Savannah River Site Environmental Report for 2013

Savannah River Nuclear Solutions, LLC
Savannah River Site
Aiken, South Carolina

SRNS-STI-2014-00006

Front Cover - David Scott of the Savannah River Ecology Laboratory provided this year's cover photo. The flowering dogwood (*Cornus florida*) is a common native flowering tree in the eastern United States, with colorful cultivars favored for landscaping by homeowners. This tree grows to around 30 feet in height and shows truly beautiful displays throughout the year. White and pink flower-like bracts dominate its branches during March and April, and bright red berries appear with the approach of fall. Its leaves are bright green but turn to a vibrant red during fall. The beautiful white display of the dogwood is one of the first signs of spring in the pine and hardwood forests at SRS.

For more information about this report, or to obtain additional copies, contact

Amy Meyer
Savannah River Nuclear Solutions, LLC
Building 730-4B, Savannah River Site

P. O. Box 616
Aiken, SC 29802-9975
Telephone: (803) 952-8660
E-mail address: amy.meyer@srs.gov

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SRS wants to make the *Savannah River Site Environmental Report* more useful to its readers. It is important that the information we provide is easily understood, of interest, and communicates DOE's efforts to protect the public and minimize our impact on the environment. We would like to know from you whether we are successful in achieving these goals. Your comments are appreciated and will help us to improve our communications. Please complete the survey, then fold and tape this page so the postage-paid notation and the mailing address are visible, and place it in the mail. You may also complete an online survey on the SRS website at http://www.srs.gov/general/pubs/ERsum/er13/index.html.

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P. O. BOX 616
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SRNS-STI-2014-00006

Savannah River Site

Environmental Report for 2013

Prepared by
Savannah River Nuclear Solutions, LLC
Savannah River Site
Aiken, SC 29808

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TO OUR READERS

The Savannah River Site (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 until1985, when data from both programs were merged into one public document.

The Savannah River Site Environmental Report for 2013 (SRNS-STI-2014-00006) is an overview of effluent monitoring and environmental surveillance activities conducted on and in the vicinity of SRS from January 1 through December 31, 2013 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 2013 report was compiled and prepared by Savannah River Nuclear Solutions, LLC (SRNS), the Site's management and operations (M&O) contractor. The "Environmental Monitoring Program Management Plan" (SRS EM Plan 2013) 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 2013) describes the associated quality assurance requirements.

Complete data tables are included on the compact disk (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 locations, and dose maps; and 3) annual reports from a number of other SRS organizations. The data tables are presented as Adobe® and Excel® formats. The Excel® spreadsheets are unformatted; they are not intended to be printed. However, if printing is desired, the user can print the Acrobat® pdf files. If you wish to print the "SRS Maps" on the CD, we recommend (to ensure clarity) that figures be printed 8.5 x 11 inches.

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, and 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) "Sample-Con" 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. If the uncertainty (standard deviation) is large, the significance may also be set to "No."

- 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 xix.

A

ACM	Asbestos-Containing Material
ADN	Asbestos Disturbance Notice
AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
ARP	Actinide Removal Process

B

BAT	Best Available Technology
BCG	Biota Concentration Guide
BJWSA	Beaufort-Jasper Water and Sewer Authority

C

C&D	Construction and Demolition
CAA	Clean Air Act
CD	Compact Disk
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
Ci	Curie
CMP	Chemicals, Metals, and Pesticides
CO	Carbon monoxide
CSRA	Central Savannah River Area
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year

D

DCS	Derived Concentration Standard
DNR	Department of Natural Resources
DOE	United States Department of Energy
DOE-SR	U.S. Department of Energy - Savannah River Operations Office
DOECAP	DOE Consolidated Audit Program
DWPF	Defense Waste Processing Facility

E

EA	Environmental Assessment
EDAM	Environmental Dose Assessment Manual
EEC	Environmental Evaluation Checklist
EIS	Environmental Impact Statement
EM	Environmental Management
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ERPP	Environmental Radiological Protection Program
ESA	Endangered Species Act
ETP	Effluent Treatment Project

F

FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
ft	Feet/Foot
ft^2	Square Feet
ft^3	Cubic Feet
FY	Fiscal Year

G

gals	Gallons
GDNR	Georgia Department of Natural Resources
GHG	Greenhouse Gas
GSA	General Separations Area

H

HEU	Highly Enriched Uranium
HPSB	High Performance Sustainable Building
HVAC	Heating, Ventilation, and Air Conditioning
HWMF	Hazardous Waste Management Facility

I

I&D	Industrial and Domestic
ICRP	International Commission on Radiological Protection
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization

K

KAC	K-Area Complex
KAMS	K-Area Material Storage
kg	Kilogram

L

lbs	Pounds

M

m^3	Cubic Meters
M&O	Management and Operations
MACT	Maximum Achievable Control Technology
MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Levels
MCU	Modular Caustic Side Solvent Extraction Unit
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDN	Mercury Deposition Network
MSDU	Mega Saltstone Disposal Unit
MEI	Maximally Exposed Individual
MFFF	Mixed Oxide Fuel Fabrication Facility
mi	Mile
mi^2	Square Mile
MOX	Mixed Oxide
mrem	Millirem
mSv	Millisievert
MWMF	Mixed Waste Management Facility

N

NADP	National Atmospheric Deposition Program
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
NOAV	Notices of Alleged Violation
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
NTN	National Trends Network
NWPs	Nationwide Permits

O

O&M	Operations and Maintenance
ODS	Ozone-Depleting Substances
ORPS	Occurrence Reporting and Processing System

P

P2	Pollution Prevention
PA	Performance Assessments
PC	Personal Computers
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene
pCi/g	Picocuries Per Gram
pCi/L	Picocuries Per Liter
PM	Particulate Matter
ppm	Parts Per Million

Q

QA	Quality Assurance
QC	Quality Control

R

RCRA	Resource Conservation and Recovery Act
RCW	Red-Cockaded Woodpecker

RHA	Rivers and Harbors Act
RICE	Reciprocating Internal Combustion Engine
RM	River Mile
RMP	Risk Management Plan

S

SA	Supplement Analysis
SARA	Superfund Amendment and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDP	Salt Disposition Process
SDU	Saltstone Disposal Unit
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SNM	Special Nuclear Materials
SPD	Surplus Plutonium Disposition
SO_2	Sulfur Dioxide
SRARP	Savannah River Archaeological Research Program
SREL	Savannah River Ecology Laboratory
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SSP	Site Sustainability Plan
STP	Site Treatment Plan
S.U.	Standard Units
SWDF	Solid Waste Disposal Facility
SWPF	Salt Waste Processing Facility

T

TCE	Trichloroethylene
TLD	Thermoluminescent Dosimeter
TRI	Toxic Release Inventory
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids

U

US	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFS-SR	United States Forest Service-Savannah River

USGS	U.S. Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet

V

VEGP	Vogtle Electric Generating Plant
VOC	Volatile Organic Compound

W

WQC	Water Quality Criteria
WIPP	Waste Isolation Pilot Plant
WSB	Waste Solidification Building
WTP	Water Treatment 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 Abbreviations	Location Name/Other Applicable Information
4M	Fourmile
4MB	Fourmile Branch (Fourmile Creek)
4MC	Fourmile Creek
BDC	Beaver Dam Creek
BG	Burial Ground
BLTW	Burke and Screven Counties Wells (Georgia)
EAV	E-Area Vaults
FM	Four Mile
FMB	Fourmile Branch (Fourmile Creek)
GSTW	Burke and Screven Counties Wells (Georgia)
HP	HP (sampling location designation only; not an actual abbreviation)
HWY	Highway
JAX	SRS Boundary Wells
KP	Kennedy Pond
L3R	Lower Three Runs
MHTW	Burke and Screven Counties Wells (Georgia)
MPTW	Burke and Screven Counties Wells (Georgia)
MSB	SRS Boundary Wells
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
TR	Burke and Screven Counties Wells (Georgia)
U3R	Upper Three Runs
VEGP	Vogtle Electric Generating Plan (Plant Vogtle)

Sampling Locations Known by More Than One Name
Augusta Lock and Dam; New Savannah River Lock & Dam
Beaver Dam Creek; 400-D
Fourmile Creek–2B; Fourmile Creek at Road C
Fourmile Creek–3A; Fourmile 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 Hwy 125
Upper Three Runs–1A; Upper Three Runs–1A at Road 8-1
Upper Three Runs–3; Upper Three Runs–3 at Road C
Highway 17 Bridge; Houlihan Bridge
Stokes Bluff; Stokes Bluff Landing

INTRODUCTION — Chapter 1

Michael Griffith
Savannah River Nuclear Solutions, LLC

Timothy Jannik
Savannah River National Laboratory

This report was prepared in accordance with United States Department of Energy (DOE) Order 231.1B "Environment, Safety, and Health Reporting" to present summary environmental information and 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, and*
- *Providing results for radiological monitoring and clearance of property.*

This report is the principal document that demonstrates compliance with the requirements of DOE Order 458.1, "Radiation Protection of the Public and the Environment," and is a key component to DOE's effort to keep the public informed of environmental conditions at SRS.

MISSIONS

The mission of SRS is to safely and efficiently operate SRS to protect public health and the environment while supporting the nation's nuclear deterrent and the transformation of the Site for future use. Activities at SRS support the DOE Environmental Management (EM) program, the National Nuclear Security Administration (NNSA), and the needs of the nation and are organized around three primary mission areas:

- **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.

You will find more information on SRS's website at http://www.srs.gov/general/srs-home.html.

ORGANIZATION

To execute SRS's missions, two federal agencies, two state universities and several contractors participate in various supporting roles. The relationship of these contractors with DOE is shown in Figure 1-1 and each entity is described on the following pages.

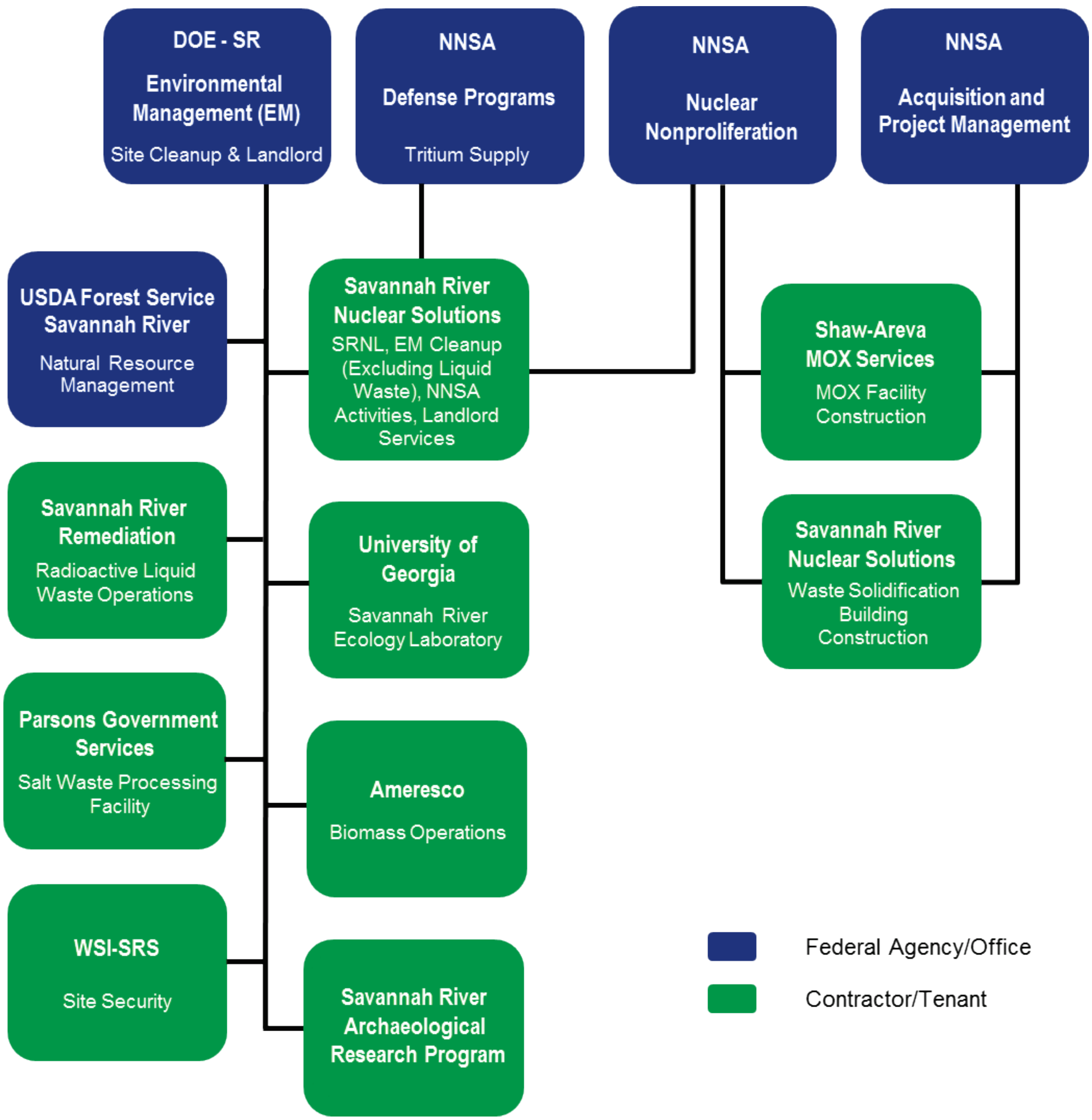

Figure 1-1 SRS Organization

The DOE Savannah River Operations Office (DOE-SR) is responsible for oversight of Environmental Management operations and landlord services supporting all mission areas at SRS. You will find more information on the DOE-SR website at http://sro.srs.gov.

NNSA offices that include the SRS office are responsible for management of key national security mission areas including defense programs and nuclear nonproliferation. NNSA is also responsible for emergency operations related to SRS tritium facility functions and DOE/NNSA radiological emergency response assets. You will find more information on the NNSA website at http://www.nnsa.energy.gov/aboutus/ourlocations/savannah-river-site.

Savannah River Nuclear Solutions, LLC (SRNS), a joint venture of Fluor Corporation, Newport News Nuclear, and Honeywell International, Inc., is the SRS management and operations contractor. SRNS operates the Savannah River National Laboratory (SRNL), nuclear materials and used nuclear fuel facilities, solid waste management facilities, tritium programs, Site infrastructure, and waste site remediation and closure projects in support of all three SRS mission areas. You will find more information on the SRNS website at http://www.savannahrivernuclearsolutions.com/.

Operated by SRNS, SRNL is SRS's and DOE-EM's applied research and development laboratory. SRNL creates practical, high-value, cost-effective technological solutions in all three SRS mission areas. SRNL also provides technical leadership and key support for future SRS missions. You will find more information on the SRNL website at http://srnl.doe.gov.

Savannah River Remediation LLC (SRR) is the DOE-SR liquid waste contractor responsible for treating, storing, and disposing of radioactive liquid waste. SRR is composed of a team of companies led by URS Corporation with partners Bechtel National, CH2M Hill, and Babcock & Wilcox. Critical subcontractors for the contract are AREVA, Energy Solutions, and URS Safety Management Solutions. You will find more information on the SRR website at http://srremediation.com.

Parsons Government Services, Inc. is the DOE-SR contractor responsible for the design, construction, startup, and operation of the Salt Waste Processing Facility (SWPF). The SWPF will separate radioactive salt solutions currently stored in below ground tanks at SRS. The separated solutions will be transferred to the Defense Waste Processing Facility (DWPF) or the Saltstone Facility for more processing. You will find more information on the Parsons website at http://www.parsons.com/projects/Pages/salt-waste-processing-facility.aspx.

Shaw Areva MOX Services, LLC is the NNSA contractor responsible for the design, construction, startup, and operation of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF). The MFFF will convert plutonium that could be used to make weapons to a form that can be used in a commercial nuclear power plant. You will find more information on the Shaw Areva MOX Services website at http://www.moxproject.com.

WSI-SRS is the DOE-SR contractor responsible for the protective force that fulfills security requirements and executes emergency contingency plans that protect special nuclear materials, government assets, and Site employees from security threats. WSI-SRS obtained ISO 14001, Environmental Management Systems registration in 2008 and currently maintains that registration. You will find more information on the corporate website at http://www.g4sgs.com.

Ameresco Federal Solutions, Inc. constructed and now operates biomass steam generating plants in K and L Areas and the steam and electricity cogeneration plant located near F Area. DOE-SR has contracted Ameresco to supply steam and electricity to SRS. Data from the plants are not included in the *SRS Environmental Report for 2013* because the facilities operate under environmental permits issued directly to Ameresco by the South Carolina Department of Health and Environmental Control (SCDHEC). You will find more information on the Ameresco website at http://www.ameresco.com/sites/default/files/cs_savriver_v5.pdf.

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. SREL's mission is to provide an independent, university-based perspective on the environmental risks associated with past, present and future DOE missions on the SRS, to train future generations of scientists on how to evaluate such risks and to provide local communities with data on how DOE and Site contractors are addressing environmental issues of importance to environmental protection and human health. You will find more information on the laboratory's website at http://srel.uga.edu.

Under an Interagency Agreement with DOE-SR, the United States Department of Agriculture (USDA) Forest Service-Savannah River (USFS-SR) contributes to environmental stewardship at SRS by: managing the Site's natural resources, including timber; maintaining and improving habitat for threatened, endangered, and sensitive species; maintaining secondary roads and Site boundaries; performing prescribed burns and protecting the Site from wild-land fires; and evaluating the effects of its management practices on the environment. You will find more information on the USFS-SR website at http://www.fs.usda.gov/savannahriver.

The Savannah River Archaeological Research Program (SRARP) is a research unit of the University of South Carolina that provides the technical expertise to support management of SRS cultural resources. SRARP responsibilities include identifying, evaluating, and protecting SRS archaeological sites and artifacts, conducting compliance based research, offering public outreach programs, and preparing documents and reports for state and federal regulators. You will find more information on the SRARP website at http://www.srarp.org.

SITE LOCATION, DEMOGRAPHICS, AND ENVIRONMENT

SRS was constructed during the early 1950s to produce materials (primarily plutonium-239 and tritium) used in nuclear weapons. 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 1-2). The Savannah River flows along the Site's southwestern border. The capital letters within the SRS borders on Figure 1-2 identify operational 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. 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 the southwest by the Savannah River for 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 is also used for commercial and sport fishing, boating, and other recreational activities. The river is not currently used for any large-scale irrigation projects 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 systems. SRS uses groundwater for both industrial processes and 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. The catastrophic Charleston Earthquake of 1886, with an estimated magnitude of 7.0 on the Richter scale, dominates characterization of regional earthquake activity. 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 the1886 event) near Charleston (Taiwani 2001). Levels of seismic activity within this region are very low, with magnitudes generally less than or equal to 3.0.

