	Trichloroethylene	µg/L	37.9	FGW005 C	5	
	Gross Alpha	pCi/L	1,830	FGW005 C	15	
	Nonvolatile Beta	pCi/L	707	FGW005 C	4 mrem/yr[b]	
F-Area Seepage Basin	Tritium	pCi/mL	3,520	FSB 94C	20	Fourmile Branch
	Gross Alpha	pCi/L	652	FSB 94C	15	
	Nonvolatile Beta	pCi/L	1,490	FSB 94C	4 mrem/yr[b]	
H Area	Trichloroethylene	µg/L	6.1	HGW 3D	5	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	Gross Alpha	pCi/L	6.11	HR3 16DU	15	
	Nonvolatile Beta	pCi/L	65.5	HAA 15A	4 mrem/yr[b]	
H-Area Seepage Basin	Tritium	pCi/mL	1,980	HSB70C	20	Fourmile Branch
	Gross Alpha	pCi/L	44.8	HSB102D	15	
	Nonvolatile Beta	pCi/L	648	HSB116D	4 mrem/yr[b]	
K Area	Tritium	pCi/mL	980	KDB 2	20	Indian Grave Branch
	Tetrachloroethylene	µg/L	16.1	KRP 9	5	
	Trichloroethylene	µg/L	16.4	KRP 9	5	
L Area	Trichloroethylene	µg/L	9.65	LAC 8DL	5	L-Lake
	Tetrachloroethylene	µg/L	43.1	LSW 25DL	5	
	Tritium	pCi/mL	642	LSW 25DL	20	
P Area	Tritium	pCi/mL	18,000	PSB011DL	20	Steel Creek
	Tetrachloroethylene	µg/L	400	PGW029DL	5	
	Trichloroethylene	µg/L	5,200	PGW026DL	5	
R Area	Trichloroethylene	µg/L	15.9	RAG008DL	5	Mill Creek in Northwest; Tributaries of PAR Pond
	Tritium	pCi/mL	1,500	RPS004C	20	
	Strontium-90	pCi/L	26.9	RPC 11DU	8	
Sanitary Landfill	Trichloroethylene	µg/L	7.44	LFW 32	5	Upper Three Runs
	Tetrachloroethylene	µg/L	5.71	LFW 59D	5	
	Vinyl Chloride	µg/L	91.9	LFW 21	2	
TNX	Trichloroethylene	µg/L	130	TRW 3	5	Savannah River Swamp

[a] MCL = Maximum Contaminant Level
[b] The activity (pCi/L) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample.

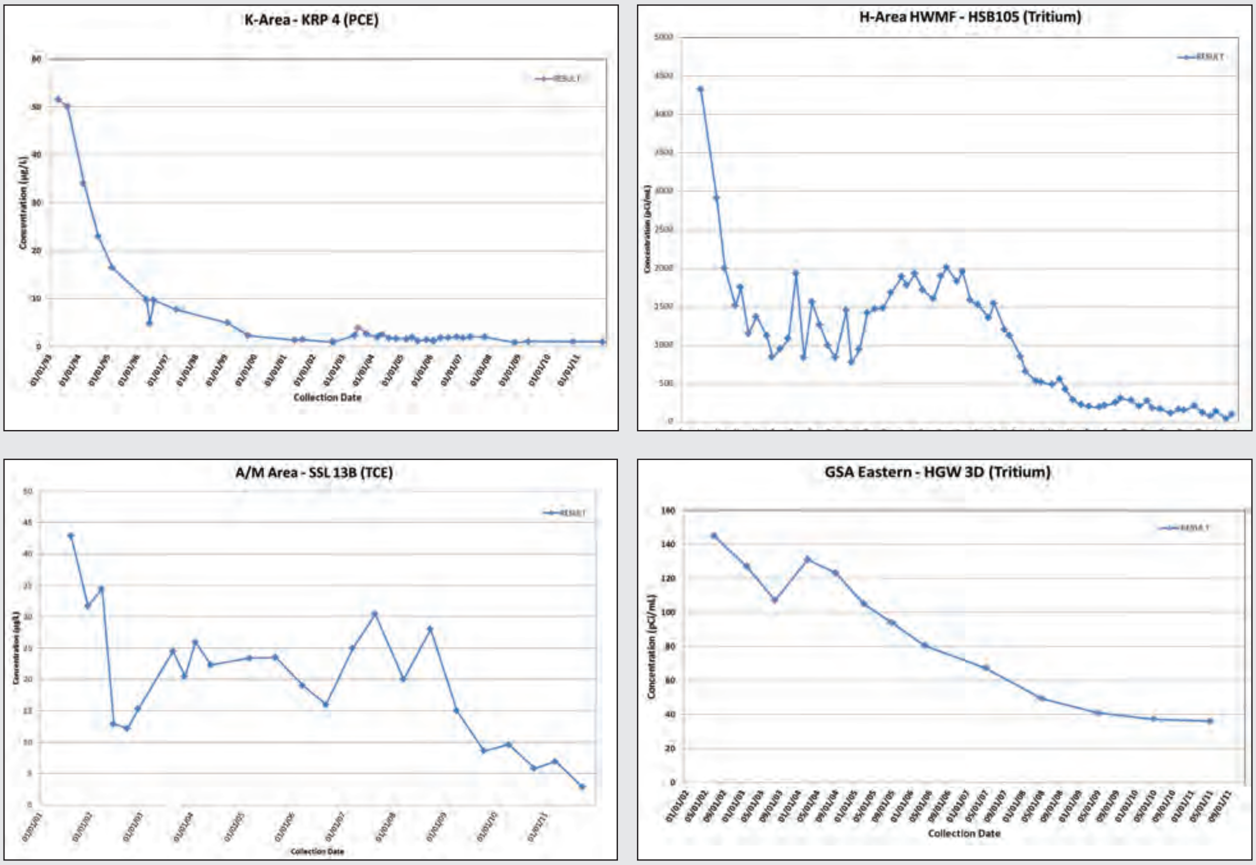


Figure 7-3 Concentration verses Time Plots for Representative Wells at SRS

Quality Assurance

CHAPTER 8

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Savannah River Site (SRS) conducts an environmental Quality Assurance (QA) program to ensure the integrity of analyses performed by SRS and offsite laboratories and to ensure that quality control (QC) program requirements are met. The program's objectives are to ensure that samples are representative of the surrounding environment, and that analytical results are accurate. The focus of this chapter is on environmental laboratory QA. QA and QC definitions are provided in the Glossary.

Environmental QA Program Integration

Laboratory QA

The SRS comprehensive environmental QA program follows the requirements defined in the site's quality assurance procedures. SRS has developed and implemented QA procedures that address these requirements. The SRS independent QA organization reviews and assesses the QA program to ensure compliance with site requirements. SRS environmental personnel periodically conduct QA self-assessments on specific environmental program activities. Results, improvement opportunities, and corrective actions generated by these assessments are documented, handled, and corrected as appropriate. Site management participates in the Management Field Observation process, and the results from these reviews also are documented.

SRS laboratories have documented QA programs that meet SRS and Department of Energy (DOE) requirements. Based on inspections of instrument records and on data reviews, no corrective actions were identified during 2011.

For SRS laboratories, instrumentation includes: liquid scintillation and gas flow proportional counter, alpha and gamma spectrometry, inductively coupled plasma atomic emission spectrometry (ICP-AES), inductively coupled plasma mass spectrometry (ICP-MS), and flow injection mercury system (FIMS). Analyses are also performed for pH, biological oxygen demand, fecal coliform, total residual chlorine, total suspended solids and temperature. Methodology and instrument performance is monitored through the use of QC standards and control charts. Analytical batch performance is measured through the use of QC samples (blanks, spikes, carriers, tracers, laboratory control samples, and laboratory duplicates). QC results that fall outside of specified limits may result in analytical batch or individual sample reruns. For those batches or samples that fall outside of limits, but for which the results are determined to be satisfactory, the reason(s) are documented in the data package, which includes the QA cover sheet, instrument data printouts, and associated QC data.

Laboratory Certification

SRS is certified by the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Laboratory Certification for measurement of field pH, temperature, total residual chlorine, biological oxygen demand, fecal coliform, and for low-level mercury.