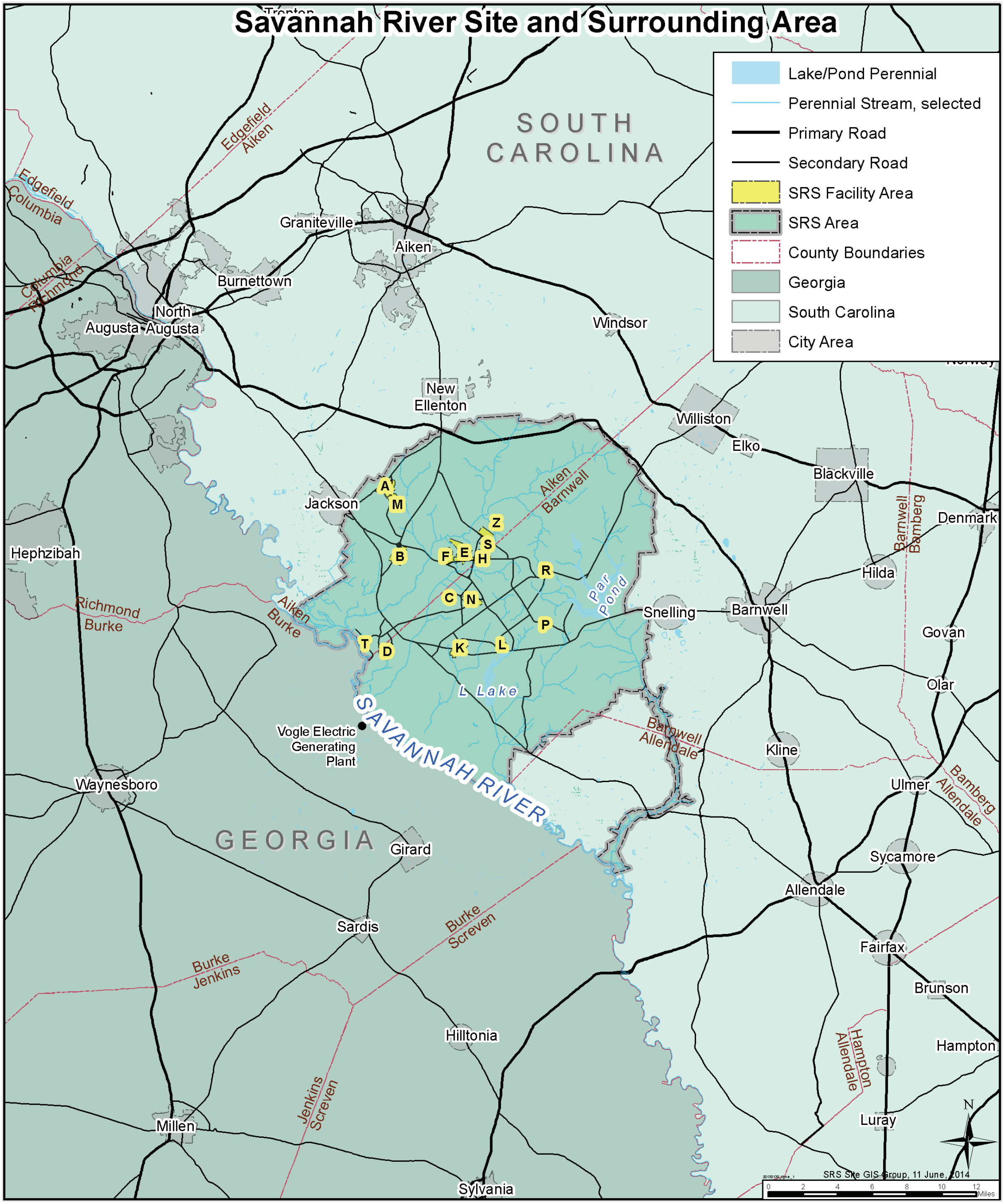

Figure 1-2 The Savannah River Site and Surrounding Area

Land and Forest Resources

About 90 percent of SRS land area consists of natural and managed forests planted, maintained, and harvested by the USFS-SR. Four major forest types are found on SRS: mixed pine-hardwoods, sandhills pine savanna, bottomland hardwoods, and swamp floodplain forests. More than 345 Carolina bays exist on SRS. Carolina bays are relatively shallow depressions that provide important wetland habitat and refuge for many plants and animals.

Animal and Plant Life

SRS uses only about 10 percent of the total land area of the Site for mission-orientated facilities. The remainder is maintained in healthy, productive, and 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.

DOE EM PRIMARY SITE ACTIVITIES

Nuclear Materials Stabilization

In the past, the separations facilities located in F and H Areas processed special nuclear materials (SNM) 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.

SRS's two primary separations facilities, called "canyons" because of their resemblance to a gorge in a deep valley between steeply vertical cliffs, are located in F and H Areas. F Canyon and H Canyon are where nuclear materials were chemically recovered and purified. F Canyon was deactivated in 2006 while H Canyon continues to operate. H Canyon is a multi-purpose facility supporting both DOE-EM and NNSA missions. Its unique design and capability allows it to disposition surplus uranium and plutonium materials. One of the primary missions of H Canyon since 2003 has been to recover highly enriched uranium from various spent and un-irradiated nuclear fuels as well as from uranium bearing materials from across the DOE complex. The uranium solution is purified through the separation process and down blended into a low-enriched uranium product using natural uranium that is shipped offsite and used in the manufacture of commercial reactor fuel, which is a key function of the nation's nuclear nonproliferation program. H Canyon also dissolves plutonium (non-pit) materials into a solution that will be fed to the HB-Line facility (located on top of H Canyon) for conversion into a purified oxide product. This plutonium oxide product is forecasted as feed for the MFFF. Other H Canyon missions include disposing of vulnerable sodium reactor experiment fuel while also conducting tests to support NNSA's Next Generation Safeguards Initiative. During 2013, SRS used H Canyon and HB-Line to prepare surplus plutonium materials for disposition at the Waste Isolation Pilot Plant (WIPP) in New Mexico. You will find more information on SRS's website at http://www.srs.gov/general/programs/harea/index.htm.

Nuclear Materials Consolidation and Storage

SRS provides for the handling and interim storage of our nation's surplus plutonium and other SNM and fulfills the United States' commitment to international nonproliferation efforts in a safe and environmentally sound manner. The K-Area Complex is DOE's only SNM storage facility designated for interim safe storage of plutonium. The principal operations building formerly housed K Reactor, which produced nuclear materials to support the United States during the Cold War for nearly four decades. DOE has revitalized this very robust structure to safely store nuclear materials. The stored materials have various proposed disposition paths including WIPP, the Defense Waste Processing Facility (DWPF), H Area facilities, and the MFFF. You will find more information on the Nuclear Materials Management page on SRS's website at http://www.srs.gov/general/programs/nmm/index.htm.

Used Nuclear Fuel Storage

SRS supports the Global Threat Reduction Initiative and research reactor programs by safely and cost effectively receiving and storing used fuel elements from foreign and domestic research reactors, pending disposition. Currently, used nuclear fuel is stored at the L-Area Complex. You will find more information on the L-Area Complex fact sheet on SRS's website at http://www.srs.gov/general/news/factsheets/esrs_lac.pdf.

Waste Management

SRS manages large volumes of radiological and nonradiological waste created by previous operations at the nuclear reactors and their support facilities, as well as newly generated waste created by ongoing Site operations. Specific waste management initiatives are described below and on the following pages.

Radioactive Liquid Waste Management

Radioactive liquid waste is generated at SRS as byproducts from the processing of nuclear materials for national defense, research, and medical programs. Approximately 37 million gallons of radioactive liquid waste are safely stored in underground tanks located in the F- and H-Area Tank Farms.

While waste is stored in the tanks, sludge settles by gravity to the bottom of the tank and a liquid (salt), known as supernate, resides on top of the sludge. The supernate is reduced by evaporation and the condensed vapors are transferred to the Effluent Treatment Project for treatment. The concentrated salt that remains is transferred to the Salt Disposition Process (SDP). The SDP consists of the Actinide Removal Process (ARP) and Modular Caustic Side Solvent Extraction Unit (MCU). The two systems work together as an integrated process to remove nearly all of the radioactive isotopes from the salt. Processing of salt waste will continue through the SDP facilities until the Saltwaste Processing Facility (SWPF), which is currently under construction, becomes operational. The low-activity decontaminated salt is then sent to the Saltstone Production Facility, where it is mixed with cement, fly ash, and furnace slag and poured into concrete Salt Disposal Units (SDUs) (formerly referred to as vaults) for safe disposal, at the Saltstone Disposal Facility. New circular SDUs, designed and tested to be watertight, have been constructed and placed in operation. The high-activity contaminates that were removed at ARP and MCU are transferred along with the tank sludge for treatment at DWPF. At DWPF, the waste is treated and converted into a solid glass form suitable for long-term storage and disposal. This solidification process is also known as vitrification. You will find more information on the Radioactive Liquid Waste Disposition page on SRS's website at http://www.srs.gov/general/programs/liquidwaste/index.htm and the Waste Solidification page at http://www.srs.gov/general/programs/solidification/index.htm.

SRS waste tanks have provided more than 50 years of safe storage for radioactive liquid waste. Removing waste from the tanks will allow for permanent closure of the Site's radioactive liquid waste tanks, a high priority for DOE.

You will find more information on SRS's website at http://www.srs.gov/general/news/factsheets/lnwtc.pdf.

Solid Waste Management

Solid wastes managed at SRS include the following types:

- Low-level radioactive solid waste, which includes items such as protective clothing, tools, and equipment that have become contaminated with small amounts of radioactive material;
- Transuranic (TRU) waste, contains alpha-emitting isotopes with an atomic number greater than that of uranium;
- Hazardous waste, is any toxic, corrosive, reactive, or ignitable material that could affect human health or the environment;
- Mixed waste, contains both hazardous and radioactive components; and
- Sanitary waste, which like ordinary municipal waste, is neither radioactive nor hazardous.

All wastes generated at SRS 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 SRS must manage. You will find a summary of waste minimization activities in Chapter 2, "Environmental Management System."

During 2013, SRS completed remediation and repackaging of the remaining legacy TRU waste. SRS has now disposed of or packaged for disposal 5,138 cubic meters of legacy TRU waste. You will find more information on the Solid Waste Management page on SRS's website at http://www.srs.gov/general/programs/solidwaste/index.htm.

Area Completion

Past operations at SRS have resulted in the release of hazardous and radioactive substances to soil and groundwater. The purpose of the Area Completion program is to deactivate and decommission contaminated facilities and remediate soils, groundwater, surface water, and sediments to levels that are protective of human health and the environment. The program provides for post-closure care and corrective action(s) at closed waste units to address contamination from hazardous constituents and substances (including radionuclides) and for the investigation and remediation of solid waste management units (SWMUs) as appropriate.

Two major federal laws drive environmental cleanup: the Resource Conservation and Recovery Act (RCRA), which establishes a system for tracking and managing hazardous wastes from generation to disposal; and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, which addresses the protection and cleanup of the environment from known release of hazardous substances. SRS is meeting the integrated requirements of these two laws through a Federal Facility Agreement (FFA) between DOE, the Environmental Protection Agency (EPA), and SCDHEC, which specifies how DOE will address known or potential contamination at SRS waste units.

SRS uses a streamlined cleanup strategy to accelerate work and reduce overall lifecycle costs. A key component of this approach is the use of a core team process with EPA and SCDHEC. In reaching such decisions, the team solicits and considers public and stakeholder (such as the Citizens Advisory Board) input.

During 2013, SRS completed remediation of the 400^{th} of 515 waste units, expanded the phytoremediation system (using trees and plants to remove or break down pollutants) at the Mixed Waste Management Facility in E Area, and initiated a continuous improvement project to identify and optimize opportunities to reduce cost associated with the SRS groundwater monitoring program. You will find more information on the Area Completion Projects page on SRS's website at http://www.srs.gov/general/programs/soil/extpage.html.

Effluent Monitoring and Environmental Surveillance

SRS conducts extensive environmental monitoring within a 2,000 square-mile network extending 25 miles from SRS, with some monitoring performed as far as 100 miles from the Site. This area includes neighboring cities, towns, and counties in South Carolina and Georgia. 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 are analyzed for the presence of radioactive and nonradioactive contaminants. SRS selects sampling locations, sample media, sampling frequency, and types of analysis based on environmental regulations, exposure pathways, public concerns, and measurement capabilities. The selections also reflect the Site's commitment to safety, protecting human health, meeting regulatory requirements, reducing the risks associated with past, present, and future operations, and improving cost effectiveness.

During 2013, SRS accomplished several significant milestones while maintaining its record of environmental excellence, 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 to the public was well below the DOE public dose limit. You will find more information on the Environmental Monitoring fact sheet on the SRS website at http://www.srs.gov/general/news/factsheets/env_monitoring.pdf.

NNSA PRIMARY SITE ACTIVITIES

Tritium Processing

Tritium is a radioactive form of hydrogen gas that is a vital component of nuclear weapons. Tritium has a half-life of 12.3 years and must be periodically replenished. SRS is the nation's only facility for extracting, recycling, purifying, and reloading tritium. Tritium is replenished by recycling tritium from existing warheads and by extracting tritium from target rods irradiated in nuclear reactors operated by the Tennessee Valley Authority. Recycled and extracted gases are purified to produce tritium suitable for use. SRS tritium facilities are part of the NNSA's Defense Programs operations at SRS. You will find more information on the Defense Programs page on SRS's website at http://www.srs.gov/general/programs/dp/index.htm.

Nuclear Nonproliferation

SRS is one of the primary DOE sites with missions to address issues of national security and nonproliferation, including legacy material disposition. Currently under construction, the MFFF will convert surplus weapons-grade plutonium to a form that can be used to generate electricity in commercial nuclear power reactors. Once irradiated, the plutonium in the MOX fuel can no longer be readily used for nuclear weapons. You will find more information on the MOX project website at http://www.moxproject.com.

ENVIRONMENTAL MANAGEMENT SYSTEM

Chapter 2

Kim Cauthen
Savannah River Nuclear Solutions, LLC

The Department of Energy (DOE) is committed to implementing sound stewardship practices to protect the air, water, land, and other natural, archaeological, and cultural resources that may be affected by Savannah River Site (SRS) construction, operations, maintenance, and decommissioning activities. The Environmental Management System (EMS) provides for the systematic planning, integrated execution, and evaluation of SRS activities for: (1) public health and environmental protection, (2) pollution prevention and waste minimization, (3) compliance with applicable environmental and cultural resources protection requirements, and (4) continuous improvement of the EMS.

SRS EMS IMPLEMENTATION

Introduction

EMS is a recognized business tool with a well-developed structure and format that reflects the best environmental and sustainability practices. DOE has integrated the specific framework provided by DOE Orders into SRS's current management practices and procedures. While there are a number of acceptable EMS models, each follows a similar format. The framework chosen by DOE is the International Organization for Standardization (ISO) Standard 14001 (Environmental Management Systems). The ISO 14001 model employs a cycle of policy development, planning, implementation and operation, checking, corrective action, and management review. The ultimate goal is to improve performance as the cycle repeats.

DOE Order 436.1, "Departmental Sustainability," describes the requirements and responsibilities for implementing the EMS program. The Order requires SRS to develop and implement an annual Site Sustainability Plan (SSP) that identifies the Site's contributions toward meeting sustainability goals. In addition, SRS must use an EMS as a platform for SSP implementation and programs with objectives and measurable targets that contribute to SRS meeting its sustainability goals. Table 2-1 provides a list of the SRS EMS and sustainability objectives along with the status of the Site's progress toward meeting these goals.

The implementation strategy is documented in the *Environmental Management System Description Manual* (G-TM-G-00001) located on the SRS website at http://www.srs.gov/general/pubs-/envbul/documents/ems_manual.pdf. WSI-SRS and Shaw AREVA MOX Services, LLC maintain similar EMS programs in compliance with applicable DOE Orders and contract-specific requirements.

SRS performs self-assessments to identify issues, areas of concern, good practices and determine the overall health of the environmental program. SRS conducted 15 program level self-assessments in 2013. These assessments identified only minor items related to minor equipment repairs and submittal of records. These issues were corrected and documented in the SRS tracking system. You will find information on assessments and inspections by outside agencies in Chapter 3, "Compliance Summary."

Implementation of the EMS program is a part of an overall Integrated Safety Management System (ISMS) approach at SRS. The EMS is based on a continual improvement framework depicted in Figure 2-1. SRS organizations follow this approach and include environmental and regulatory requirements into their programs and procedures.

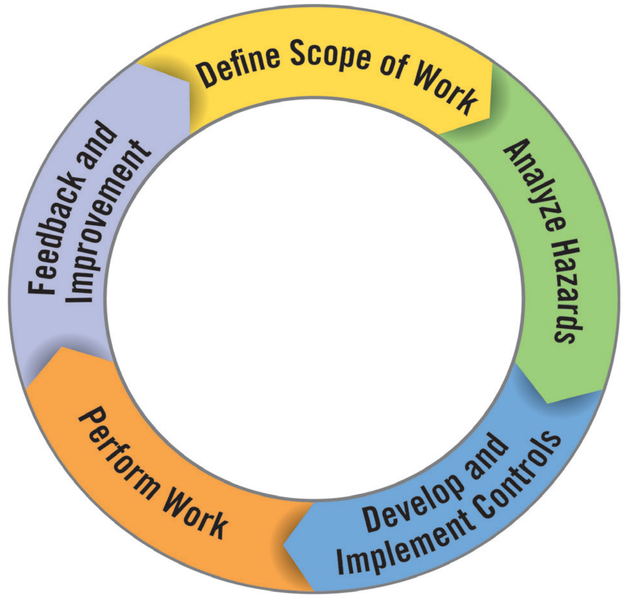

Figure 2-1
Integrated Safety Management System Continual Improvement Framework

Environmental Policy

The SRS Environmental Policy documents SRS's intent to implement sound stewardship practices that protect the air, water, land, and other natural and cultural resources potentially impacted by SRS construction, operations, maintenance, and decommissioning activities. The policy is reviewed annually and updated as needed. Chapter 6 of the *SRS Policy Manual* on the DOE-SR website at http://sro.srs.gov/pdf_files/SRSPM_250_1_1A.pdf contains the current policy. Shaw AREVA MOX Services, LLC has a similar EMS Policy in place with respect to its EMS program.

Objectives, Targets, and Programs

Through the EMS, SRS identifies significant environmental aspects. New objectives and targets are set each year to meet these aspects and support DOE environmental objectives.

SRS established 10 specific objectives and targets for 2013. These targets and a summary of SRS's progress in achieving them are shown in Table 2-1.

Table 2-1 2013 SRS EMS Targets (Summary)

EMS Objectives/Target	Status
Minimize energy use in SRS buildings	SRS conducted a study during 2013 that identified 25 buildings that required assessment against the High Performance Sustainable Building (HPSB) guiding principles. Recommended actions for achieving the guiding principle objectives will be implemented in FY 2014 and FY 2015 as funds become available.
Reduce greenhouse gases	The SRS biomass plants continued to provide steam and electricity for operations and provide significant reductions in greenhouse gas (GHG) emissions compared to the coal plants used until 2012. Savannah River Nuclear Solutions (SRNS), LLC sponsored a community event that allowed local residents to exchange gasoline-powered lawn equipment for electric and battery powered devices. The removal of the gasoline equipment from use reduced GHG by almost 2,000 pounds during the year. The exchanged equipment was recycled.

Table 2-1 2013 SRS EMS Targets (Summary Continued)

EMS Objectives/Target	Status
Maximize renewable energy	Biomass facilities continued to provide steam and electricity for Site operations.
Maximize alternative fuel vehicle usage	SRS continued to maximize the use of E85 vehicles. Approximately 80% of SRS's light duty fleet currently use E85 fuel or are gasoline hybrids.
Maximize the purchase of green products	SRS included a requirement to use cost-effective Environmentally Preferable Purchasing (EPP) products in all new applicable procurement solicitations. At least 95% of applicable solicitations included the EPP clause.
Minimize the use of toxic chemicals	Through effective monitoring of chemical purchases and use of less toxic replacements, SRS reduced the purchase of high hazard chemicals during the year by 23.75%.
Minimize solid waste generation	SRS continued to minimize sanitary and office waste disposal by achieving a 38.5% recycle rate during the year. Two community events were held to promote conservation and energy reduction. SRS, in partnership with the SRS Community Reuse Organization, donated wood used to package construction materials for use by local high schools to teach carpentry skills.
Maximize the use of low-energy electronics	A minimum of 95% of electronic products purchased during the year met the Electronic Product Environmental Assessment Tool (EPEAT) standards.
Ensure all releases to the environment remain within established regulatory limits	SRS environmental programs used an aggressive mixture of proactive in-field observations and education of SRS personnel. These programs ensured that SRS facilities maintain their requirements and commitments. Chapter 3, "Compliance Summary," discusses the specific compliance status for SRS operations.
Ensure facility activities meet regulatory expectations	SRS assigns employees to perform inspections of major facilities on a regular basis. The results of these inspections are formalized in lessons learned that are shared Site wide.

SUSTAINABILITY ACCOMPLISHMENTS

Pollution Prevention/Waste Minimization

SRS strives to prevent or reduce pollution and waste generation whenever feasible. In 2013, pollution prevention (P2) projects avoided or diverted 6,357 cubic meters (m^3) of sanitary, hazardous, and low level radioactive wastes. The annual cost avoidance from these projects resulted in nearly $12 million. Table 2-2 shows a 2013 summary of the P2 and waste minimization projects and their contributions.

Figure 2-2 Ameresco Biomass Co-generation Facility

Annually, SRS establishes a performance target for recycling its routine office-type sanitary waste stream. For 2013, the office and building waste recycle target was 35% and SRS achieved a recycle rate of 38%. This equals 600 metric tons of routine sanitary waste diverted to recycle markets. In addition, SRS diverted many useful materials to recycle or reuse during the year. Table 2-2 provides highlights of those activities.

Table 2-2 Summary of SRS Pollution Prevention Activities

Activity Description	Waste Minimized or Recycled
Hazardous waste generation avoided due to pollution prevention projects	6.018 m^3
Low level radioactive waste generation avoided due to pollution prevention projects	67.5 m^3
Mixed hazardous and low level mixed waste generation avoided due to pollution prevention projects	25.3 m^3
Transuranic waste generation avoided due to pollution prevention projects	72.9 m^3
Lead recycled	11,867 lbs
Light bulbs recycled	12,900 lbs
Used oil recycled	20,000 gals
Lead-acid batteries recycled	174,000 lbs
Used tires recycled	36,000 lbs
Metals recycled	2,333,670 lbs
Wood/lumber recycled	1,138,000 lbs
Furniture recycled/reused	154,850 lbs
Scrap electronic devices recycled (Does not include computers returned to vendor for reissuance)	182,480 lbs

Energy Intensity

Energy intensity is best described as the amount of energy per square foot needed to satisfy the energy needs of a facility. DOE as an agency is required to reduce its energy intensity by 30% by FY 2015 from a FY 2003 baseline. SRS has surpassed the goal by achieving a 72.8% decrease through FY 2013. The major contributor to the reduction in 2013 was shutdown of the coal fired energy facilities at SRS and the full operation of the biomass facilities for providing steam and electricity. Energy derived from renewable sources of energy such as biomass are not used in energy intensity calculations.

While SRS has met the DOE goal, SRS is finding ways to further reduce energy intensity. SRS conducted many activities in FY 2013 that reduced energy intensity including:

- Continued operation of the Ameresco Biomass Co-generation Facility. This activity had the most impact on energy intensity reduction since steam and electricity output from the plant are not included in the intensity metric. The reduction in energy intensity is due to the use of biomass, a renewable energy source, instead of coal previously used at SRS. Figure 2-2 shows the Ameresco Biomass Co-generation Facility.
- Completed replacement of several heating, ventilation, and air conditioning (HVAC) units with new, higher Seasonal Energy Efficiency Ratio units;
- Advised SRS personnel to reduce energy usage during summer months;
- Utilized “cool roof” technology (material designed to reflect more sunlight and absorb less heat than standard roofs) on roof replacements; and
- Installed Verdiem® energy management software on selected computers at the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF).

SRS conducted many significant activities in energy intensity specifically in the Tritium facilities in 2013 including:

- Completed construction of two new buildings that allowed the relocation of personnel into offices that incorporate energy efficient features;
- Continued design of the ice storage system for the Materials Test Facility. This system is a pilot application for the use of stored ice to support the equipment cooling needs of a process facility. Ice is produced during times of low cooling needs and used to supplement cooling when needs are high;
- Achieved High Performance Sustainable Building (HPSB) status for the Tritium Administration Building against the standards for existing buildings. Older, existing buildings generally use more energy and water than new buildings of the same size. SRS uses the HPSB standards to determine the best methods to reduce energy and water use, which reduces impacts to the environment, and lowers operating cost; and
- Started the process to achieve HPSB status for the Tritium Engineering Facility against the standards for new construction.

Renewable Energy

A variety of laws, regulations, and DOE orders encourage the use of renewable energy sources such as biomass fuels. DOE used Energy Saving Performance Contracts to construct new steam and electrical generation facilities that use biomass as the primary fuel. This has eliminated coal as a source of energy at SRS. SRS has four biomass steam plants in permanent operation in A Area, L Area, K Area, and F Area.

Greenhouse Gas Reduction

SRS is committed to reducing GHG Scope 1 and 2 emissions by 28% by FY 2020 from the FY 2008 baseline. Scope 1 consists of direct emissions such as onsite combustion of fossil fuels or fugitive GHG emissions and Scope 2 consists of indirect emissions associated with the consumption of electricity, heat, or steam. Actual targets by DOE take into account new mission growth and other factors.

Ongoing organization of GHG data associated with the various impact sources, such as Site energy use and vehicle/equipment use will allow for development of a comprehensive inventory and subsequent management.

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

- Purchased electricity,
- Wood (biomass),
- Fuel oil,

- Propane,
- Hydrofluorocarbons,
- Gasoline,
- Diesel fuel,
- E85 (ethanol) fuel, and
- Jet fuel.

SRS has greatly reduced GHG emissions by transferring to a biomass-based energy supply versus the previous coal-based supply. GHG reduction of 75.2% was realized in FY 2013 due to the operation of the existing biomass plants and the recent addition of the Ameresco Biomass Co-generation Facility.

Water Management

DOE Order 436.1 requires that sites reduce potable water intensity by 26% by FY 2020 relative to the FY 2007 baseline. Compared to the baseline, SRS has currently reduced potable water intensity by 10.9%. In FY 2013, low-flow toilet flush valves, low-flow urinal flush valves, and low-flow faucets continued to be installed as part of routine maintenance practices. In recent years, several hundred faucets and flush valves have been replaced with reducers or low-flow units.

Transportation and Fleet Management

The primary DOE transportation and fleet management goals are to decrease fleet petroleum consumption by 2% annually by FY 2020 from the FY 2005 baseline and increase alternative fuel (E85) consumption by 10% annually by FY 2015 relative to the FY 2005 baseline. SRS has exceeded this goal.

The use of E85 fuel at SRS has increased dramatically in recent years while gasoline usage has decreased. Approximately 80% of vehicles in the light duty fleet currently utilize E85 fuel or are gasoline hybrids. The Site works to ensure the use of E85 fuel remains high by prioritizing the use of flex fuel vehicles. In the initial year of E85 fuel use (FY 2000), SRS consumed about 80,000 gallons of E85 fuel. In FY 2013, this consumption total was greater than 234,000 gallons. The result is an increase of nearly 194% since initiation of this fuel choice.

Sustainable Acquisition

SRS established sustainable acquisition practices for Environmentally Preferable Purchasing (EPP). In 2013, at least 95% of applicable solicitations included a requirement to use cost-effective EPP products. SRS has changed several acquisition processes to include EPP procurement practices, including:

- Review and approval of chemical purchases, this review monitors usage of hazardous chemicals and, where appropriate, recommends EPP products;
- Procurement and leasing of desktops, laptops, and monitors that meet Electronic Product Environmental Assessment Tool (EPEAT) standards and copiers that are Energy Star compliant; and
- Procurement of EPP substitutions under various new and existing contracts, including bulk janitorial supplies (e.g., cleaners, paper products) and safety items (e.g., earplugs, filters).

Electronic Assets Management

SRS continued to purchase EPEAT and other energy efficient electronic products. Leasing of many of the computers allows for easy return and redeployment of devices no longer needed at SRS.

EMS BEST PRACTICES/LESSONS LEARNED

Sustainability Campaign

SRS continued implementation of the “One Simple Act of Green” environmental awareness campaign. The program promotes individual action by connecting SRS employees to information, tools, and programs to make a difference in our environment.

During 2013, several recommendations to SRS employees included:

- Using reusable shopping bags,
- Recycling,
- Turning computers off when not in use,
- Ideas for saving money at the gasoline pump,
- Involvement in Earth Day activities,
- Personal commitments to “going green,” and
- Ideas for an environmentally friendly Christmas.

Chemical Management Center

SRS provides centralized control of chemical materials procurement and management of excess chemical materials to reduce the volume and toxicity of the chemicals procured, reduce chemical inventories and waste, and improve tracking and communication of chemicals currently in onsite inventory. Hazardous and non-hazardous chemicals are reused 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. SRS distributed for reuse more than 10,585 pounds of chemicals in 2013 for reuse and avoided more than $113,000 in chemical purchase and waste management costs.

AWARDS AND RECOGNITION

DOE recognizes significant contributions to Site missions that positively affect the local and surrounding environment. Site activities and projects are evaluated for noteworthy practices, implementation of new and emerging technologies, and insightful approaches to resolving environmental stewardship issues.

The DOE Sustainability Performance Office announced that SRS won two 2013 DOE Sustainability Awards. A DOE Individual Champion Award was presented to an SRS employee with over 20 years of sustainability work at SRS. The second award recognized SRS’s continuing efforts to “green” the SRS vehicle fleet. These are the top-level awards presented for environmental sustainable performance in DOE.

The Environmental Protection Agency awarded SRS a Federal Electronics Challenge Silver-Level award for the environmentally sustainable electronics program.

The SRS NNSA program achieved its second Gold-Level Leadership in Energy and Environmental Design certification for the MFFF construction project Technical Support Building. The MFFF construction project Administration Building was previously certified as Gold-Level in 2010.

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COMPLIANCE SUMMARY

Chapter 3

Tracy Bryant
Savannah River Nuclear Solutions, LLC

To ensure the protection of human health and the environment through safe operations, the Savannah River Site (SRS) implements compliance programs designed to fulfill requirements of applicable federal and state environmental laws and regulations, and with United States Department of Energy (DOE) orders, notices, directives, policies, and guidance.

This chapter reports the status of Savannah River Site (SRS) compliance with applicable statutes, orders, directives, and programmatic documents. The chapter addresses the following topics:

- Compliance Status,
- SRS Environmental Issues/Actions,
- Continuous Release Reporting,
- Unplanned Releases, and
- Permits.

Table 3-7, located at the end of this chapter, lists federal laws and regulations applicable to SRS and summarizes the 2013 status of each requirement.

COMPLIANCE STATUS

This section addresses SRS compliance in the areas of environmental restoration, waste management, radiation protection, air and water quality and protection, as well as other environmental requirements.

SRS's exceptional compliance record demonstrates our commitment to protect the environment. During 2013, SRS successfully managed more than 500 environmental permits, each containing numerous compliance requirements and conditions. SRS received two Notices of Violation (NOV) from the South Carolina Department of Health and Environmental Control (SCDHEC) for a one month exceedance of permit limits at two National Pollutant Discharge Elimination System (NPDES) industrial outfalls. SRS voluntarily implemented extensive corrective actions to address the violations, and SCDHEC did not assess any penalties. For the SRS NPDES program only three out of approximately 3,914 sample analyses performed during 2013 exceeded NPDES permit limits, a 99.9% compliance rate. SRS did not receive any Notices of Alleged Violation (NOAVs) in 2013 and continued to meet all regulatory requirements of its permits. NOVs/NOAVs are the formal regulatory notices that allege violations of an organization's permits or of environmental laws or regulations. SRS continues to evaluate and improve its compliance program to minimize environmental occurrences.

ENVIRONMENTAL RESTORATION

Environmental Restoration/Cleanup

SRS is included on the National Priority List (NPL) due to past releases or potential releases of hazardous substances, pollutants, or contaminants. As a result, SRS must assess the nature and extent of the public health and environmental risks associated with the releases and must determine the appropriate remedial actions required, if any, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). DOE, the United States Environmental Protection Agency (USEPA or EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) in accordance with Section 120 of CERCLA, entered into the Federal Facility Agreement (FFA) on August 16, 1993. The FFA integrates CERCLA and hazardous waste regulations (Resource Conservation and Recovery Act, or RCRA) requirements to achieve a comprehensive remediation of SRS and to coordinate administrative and public participation requirements. The FFA governs the remedial action process, sets annual work priorities, and establishes milestones for cleanup actions.

SRS has 515 waste units subject to the FFA, including RCRA/CERCLA units, Site Evaluation Areas, and facilities covered by the SRS RCRA permit. At the beginning of Fiscal Year (FY) 2013, surface and groundwater cleanup of 399 of these units were complete and 12 units were in the remediation phase. By the end of FY 2013, 400 units were complete and 11 units were in the remediation phase. You will find a listing of all 515 waste units at SRS in Appendices C ("RCRA/CERCLA Units List") and G ("Site Evaluation List") of the FFA at http://www.srs.gov/general/programs/soil/ffa/ffa.pdf. You can learn more about the status of FFA activities for FY 2013 at http://www.srs.gov/general/programs/soil/ffa/ffaapr.pdf.

Waste Management

Radioactive Liquid Waste Processing and Disposition

SRS continued to meet all regulatory requirements and deadlines pertaining to radioactive liquid waste processing and disposition. You will find more information on Liquid Waste Disposition at http://www.srs.gov/general/programs/liquidwaste/index.htm and the Waste Solidification page at http://www.srs.gov/general/programs/solidification/index.htm on SRS's website.

The Actinide Removal Process (ARP), Modular Caustic Side Solvent Extraction Unit (MCU), and Saltstone Production Facility (SPF) are permitted under the SCDHEC Industrial Wastewater Regulations. The ARP/MCU process will eventually be replaced by the Salt Waste Processing Facility (SWPF), which is currently under construction. The Saltstone Disposal Facility (SDF) is permitted under the SCDHEC Solid Waste Landfill Regulations. In 2013, SRS continued to use circular Saltstone Disposal Units (SDUs) for disposal operations. SRS completed design of a new mega SDU (MSDU) and broke ground for construction in 2013 with plans to begin operations in 2015. The MSDU is similar to the current circular SDU but will be much larger and will hold ten times the volume of waste. In FY2013, over 2 million gallons of waste was processed and disposed through the Saltstone facilities.

The Defense Waste Processing Facility (DWPF) is permitted under SCDHEC Industrial Wastewater Regulations. In FY 2013, DWPF produced 225 canisters with approximately one million gallons of glass, immobilizing approximately 4.5 million curies of radioactivity. Since operations began in March 1996, approximately 14.5 million pounds of glass have been produced, and 52.5 million curies have been immobilized.

The Effluent Treatment Project (ETP) is permitted under the SCDHEC Industrial Water Regulations and processes approximately 20 million gallons of wastewater per year that is monitored and discharged to a state permitted outfall.

Radioactive Liquid Waste Tank Closure

SCDHEC permits the F- and H-Area Tank Farms under the Industrial Wastewater Regulations through the provisions of Section IX, "High-Level Radioactive Waste Tank System(s)," of the FFA. In addition, tank closure activities are subject to DOE Order 435.1, "Radioactive Waste Management," and the Ronald W. Reagan National Defense Authorization Act (NDAA), Section 3116, which is discussed later in this chapter.

Stabilizing the tanks with grout completes operational closure and significantly reduces future risk to the environment, the public, and the SRS workforce. Operational closure activities can only begin after waste in the tanks has been removed for processing/treatment and dispositioning. SCDHEC, through the Pollution Control Act, oversees the closure process through the protocols established in the Industrial Wastewater General Closure Plan for both the F- and H-Area Tank Farms. DOE, SCDHEC, and EPA work closely together to establish requirements, such as the Appendix L of the FFA, which provides the closure commitments for removing the tanks from service.

SRS met the FFA commitment to operationally close Tanks 18F and 19F by December 31, 2012. In 2013, SRS completed closure of Tanks 5F and 6F. As with Tanks 18F and 19F, both tanks underwent an extensive waste removal process that included bulk waste removal, specialized mechanical cleaning, and isolation of the tanks from all external systems. These activities culminated in regulatory confirmation that the tanks were ready for stabilization. SRS operationally closed Tanks 5F and 6F in December 2013.

The Radioactive Liquid Waste Operational Closure of Tanks fact sheet, found on SRS's website at http://www.srs.gov/general/news/factsheets/lnwtc.pdf provides additional information.

Figure 3-1 SRS Employees Grouting Tanks 5F and 6F

Atomic Energy Act/DOE Order 435.1, Radioactive Waste Management

The Atomic Energy Act of 1954 (AEA) gives DOE the authority and responsibility to ensure that radioactive waste is managed in a manner that is protective of health and safety of workers, the public and of the environment. DOE Order 435.1 describes the processes and procedures DOE uses to carry out this responsibility.

SRS manages, treats, stores, and disposes of low-level, high-level, and transuranic (TRU) waste in compliance with DOE Order 435.1. As required by Manual 435.1-1, "Radioactive Waste Management," DOE is required to perform risk informed assessments to evaluate the potential impacts of low-level radioactive waste disposal to the workers, the public, and the environment. The risk-informed assessments are called Performance Assessments (PAs). The PAs provide the technical basis and evaluation needed to demonstrate compliance with DOE Order 435.1. DOE approved site-specific PAs for the E-Area Low Level Waste Facility, Saltstone Disposal Facility, and the F-Area Tank Farm. A site-specific PA for the H-Area Tank Farm is currently under review.

SRS performs a comprehensive PA annual review to ensure operations and any developing information do not alter the original conclusions of the PAs, and there is a reasonable expectation the facility will continue to meet the performance objectives of the Order. The 2013 annual reviews for the E-Area Low-Level Waste Facility PA, the Saltstone Disposal Facility PA, and the F-Area Tank Farm PA showed that operations in FY 2013 were within the performance envelope and that SRS continued to operate the facilities such that the public and the environment were protected.

Also, as required by the Order, SRS has prepared a composite analysis, which assesses the combined impact of multiple low-level waste disposal facilities after closure. The analysis demonstrates a reasonable expectation that DOE dose limits will not be exceeded by estimating the projected dose to future members of the public from radioactivity that may remain after disposal operations at SRS have ceased. The composite analysis results are used for planning, radiation protection activities and future use commitments to minimize the likelihood that SRS low-level waste disposal activities will result in the need for future corrective or remedial actions to adequately protect the public and the environment after closure.

Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005, Section 3116

NDAA Section 3116(a) is legislation that allows the Secretary of Energy, in consultation with the Nuclear Regulatory Commission (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) and does not require deep geologic disposal. Under this legislation, the Secretary of Energy signed the *Determination for Closure of the F-Tank Farm* in March, 2012. The determination acknowledges that the stabilized tanks and ancillary structures in F-Area Tank Farm closure will not require permanent isolation in a deep geologic repository because highly radioactive residuals were removed to the maximum extent practical. Therefore, closure will be managed pursuant to closure plans approved by SCDHEC.

During 2013, DOE supported the NRC in their F-Tank Farm monitoring role under Section 3116 of the NDAA by hosting on-site observation visits, participating in teleconferences with the NRC, and by providing various documents to the NRC, as requested. In February 2013, DOE issued the basis for the Secretary's determination for closure of the H-Tank Farm for NRC review, as part of DOE's H-Tank Farm consultation with the NRC under NDAA Section 3116. In addition, DOE also provided the document for public review and comment.

Through 2013, DOE also supported the NRC consultative role for the H-Tank Farm by participating in public meetings and teleconferences with the NRC, hosting an NRC site visits for H-Tank Farm, and providing numerous documents as requested by the NRC. DOE anticipates finalizing the H-Tank Farm 3116 Basis Document in 2014 upon conclusion of the NRC consultative process and consideration of public comments.

Based on the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site,* SRS is authorized to dispose of treated salt waste in the Saltstone Disposal Facility. The Saltstone Disposal Facility is currently monitored by the NRC in coordination with the State of South Carolina as required by NDAA Section 3116(b). The NRC monitors disposal actions taken by DOE to evaluate compliance with the performance objectives set out in Title 10 Code of Federal Regulations (CFR) Part 61, Subpart C, "Performance Objectives." The NRC documents and publishes its monitoring activities during each calendar year. These reports are available to the public on the NRC web page at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1911/.