SRS is also certified for analytical measurements using the following methods:

- Total suspended solids (Standard Methods, 2540D) (SM, 1992), 25 metals by ICP-AES (EPA, 200.7) (EPA, 1994a), mercury by FIMS (EPA, 245.2) (EPA, 1974), and 17 metals by ICP-MS (EPA, 200.8) (EPA, 1994b)
- 26 metals by ICP-AES (EPA, 6010C) (EPA, 2008a), mercury by FIMS (EPA, 7470A and 7471B)(EPA, 2008c and EPA, 2008d), and 15 metals by ICP-MS (EPA, 6020A) (EPA, 2008b)

Certificates are renewed every three years; the current certificates expire in June 2012.

Laboratory Performance

During 2011, SRS laboratories performing NPDES analyses participated in the SCDHEC-required proficiency testing studies, per State Regulation 61-81 ("State Environmental Laboratory Certification Program"). All laboratories utilized accredited proficiency testing providers, accredited by the American Association of Laboratory Accreditation.

SRS laboratories reported acceptable proficiency testing results during 2011; therefore, state certification was maintained for all analyses.

During 2011, SRS continued to participate in the DOE Mixed Analyte Performance Evaluation Program (MAPEP), a laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE. The DOE Radiological and Environmental Sciences Laboratory, under the direction of the Office of Health, Safety, and Security, administers the MAPEP. MAPEP samples include water, soil, air filter, and vegetation matrices, all with environmentally important stable inorganic, organic, and radioactive constituents. Two separate studies were offered by MAPEP in 2011. In 2011, SRS participated in the two studies, and the results for both studies (141 analyses) were found to be satisfactory.

SRS reviews laboratory performance by analyzing field blind and duplicate samples throughout the year.

SRS personnel routinely conduct blind sample analyses for field measurements of pH to assess the quality and reliability of field data measurements. The blind sample analyses results were acceptable during 2011 with no percent difference values greater than 20 percent. Blind pH sample results can be found in data table 8-1 (see "SRS Environmental Data/Maps" on the compact disk (CD) accompanying this report).

The results for SRS and subcontract laboratory blind and duplicate sample analyses indicated that, although there were some differences, no problems occurred consistently within the laboratories during 2011. For blind samples, only two percent difference values out of 76 were greater than 20 percent; for duplicate samples, only five percent difference values out of 78 were greater than 20 percent. Complete field blind and duplicate sample program results can be found in data tables 8-2 and 8-3 (see "SRS Environmental Data/Maps" on the CD accompanying this report).

SRS's water quality program requires checks of 10 percent of the samples to verify analytical results. Duplicate samples from SRS streams and the Savannah River were analyzed by SRS and a subcontract laboratory in 2011. Results for the field duplicate sampling program indicated that, although there were some differences, no problems occurred consistently within the laboratories. Detailed stream and Savannah River field duplicate sample results can be found in data table 8-4 (see "SRS Environmental Data/Maps" on the CD accompanying this report).

Data Evaluation

Environmental investigations of soils and sediments, primarily for Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) projects, are performed by SRS and subcontract laboratories. Evaluation of the data is completed by SRS according to U.S. Environmental Protection Agency (EPA) standards for analytical data quality, or as specified by SRS onsite customers.

SRS environmental data review program is based in part on two EPA guidance documents, "Guidance for the Data Quality Objectives Process for Superfund" [EPA, 1993a] and "Systematic Planning: A Case Study for Hazardous Waste Site Investigations" [EPA, 2006]. These documents identify QA issues to be addressed, but they do not specify a procedure for data evaluation or provide pass/fail criteria to apply to data and document acceptance. Hence, the SRS data review program contains elements from, and is influenced by, several other references, including

- "Guidance on Environmental Data Verification and Data Validation" (QA/G-8) [EPA, 2002b]
- "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" [EPA, 1999b]
- "USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review" [EPA, 2005]
- "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review" [EPA, 2004]
- "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA, November 1986, SW-846, Third Edition; Latest Update, February 2008 [EPA, 2008f]
- "DOE Quality Systems for Analytical Services," Revision 2.6, November 2010 [DOE, 2010]

- "Analytical Data Qualification," ER-SOP-033, Revision 4 [SRNS, 2010]

For the SRS program, many QA parameters are evaluated by automated processing of electronically reported data. Others are selectively evaluated by manual inspection of associated analytical records. A summary of findings is presented in each project narrative or validation report prepared by Environmental Compliance & Area Completion Projects (EC&ACP) personnel.

Commercial Laboratory Evaluation

The DOE Consolidated Audit Program (DOECAP) implements a consolidated, uniform audit program for conducting annual audits of commercial laboratories (subcontract laboratories) with the main purpose of providing trained auditors to support consolidated audits thereby eliminating audit redundancy from all DOE program line organizations and field sites. An annual DOECAP evaluation of each subcontract laboratory is performed to ensure that all the laboratories demonstrate technical capability and proficiency and follow the required QA programs. The 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. In 2011, evaluations were conducted at three laboratories, resulting in a total of 23 Priority II findings. The findings are fairly evenly distributed among the laboratories audited.

A Priority II finding documents a deficiency that is not of sufficient magnitude to render the audited facility unacceptable to provide services to DOE. A report on the 2011 findings and recommendations was provided to each laboratory. Each affected laboratory then submitted corrective action responses, and the responses subsequently were reviewed. The findings typically are resolved during the next laboratory audit (scheduled for 2012).

Evaluations also were conducted at three laboratories in 2010, resulting in 13 Priority II findings. Each laboratory submitted a corrective action response that addressed each finding. Ten of the 13 Priority II findings identified during 2010 were reviewed and closed during 2011. It is anticipated that the remaining three findings will be closed out with the next scheduled audit in 2012.

During 2011, subcontract laboratories participated in various water pollution studies. The subcontract laboratories reported acceptable proficiency testing results; therefore, state certification was maintained for all analyses.

MAPEP results for subcontract laboratories used by SRS in 2011 also were satisfactory, with the exception of vegetation analyses for several radionuclides at one laboratory. The laboratory with the finding did not perform vegetation analyses for SRS. The laboratory will be evaluated for the cause of the failed analyses and will be required to develop corrective actions to prevent a recurrence.

To help participants identify, investigate, and resolve potential quality concerns, MAPEP issues a letter of concern to a participating laboratory upon identification of a potential analytical data quality problem in the MAPEP results. Letters of concern have been issued since 1996 that are intended to be informative and not punitive. A copy of each letter is sent to DOE/contractor oversight points of contact.

Surveys and Special Sampling

CHAPTER 9

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Environmental Compliance & Area Completion Projects

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In addition to sampling during routine Savannah River Site (SRS) Operations, special sampling is performed for pre-operational baseline monitoring prior to start-up of any new activity or facility, and for nonroutine radiological and nonradiological surveys conducted on and off site. Both short- and long-term radiological and nonradiological surveys are used to monitor the effects of SRS effluents on the site's environment and in its immediate vicinity.

Annual surveys of Creek Plantation Swamp are performed in order to determine the amount and/or distribution of radioactivity that was deposited there during the 1960s. Nonroutine occurrences unrelated to SRS Operations are characterized in order to determine the impact to the SRS Environmental Monitoring Program and the health-impact to the public. On March 11, 2011 following an earthquake and tsunami, a nuclear disaster resulting in releases of radioactive materials occurred at the Fukushima Daiichi Nuclear Power Plant in Japan. Radiation from Japan's Fukushima nuclear incident and the detection of elevated levels of radioisotopes led to the EPA establishing special monitoring protocols for sampling and testing of food, air, and water across the US. Accordingly, SRS expanded its routine environmental surveillance program to assure the public that no harmful levels had reached the immediate community surrounding SRS.

Savannah River Swamp Surveys

Description of Surveillance Program

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 Curies (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 (figure 9-1). Fifty-four monitoring locations were designated on the trails to allow for continued monitoring at a consistent set of locations.

The 2011 survey was designated as a cursory survey, requiring limited media sampling and analysis. Cursory surveys provide assurance that conditions observed during the more detailed comprehensive surveys have not changed significantly. A comprehensive survey (requiring extensive media sampling and analyses) is performed every five years and was last conducted in 2007.

As a continuous improvement initiative, the trail markers were remapped during 2011 using rugged field Global Positioning System (GPS) units and signs were replaced on the trails markers. The data from ground soil sample results were mapped with the aerial survey measurement results. The planned 2012 comprehensive survey will include ground exposure measurements, as well as aerial survey measurements.