Resource Conservation and Recovery Act (RCRA)

Low-level, mixed low-level (a mixture of radioactive and hazardous waste) and hazardous waste generated from onsite industrial processes is stored, treated and disposed of in vaults or trenches at the E-Area Low-Level Radioactive Waste Facility if it meets the E-Area performance objectives under DOE Order 435.1. If the waste generated does not meet the E-Area performance objectives or if disposal onsite is not cost-effective, SRS secures offsite commercial or federal disposal. RCRA established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste, such as a flammable or corrosive liquid. EPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste at SRS. A RCRA hazardous waste permit application contains two parts – Part A and Part B. Part A consists of the required EPA forms along with general facility information including maps, drawings, and photographs. Part B of the RCRA hazardous waste permit application contains detailed, site-specific information addressing the treatment, storage, and disposal facilities operated and closed by SRS. The SRS RCRA permit renewal application currently has 10 volumes. In 2013, SRS operated active treatment, storage, and disposal facilities and maintained closed facilities in compliance with the SRS RCRA permit requirements.

Nineteen underground storage tanks (USTs) at SRS contain usable petroleum products and are regulated under Subtitle I of RCRA. These tanks require an annual compliance certificate from SCDHEC. A SCDHEC inspection and audit on October 23, 2013 found all 19 tanks to be in compliance, marking 11 consecutive years without a violation.

Federal Facility Compliance Act (FFCA)

The FFCA requires the identification of existing quantities of mixed waste, the proposed methods and technologies for treatment and management, the creation of enforceable timetables, and the tracking and completion of deadlines. In 1995, SRS obtained approval of a Site Treatment Plan (STP) as required by the FFCA. As part of compliance activities associated with the Consent Order, SRS and SCDHEC meet annually to discuss the status of the STP and determine if the agreed-upon, five-year interval is appropriate or if more frequent meeting intervals are necessary. SRS and SCDHEC held the annual STP status meeting in October 2013, where current milestones were examined against projected STP goals. No concerns regarding these milestones warranted submittal of a 2013 STP update. SRS will schedule the next annual STP status meeting in 2014.

Toxic Substances Control Act (TSCA)

SRS has a well-structured program that complies with TSCA regulations, DOE orders, and Site policies regarding the historical use, storage, and disposal of lead, asbestos, and organic chemicals, including polychlorinated biphenyl compounds (PCBs). SRS disposes of routinely generated nonradioactive PCBs at an EPA-approved facility. Disposal is completed within the regulatory period of one year from the date of generation. SRS completed the 2013 PCB document log and submitted the 2013 annual report of onsite PCB disposal activities to EPA in July 2014, meeting applicable requirements.

For some forms of radioactive PCB wastes, disposal options are not immediately available, specifically those contaminated with TRU radionuclides. Such wastes will remain in long-term storage pending necessary processing and packaging that will allow disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. SRS stores these wastes in TSCA-compliant storage facilities. SRS completed 36 shipments of PCB/TRU waste to WIPP in 2013.

Infectious Waste

To comply with South Carolina Infectious Waste Management Regulation, R.61-105, SRS contracts with a vendor for monthly pick-up and destruction of infectious (medical) waste generated in the N-Area Medical Building. In 2013, SRS managed all infectious wastes in compliance with the requirements for treatment, storage, transportation, and disposal or destruction. SRS is registered as a large quantity generator based on the amount of infectious waste generated per month. The current SRS Infectious Waste Generator Registration expires on April 30, 2017.

RADIATION PROTECTION

DOE Order 458.1, Radiation Protection of the Public and the Environment

DOE Order 458.1, "Radiation Protection of the Public and the Environment," establishes the requirements to protect the public and the environment against any undue risk from radiation associated with radiological activities at DOE sites. This Order requires an Environmental Radiological Protection Program (ERPP). The SRS ERPP is a composite of plans, procedures, and other documents that describe the methods used to ensure SRS implements the appropriate actions to comply with the requirements of DOE Order 458.1.

DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard to the general public is 100 millirem (mrem) (1 millisievert [mSv]) per year to a person from routine DOE operations. In 2013, the SRS dose to the representative person was 0.19 mrem, which is less than 1% of the 100 mrem standard and consistent with estimated doses to the public from previous years. Chapter 6, "Radiological Dose Assessments," provides additional information on the process for determining radiological dose to the public.

AIR QUALITY AND PROTECTION

Clean Air Act (CAA)

Though EPA maintains overall authority for the control of nonradiological air pollution under the CAA, EPA has delegated regulatory authority for all types of emissions to SCDHEC because South Carolina's air pollution regulations are at least as stringent as the federal requirements. SRS is required to comply with SCDHEC Regulation 61-62, "Air Pollution Control Regulations and Standards." The various CAA programs covered by these SCDHEC regulations are discussed below.

Title V Operating Permit Program

SCDHEC classifies SRS as a "major source" of nonradiological air emissions, and SRS falls under the CAA Part 70 Operating Permit Program. The Part 70 Operating Permit regulates radioactive, nonradioactive, toxic, and criteria pollutant emissions from 19 emission units, with each unit having specific emission limits, operating conditions, and monitoring and reporting requirements. The operating permit also contains an "Insignificant Activities List," that identifies approximately 500 sources at SRS that are exempt from monitoring based on insignificant emission levels, or on equipment size or type. Insignificant emission sources typically emit less than five tons of criteria pollutants or less than 1,000 pounds of toxic air pollutants per year.

SCDHEC issued an air construction permit (08800139CA) for the Mixed Oxide Fuel Fabrication Facility (MFFF), a part of the SRS Nuclear Nonproliferation Program. Construction of the MFFF began August 1, 2007 and continued through 2013.

The National Ambient Air Quality Standards are air pollution control standards set by the EPA and regulated by SCDHEC as Standard 2 pollutants. Under existing regulations, SRS is not required to conduct onsite monitoring for the Standard 2 pollutants; however, SRS is required by the Part 70 Operating Permit to demonstrate compliance through air dispersion modeling and submittal of an annual emissions inventory of air pollutant emissions. Table 3-1 shows the total air emission estimates for all SRS permitted sources as determined by the air emissions inventory conducted for the last five years. SCDHEC review of the emissions has found that SRS sources operated in compliance with permitted emission rates and the ambient air quality standards.

Table 3-1 SRS Estimated SCDHEC Nonradiological Pollutant Air Emissions, 2009 - 2013 (TV-0080-0041 & TV-0300-00036)

Pollutant Name	Emissions (Tons/Year)				
	2009	2010	2011	2012[b]	2013[c]
Sulfur dioxide (SO_2)	4,000	4,110	4,560	953	6.8
Total particulate matter (PM)	399	803	329	26	12.4
Particulate matter < 10 micrometers (PM10)	264	637	142	18	9.1
Particulate matter < 2.5 micrometers (PM2.5)	222	136	427	16	7.2
Carbon monoxide (CO)	40.7	44.6	125	52	21.7
Volatile organic compounds (VOCs) (Ozone Precursors)[a]	65	45	46	40	41.5
Gaseous fluorides (as hydrogen fluoride)	12.2	12.2	12.3	3	0.0025
Nitrogen dioxide (NO_2)	1,790	2,060	2,060	621	268.4
Lead (lead and lead compounds)	0.034	0.0391	0.0166	0.00064	0.0047

[a] Corrected errors in 2009-2011 entries during 2012 annual report generation.
[b] Decreases in emissions attributed to limited use of D Area Powerhouse during 2012.
[c] D-Area Powerhouse permanently ceased all operations on April 25, 2012. Decreased emissions are attributed to no production in 2013. The increase in lead emissions is result of annual emission inventory reporting of lead and lead compounds where previously only lead was included.

Accidental Release Prevention Program

The Clean Air Act Amendments of 1990 Section 112(r) requires any facility that maintains specific hazardous or extremely hazardous chemicals in quantities above specified threshold values to develop a risk management plan (RMP). SRS has maintained hazardous and extremely hazardous chemical inventories below the threshold value; therefore, SRS was not required to develop an RMP. Additionally, no reportable 112(r)-related hazardous or extremely hazardous chemical releases occurred at SRS in 2013.

Ozone-Depleting Substances

Stratospheric ozone surrounds the earth and filters the sun's ultraviolet (UV) radiation. Ozone depletion is caused by the release of chlorofluorocarbons (CFCs), hydrofluorocarbons (HCFCs), halons, and other ozone-depleting substances, which are used widely as refrigerants, insulating foams, solvents, and fire extinguishers.

The CAA mandates air quality standards for the protection of stratospheric ozone. The CAA Title V Operating Permit Program requires SRS to comply with the standards for emissions reduction and the systematic reduction of ozone depleting substances pursuant to 40 CFR 82, "Protection of Stratospheric Ozone." 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 leak repair data for large (greater than or equal to a 50-pound charge) heating, ventilation, and air conditioning/chiller systems are reported monthly. Incidental discharges from refrigerant sources at SRS during 2013 totaled 11,119 pounds. In 2013, SRS did not experience any releases of refrigerant during recycle and recovery activities in excess of acceptable amounts allowed by the regulation.

The CAA also requires that SRS not knowingly or willfully release ozone-depleting substances (ODS) such as halon into the atmosphere (40 CFR 82, Subpart H, "Halon Emissions Reduction"). SRS uses halon-containing equipment as a fire suppression agent in some facilities. SRS maintains and recharges halon-containing equipment, and manages the DOE complex halon repository (Savannah River Halon Repository). SRS reports the total halon inventory in an annual report to DOE. As of December 31, 2013, there were approximately 41,239 pounds in the SRS inventory, including 19,191 pounds in 84 installed fire suppression systems. The balance, approximately 22,048 pounds of halon, is maintained in cylinders of varying size and weights. SRS shipped 11,041 pounds of halon to the Defense Logistics Agency on June 6, and one 546 pounds halon system was removed from service during 2013. In addition to the SRS inventory, SRS maintains 22,048 pounds of halon in the DOE complex halon repository at SRS.

During this reporting period, SRS accidentally discharged approximately 361 pounds of halon due to a one-time fire suppression system failure. This is a reduction in releases from previous years. Approximately 31 pounds was discharged during routine reclamation and servicing activities at SRS in 2013 — an acceptable practice according to recognized maintenance standards.

Air Emissions Inventory

SCDHEC Regulation 61-62.1, Section III ("Emissions Inventory"), requires compilation of an air emissions inventory in order to locate all sources of air pollution and to define and characterize the various types and amounts of pollutants. To demonstrate compliance, SRS conducted the initial comprehensive inventory of air emissions sources in 1993. SRS used source operating data and calculated emissions from 1990 to establish the baseline emissions and to provide data for air dispersion modeling.

SRS is required to update the Site annual air emission inventories to SCDHEC by March 30 for the previous calendar year. SRS submitted the 2013 emissions inventories on March 27, 2014. SRS provides its air emissions inventory to the EPA for inclusion in the National Emissions Inventory, a comprehensive and detailed estimate of air emissions of both criteria and hazardous air pollutants from all air emissions sources. You will find the most recent information on the EPA website at http://www.epa.gov/ttn/chief/eiinformation.html .

National Emission Standard for Hazardous Air Pollutants (NESHAP)

NESHAP is a CAA-implementing program that sets air quality standards for hazardous air pollutants, such as radionuclides, benzene, Reciprocating Internal Combustion Engines (RICE), emissions and asbestos.

NESHAP Radionuclide Program

The current list of 187 hazardous air pollutants includes all radionuclides. EPA has delegated regulation of these pollutants to SCDHEC; however, EPA continues to oversee some aspects of the regulation.

SRS maintains compliance with the NESHAP Radionuclide Program by performing all required inspections and maintaining monitoring systems to meet regulatory requirements. Subpart H of the NESHAP regulations require SRS to determine and report annually by June 30 the highest effective dose from airborne emissions to any member of the public at an offsite point. SRS transmitted the *SRS Radionuclide Air Emissions Annual Report for 2012* on June 13, 2013 to EPA, SCDHEC, and DOE headquarters.

During 2013, the maximally exposed individual (MEI) effective dose equivalent, calculated using the NESHAP required CAP88 computer code, was estimated to be 0.0382 mrem/yr (0.000382 mSv/yr), which is less than 0.04 % of the 10 mrem/yr (0.10 mSv per year) EPA standard. Chapter 6, "Radiological Dose Assessments," contains details on this calculation.

NESHAP Non-Radionuclide Program

SRS facilities use many chemicals identified as toxic or hazardous air pollutants, but most of them are not regulated under the CAA or federal NESHAP regulations due to the small quantities or the manner of use at SRS. Except for asbestos, SRS facilities and operations do not fall into any of the "categories" listed in the regulation. In December 1993, EPA issued a final list of hazardous air pollutant-emitting source categories potentially subject to maximum achievable control technology (MACT) standards; these standards have not yet affected SRS.

NESHAP Reciprocating Internal Combustion Engine (RICE) Program

In 2013, NESHAP emission standards applicable to stationary RICE became effective. SRS operates numerous RICE impacted by these regulations. It should be noted that RICE must also comply with New Source Performance Standards (NSPS) Subparts IIII and JJJJ. On behalf of all Site tenants, DOE-SR successfully submitted initial, semiannual, and annual RICE compliance certifications in 2013.

NESHAP Asbestos Abatement Program

Asbestos operations and maintenance (O&M) activities, minor and small jobs, as well as building renovations and demolitions at SRS fall under SCDHEC and federal regulations. SRS conducted 81 permitted renovations and demolitions involving asbestos in 2013.

The SCDHEC Asbestos Abatement Group License (Number ASB-8021) allows SRS to manage O&M, minor and small projects through the SRS Asbestos Disturbance Notice (ADN) procedure. In addition to "project-specific" ADNs, SRS issues ADN notifications to each Site facility on a quarterly basis, which allows SRS to report amounts of Asbestos Containing Material (ACM) removed and disposed of during each quarter. SRS issued 63 ADN notifications in 2013. Certified personnel removed and disposed of 149 linear feet, 177 square feet, and 7 cubic feet of friable (easily crumbled or pulverized) ACM, and 91 linear feet, 4,053 square feet and 36 cubic feet of non-friable ACM during 2013. Nonradiological asbestos waste was disposed of at the Three Rivers Solid Waste Authority Landfill and the SRS Construction and Demolition (C&D) Landfill. Both disposal sites are SCDHEC-approved landfills for the disposal of regulated and non-regulated ACM.

Additionally, SRS disposed of 95 linear feet, 3,274 square feet, and 10 cubic feet of radiologically contaminated asbestos waste in 2013 at the SRS E-Area Low-Level Waste Facility.

The 2013 SRS Annual Asbestos Group License Report listed 253 asbestos specialists certified by SCDHEC who are employed at SRS.

WATER QUALITY AND PROTECTION

Clean Water Act (CWA)

National Pollutant Discharge Elimination System (NPDES)

SCDHEC administers the NPDES program under EPA authority. The program protects surface waters by limiting releases of effluents into streams, reservoirs, and wetlands.

With the exception of Ameresco Federal Solutions, Inc. ("Ameresco"), who has its own NPDES permit, SRS operated pursuant to five NPDES permits in 2013:

- Two permits for industrial wastewater discharges (SC0047431 for the D-Area Powerhouse and SC0000175 for the remainder of SRS);
- Two general permits for stormwater discharges (SCR000000 for industrial and SCR100000 for construction discharges); and,
- One general utility water permit SC250273.

Throughout the year, SRS monitors 29 NPDES-permitted industrial wastewater outfalls across SRS on a monthly basis. For each outfall, physical, chemical, and/or biological parameters are determined and reported to SCDHEC in SRS monthly discharge monitoring reports, as required by the permit. In 2013, the SRS NPDES program maintained a greater than 99% compliance rate. SRS had three permit limit exceptions during 2013 and received two NOVs; one for an exception of total suspended solids limits at A-01 Outfall and the second for an exception of toxicity at D-01 Outfall. Table 3-2 summarizes the NPDES exceptions.

SRS has one no-discharge permit for land application of biosolids (ND0072125). This permit was renewed in 2010 and is applicable for 10 years. Chapter 4, "Effluent Monitoring," provides additional information about SRS's NPDES permits.

Table 3-2 Summary of NPDES Limit Exceptions

Outfall	Parameter	Number of Exceptions	Description/Solution
A-01	Total Suspended Solids	1	Maintenance activities at the constructed wetlands resulted in higher solids levels than normal. This was a one-time event.
D-01	Toxicity	1	Low-pH groundwater intrusion into the discharge channel caused a lowering of the pH at the outfall discharge, which resulted in failure of the toxicity test. The sampling point was relocated to minimize impact of low pH groundwater.
D-01	pH	1	Low-pH groundwater intrusion into the discharge channel caused a lowering of the pH at the outfall discharge to below outfall limits. Sampling point was relocated to minimize impact of low pH groundwater.

The NPDES General Permit for Stormwater Discharges (SCR000000) associated with industrial activity requires installing, implementing, and maintaining control measures to ensure that stormwater discharges do not result in an exceedance of water quality standards in receiving streams. You will find the results from sampling of stormwater outfalls in Data Table 4-9. The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2013* on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

Dredge and Fill; Rivers and Harbors

In 2013, SRS had three open permits under the Nationwide Permits (NWPs) program (general permits under Section 404) and the Rivers and Harbors Act Section 10 as follows:

- SRS completed dam construction on an unnamed tributary to Fourmile Branch for the Mixed Waste Management Facility Groundwater Interim Measures project in 2000 under NWP 38, "Hazardous Waste Cleanup." However, mitigation for the impact to wetlands was pending in 2013 and must be addressed before the permit can be closed. DOE is evaluating a request 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 pump house canals to allow for better flow to the water intake of each pump house. The U.S. Army Corps of Engineers (USACE) issued a RHA Section 10 permit (SAC-2008-1156) on March 24, 2009, to allow the dredging work to begin. SRS successfully dredged both canals and returned them to their original design.

Maintenance dredging of accumulated sediments in the 681-5G canal will occur as needed until the permit authorization expires on March 31, 2014.

- SRS installed stream flow measurement equipment in Four Mile Branch, Lower Three Runs, Pen Branch, and Steel Creek, and/or in wetlands adjacent to these streams. This activity was permitted by rule in August 2013.

Safe Drinking Water Act (SDWA)

SCDHEC regulates drinking water facilities under the SWDA. SRS uses groundwater sources to supply onsite drinking water facilities. The A-Area drinking water system supplies most Site areas. The D-Area drinking water system was shut down in April 2013. Remote facilities such as field laboratories, barricades, and pump houses utilize small drinking water systems or bottled water.

SRS and SCDHEC collect and analyze samples to ensure that all Site domestic water systems meet SCDHEC and EPA bacteriological and chemical drinking water quality standards. All samples collected in 2013 met those standards. Refer to Chapter 5, "Environmental Surveillance," of this report for results.

SRS samples domestic water systems for lead and copper on a three-year, rotating cycle. In 2013, the A-Area water system was below the SCDHEC action levels for lead and copper.

OTHER ENVIRONMENTAL REQUIREMENTS

National Environmental Policy Act (NEPA)

NEPA established a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes. The NEPA process is used to identify the potential environmental consequences of proposed federal activities and alternatives to support informed, environmentally sound decision-making regarding design and implementation

SRS initiates the evaluation process required by NEPA by completing an Environmental Evaluation Checklist (EEC) for new projects or changes to existing projects. SRS uses the EEC to review the proposed action, identify any potential environmental concerns, and determine the appropriate level of NEPA review required for the project.

SRS conducted 440 NEPA reviews in 2013 (Table 3-3). Categorical exclusion (CX) determinations accounted for 82 percent of completed reviews. Although CX determinations represent the dominant form of NEPA review, the preparation of Environmental Impact Statements (EISs) and Environmental Assessments (EAs) required the greatest effort and expenditure. You will find additional information on SRS NEPA activities on the NEPA webpage at http://www.srs.gov/general/pubs/envbul/nepa1.htm.