Surveillance Results Summary

Figure 9-2 depicts the 2011 aerial measurement footprints mapped over the 1998 aerial survey regions that are outlined with dark blue and green lines. The color schemes indicate highest to lowest concentrations–purple, red, orange, yellow, green, light blue, and dark blue. The soil sample results with GPS coordinates were also included on the map for comparison. Any

Field Sampling Team Obtains GPS Coordinates of Creek Plantation Transects during 2011 (both photos above)

differences between the sample results and gamma-overflight results are likely due to differences in averages over a region compared to point source results. The comprehensive survey of 2012 will provide a more accurate comparison with exposure measurements taken on the ground at every trail marker.

As anticipated, based on source term information and historical survey results, cesium-137 was the primary manmade radionuclide detected in the 2011 survey. Cesium-137 was detected in 41 of the 44 soil samples while no cobalt-60 was detected in any of these samples. Cesium-137 concentrations in soil varied from a minimum of below the minimum detectable concentration (MDC) to a maximum of 29.4 (+/-1.21) pCi/g. These levels are comparable with those from previous surveys (data table 9-1). The highest concentrations occurred on trails 1, 4, 5, and 9 (figure 9-3) and concentrations decreased with depth. These levels are consistent with the aerial survey measurements of higher activity regions around 1, 4, and 9 (figure 9-2). Stronium-89, 90 was detected in 6 of the 44 soil samples. The activity ranged from below the MDC to 0.248 (+/- 0.0517) pCi/g.

Cesium-137 was detected in six of the 11 vegetation samples while no cobalt-60 was detected in any of these samples. Detectable concentrations varied from a minimum below the MDC to a maximum of 4.58 (+/-0.166) pCi/g. These levels are comparable to results of previous surveys (data table 9-2). Higher concentrations generally were observed on trails 1, 5, and 9 (figure 9-3) which is consistent with what was seen in the soil results and aerial survey measurements (figure 9-2). Strontium-89, 90 was detected in 10 of the 11 vegetation samples. The activity ranged from below the MDC to 0.282 (+/-0.0325) pCi/g.

Thermoluminescent dosimeters (TLD) were placed at 32 monitoring sites in the swamp during 2011 to determine ambient gamma exposure rates, and all were retrieved. The exposure time varied from 42 to 50 days. The gamma exposure rates ranged from 0.25 to 0.66 millirem (mrem)/day, which is consistent with the ranges observed historically (data table 9-3). The highest exposure rates were measured on trails 1, 4, 8, and 9 (figure 9-4). These results confirm the aerial survey map results revealing higher levels of activity on trails 1, 4, and 9 (figure 9-2) and follows trends observed in previous surveys.

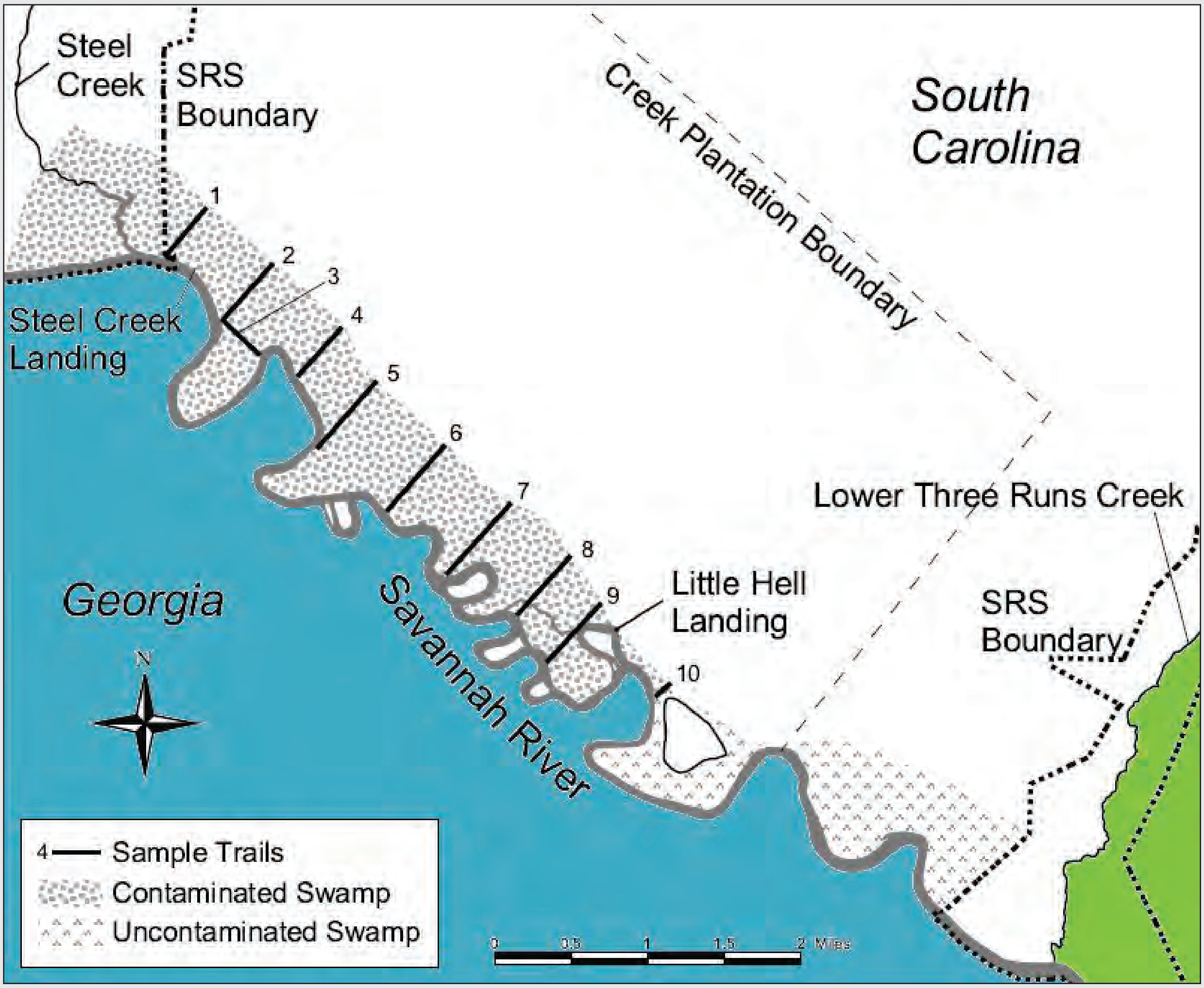


Figure 9–1 Creek Plantation Swamp Trails

Post Japan Tsunami/ Earthquake Event

On March 11, 2011 near the coast of Honshu Island, Japan a 9.0 U.S. Geological Survey (USGS) magnitude earthquake at a depth of 19.9 miles occurred triggering a destructive tsunami with waves more than 45 feet (14 meters) in height. This was the largest quake in Japan since the tracking of earthquakes began 130 years ago. The earthquake led to the automatic shutdown of 11 reactors at four sites (Onagawa, Fukushima Dai-ichi, Fukushima Dai-ni and Tokai) along the northeast coast. Diesel generators provided power until about 40 minutes later, when a tsunami appeared to have caused the loss of all power to the six Fukushima Dai-ichi reactors (www.nrc.gov).

Following the event, the radiological monitoring programs throughout the United States including SRS reported detectable levels of the radionuclides associated with the releases from Japan. To determine the dose impact and distribution of contamination in the environment, quarterly milk sampling, annual vegetation at certain air surveillance locations and edible foodstuff collection were conducted. Vegetation was collected at the Burial Ground North location, four perimeter locations, three 25-mile locations, and the Savannah location. In addition, vegetation was collected near a Georgia dairy location.

Samples were analyzed for iodine (I-131), as well as other gamma-emitting radionuclides.

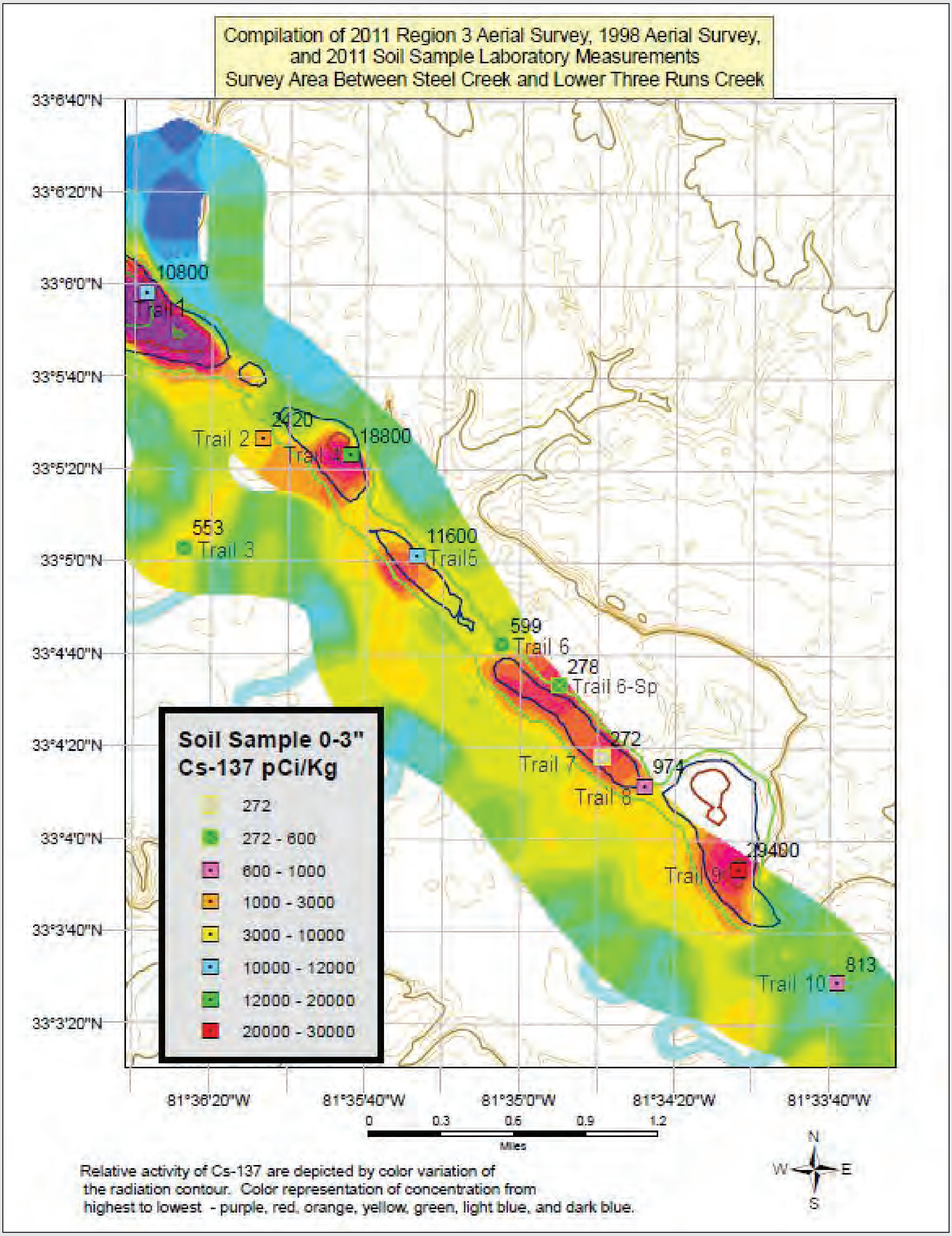
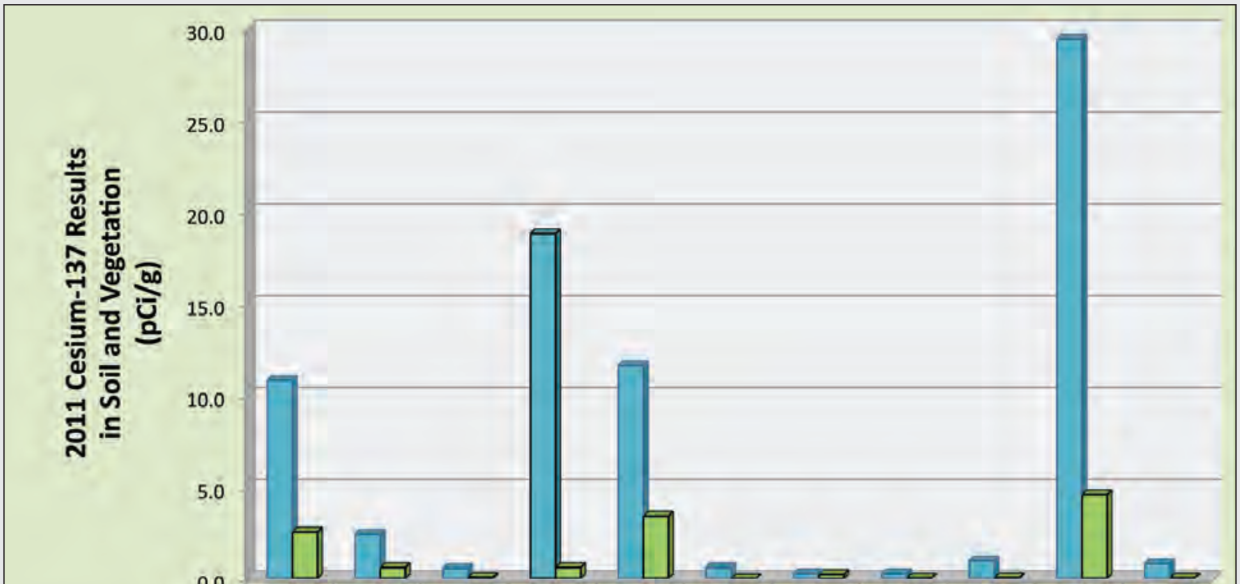


Figure 9–2 Compilation of 2011 Region 3 Aerial Survey, 1998 Aerial Survey, and 2011 Soil Measurement Results



	Trail 1	Trail 2	Trail 3	Trail 4	Trail 5	Trail 6	Trail 6-Special	Trail 7	Trail 8	Trail 9	Trail 10
Cs-137 in Soil 0-3" (pCi/g)	10.80	2.42	0.55	18.80	11.60	0.60	0.28	0.27	0.97	29.40	0.81
Cs-137 in Vegetation (pCi/g)	2.55	0.60	0.06	0.60	3.41	-0.04	0.23	0.03	0.05	4.58	0.04

Figure 9–3 2011 Creek Plantation Cesium-137 Results in Soil and Vegetation (pCi/g)