Table 3-3 Summary of NEPA Reviews

Type of NEPA Review	Number
Categorical Exclusion Determination	360
"All No" EEC Determinations[a]	56
Actions Tiered to Previous NEPA Reviews	17
EIS[b]	3
Supplement Analysis[c]	2
Interim Action[d]	2
Revised Finding of No Significant Impact (FONSI)	0
EA	0
Total NEPA Reviews	**440**

[a] Proposed actions that require no further NEPA action

[b] DOE/EIS-0283-S2, Surplus Plutonium Disposition Supplemental EIS; DOE/EIS-0375, Disposal of Greater-Than-Class-C Low-Level Radioactive Waste; DOE-EIS/0423-S1, Long-Term Management and Storage of Elemental Mercury (all in process)

[c] SA for SRS Spent Nuclear Fuel (DOE/EIS-0279-SA-01 and DOE/EIS-0218-SA-06, March 2013); SA for High-Level Waste Tank Closure (DOE-0303-SA-02)

[d] An interim action is an action within the scope of an EIS that is taken before a Record of Decision is issued. An interim action may not have adverse impacts on the environment or prejudice the selection of alternatives considered in the EIS.

The following major NEPA reviews were completed in 2013:

- *Interim Action Determination for the K-Area Materials Storage (KAMS) Area Expansion at the Savannah River Site (SRS)* – DOE is preparing the Surplus Plutonium Disposition (SPD) Supplemental Environmental Impact Statement (SEIS) (DOE/EIS-0283-S2).The Final Storage Area and Presentation Room at the K-Area Material Storage (KAMS) facility provides an opportunity for KAMS expansion and would provide storage space to support alternatives evaluated in the SPD SEIS. In addition, there would be no adverse impacts to the environment, cost, schedule, or choice of alternatives by starting construction activities for a KAMS expansion before issuing a Record of Decision for the SPD SEIS. Therefore, this action is clearly an allowable interim action in accordance with DOE regulations implementing NEPA. DOE-SR published the Interim Action Determination in April 2013.

- *Amended Interim Action Determination for Disposition of Certain Plutonium Materials at the K-Area Complex, Savannah River Site* – In October 2011, DOE-SR approved an Interim Action Determination, Disposition of Certain Plutonium Materials Stored at the Savannah River Site. This Amended Interim Action Determination revised the 2011 Interim Action Determination by adding a second SRS facility to prepare surplus plutonium for disposal at the WIPP. DOE-SR would use the K-Area Complex (KAC) in addition to the HB-Line to prepare approximately 500 kilograms (kg) of plutonium for disposal at WIPP. Because of the small fraction of material involved relative to the six metric tons of plutonium materials being evaluated in the SPD SEIS, and because this material does not lend itself to disposition using the other alternatives, disposal of this material as TRU waste would not affect DOE's ultimate selection of disposition alternatives. Use of capabilities in the KAC, in addition to the HB-Line, changes neither environmental impacts nor the choice of reasonable alternatives. Therefore, this action is clearly an allowable interim action in accordance with DOE regulations implementing NEPA. DOE-SR published the Amended Interim Action Determination in October 2013.

- *Supplement Analysis, Savannah River Site Spent Nuclear Fuel Management* – DOE prepared this SA to determine if proposed changes to the SRS spent nuclear fuel management program, including the processing of highly enriched uranium (HEU) solutions returned to the United States from Canada, required additional review under NEPA, such as supplementing the EIS or preparing a new EIS. DOE determined that using conventional processing in H-Canyon rather than a melt and dilute process to manage some spent nuclear fuel did not require additional NEPA review. In addition, DOE determined that transporting HEU solutions to SRS in casks certified by the Nuclear Regulatory Commission, and making minor modifications to H-canyon to receive the solutions, did not require additional NEPA review. DOE published an Amended Record of Decision in the *Federal Register* on April 5, 2013.

Emergency Planning and Community Right-to-Know (EPCRA)/SARA Title III

EPCRA 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 (TRI) report to include waste management activities. SRS is required to implement the following reporting programs. SRS complied with all reporting requirements in 2013.

Executive Order 12856

Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires that all federal facilities comply with Right-to-Know laws and pollution prevention requirements. SRS complies with the applicable reporting requirements for EPCRA, and incorporates the applicable TRI chemicals into its pollution prevention efforts.

Chemical Inventory Report (Tier II)

As required by Section 312 (Chemical Inventory Reporting) of EPCRA, SRS completes an annual Tier II Chemical Inventory Report for all hazardous chemicals in excess of specified quantities present at SRS during the calendar year. SRS submits hazardous chemical storage information to state and local authorities electronically via the Homeland Security E-Plan database by March 1 for the previous calendar year. SRS submitted its Tier II Chemical Inventory for 2013 on February 27, 2014.

Toxic Release Inventory Report (Form R)

As required by 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 those above the threshold value to EPA.

For 2013, SRS submitted a Form R on June 30, 2014 for each of the following regulated chemicals: ammonia, chromium, formic acid, lead, manganese, mercury, n-hexane, naphthalene, nickel, nitrate, nitric acid, sodium nitrite, sulfuric acid, and toluene. You will find details on the EPA website at http://www.epa.gov/tri/tridata.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA regulates the application of restricted-use pesticides (RUPs) at SRS through a state-administered certification program. A licensed pesticide specialist approves and supervises pesticide applications, and applicators record all pesticide usage. This allows SRS to monitor application practices and report total annual chemical inventories and usage.

The South Carolina NPDES General Permit for Discharges from the Application of Pesticides requires tracking of pesticide (including pesticides, herbicides, biocides) applications near waters bodies as well as right-of-way treatments of intrusive vegetation. Due to unusually heavy rainfall events in 2013, SRS submitted a Notice of Intent (NOI) notifying SCDHEC that threshold limits of pesticide applications had been reached. As a result, SRS implemented programmatic enhancements including an Integrated Pest Management Plan and a Pesticide Discharge Management Plan. These plans enhance environmental stewardship by using work methods that emphasize alternative pest eradication practices to pesticide use and application methods that reduce unintended impacts to the environment.

Endangered Species Act (ESA)

The ESA 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 federally endangered plant and animal species exist at SRS, including the wood stork, the red-cockaded woodpecker (RCW), the shortnose sturgeon, the pondberry, and the smooth purple coneflower. In addition, the gopher tortoise, which was recently listed as a candidate for protection by the ESA, is found at SRS. While the bald eagle is no longer on the endangered species list, it remains protected by the Bald and Golden Eagle Protection Act. A golden eagle observed in 2013 and into 2014 at SRS is protected under this Act. Also found at SRS is the Carolina gopher frog, which is a South Carolina endangered amphibian and the swallow-tailed kite, a South Carolina endangered bird. Programs are in place onsite to enhance the habitat and survival of such species.

The United States Department of Agriculture Forest Service-Savannah River (USFS-SR) manages programs onsite to enhance the habitat and survival of these species. The USFS-SR implemented a program in 1986 to enhance the recovery of the RCW at SRS. The RCW population has since increased from four individuals in three groups to 264 individuals in 66 groups. The USFS-SR actively manages over 65,000 acres in the RCW habitat management area using mechanical, chemical and prescribed fire operations to effectively create and improve habitat by restoring the natural fire regime, improving native plant diversity in the understory, and enhancing native pine stands. In addition, USFS-SR inserts artificial cavities into living pine trees to supplement the available cavities for roosting and nesting.

During Fiscal Year 2013, while implementing the *United States Department of Energy Natural Resources Management Plan for SRS* (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5208304.pdf), USFS-SR developed three biological evaluations for timber, research, and wildlife-related management activities associated with three SRS watersheds. These biological evaluations determined that forest implementation plans are not likely to affect threatened and endangered species adversely due to beneficial, insignificant, or discountable effects. USFS-SR reviewed revisions to seven SRS watershed management plans and determined additional biological evaluations were not warranted. USFS-SR also developed one biological evaluation for military training activities in the Savannah River.

National Historic Preservation Act (NHPA)

The NHPA requires that all federal agencies consider the impacts to historic properties in all their undertakings. SRS ensures compliance with the NHPA through several processes. SRS has implemented the *Cold War Programmatic Agreement* and *SRS's Cold War Built Environment Cultural Resource Management Plan*. 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 investigation of archaeological research problems associated with cultural development within the Savannah River valley, using the results to help DOE manage more than 1,900 known archaeological sites at SRS.

SRARP uses the Site Use Program to ensure compliance with NHPA. Through this program, SRARP evaluates all locations being considered for activities, such as construction, to ensure that archaeological or historic sites are not impacted. Evaluations include surveying for archaeological resources and documenting areas of importance with regard to historic and prehistoric significance.

You will find more information on activities conducted by the SRARP in 2013 on the SRARP website at http://www.srarp.org. In addition, SRARP's 2013 report is located on the SRS webpage at http://www.srs.gov/general/pubs/ERsum/index.html.

Migratory Bird Treaty Act (MBTA)

The MBTA prohibits the taking, possession, import, export, transport, selling, purchase, barter of, offering for sale, or purchase of any migratory bird or its eggs, parts, and nests, except as authorized under a valid permit.

In 2013, SRS found two Northern Mockingbird (*Mimus polyglottos)* nests in large mobile equipment located at two Site locations. These nests required protection under the MBTA. SRS maintained barricades around the equipment until the hatchlings fledged.

DOE ORDERS/EXECUTIVE ORDERS FOR ENVIRONMENTAL SYSTEMS

Summary of Environmental Management Systems (EMS)

The majority of SRS organizations comply with the requirements set forth in DOE Order 436.1 "Departmental Sustainability" to use an EMS as the framework to implement, manage, measure, and continually improve upon sustainable environmental, energy, and transportation practices. However, some Site organizations have not incorporated DOE O 436.1 contractually and continue to operate and comply with DOE Order 450.1A, "Environmental Protection Program." Chapter 2, "Environmental Management System," contains additional information on these and other sustainability programs.

Floodplain and Wetlands Management

As required by 10 CFR 1022, "Compliance with Floodplains and Wetlands Environmental Review Requirements," DOE establishes policies and procedures for implementing compliance with Executive Orders 11988, "Floodplain Management," and 11990, "Protection of Wetlands." This regulation includes DOE policies regarding the consideration of floodplains and wetlands factors in planning and decision-making. It also includes DOE procedures for identifying proposed actions involving floodplains and wetlands, providing early public reviews of such proposed actions, preparing floodplains/wetlands assessments, and issuing statements of findings for actions in floodplains. SRS activities in 2013 did not require the preparation of a floodplain or wetland assessment.

SRS ENVIRONMENTAL ISSUES/ACTIONS

Lawsuits

SRS was not involved in any environmental lawsuits during 2013.

Notice of Violation/Notice of Alleged Violation

D-01 Outfall - On September 5, 2013, a pH level of 5.8 standard units (S.U.) was recorded, which is below the acceptable lower limit of 6.0 S.U. On September 16, 2013, results from toxicity tests indicated a failure of that test. Both exceptions were attributed to low pH groundwater intrusion into the outfall discharge channel.

A-01 Outfall - On October 10, 2013 total suspended solids of 73 mg/L was recorded, which exceeds the daily limit of 40 mg/L. This exception was attributed to maintenance activities being performed upstream of the outfall.

SRS received two NOVs on December 3, 2013 for the toxicity failure at D-01 and the solids exception at A-01. Corrective actions had already been taken, and no further actions were required.

NOVs/NOAVs received from 2009 through 2013 are summarized in Table 3-4.

Table 3-4 NOV/NOAV Summary, 2009 - 2013

Program Area	NOV/NOAV				
	2013	2012	2011	2010	2009
CAA	0	0	0	2	0
CWA	2	1	0	0	0
RCRA	0	0	0	0	0
CERCLA	0	0	0	0	0
Others	0	0	0	0	0
Total Notices of Violation	**2**	**1**	**0**	**2**	**0**

Environmental Occurrences

The Occurrence Reporting and Processing System (ORPS) ensures that the DOE complex and the National Nuclear Security Administration (NNSA) are informed of events that could adversely affect the health and safety of the public and workers, the environment, DOE missions, or the credibility of the Department. Of the 122 ORPS-reportable events at SRS in 2013, there were four ORPS reportable events within ORPS Group 5 (Environmental) or ORPS Group 9 (Noncompliance Notification). The four ORPS reportable events are described below:

On April 10, 2013, SRS identified a discharge to a storm water manhole feeding the A-11 Outfall. A pH reading of 9.58 was obtained from a sample, which exceeded the maximum pH limit of 9.0 listed on the SCDHEC permit. The A-11 Outfall discharges to a Site stream that leads to the Savannah River.

On July 9, 2013, SRS reported a preliminary system failure to SCDHEC whereby the corrosion (cathodic) protection systems at seven USTs associated with fuel stations failed, resulting in a non-compliance with UST corrosion protection regulations. The failure was promptly repaired and a SCDHEC inspection of the SRS UST program at in October found no deficiencies.

On December 3, 2013, SRS received a Notice of Violation from SCDHEC due to exception of a permit limit at D-01 Outfall. The exception is attributed to low pH groundwater intrusion into the outfall discharge channel.

On December 3, 2013, SRS received a Notice of Violation from SCDHEC after sample results from the A-01 Outfall following maintenance activities showed an exception of the daily total suspended solids permit limit. Maintenance activities at the outfall caused silt and other solids to escape from the cell to a NPDES sample collection point.

SRS investigated each event at the time of discovery and took corrective action to prevent reoccurrence of the event.

Environmental Audits

SCDHEC, EPA, and the USACE conducted inspections and audits of the SRS environmental program for regulatory compliance. Table 3-5 provides a summary of the results of the 2013 audits and inspections.

Table 3-5 Summary of Audits/Inspections and Results

Audit/Inspection	Purpose	Results
632-G C&D Landfill, 288-F Landfill, 488-4D Ash Landfill Inspections	SCDHEC conducted four quarterly inspections of the landfills.	No issues were identified.
Comprehensive Groundwater Monitoring Evaluation	SCDHEC inspected SRS groundwater facilities associated with the F-Area and H-Area Seepage Basins, M-Area Settling Basin, Metallurgical Laboratory Basin, Mixed Waste Management Facility, and Sanitary Landfill. A records review of groundwater related files was also completed.	Inspectors identified seven damaged groundwater monitoring well signs and two damaged purge water signs. Signs were not posted at five newly installed wells. Signs were replaced or posted, as required, and no other issues were noted.
Industrial Wastewater Construction Permit Inspections	SCDHEC conducted inspections to approve the operation or closure of a variety of industrial wastewater treatment projects including the industrial wastewater permitted facilities in D Area, the Western Sector Treatment System, the waste disposal modification at the SPF, and Tanks 18F and 19F in the F-Area Tank Farm.	No issues were identified.
Infectious Waste Inspection	SCDHEC Department of Health inspected the medical waste storage in 719-5N.	No issues were identified.
Interim Sanitary Landfill Post-Closure Inspection	SCDHEC conducted an annual review of the landfill.	No issues were identified.
RCRA Compliance Evaluation Inspection (CEI)	SCDHEC inspected 10 Site facilities and reviewed hazardous waste program requirements (i.e., notifications and reports to SCDHEC, plans, training records, internal inspections, and waste documentation).	No issues were identified.

Table 3-5 Summary of Audits/Inspections and Results (Continued)

Audit/Inspection	Purpose	Results
Underground Storage Tank CEI	SCDHEC inspected 19 SRS USTs.	No issues were identified.
Z-Area Saltstone Solid Waste Landfill Inspections	SCDHEC performed inspections of SDU 4 exterior conditions to observe existing and potential moisture areas. Inspections were conducted monthly.	Moisture areas on the SDF Vault 4 exterior walls are due to a combination of factors: saltstone shrinkage from grout curing, bleed and process water accumulation inside of the exterior wall, and hydrostatic pressure causing water to weep through pre-existing construct-ion cracks. SRS documents these moisture areas per procedure. SCDHEC reviews these documents during inspections. No violations were noted.

Regulatory Self-Disclosures

SRS made one self-disclosure during 2013, which is summarized below.

- *Incident Report To SCDHEC On Hazardous Waste Management* - On May 30, 2013, SRS submitted an incident report to SCDHEC regarding the inappropriate disposal of remnant coatings by a subcontractor company working at the SRS Waste Solidification Building (WSB). In an effort to manage the disposal of the coating as a solidified, nonhazardous waste, the subcontractor mixed the coating parts together. However, this action is considered hazardous waste treatment, which the subcontractor was not qualified to perform. The subcontractor developed and implemented corrective actions.

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 2013.

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 of a hazardous substance (including radionuclides) occurs, CERCLA requires notification to the National Response Center. Reportable quantities are those quantities of a hazardous substances 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 reportable releases in 2013.

The CWA requires SRS to notify the National Response Center if an oil spill causes a sheen on navigable waters, such as rivers, lakes, or streams. Although 25 small petroleum product spills occurred in 2013 at SRS, none required notification.

SRS made one notification to SCDHEC in 2013 to report an 80-gallon diesel fuel spill that resulted from a traffic accident involving a vendor delivery truck. SRS recorded and cleaned up four chemical, two sewage, and 25 petroleum product spills. These events did not require notification as required by CERCLA or SCDHEC because they were below reportable quantities.

PERMITS

SRS had 570 construction and operating permits in 2013 that specified operating levels to each permitted source. Table 3-6 identifies these permits. These numbers reflect permits for all organizations at SRS, with the exception of Ameresco.

Table 3-6 SRS Permits

Type of Permit	Number of Permits
Air	7
USACE - Section 10, Rivers & Harbors Act of 1899	1
USACE Nationwide Permit	2
USACE - 404 Permit (Dredge and Fill)	0
Asbestos Demolition/Abatement/Temporary Storage of Asbestos Waste	82
Domestic Water	222
Industrial Wastewater	77
NPDES Discharge	3
NPDES No Discharge	1
NPDES General Utility Water Permit	1
Stormwater Discharge	1
Construction Stormwater Grading Permit	8
RCRA Hazardous Waste	1
RCRA Solid Waste	4
RCRA Underground Storage Tank	7
Sanitary Wastewater	121
SC Department of Natural Resources Scientific Collecting Permit	1
SCDHEC 401	2
SCDHEC Navigable Waters	1
Underground Injection Control	28
Total Number of Permits	**570**

KEY FEDERAL LAWS AND REGULATIONS COMPLIANCE SUMMARY

Table 3-7 lists federal laws and regulations applicable to SRS and summarizes the 2013 status of each requirement.

Table 3-7 Key Federal Environmental Laws and Regulations Applicable to SRS

Regulatory Program Description	2013 Status
Atomic Energy Act (AEA)/DOE Order 435.1 grants authority to DOE to develop applicable standards (documented in DOE Orders) for protecting the public and environment from radioactive materials.	The 2013 PA review showed that radioactive low-level waste operations were within the required performance envelope and the facilities continued to protect the public and environment.
Clean Air Act (CAA) establishes air quality standards for criteria pollutants, such as sulfur dioxide and particulate matter, and for hazardous air emissions, such as radionuclides and benzene.	SRS continues to operate in accordance with all permit requirements of the CAA in 2013. SRS successfully implemented new RICE requirements.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes criteria for liability and compensation, cleanup, and emergency response requirements for hazardous substances released to the environment	By the end of FY 2013, 400 RCRA/CERCLA waste unit cleanups were completed and 11 waste units were in the remediation phase.
Clean Water Act (CWA) regulates liquid discharges at outfalls (e.g., drains or pipes) that carry effluent to streams (NPDES, Section 402); regulates dredge and fill operations in waters of the United States (Section 404) and water quality for those activities (Water Quality Criteria [WQC], Section 401)	In 2013, the SRS NPDES program maintained a greater than 99% compliance rate. SRS had three permit limit exceptions during 2013 and received two NOVs: one for an exception of total suspended solids (TSS) and one for an exception of toxicity.
Emergency Planning and Community Right-to-Know Act (EPCRA) also referred to as the Superfund Amendment Reauthorization Act (SARA), Title III, requires reporting of hazardous substances and their releases to EPA, state emergency response commissions, and local planning units.	SRS complied with all reporting and emergency planning requirements for 2013. SRS submitted the Chemical Inventory Report (Tier II) in February 2014 and the Toxic Release Inventory (Form R) for 2013 on June 28, 2014.
Endangered Species Act (ESA) prevents the extinction of threatened and endangered species and conserves critical habitats.	SRS is host to numerous species of flora and fauna. Many species have been categorized as endangered or threatened. SRS continued to protect these species and their habitats as outlined the Natural Resource Management Plan for SRS.