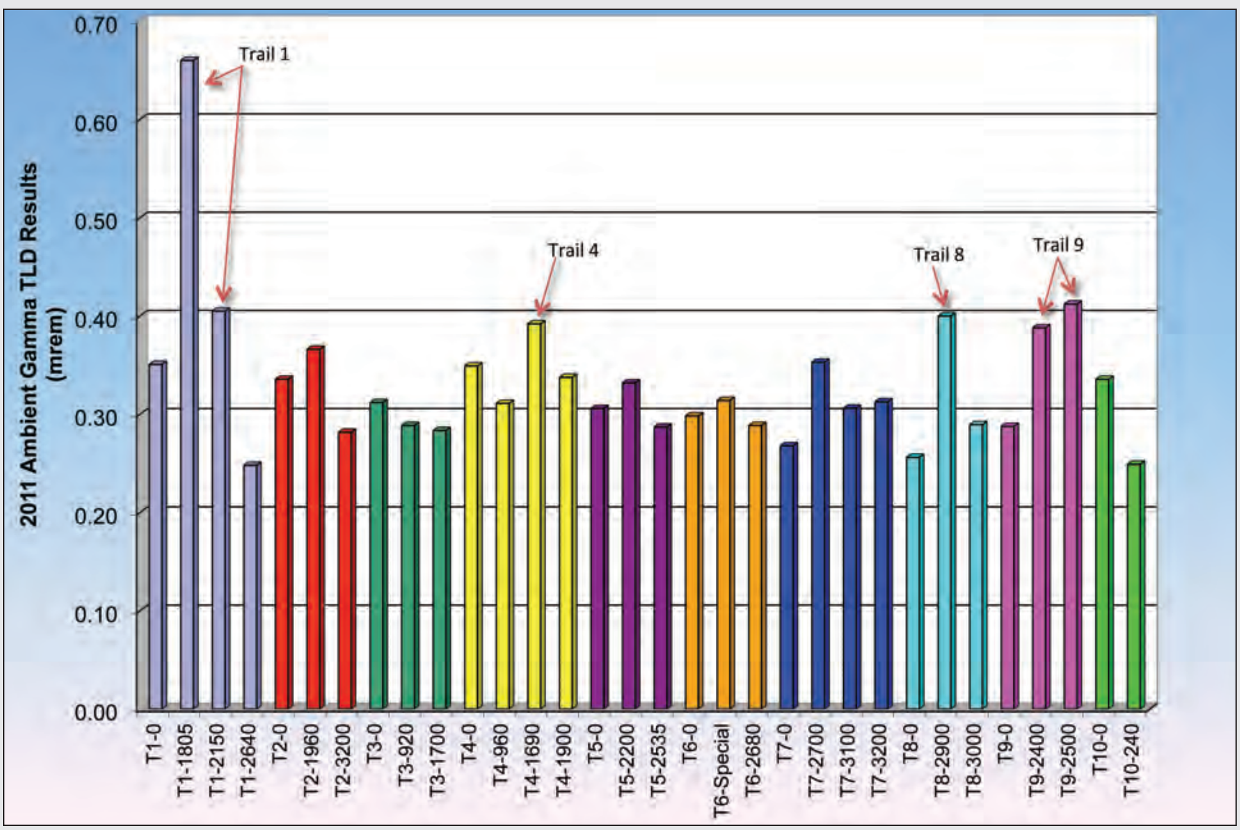


Figure 9–4 2011 Creek Plantation Ambient Gamma TLD Results in mrem/day

Surveillance Results Summary and Dose Impact

Charcoal Canister Results

During the sampling period of March 9 through April 27, 2011 a total of 29 out of 74 charcoal canister samples showed iodine-131 levels greater than the MDC. All 21 charcoal samples collected during the weeks of March 30 and April 6, 2011 were greater than the MDC for iodine-131. The iodine-131 levels fell below the MDC the week of April 6, 2011 and remained below the MDC thereafter. Results for iodine-129 and iodine-131 are summarized in table 9-1 below and are validated by other results published in the United States. Only one charcoal sample from the Talatha Gate Location had cesium-137 at 5.68E-03 (+/-1.37E-03) pCi/m^3, slightly above the MDC of 5.41E-03 pCi/m^3. All of these results are included in Surveillance data table 5-2.

Particulate Filter Results

During the sampling period March 9 through April 27, 2011, two out of 55 particulate filters showed iodine-131 levels greater than the MDC. One was at the Highway 301 sampling location at 1.68E-02 (+/-5.50E-03) pCi/m^3. The other sample was at the Savannah sampling location with an iodine-131 concentration at 2.29E-02 (+/-6.90E-03) pCi/m^3. These results are validated by other results published in the United States. The health impact will be discussed in the dose section. There was no cesium-137 above the MDC in any of the samples. Results are included in data table 5–1.

Wet/Dry Deposition Results

Iodine-131 was detectable in 11 of the 26 deposition samples that were collection during March 9 and April 27, 2011 with a maximum of 1.52E+03 (+/- 1.32E+02) pCi/m^2. Iodine-131 results for all the samples are summarized table 9-2 below. There were no other gamma-emitting radionuclides greater than the MDC.

Vegetation Results

Grassy vegetation was collected on April 6 and 7, 2011. For gamma spectroscopy analyses, each sample was split and half processed wet and the other half processed dry. The sample was not homogenized prior to counting due to the short half-life of iodine-131. Results are summarized in table 9-3 below. Results for wet vegetation had a maximum iodine-131 concentration of 1.19E-01 (+/-9.11E-03) pCi/g, whereas, results of dry vegetation show a maximum of 5.26E-01 (+/-4.69E-02) pCi/g. These results are validated by other results published in the United States.

Milk Results

Milk was collected at all six dairies on April 4, 2011. Gamma spectroscopy results revealed detectable levels of iodine-131 in five out of six dairies at an average of 6.99E-03 (+/-2.92E-04) pCi/mL and a maximum of 1.23E-02 (+/- 9.04E-04) pCi/mL). Results are summarized in table 9-4. No other gamma emitting radionuclides were greater than the MDC.

Table 9–1 2011 Post Fukishima Event Charcoal Canister Radioiodine Results

Location	Average I-131 (pCi/m^3)	Standard Deviation	Maximum I-131 (pCi/m^3)	Standard Deviation
Onsite	2.90E-02	4.53E-03	1.17E-01	1.21E-02
Perimeter	3.11E-02	1.91E-03	1.27E-01	1.41E-02
Offsite	3.24E-02	3.32E-03	1.09E-01	1.21E-02
Location	**Average I-129 (pCi/m^3)**	**Standard Deviation**	**Maximum I-129 (pCi/m^3)**	**Standard Deviation**
Onsite	3.19E-03	8.55E-04	6.41E-03	1.25E-03
Perimeter	1.67E-03	2.59E-05	7.38E-03	1.55E-03
Offsite	1.64E-03	1.92E-04	4.53E-03	1.40E-03

Strawberry Results

The only local edible foodstuffs available at the time of the event were strawberries. Like the vegetation, they were split and half counted by gamma spectroscopy wet and the other half dried and counted after drying. Results for the wet strawberries showed no detectable gamma emitting radionuclides greater than the MDC for cesium-137 (MDC = 5.15E-03 pCi/g) and iodine-131 (MDC = 5.46E-03 pCi/g). Results for the dry strawberries showed no detectable gamma emitting radionuclides greater than the MDC for iodine-131 (MDC = 1.03E-01 pCi/g) and detectable levels of cesium-137 at 4.52E-02 (+/-1.06E-02) pCi/g.

Dose Impacts to the Public

The dose impact from the radioiodine levels for the airborne pathway would equate to <0.1 mrem, far below the average natural background radiation dose of 310 mrem.

Table 9–2 2011 Post Fukishima Event Iodine-131 Results of Wet/Dry Deposition

Location	Date	Iodine-131 Conc (pCi/m^2)	Standard Deviation	MDC (pCi/m^2)	Sig
BURIAL GROUND NORTH	3/30/2011	2.21E+02	4.00E+01	7.82E+01	Y
BURIAL GROUND NORTH	4/6/2011	-8.78E-01	1.92E+01	6.69E+01	N
BURIAL GROUND NORTH	4/13/2011	2.64E+02	2.74E+01	3.98E+01	Y
BURIAL GROUND NORTH	4/20/2011	1.33E+01	1.49E+01	5.40E+01	N
BURIAL GROUND NORTH	4/27/2011	-5.81E+00	1.38E+01	4.80E+01	N
D-AREA	4/6/2011	1.52E+03	1.32E+02	1.75E+02	Y
DARKHORSE	4/13/2011	8.30E+00	1.35E+01	4.86E+01	N
DARKHORSE	4/20/2011	-1.73E+01	1.82E+01	5.19E+01	N
DARKHORSE	4/27/2011	1.29E+01	1.56E+01	5.64E+01	N
DARKHORSE	3/30/2011	2.88E+02	4.86E+01	7.97E+01	Y
DARKHORSE	4/6/2011	8.49E+02	6.00E+01	7.71E+01	Y
GREEN POND	3/30/2011	2.71E+02	3.65E+01	8.17E+01	Y
GREEN POND	4/6/2011	2.46E+02	4.44E+01	6.56E+01	Y
GREEN POND	4/13/2011	1.36E+01	1.47E+01	5.29E+01	N
GREEN POND	4/20/2011	-2.95E+01	1.54E+01	4.89E+01	N
GREEN POND	4/27/2011	-8.05E+00	1.45E+01	4.99E+01	N
HIGHWAY 301 @ STATE LINE	3/30/2011	6.91E+02	5.19E+01	6.80E+01	Y
HIGHWAY 301 @ STATE LINE	4/7/2011	1.72E+01	1.79E+01	6.52E+01	N
HIGHWAY 301 @ STATE LINE	4/13/2011	7.38E+00	1.32E+01	4.72E+01	N
HIGHWAY 301 @ STATE LINE	4/27/2011	-2.08E+01	1.90E+01	6.38E+01	N
PATTERSON MILL ROAD	3/30/2011	1.43E+03	7.91E+01	8.56E+01	Y
PATTERSON MILL ROAD	4/6/2011	1.63E+02	4.32E+01	6.47E+01	Y
PATTERSON MILL ROAD	4/13/2011	-7.91E+00	1.36E+01	4.66E+01	N
PATTERSON MILL ROAD	4/20/2011	-8.06E+00	1.38E+01	4.71E+01	N
PATTERSON MILL ROAD	4/27/2011	-2.10E+00	1.41E+01	4.94E+01	N
SAVANNAH, GA	4/7/2011	7.26E+02	7.95E+01	1.59E+02	Y
Overall Average		**2.56E+02**	**9.00E+00**		
Maximum		**1.52E+03**	**1.32E+02**		