Table 3-7 Key Federal Environmental Laws and Regulations Applicable to SRS (Continued)

Regulatory Program Description	2013 Status
The Federal Facility Agreement for the Savannah River Site (FFA) (89-05-FF) between the EPA, DOE, and SCDHEC integrates CERCLA and RCRA requirements to achieve a comprehensive remediation of high-level radioactive waste tanks at SRS.	SRS closed high-level waste Tank 5F and Tank 6F in December 2013.
Federal Facility Compliance Act (FFCA) requires compliance on the part of Federal agencies with all requirements of federal, state, and local solid/hazardous waste laws.	SRS and SCDHEC held the annual Site Treatment Plan (STP) status meeting in October. No concerns were identified that required submittal of a 2013 STP update.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates restricted-use pesticides (RUPs) through a state-administered certification program.	SRS continues to operate in compliance with FIFRA requirements.
Migratory Bird Treaty Act (MBTA) provides for the protection of migratory birds, including their eggs and nests.	SRS found two Northern Mockingbird (*Mimus polyglottos)* nests in large mobile equipment located at two Site locations. SRS maintained barricades around the equipment until the hatchlings fledged.
National Defense Authorization Act, Section 3116(a) (NDAA) NDAA allows the Secretary of Energy, in consultation with the NRC, to determine that certain waste from reprocessing is not high-level radioactive waste requiring deep geologic disposal if it meets the criteria set forth in Section 3116. Section 3116(b) addresses monitoring by NRC and SCDHEC.	In February 2013, DOE issued the basis for the Secretary's determination for closure of the H-Tank Farm for NRC review, as part of DOE's H-Tank Farm consultation with NRC under NDAA Section 3116. In addition, DOE also provided the document for public review and comment.
National Environmental Policy Act (NEPA) requires federal agencies to identify potential environmental consequences of proposed federal actions and alternatives to ensure informed, environmentally sound decision-making regarding design and implementation of programs and projects.	SRS is in full compliance with NEPA requirements. In 2013, • 440 NEPA reviews were completed, • 360 Categorical Exclusion Determinations were completed, and • Three major NEPA reviews were completed.
National Historic Preservation Act (NHPA) protects historical and archaeological sites.	216 acres of land were surveyed, resulting in 23 newly discovered sites being recorded. In FY2013, 7,902 artifacts were curated.

Table 3-7 Key Federal Environmental Laws and Regulations Applicable to SRS (Continued)

Legislation	2013 Status
Resource Conservation and Recovery Act (RCRA) governs the management of hazardous and non-hazardous solid waste and underground storage tanks (USTs) containing petroleum products, hazardous materials and wastes. Also regulates universal waste and recyclable used oil.	SRS operated active hazardous waste treatment, storage, and disposal facilities and performed post closure corrective actions at closed RCRA facilities and investigated/remediated solid waste management units as appropriate in accordance with the RCRA permit. SRS received the annual compliance certificate for 19 underground storage tanks after SCDHEC conducted an annual inspection.
Rivers and Harbors Act (RHA) regulates construction over, or obstruction of, navigable waters of the United States.	SRS continued to operate within the requirements of the RHA.
Safe Drinking Water Act (SDWA) provides for the protection of drinking water and public drinking water resources.	SRS maintains two domestic water systems. These systems met all primary drinking water standards, as well as operational and maintenance requirements.
Toxic Substances Control Act (**TSCA**) regulates polychlorinated biphenyls (PCBs), radon, asbestos and lead and requires evaluation and notification to EPA for new chemicals and significant new uses of existing chemicals.	SRS manages all TSCA-regulated materials in compliance with all requirements. SRS submitted the 2013 annual report of onsite disposal activities to EPA in July 2014.

EFFLUENT MONITORING

Chapter 4

Lori Coward, Jana D. Ackerman
John Adams, Greta Fanning, Martha Thompson
Savannah River Nuclear Solutions, LLC

Timothy Jannik
Savannah River National Laboratory

Effluent monitoring is a major activity on the Savannah River Site (SRS). Effluent monitoring is the collection and analysis of samples or measurements of liquid and airborne effluents to determine and quantify contaminants and process-stream characteristics, assess any chemical or radiological exposures to members of the public, and demonstrate compliance with applicable Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and Department of Energy (DOE) standards.

SRS conducts monitoring activities for the following effluent categories:

- Radiological airborne emissions,
- Radiological liquid discharges,
- Nonradiological airborne emissions, and
- Nonradiological liquid discharges.

This chapter presents a summary of the effluent monitoring programs and data results. The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" folder for the Environmental Report for 2013 on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

Data from the Ameresco biomass steam generating plants, and the steam and electricity cogeneration plant are not included in this report because the facilities operate under environmental permits issued directly to Ameresco by SCDHEC.

In 2013, effluent releases for all categories except nonradiological liquid effluent were below permit limits and applicable standards. Three nonradiological liquid effluent samples taken to demonstrate compliance with the National Pollutant Discharge Elimination System (NPDES) permit requirements exceeded permit limits. You will find additional details on these three exceptions in Chapter 3, "Compliance Summary."

RADIOLOGICAL MONITORING

Radiological effluent monitoring analytical results are a major component in demonstrating compliance with radiological dose standards for radiological exposures to the public established by EPA and DOE.

SRS works to ensure that radiation exposures to employees and that releases of radioactivity to the environment remain below regulatory limits. SRS takes actions to further reduce exposures and releases to levels which are as low as reasonably achievable.

Chapter 4 Key Terms

Effluent *is a release of treated or untreated water or air from a pipe or a stack to the environment. Liquid effluent flows into a body of water such as a stream or lake. Airborne effluent (also called emission) discharges into the atmosphere.*

Elemental tritium *is a radioactive isotope of hydrogen and occurs as a gas.*

Gross alpha and beta releases *are the total alpha-emitting and beta-emitting activity that are determined at each effluent location.*

Outfall *is a place where treated or untreated water flows out of a pipe to mix with water from a body of water such as a stream or lake.*

Radiological *pertains to materials that emit energy from unstable atoms.*

EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) program establishes the limits for radionuclide emissions from facilities owned or operated by DOE.

Subpart H of Title 40 Code of Federal Regulations (CFR) Part 61 details the methods for estimating and reporting radioactive emissions from point sources. SCDHEC regulates both radioactive and nonradioactive airborne pollutant emissions from SRS sources. SCDHEC permits each major source of airborne emissions on the SRS Part 70 Air Quality Permits with specific limitations and monitoring requirements.

Data Tables 4-1 and 4-2 provide a summary of analytical results and individual sample results for radioactive airborne and liquid effluent measurements taken at SRS in 2013. Radioactive airborne and liquid release data by facility function are contained in Data Tables 4-3 and 4-4.

Unidentified alpha and beta releases make up a relatively large percentage of the offsite doses. Data Tables 4-3 and 4-4 list separately the unidentified alpha and unidentified beta releases.

SRS uses conservative methods to analyze unidentified alpha and unidentified beta releases that include small amounts of unidentified manmade radionuclides as well as naturally occurring radionuclides, such as uranium, thorium, and potassium-40.

Chapter 4 Key Terms (Continued)

Tritium oxide or tritiated water *is water in which the tritium isotope has replaced a hydrogen atom. Stack releases of tritium oxide typically occur as water vapor.*

Unidentified alpha and beta releases *are the alpha-emitting and beta-emitting activity remaining when the sum of individually measured alpha-emitting (e.g., plutonium-239) and beta-emitting (e.g., cesium-137) radionuclides are subtracted from the gross alpha and beta releases.*

Airborne Emissions

SRS quantifies the total amount of radioactive material released to the environment by using (1) data obtained from monitored airborne effluent release points, (2) estimates of diffuse sources, and (3) estimates for unmonitored sources based on approved EPA calculation methods.

For process area stacks that release or have the potential to release radioactive materials, SRS uses a variety of methods to estimate the emissions from facilities that release or have the potential to release radioactive materials, including periodic sampling systems or approved calculation methods. Depending on the processes involved, SRS may also use real-time instrumentation to monitor discharge stacks to determine instantaneous and cumulative releases (e.g., of tritium) to the atmosphere.

Calculated Sources

Each year, SRS calculates radionuclide release estimates (in curies [Ci]) from unmonitored diffuse and point sources. Point sources are stacks or other exhaust points, such as vents, from buildings performing authorized tasks using radionuclides. In contrast, emissions from diffuse sources are not actively ventilated or exhausted. Diffuse emissions may not originate from a single location, but are released over a larger discrete area. SRS diffuse sources include evaporative emissions, research laboratories, disposal sites and storage tanks, and deactivation and decommissioning activities. These estimates are included in the SRS radioactive release totals in Data Table 4-3.

SRS calculates unmonitored releases using the methods contained in 40 CFR 61 Appendix D (EPA 1989). Because these methods employ conservative assumptions, they generally lead to overestimation of actual emissions. Although SRS does not monitor these releases at their source, onsite and offsite environmental surveillance monitoring stations are in place to quantify unexpected airborne releases. You will find additional information in Chapter 5, "Environmental Surveillance."

Releases Summary

Tritium releases in elemental and oxide forms make up the majority of the radionuclide releases from SRS to the air which is summarized below.

Data Table 4-3 presents year-end estimates of the radiological airborne emissions from SRS including tritium. These estimates include monitored, unidentified alpha and beta, calculated diffuse and point source releases, and annual totals based on actual operation time. Also included in Data Table 4-3 are the calculated radionuclides released based on the history of the spent fuel that was dissolved in the H Canyon facility. The dissolution process releases radionuclides (i.e., krypton-85, carbon-14, and tritium oxide) that are not monitored by the H Canyon facility stack sampling system and are therefore calculated.

Tritium

More than 61% of the total monitored radioactivity released to the atmosphere from SRS operations in 2013 is attributed to tritium. SRS released about 24,300 Ci of tritium in 2013, compared with approximately 16,700 Ci in 2012, an increase of 46%. Approximately 95% of the releases came from the five tritium processing facilities in H Area. The increase in tritium releases in 2013 is primarily due to shutdown activities in H Area. These shutdown activities such as opening previously closed systems (e.g., glove boxes, piping systems) are necessary to prepare for future deactivation activities. A small amount (~15 Ci) of tritium was released from the dissolution of spent nuclear fuel in H Canyon. The remainder is split between the reactor areas and the estimated releases from ongoing remediation and restoration activities. The amount of tritium released from SRS fluctuates because of changes in the SRS missions and in the annual production schedules of the tritium processing facilities. For the past 10 years, the general trend has been a reduction in tritium releases to the atmosphere. The tritium releases have ranged between about 17,000 to 60,000 Ci per year (Figure 4-1).

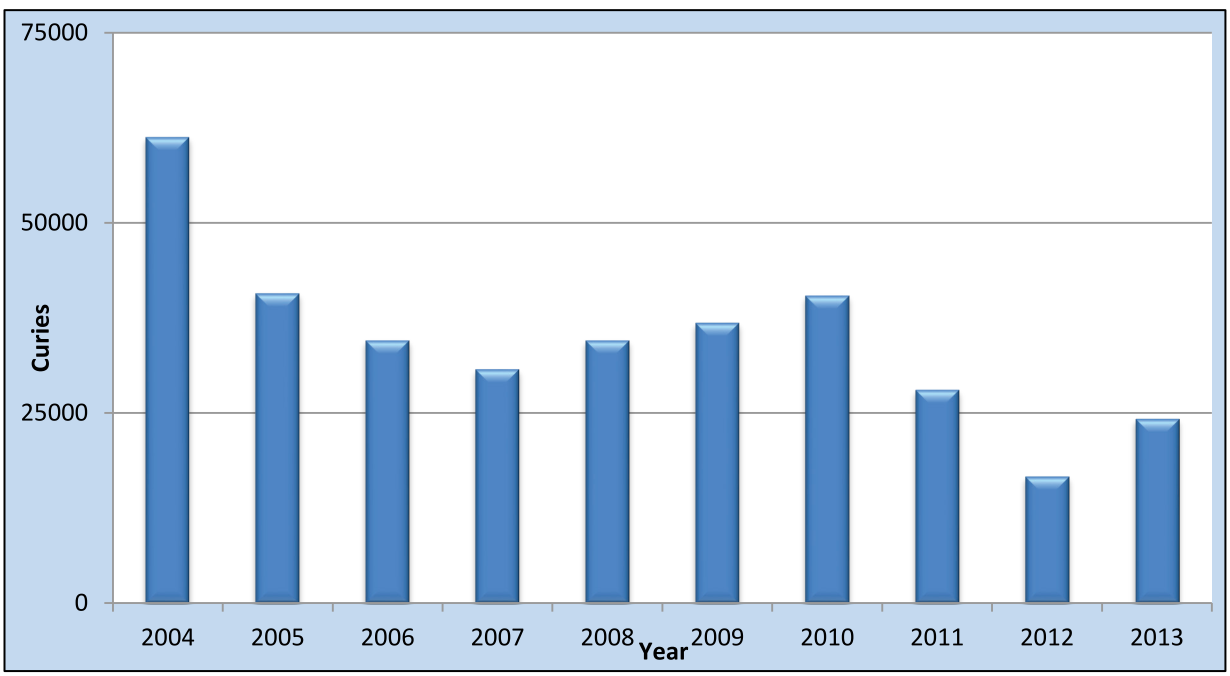


Figure 4-1 Ten-Year History of SRS Annual Tritium Releases to the Atmosphere

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Standards

SRS uses laboratory analyses of samples to determine concentrations of radionuclides in airborne emissions. The annual average concentrations are compared to the DOE derived concentration standards (DCSs) as documented in DOE Derived Concentration Technical Standard (DOE 2011a) and in accordance with DOE Order 458.1, "Radiation Protection of the Public and the Environment." These DCSs are applicable at the point of discharge and are used as a screening method to determine if existing effluent treatment systems are appropriate and effective. SRS uses the same DCSs as reference concentrations for conducting environmental protection programs that are used at all DOE sites.

Derived concentration standard *is the 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 a dose of 0.1 rem (1 mSv).*

Insignificant analytical results *are not statistically significant and/or are below the detection limit of the radioanalytical method used.*

Data Table 4-5 provides the 2013 airborne effluent annual average concentrations and comparisons against the DOE DCSs by monitored discharge point. Calculated concentrations, which are also contained in Data Table 4-5, include the tritium concentrations from the reactor areas and the tritium processing facilities. Concentrations are also calculated for krypton-85, carbon-14, and tritium released during dissolving operations in the H Canyon facility. The concentrations are calculated based on the annual releases in curies and the annual stack volume.

SRS bases this DCS comparison on isotopic concentrations; the average concentration is determined only if there is at least one statistically significant result for the isotope. With the exception of tritium releases (from several facilities) and calculated gaseous radionuclides (only from the H Canyon facility), the concentrations reported in Data Table 4-5 correspond only to the emissions that occur during sampling events. Concentrations for other periods, including any time between stack samples, gross alpha and gross beta results, and other emissions estimated using calculations, are not included in Data Table 4-5.

Most of the SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. Figure 4-2 illustrates a typical SRS stack. Because of the nature of the operations and the comparison of DCSs to measured concentrations at the release point, C Area, K Area, L Area, and the tritium facilities exceed tritium DCSs. Additionally, krypton-85 in H Area exceeds its DCS due to the dissolution of spent nuclear fuel in H Canyon facility. However, the offsite dose from all airborne releases remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv), as discussed in Chapter 6, "Radiological Dose Assessments."

Figure 4-2 Typical SRS Facility Stack

Liquid Effluents

SRS routinely samples and analyzes for radioactivity at each liquid effluent discharge point that releases or has potential to release radioactive materials. Depending on the processes involved, SRS may also monitor liquid effluents with real-time instrumentation to ensure that releases are below DOE established limits. Because the instruments have limited detection sensitivity, SRS does not use inline monitoring systems to quantify liquid radioactive releases. Instead, SRS collects samples for more sensitive laboratory analysis. As shown in Figure 4-3, effluent sampling points are near SRS facilities.

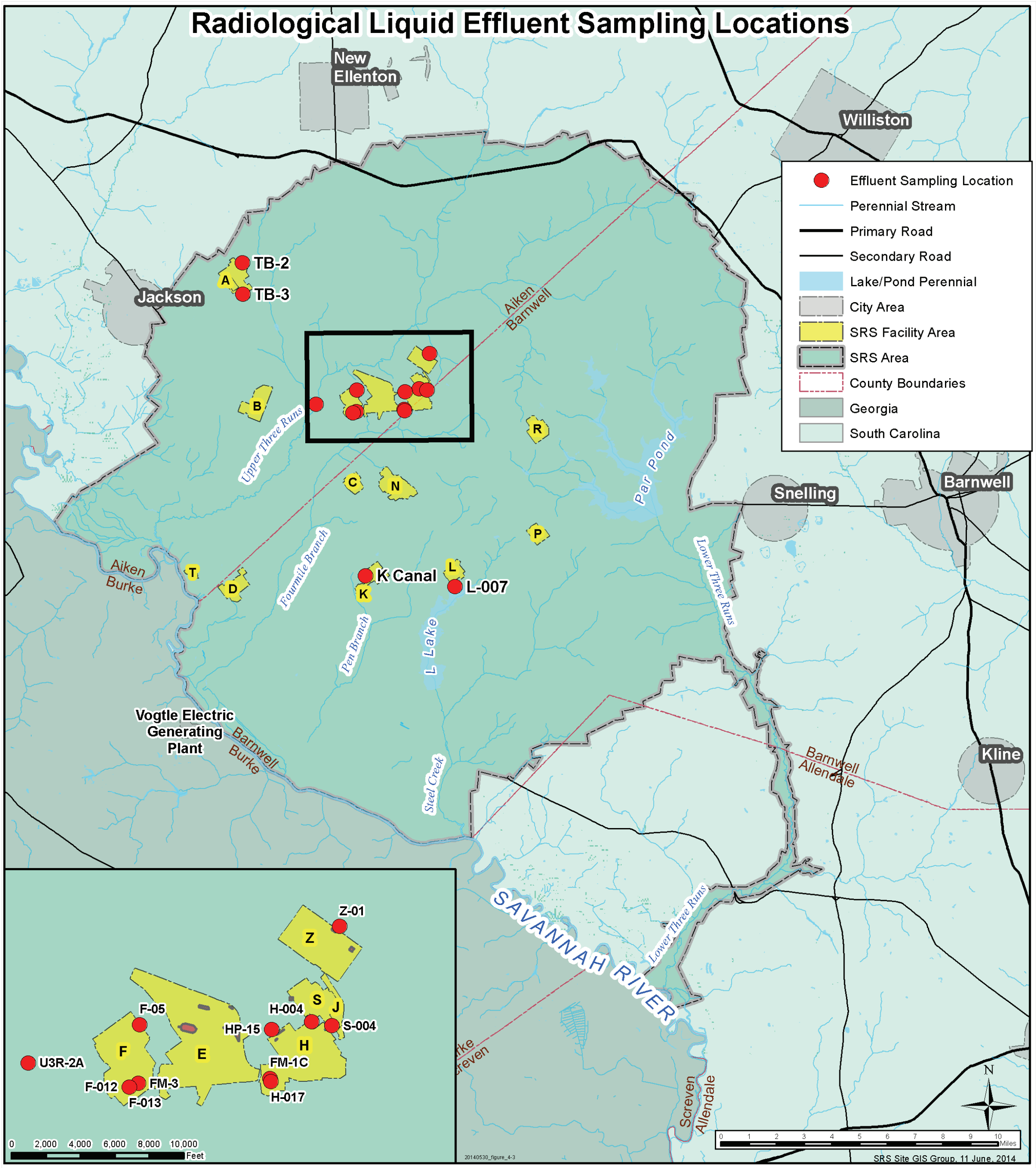


Figure 4-3 Radiological Liquid Effluent Sampling Locations

Releases Summary

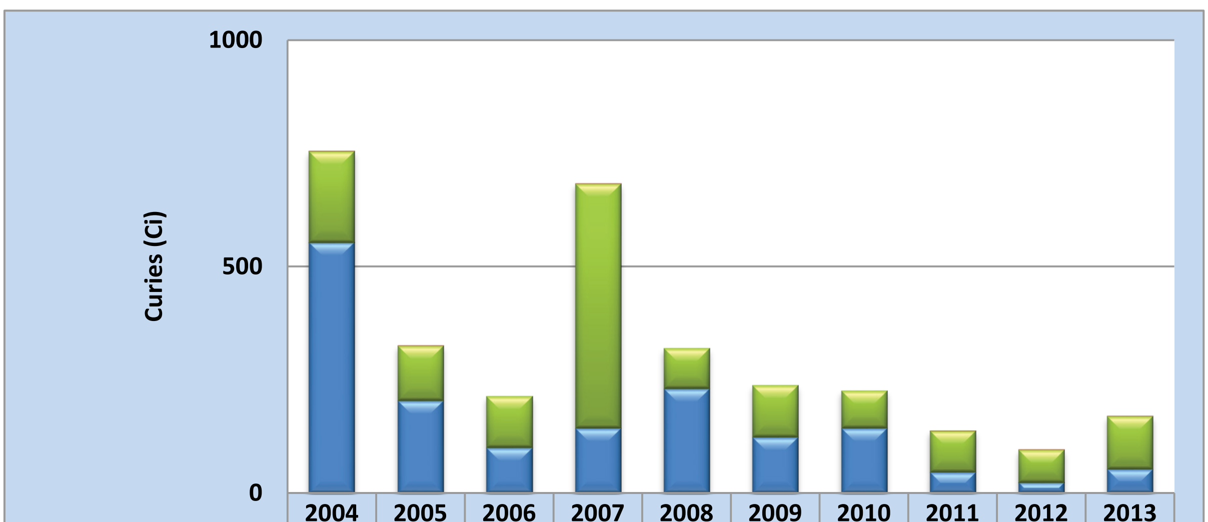
Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. Current and past operations at SRS result in releases of tritium to the Savannah River. SRS uses data from monitored liquid effluent discharge points to determine current releases to the Savannah River. These data are combined in conjunction with SRS seepage basin and Solid Waste Disposal Facility (SWDF) tritium migration release estimates to quantify the tritium released to the Savannah River from SRS operations. Data Table 4-4 provides SRS liquid radioactive releases for 2013. These data are major components in the determination of offsite dose consequences from SRS operations. Chapter 5, "Environmental Surveillance," describes groundwater migration and transport of radionuclides from SRS seepage basins and the SWDF and includes a summary table (Table 5-9) of releases to the Savannah River.