Sig = Significance

Table 9–3 2011 Post Fukishima Event Iodine-131 Results of Grassy Vegetation

COLLECTION LOCATION	I-131 Wet (pCi/g)	Standard Deviation	MDC (pCi/g)	Sig	I-131 Dry (pCi/g)	Standard Deviation	MDC (pCi/g)	Sig
Aiken Airport	8.91E-02	1.13E-02	3.61E-02	Y	2.22E-01	3.37E-02	1.53E-01	Y
Augusta Lock And Dam 614	7.69E-02	8.79E-03	3.27E-02	Y	2.23E-01	3.25E-02	1.58E-01	Y
Burial Ground North	5.33E-02	9.34E-03	3.11E-02	Y	2.63E-01	4.16E-02	1.68E-01	Y
Darkhorse @ Williston	1.19E-01	9.11E-03	3.22E-02	Y	5.26E-01	4.69E-02	1.51E-01	Y
Dairy D	2.33E-02	5.51E-03	4.07E-02	N	2.02E-01	3.00E-02	1.92E-01	Y
Green Pond	9.84E-02	1.03E-02	2.99E-02	Y	2.79E-01	2.67E-02	1.09E-01	Y
Hwy 301	5.52E-02	9.18E-03	4.64E-02	Y	4.01E-01	2.96E-02	1.16E-01	Y
Patterson Mill Road	9.44E-02	9.93E-03	3.01E-02	Y	2.38E-01	4.05E-02	1.76E-01	Y
Savannah, Ga	8.31E-02	1.01E-02	3.68E-02	Y	1.60E-01	3.09E-02	1.66E-01	N

Table 9–4 2011 Post Fukishima Event Iodine-131 Results of Milk

COLLECTION LOCATION	I-131 (pCi/mL)	Standard Deviation	MDC (pCi/mL)	Significance
Dairy Location #1 in SC	5.95E-03	7.00E-04	2.80E-03	Y
Dairy Location #2 in SC	3.11E-03	4.29E-04	2.57E-03	Y
Dairy Location #3 in GA	1.23E-02	9.04E-04	3.50E-03	Y
Dairy Location #4 in SC	8.14E-03	8.41E-04	2.99E-03	Y
Dairy Location #5 in SC	2.02E-03	5.77E-04	3.88E-03	N
Dairy Location #6 in GA	1.04E-02	7.29E-04	2.98E-03	Y
Overall Average	**6.99E-03**	**2.92E-04**		
Maximum	**1.23E-02**	**9.04E-04**		

Sig = Significance

Applicable Guidelines, Standards, and Regulations

APPENDIX **A**

Jack Mayer
Savannah River National Laboratory

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, 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); and in the Clean Water Act (i.e., National Pollutant Discharge Elimination System-NPDES).

SRS compliance with environmental requirements is assessed by the DOE-Savannah River Operations Office (DOE-SR), the South Carolina Department of Health and Environmental Control (SCDHEC), and the U.S. Environmental Protection Agency (USEPA).

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 Public, ICRP Publication 43
- DOE Order 5400.5, "Radiation Protection of the Public and the Environment."
- 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 Procedure 101 (SRS Environmental Monitoring Program Management Plan) of the SRS Environmental Requirements and Program Documents, Manual 3Q1. This document is reviewed annually and updated every 3 years.

SRS has implemented and adheres to the SRS Environmental 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 450.1A (*Environmental Protection Program*) requirement. SRS maintains an EMS that fully meets the requirements of ISO 14001. The full text of the SRS Environmental Policy appears on the compact disk (CD) accompanying this report.

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 A-6.

Radiological airborne releases are also subject to USEPA regulations cited in 40 CFR 61 (Code of Federal Regulations), *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

Table A-1 National Ambient Air Quality Standards for Criteria Air Pollutants – 2011a

Pollutant	Measuring Interval	Micrograms Per Cubic Meter Unless Noted Otherwise [b c]
Carbon Monoxide	1 hour 8 hour	40 mg per cubic meter [e] 10 mg per cubic meter [e]
Gaseous Fluorides (as HF)	12 hr. avg. 24 hr. avg. 1 wk. avg. 1 mo. avg.	3.7 2.9 1.6 0.8
Lead	Rolling 3-month Average [g]	0.15
Nitrogen Dioxide	annual	100
Ozone	8 hours 8 hours	0.08 ppm [d f] 0.075 ppm [d]
PM10	24 hours annual	150 [d] 50 [d]
PM2.5 (Primary and Secondary Standards)	24 hours annual	35 [d] 15 [d]
Sulfur Dioxide	3 hours 24 hours annual	1300 [e] 365 [e] 80

[a] Final rules signed May 27, 2011

[b] Arithmetic Average except in case of total suspended particulate matter

[c] At 250 degrees C and 760 mm Hg.

[d] Attainment determinations will be made based on the criteria contained in 40 CFR 50 Appendices H, I, K and N.

[e] Not to be exceeded more than once a year.

[f] The 1997 standard – and the implementation rules for that standard – will remain in place for implementation purposes as USEPA undertakes rulemaking to address transition from the 1997 ozone standard to the 2008 ozone standard.

[g] Detailed explanation of the rolling 3-month average calculation can be found in 40 CFR 50.16

Regulation 61-62, *Air Pollution Control Regulations and Standards*. As with many regulations found in the 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 are also 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 Standard*s, 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 USEPA-approved dispersion models and then comparing the results to the standard. The pollutants, measuring intervals, and allowable concentrations are provided in table A-1.

Over 250 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, compliance is determined by air dispersion modeling.

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 noted, 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 apply. 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 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.

The A-Area steam facility (Building 784-7A), which uses a smaller, less polluting, biomass boiler and a backup oil-fired boiler, replaced the old coal-fired boilers that had operated previously in that area of the site. This new facility complies with 40 CFR 63, Subpart DDDDD standards. Both particulate and sulfur dioxide emissions at the new facility are projected to be considerably lower than at the existing coal-fired facility. The emission standards for these two new boilers are presented in tables A-4 and A-5. A similar, but larger facility at SRS is expected to come online in 2012.

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

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

[a] British thermal unit
[b] Heat input per hour

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

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

[a] British thermal unit
[b] Heat input per hour

Liquid (Process) Effluent Discharges

DOE Order 5400.5 establishes DCGs for radionuclides in process effluents. (DCGs for radionuclides in liquid are discussed in more detail on page A-7.) 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
- screening values for considering best available technology (BAT) for treatment of liquid effluents
- DOE Order 5400.5 exempts aqueous tritium releases from BAT requirements but not from as low as reasonably achievable (ALARA) considerations.

Four NPDES permits are in place that allow SRS to discharge water into site streams and the Savannah River: two industrial wastewater permits (SC0047431 and SC0000175) and two stormwater runoff permits (SCR000000 for industrial discharges and SCR100000 for construction discharges).

A fifth 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

Table A–4 Airborne Emission Limits for SRS 784–7A Biomass Boiler

Sulfur Dioxide	0.50 lb/10^6 Btu[a,b]
Total Suspended Particulates	0.60 lb/10^6 Btu[a,b]
Nitrogen Oxides	0.33 lb/10^6 Btu[a,b]
Opacity	20%

[a] British thermal unit
[b] Heat input per hour

Table A–5 Airborne Emission Limits for SRS 784–7A Oil-Fired Package Boiler

Sulfur Dioxide	3.5 lb/10^6 Btu[a,b]
Sulfur Dioxide	0.5% Sulfur
Total Suspended Particulates	0.60 lb/10^6 Btu[a,b]
Total Suspended Particulates	0.03 lb/10^6 Btu[a,b]
Nitrogen Oxides	0.15 lb/10^6 Btu[a,b]
Opacity	20%

[a] British thermal unit
[b] Heat input per hour

for collecting each sample-can be found in the individual permits, which are available to the public through SCDHEC's Freedom of Information Office (phone contact 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-6 provides some of the specific South Carolina freshwater standards used in water quality surveillance, but because some of these standards 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 site streams (Table A-6).

Drinking Water

The federal Safe Drinking Water Act, enacted in 1974 to protect public drinking water supplies, was amended in 1977, 1979, 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 USEPA National Primary Drinking Water Regulations (40 CFR 141).

SRS drinking water is supplied to most site areas by the A-Area and D-Area systems, which are actively regulated by SCDHEC. Remote facilities such as field laboratories, barricades, and pumphouses utilize small drinking water systems, which receive a lesser degree of regulatory oversight, and/or bottled water which is purchased offsite.

Bacteriological samples are collected and analyzed monthly or quarterly at an onsite laboratory. SCDHEC personnel periodically collect samples and analyze chemical and organic constituents from the A-Area and D-Area systems. Lead and copper compliance samples are collected every three years from these systems. All sample results in 2011 met SCDHEC water quality standards.

Groundwater

Groundwater is a valuable resource and 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.

Table A–6 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 6.0 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.12, Regulation 61–68, "Water Classifications and Standards" (April 25, 2008)
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 in the parameter immediately 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
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" (April 25, 2008)

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

SOURCE: SCDHEC, 2008

The most common are final federal primary drinking water standards (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/drink/standardsriskmanagement.cfm 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 reports that can be obtained by contacting the groundwater manager of the Savannah River Nuclear Solutions (SRNS) Environmental Compliance and Area Completion Projects group at (803)-952-6523. The regulatory standards for radionuclide discharges from industrial and governmental facilities are set under the Clean Water Act and under Nuclear Regulatory Commission and DOE regulations. In addition, radionuclide cleanup levels, which fall under the authority of DOE, are included in the site RCRA permit. The proposed drinking water maximum contaminant levels (MCLs) 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 could exceed the USEPA annual dose equivalent for persons consuming two 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 and reference levels are

- specific conductance at values equal to or greater than 100 µS/cm
- alkalinity (as $CaCO_3$) at values equal to or greater than 120 mg/L
- total dissolved solids (TDS) at values equal to or greater than 500 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 Doses

The radiation protection standards followed by SRS are outlined in DOE Order 5400.5 and include USEPA 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 Pathway 100 mrem per year

The USEPA 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 total body or organ dose (DOE Order 5400.5 interprets this dose as committed effective dose equivalent) of more than 4 mrem (0.04 mSv).

In 2000, USEPA 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 MCLs for radionuclides, including uranium. In essence, it reestablishes the MCLs from USEPA'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 USEPA 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 USEPA 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 BAT 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 BAT waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from BAT 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 two 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 group compares the monthly liquid effluent concentrations and 12-month average concentrations against the DOE DCGs.

Environmental Management

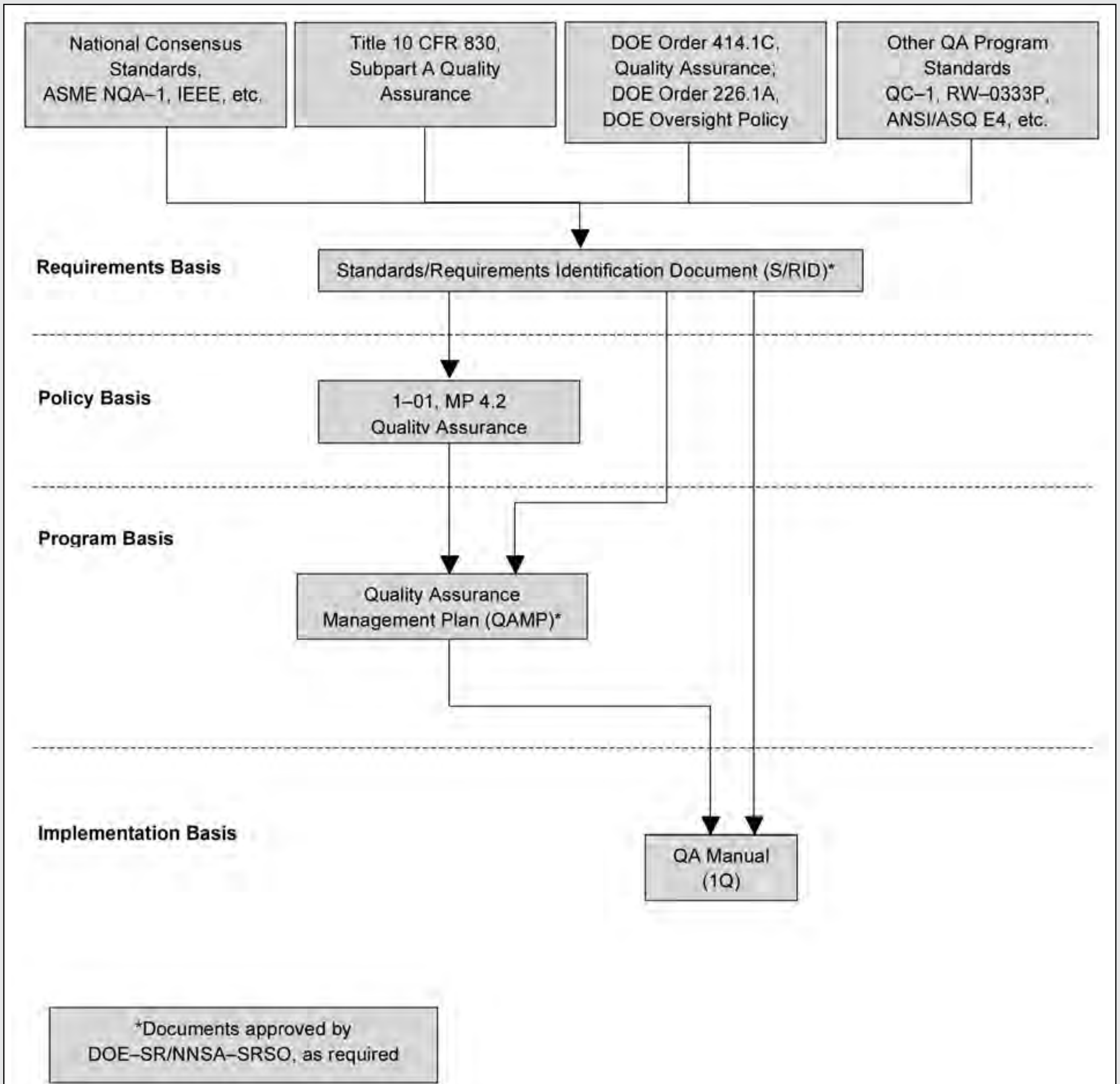
SRS began its cleanup program in 1981. Two major federal statutes provide guidance for the site's environmental restoration and waste management activities-RCRA and CERCLA. RCRA addresses the management of hazardous waste and requires that permits be obtained for facilities that treat, store, or dispose 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 established a National Priority List of sites targeted for assessment and, if necessary, corrective/remedial action. SRS was placed on this list December 21, 1989 (USEPA, 1989). In August 1993, SRS entered into the Federal Facility Agreement (FFA, 1993) with USEPA Region 4 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 USEPA or state regulators for approval.

The disposition of facilities after they are declared excess to the government's mission is managed by Site Area Completion Projects. The disposition process is conducted in accordance with DOE Order 430.1B, *Real Property Asset Management*, and its associated guidance documents. The major emphases are reducing risks to workers and the public and minimizing real property asset lifecycle costs.

Quality Assurance/Quality Control

DOE Order 414.1C, *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, the current site management and operations contractor (SRNS) developed its Quality Assurance Management Plan (SRNS-RP-2008-00020).



References to the standards, guidance, and documents cited in this figure can be found in SRS, 2011

Figure A–1 SRS EM Program QA Document Hierarchy
This diagram depicts the hierarchy of relevant guidance and supporting documents for the SRS QA program.

The plan's requirements are implemented by the SRNS Quality Assurance Manual (1Q).

The SRS Environmental Monitoring Quality Assurance Project Plan (3Q1, Procedure 102), was written to apply the QA requirements of Manual 1Q to the environmental monitoring and surveillance program. The 3Q1 manual includes procedures on sampling, analysis, and reporting that emphasize the quality control requirements for the Environmental Monitoring group.

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 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 the SRNS Retention Schedule Matrix (WSRC-EM-96-00023).

Environmental Monitoring group assessments are implemented according to the following documents:

- DOE Order 414.1C, "Quality Assurance"
- DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance."
- DOE Environmental Management Consolidated Audit Program (EMCAP)
- SRNS 1Q, Quality Assurance Manual
- SRNS 12Q, Assessment Manual

Figure A-1 illustrates the hierarchy of relevant guidance documents that support the SRS QA program.