Discharges of Liquid Effluents

SRS quantifies discharges of liquid effluents at the point of release. SRS bases the release totals on measured concentrations and measured flow rates. Figure 4-4 illustrates a typical SRS liquid effluent outfall location.

Figure 4-4 Typical SRS Liquid Effluent Outfall

The total amount of tritium released directly from process areas to SRS streams during 2013 was 170 Ci. This is an increase from the 96 Ci released in 2012. Figure 4-5 shows direct releases of tritium to SRS streams for the past ten years. As seen in Figure 4-5, the total direct release of tritium has a general decreasing trend. The increase that occurred from 2012 to 2013 was due to higher than average rainfall. The rain picked up atmospheric tritium, which was deposited in outfalls, and it also caused higher effluent flow volumes to be released.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SRNL	1	0.495	0	0.33	0	0	0	0.28	0.21	0.12
Reactor Areas	201	121	113	540	89	114	83	91.5	71.6	116.8
Separations Areas	554	205	101	144	231	124	144	46.5	24.1	53.3

Figure 4-5 Ten-Year History of Direct Releases of Tritium to SRS Streams

Unusually heavy rainfall events in 2013 also caused the Z-Area stormwater basin to fill and discharge to the Z-01 Outfall location. This basin does not normally discharge. Samples were collected during rain events that occurred in February, March, June, and July. The levels of cesium-137 measured ranged from 300 pCi/L to 4,190 pCi/L. Z-01 Outfall results are included in Data Table 4-2. You will find additional information about the basin and downstream impacts in Chapter 5, "Environmental Surveillance."

Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Standards

DCSs are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). DOE Order 458.1 requires comparison to DCS values for most radionuclides. According to DOE Order 458.1, exceedance of the DCSs at any discharge point may require an investigation of "best available technology" (BAT) waste treatment for the liquid effluents. DOE Order 458.1 specifically excludes tritium in liquid effluents from BAT requirements; however, DOE Order 458.1 does not exclude it from the requirement to keep radioactive emissions and external exposures as low as reasonably achievable. Compliance with DCSs is demonstrated when the sum of the fractions 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 2013 liquid effluent annual-average concentrations, the quantities of radionuclides released compared to the DOE DCSs by discharge point. All discharges in 2013 were well below the standards and the sum of the fractions for all locations was less than 1.00.

DCSs are based on a 100-mrem exposure and the highly conservative assumption that a member of the public has continuous direct access to the actual liquid at the point of discharge. Because of security controls and the considerable distances between most SRS operating facilities and the SRS boundary, this scenario is highly improbable, if not impossible.

NONRADIOLOGICAL MONITORING

Airborne Emissions

SCDHEC regulates nonradioactive air pollutant emissions from SRS sources. SCDHEC permits, regulates, or exempts each source of airborne emissions in the SRS Part 70 Air Quality operating permit. Various SCDHEC and EPA pollution control regulations and standards outline the bases for the limitations and monitoring requirements specified in the SRS Part 70 Air Quality Permits. Many of the applicable standards are source-dependent (i.e., applicable to certain types of industries, processes, or equipment). See http://www.scdhec.gov/homeand environment/air/ for the SCDHEC standards for airborne pollutants.

Monitoring Program

Major nonradiological emissions of concern from SRS facility stacks include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter, volatile organic compounds (VOCs), and toxic and hazardous air pollutants. The SRS Part 70 Air Quality Permits have numerous continuous and periodic monitoring requirements; only the largest emission sources are discussed below.

The primary method of documenting source emissions 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. However, many of the SRS processes are unique sources requiring nonstandard, complex calculations. SRS compares the hourly and total actual annual emissions for each source against their respective permit limitations.

SRS is required to perform stack compliance tests every two years at the 784-7A Biomass Boiler. The tests include sampling of boiler exhaust gases to determine particulate matter. In addition, SRS monitors and records opacity (e.g., particulate matter) during times of operation and performs weekly visual inspections. SRS conducted and passed a compliance stack test at the SRS biomass boiler in February 2013. The next test is required prior to March 31, 2015.

All fuel oil-fired equipment operated on SRS must comply with sulfur dioxide standards, and SRS reports compliance to SCDHEC semiannually. The sulfur content of the fuel oil used at SRS must be below 0.05%; SRS verifies compliance by analysis and requires the vendor to supply fuel certification 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 SRS consumption limit.

SRS has several soil vapor extraction units and two air strippers that are sources of toxic air pollutants and VOCs. SRS must sample monthly for VOC concentrations and calculate the total VOC emissions for comparison against a 12-month rolling limit. SRS currently reports the VOC emissions to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices, such as electrostatic precipitators, baghouse dust collectors, or condensers. SRS must monitor these devices continuously or during operation and record and compare the data against specific operating ranges.

SCDHEC assesses compliance of all SRS permitted sources during annual compliance inspections. The inspections include a review of each permit condition (e.g., daily monitoring readings, equipment calibrations, control device inspections, etc.); SCDHEC last performed an air compliance inspection in May 2012 and found no instances of noncompliance. SCDHEC did not perform an inspection in 2013.

Releases Summary

SRS is required to report its air emissions inventory for all Site emission sources annually to SCDHEC. SRS compiles operating data and calculates emission data for each calendar year. Data Table 4-7 provides a list of the 2009-2013 estimated emissions.

Chapter 3, "Compliance Summary" provides a summary of the emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in each of the past five years. A review of the calculated emissions for each source for each calendar year demonstrated that SRS sources operated in compliance with permitted emission rates.

SCDHEC limits use of diesel fuel in the Site's Title V operating permit as VOC emissions are directly related to fuel consumption. The total diesel fuel consumption for portable air compressors, generators, emergency cooling water pumps, and firewater pumps was found to be well below the SRS limit for the entire reporting period. As reported to SCDHEC during 2013, the calculated annual VOC emissions were well below the permit limit for each unit.

Liquid Effluents

Monitoring Program

SRS monitors nonradioactive liquid discharges to surface waters through the NPDES program, 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. SCDHEC administers the NPDES permit program under EPA authority in South Carolina and is responsible for the permitting, compliance, monitoring, and enforcement activities of the program. The permits issued by SCDHEC to SRS provide specific requirements for sampling locations, parameters to be tested, and monitoring frequency as well as collection, analytical, and reporting methods.

In 2013, activities at SRS resulted in discharges of water into SRS streams under five primary NPDES permits: two for industrial wastewater, SC0047431 (covers D Area) and SC0000175 (covers remainder of SRS); one for stormwater runoff from industrial activities, SCR000000; one for stormwater runoff from construction activities, SCR100000; and one for general utility water, SC250273.

Figure 4-6 shows NPDES industrial wastewater outfall sampling locations. Twenty-eight industrial wastewater outfalls were regulated at SRS in 2013 under NPDES Permits SC0000175 and SC0047431.

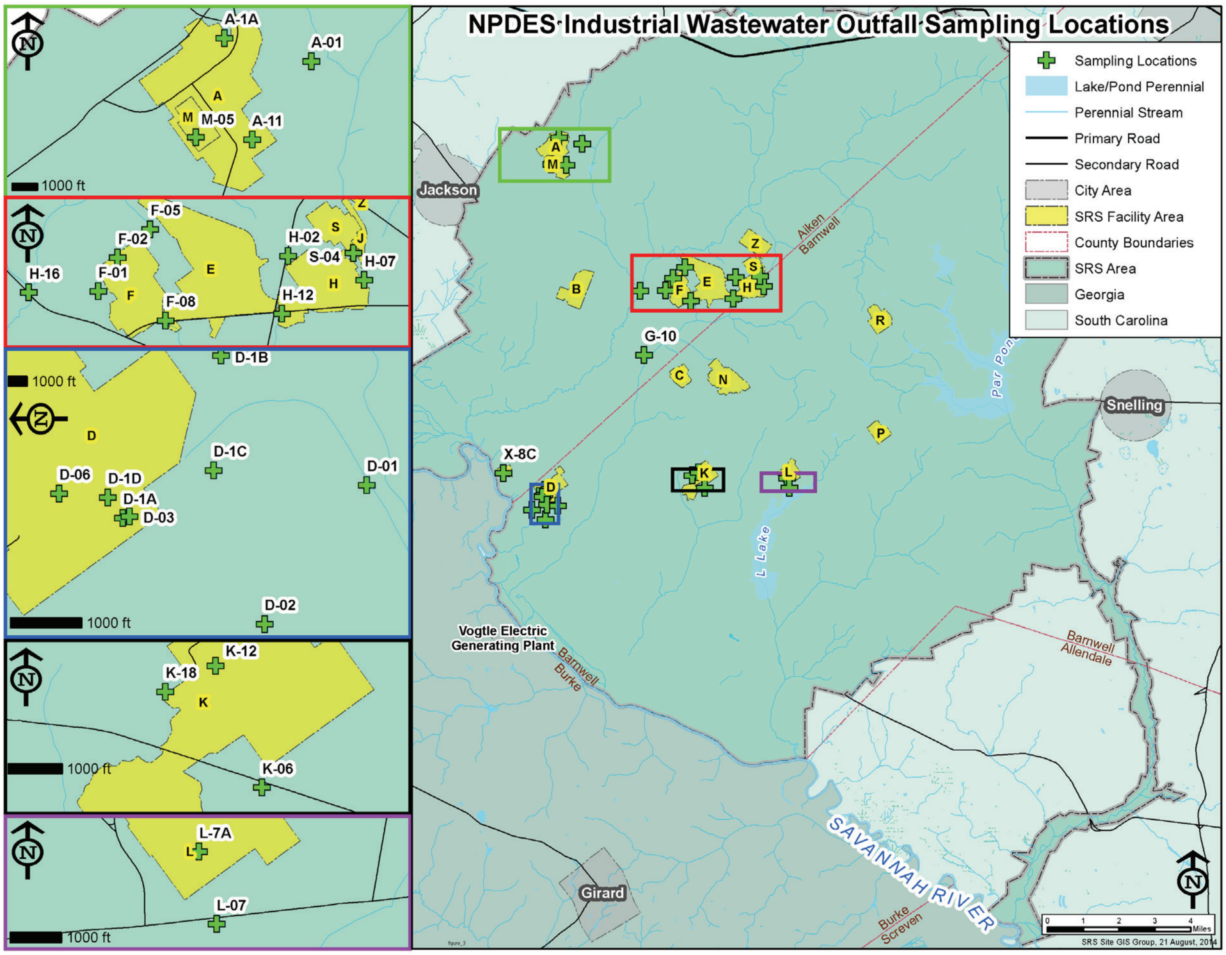


Figure 4-6 NPDES Industrial Wastewater Outfall Sampling Locations

Figure 4-7 shows NPDES industrial stormwater outfall sampling locations. Forty industrial stormwater outfalls were regulated at SRS in 2013 under Permit SCR000000, the NPDES General Permit for Stormwater Discharges associated with Industrial Activity (except construction activity).

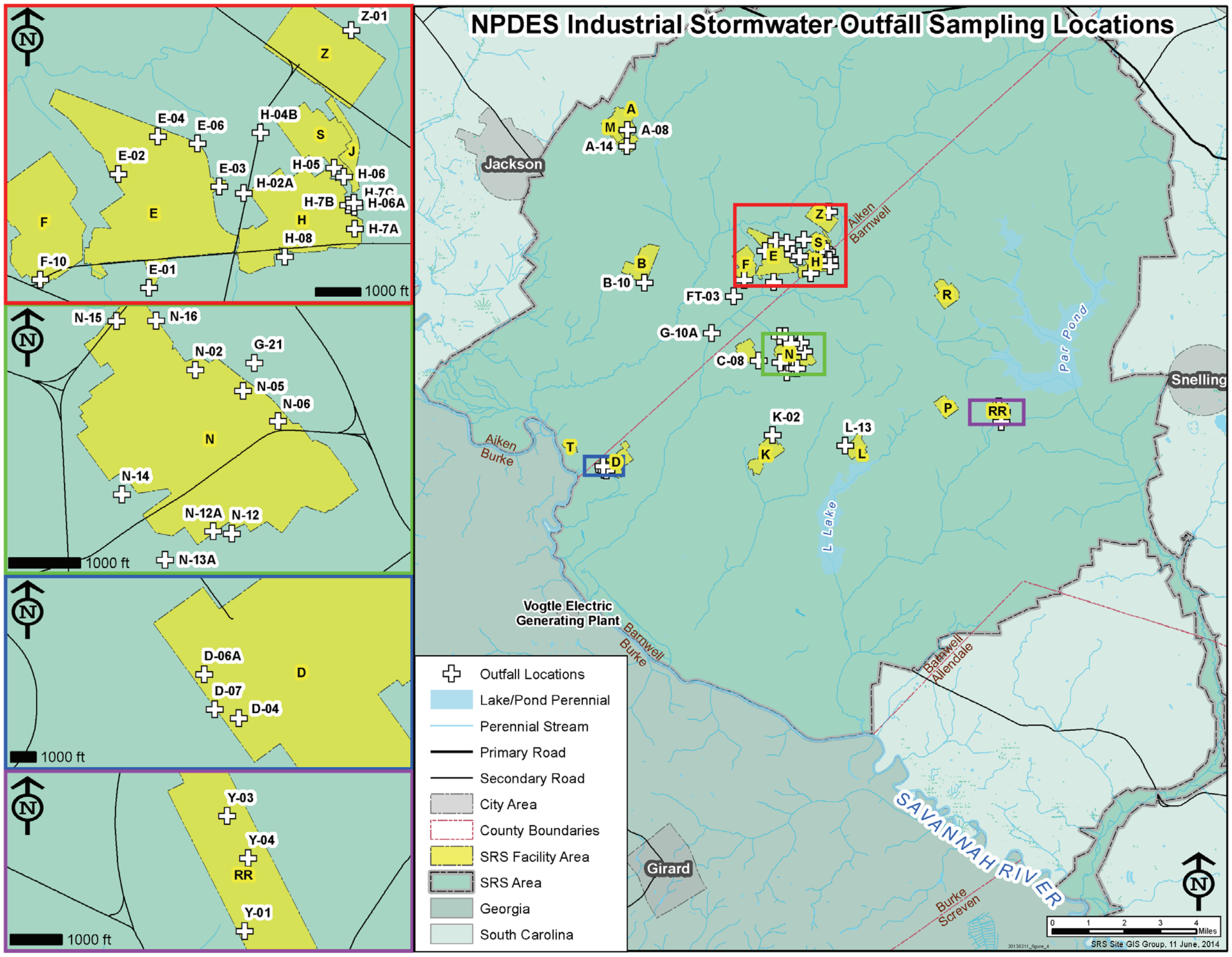


Figure 4-7 NPDES Industrial Stormwater Outfall Sampling Locations

NPDES samples are collected in the field according to 40 CFR 136 ("Guidelines Establishing Test Procedures for the Analysis of Pollutants"). This document lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant to be analyzed. Figure 4-8 shows a field technician collecting a compliance sample at an industrial wastewater outfall.

Figure 4-8 Field Technician Collects a Compliance Sample at an Industrial Wastewater Outfall

Sludge from the sanitary wastewater treatment facilities is managed under the requirements contained in Permit ND0072125, a no-discharge, land application permit issued by SCDHEC. SRS transfers sludge generated at the sanitary wastewater treatment facilities from the sludge thickener to the drying beds. The air-dried sludge removed from the drying beds is then stored in a shed until land application of the resulting biosolids occurs. One application of approximately 134 cubic yards of the dried sludge was performed from August 5 through August 29, 2013. All sample results were within permit limits for metals and nutrients.

Releases Summary

SRS reports NPDES industrial wastewater analytical results to SCDHEC through monthly discharge monitoring reports (EPA Form 3320-1). Three out of approximately 3,914 sample analyses performed during 2013 exceeded

NPDES permit limits, a 99.9% compliance rate. SRS received two Notices of Violation (NOV) from SCDHEC on September 13, 2013 for two of the three exceedances; one for total suspended solids at A-01 Outfall and one for toxicity at D-01 Outfall. SRS voluntarily implemented extensive corrective actions to address the violations, and SCDHEC did not assess any penalties. Chapter 3, "Compliance Summary," Table 3-2, Summary of SRS NPDES Limit Exceptions in 2013 describes the NPDES exceptions. Data Table 4-8 provides a compilation of industrial wastewater analytical data for 2013.

SRS monitored all industrial stormwater outfalls per the requirements of the permit. Sample results demonstrated compliance with permit requirements. Data Table 4-9 provides a compilation of stormwater analytical data for 2013. Figure 4-9 shows an employee performing a quarterly visual assessment of an industrial stormwater outfall sample. Stormwater runoff from construction activities 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 2013.

Sampling for general utility water (e.g., non-contact cooling water, steam condensate, boiler blowdown, etc.) was not required in 2013 because all discharges remained under flow thresholds.

Figure 4-9 Visual Assessment of an Industrial Stormwater Outfall Sample

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ENVIRONMENTAL SURVEILLANCE

Chapter 5

Teresa Eddy, John Adams
Lori Coward, Karen Vangelas
Savannah River Nuclear Solutions, LLC

Timothy Jannik, Dennis Jackson
Savannah River National Laboratory

The Savannah River Site (SRS) conducts environmental surveillance activities to determine the potential radiological and nonradiological impacts to the public, air, water, environmental media, and wildlife from Site operations.