Reporting

DOE Orders 231.1B, *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 2011*, is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 2011.

Radionuclide and Chemical Nomenclature

APPENDIX B

Page 1 of 2

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	Iodine-129	I-129	1.57E7 y
Americium-241	Am-241	432.7 y	Iodine-131	I-131	8.020 d
Americium-243	Am-243	7.37E3 y	Iodine-133	I-133	20.8 h
Antimony-124	Sb-124	60.20 d	Krypton-85	Kr-85	10.76 y
Antimony-125	Sb-125	2.758 y	Lead-212	Pb-212	10.64 h
Argon-39	Ar-39	269 y	Lead-214	Pb-214	27m
Barium-133	Ba-133	10.53 y	Manganese-54	Mn-54	312.1 d
Beryllium-7	Be-7	53.3 d	Mercury-203	Hg-203	46.61 d
Bismuth-212	Bi-212	1.009 h	Neptunium-237	Np-237	2.14E6 y
Bismuth-214	Bi-214	19.9 m	Neptunium-239	Np-239	2.355 d
Carbon-14	C-14	5715 y	Nickel-59	Ni-59	7.6E4 y
Cerium-141	Ce-141	32.50 d	Nickel-63	Ni-63	101 y
Cerium-144	Ce-144	284.6 d	Niobium-94	Nb-94	2.0E4 y
Cesium-134	Cs-134	2.065 y	Niobium-95	Nb-95	34.99 d
Cesium-137	Cs-137	30.07 y	Plutonium-238	Pu-238	87.7 y
Chromium-51	Cr-51	27.702 d	Plutonium-239	Pu-239	2.41E4 y
Cobalt-57	Co-57	271.8 d	Plutonium-240	Pu-240	6.56E3 y
Cobalt-58	Co-58	70.88 d	Plutonium-241	Pu-241	14.4 y
Cobalt-60	Co-60	5.271 y	Plutonium-242	Pu-242	3.75E5 y
Curium-242	Cm-242	162.8 d	Potassium-40	K-40	1.27E9 y
Curium-244	Cm-244	18.1 y	Praseodymium-144	Pr-144	17.28 m
Curium-245	Cm-245	8.5E3 y	Praseodymium-144m	Pr-144 m	7.2 m
Curium-246	Cm-246	4.76E3 y	Promethium-147	Pm-147	2.6234 y
Europium-152	Eu-152	13.54 y	Protactinium-231	Pa-231	3.28E4 y
Europium-154	Eu-154	8.593 y	Protactinium-233	Pa-233	29.967 d
Europium-155	Eu-155	4.75 y	Protactinium-234	Pa-234	6.69 h

[a] m = minute; h = hour; d = day; y = year

[b] Reference: Chart of the Nuclides, 16th edition, revised 2002, Lockheed Martin Company

Nomenclature and Half-Life for Radionuclides (cont.)

Radionuclide	Symbol	Half-life[a,b]	Radionuclide	Symbol	Half-life[a,b]
Radium-226	Ra-226	1599 y	Thorium-234	Th-234	24.10 d
Radium-228	Ra-228	5.76 y	Tin-113	Sn-113	115.1 d
Ruthenium-103	Ru-103	39.27 d	Tin-126	Sn-126	2.3E5 y
Ruthenium-106	Ru-106	1.020 y	Tritium (Hydrogen-3)	H-3	12.32 y
Selenium-75	Se-75	119.78 d	Uranium-232	U-232	69.8 y
Selenium-79	Se-79	2.9E5 y	Uranium-233	U-233	1.592E5 y
Sodium-22	Na-22	2.604 y	Uranium-234	U-234	2.46E5 y
Strontium-89	Sr-89	50.52 d	Uranium-235	U-235	7.04E8 y
Strontium-90	Sr-90	28.78 y	Uranium-236	U-236	2.342E7 y
Technetium-99	Tc-99	2.13E5 y	Uranium-238	U-238	4.47E9 y
Thallium-208	Tl-208	3.053 m	Xenon-135	Xe-135	9.10 h
Thorium-228	Th-228	1.912 y	Zinc-65	Zn-65	243.8 d
Thorium-230	Th-230	7.54E4 y	Zirconium-85	Zr-85	7.9 m
Thorium-232	Th-232	1.40E10 y	Zirconium-95	Zr-95	64.02 d

[a] m = minute; h = hour; d = day; y = year
[b] Reference: Chart of the Nuclides, 16th edition, revised 2002, Lockheed Martin Company

Errata

APPENDIX C

The following entry corrects information that was reported inaccurately in the *Savannah River Environmental Report for 2010* (SRNS-STI-2011-00059):

Data Table 5–4, Radioactivity in Rain Ion Column: The computer program code for the onsite laboratory analysis of Stronium (Sr) 89/90 (i.e., for annual environmental air surveillance particulate filters) failed to consider Yttrium ingrowth and air volume without manual manipulation. Without the manual intervention, the reported values were approximately three orders of magnitude from the correct values.

Manual calculation checks were performed, validated, and determined to be consistent with the modified computer program code. A permanent software change has been implemented to prevent recurrence. The Sr-89/90 corrected values are listed below.

Location	Sample Conc. *(pCi/m³)*	Sample Std. Dev. *(pCi/m³)*
Savannah, GA	3.59E-05	1.14E-04
Highway 21/167	1.13E-05	1.24E-04
East Talatha	1.37E-04	1.38E-04
Darkhorse @ Williston Gate	3.70E-04	1.51E-04
Talatha Gate	1.24E-04	1.03E-04
Jackson, GA	7.37E-05	1.40E-04
Green Pond	1.34E-04	1.36E-04
Barnwell Gate	-1.39E-05	9.30E-05
Patterson Mill Road	4.88E-05	1.35E-04
Allendale Gate	-8.76E-05	1.22E-04
D-Area	1.90E-04	1.41E-04
Burial Ground North	5.84E-04	1.69E-04
Aiken Airport	1.22E-04	1.06E-04
Augusta Lock and Dam 614	1.86E-05	9.17E-05
Highway 301 @ State Line	3.99E-05	1.00E-04

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.

ALARA — As Low As Reasonably Achievable. A documented process that is implemented to optimize control and management of radiological activities so that doses to the public and releases to the environment are kept ALARA.

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 – A sample that has not been exposed to the sample stream in order to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero-baseline or -background value, and sometimes is used to adjust or correct routine analytical results.

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 – A subsample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample, but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

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 water.

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 – A blend of more than one portion to be used as a sample for analysis.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – This act addresses the cleanup of hazardous substances and establishes a National Priority 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 – Six common air pollutants found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. USEPA is required by the Clean Air Act to set National Ambient Air Quality Standards for these six pollutants.

cross talk – The fraction of all recorded pulses from alpha particles that are recorded in the beta channel due to degradation in their pulse height or the fraction of all recorded pulses from beta particles that are recorded in the alpha channel due to pulse pileup or other phenomenon.

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

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

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

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

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

D

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

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

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 biologica1ly 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) (l rad = 0.01 Gy).

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 radio nuclides 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 to members of 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 l) 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.

exception (formerly "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 the 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 site waste units identified for evaluation and, if necessary, cleanup.

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

field duplicates – Independent samples collected as closely as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

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.

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.

laboratory control sample – A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It generally is used to establish intralaboratory or analyst-specific precision and bias, or to assess the performance of all or a portion of the measurement system.

laboratory duplicate – Aliquot of a sample taken from the same container under laboratory conditions and processed and analyzed independently.

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.

maximum contaminant level – The maximum allowable concentration of a drinking water contaminant as legislated through the Safe Drinking Water Act

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, pH <7; basic solutions, pH >7; and neutral solutions, 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 SRS 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.

sievert – The International System of Units (SI) derived unit of dose equivalent. It attempts to reflect the biological effects of radiation as opposed to the physical aspects, which are characterized by the absorbed dose, measured in gray. One sievert is equal to 100 rem.

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

SME – Subject Matter Expert. A person who is an expert in a particular area or topic

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 – May occasionally stimulate excessive or nuisance growths of algae and other aquatic plants when concentrations exceed 25 mg/L at the time of the spring turnover on a volume-weighted basis in lakes or reservoirs.

total suspended particulates – Refers to the concentration of particulates in suspension in the air, regardless 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., cesiurn-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, 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 at Savannah River 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).

wetland – 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

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

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–US	0.946	L	L	1.057	liq qt–US
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)