SRS conducts radiological environmental surveillance in accordance with Department of Energy (DOE) Order 458.1 to characterize routine and nonroutine releases of radioactive material from the Site, characterize the pathway(s) of exposure to members of the public, and provide data to estimate and verify the potential doses to individuals and populations near the Site. SRS measures the effects that routine and nonroutine operations have on the Site and the surrounding area and population through its monitoring programs.

Environmental surveillance is performed within and beyond the SRS perimeter at designated sampling points. The sampling points are representative of the major contaminant pathways (liquid and airborne) and extend from points near the source of Site releases out to 100 miles from the Site. The numbers of sampling locations depend on wind patterns, liquid flows and distance from the release point. Sample locations become fewer in number the farther they are from the source because a contaminate becomes increasing less concentrated the farther it is from the release point.

In 2013, radiological surveillance results, in some cases, had increased levels from previous years due to the record high levels of rainwater causing certain radionuclides to either be deposited from the air into the environment, runoff from the ground's surface, or migrate from the groundwater to the streams (Figure 5-1). In summary, 2013 radiological surveillance results are below 1% of the DOE derived concentration standard (DCS), which is less than 1% of the DOE limit of 100 millirem for all exposure pathways to the public from SRS. Exposure pathways include swimming in the Savannah River, breathing the local air, eating local farmed food, drinking the local water and milk (Figure 6-1). Dose assessment information from these exposure pathways is presented in Chapter 6, "Radiological Dose Assessments."

Chapter 5 – Key Terms

Environmental surveillance *is the collection of samples and monitoring of air, water, soil, foodstuffs, biota, and other media—or of data—from the environment. The samples are used to measure the amount of radioactivity and other contaminants in the environment.*

Dose *is a general term for the quantity of radiation (energy) absorbed.*

Contaminant pathway *is the way contaminants move and settle in the environment after release from SRS facilities to the air and water (Figure 6-1).*

Exposure pathway *is the way that a person could be impacted from releases of radionuclides into the water and air (Figure 6-1).*

Derived concentration standard *is the 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 a dose of 0.1 rem (1 mSv).*

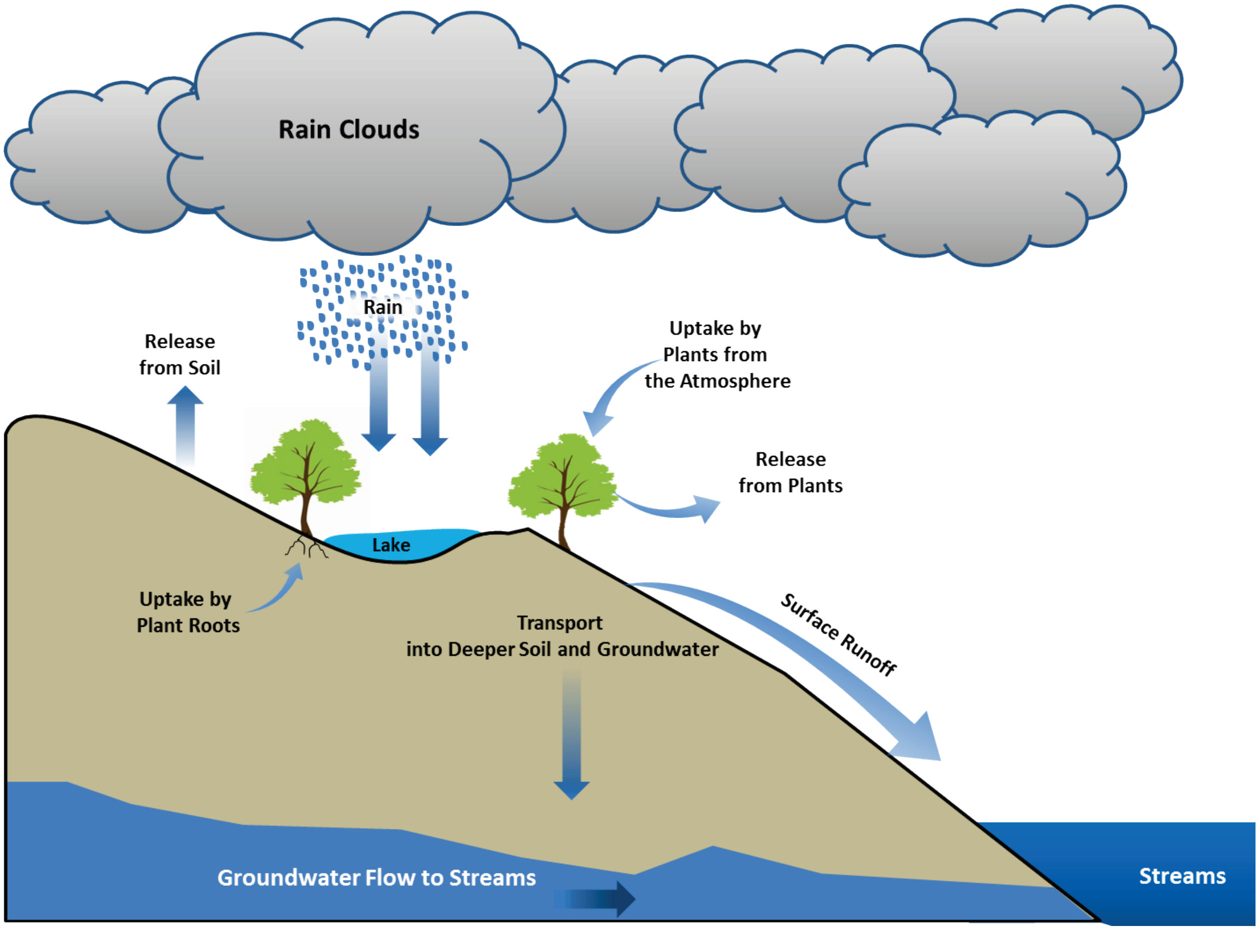


Figure 5-1 Process for Radionuclides Depositing Out of the Air into the Environment from Rainwater

SRS conducts nonradiological surveillance activities to comply with other federal and state regulations. In 2013, nonradiological surveillance results were below regulatory limits.

In summary, 2013 results from SRS onsite and offsite surveillance activities confirm that SRS operations have a minimal impact on the public and the environment with results indicating levels below applicable standards. Results from surveillance media show exposure was well below standards, indicative of a minimal impact on the general public.

SRS OFFSITE SURVEILLANCE

In addition to samples collected on Site, SRS collects samples beyond the SRS perimeter in Georgia (GA) and South Carolina (SC) at 25 and 100 miles from the Site, as well as the population centers of Aiken, Allendale, Barnwell, New Ellenton, North Augusta, and Williston in South Carolina and Augusta, Savannah, and Waynesboro in Georgia.

Chapter – 5 Key Terms (Continued)

Radionuclides *are unstable nuclides 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. Radionuclides can be alpha-emitting, beta emitting, or gamma-emitting.*

Detectable *means that the amount of radioactivity can be measured by the instrumentation.*

Minimum detectable activity (MDA) *is the smallest amount of radioactivity that the instrument can measure.*

Trend line *is a line on a graph showing the general direction that a group of data points seems to be heading.*

Surveillance involves collecting and analyzing samples of air, river water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations 25 miles from SRS and from some locations as far as 100 miles. These samples are analyzed for radioactive and/or non-radioactive contaminants to assess trends in the different environmental media.

SRS monitors the Savannah River downriver from SRS influences at River Mile 118.8 (Georgia Welcome Center at Highway 301), river locations downriver of each SRS stream entry point, and above the Site at River Mile 160 as a control location. The map in Figure 5-2 displays the SRS perimeter and offsite environmental sampling locations. Groundwater monitoring is covered in Chapter 7, "Groundwater."

During 2013, there were several enhancements or modifications to the SRS environmental surveillance program, which were made because of technology improvements, effluent program changes, budget shortfall, and/or environmental conditions during periods of heavy rainfall. These details are discussed within the appropriate sections of this chapter. Higher rainfall during 2013 impacted sampling on the Savannah River due to historically high flowrates.

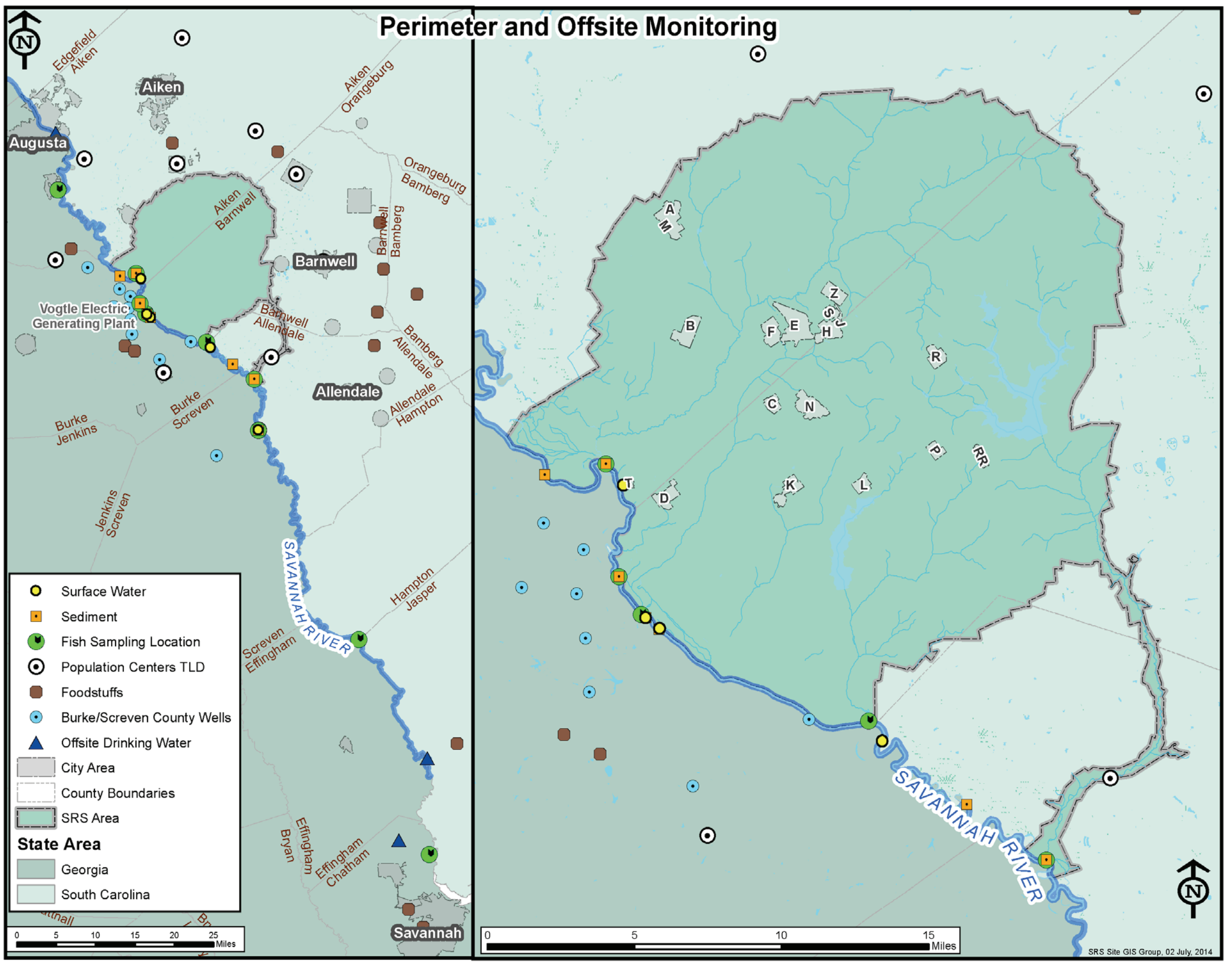


Figure 5-2 SRS Offsite Sampling Media Locations for Georgia and South Carolina

Table 5-1 summarizes the SRS offsite surveillance sampling performed in Georgia and South Carolina excluding samples collected in the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Media	South Carolina Locations	Georgia Locations	South Carolina Approximate Number of Samples	Georgia Approximate Number of Samples
Media for Airborne Contaminant Pathway				
Air Filters	1	3	52	156
Silica Gel	1	3	26	78
External Ambient Gamma Radiation Monitoring (Thermoluminescent dosimeters[TLDs])	7	5	140	100
Rain Ion Columns	0	2	0	24
Rainwater	1	3	12	36
Food Products	19	6	19	7
Milk	4	4	16	17
Soil	1	3	1	3
Vegetation (nonedible)	1	3	1	3
Media for Liquid Contaminate Pathway				
Drinking Water	3	1	36	12
Groundwater	0	10	0	36
Total	**38**	**43**	**303**	**472**

RADIOLOGICAL SURVEILLANCE

Radionuclides present in and around the SRS environment are from a number of sources, including natural background, fallout from historical atmospheric testing of nuclear weapons, offsite nuclear power plant operations, and SRS operations.

Table 5-2 summarizes the radiological surveillance sampling media and frequencies.

Table 5-2 SRS Radiological Surveillance Sampling Frequencies

Radiological Airborne Contaminant Pathway						
Media		**Sampling Frequency**				
		Weekly	**Bi-Weekly**	**Monthly**	**Quarterly**	**Annually**
Air	Airborne particulate matter		✓			
	Gaseous state of radioiodine		✓			
	Tritiated water vapor		✓			
	Tritium in rainwater			✓		
	Wet and dry deposition			✓		

Table 5-2 SRS Radiological Surveillance Sampling Frequencies (Continued)

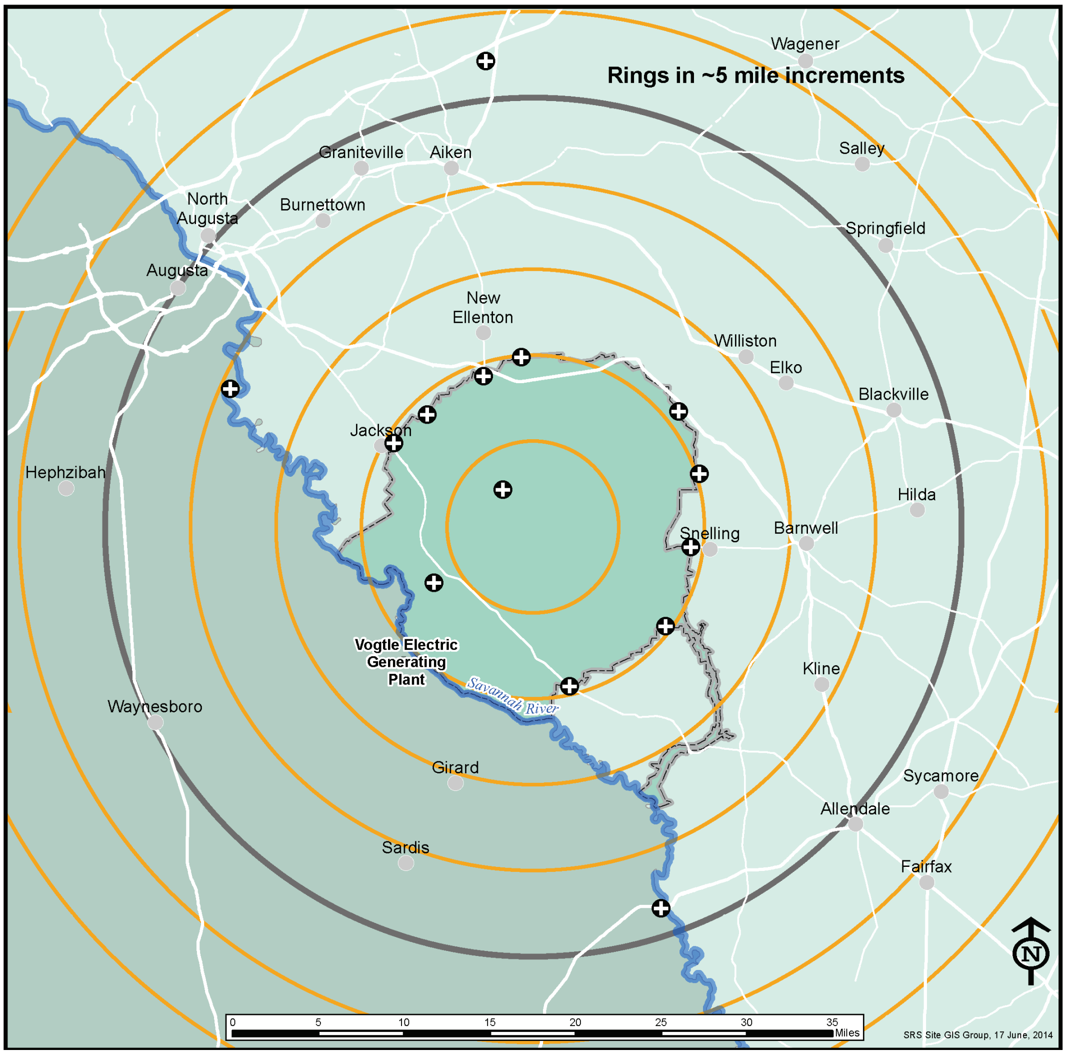
Radiological Airborne Contaminant Pathway						
Media		Sampling Frequency				
		Weekly	Bi-Weekly	Monthly	Quarterly	Annually
Soil	Airborne pathway for radioactive deposition into the environment					✓
Food Products (Collards, Meats, Fruit)	Radiological contaminants in the food chain					✓
Vegetation	Monitor for trends in radionuclide mobility and uptake by plants					✓
TLDs	Ambient gamma radiation monitoring				✓	
Water	Onsite drinking water				✓	✓
	Offsite drinking water			✓		
	Onsite surface water (streams and basins)	✓	✓	✓		✓
	Savannah River	✓				✓
Sediment	Measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed					✓
Fish and Shellfish	Bass, catfish, bream, mullet, redfish, sea trout					✓
	Oysters and Crabs					✓
Wildlife	Field and lab monitoring of onsite deer, feral hogs, turkey, and coyotes during Site sponsored controlled hunts					✓

Atmospheric Surveillance

SRS conducts atmospheric monitoring to determine whether airborne radionuclides from SRS releases have reached the environment in measurable quantities. The atmosphere contains radionuclides in various forms (gaseous, particulate matter, water vapor). In addition, rainwater can redeposit particulate matter from the air onto the ground and the radionuclides can eventually be absorbed into vegetation or soil. The atmospheric surveillance program monitors both air and rainwater.

SRS maintains a network of 15 atmospheric surveillance sampling stations (Figure 5-3 and Maps Figure 5) in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air and rainwater. Due to the reduced SRS budget, along with program changes, there are fewer results for sampling at the Savannah, GA air station (discontinued in October 2013) compared to the other air surveillance locations.

The surveillance stations are located at the center of SRS, around the Site perimeter, in population centers 25 and 100 miles from SRS, and at a control location, Georgia Welcome Center in Screven County (assumed to be unimpacted by SRS operations) nearly 25 miles from SRS. SRS has placed air sampling stations near the Site boundary and beyond to ensure that at least one monitoring station is in every 45-degree sector (Figure 5-3) to be representative of the atmospheric distribution of airborne releases into the environment. Each atmospheric surveillance sampling station consists of the components listed in Table 5-3.



Note: 100-Mile Savannah Station is Not Displayed

Figure 5-3 Air Sampling Locations Surrounding SRS up to 25 Miles

Table 5-3 Atmospheric Surveillance Stations

Media	Purpose	Radionuclides	Data Table
Glass-Fiber Filter	Airborne Particulate Matter	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides	**5-1**
Charcoal Canister	Gaseous States of Radioiodine	Iodine-129, Iodine-131, gamma-emitting radionuclides	**5-2**
Silica Gel	Tritiated Water Vapor	Tritium	**5-3**
Rainwater	Tritium in Rainwater	Tritium	**5-5**
Rain Ion Column	Wet and Dry Deposition	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides, total strontium, actinides (plutonium, americium, uranium, curium, and neptunium)	**5-4**

Table 5-3 lists the airborne radionuclides that are measured. These radionuclides were selected based on known SRS airborne releases. Background levels in the atmosphere consist of naturally occurring radionuclides (e.g., uranium, thorium, and radon) and radionuclides (e.g., strontium-90, cesium-137) from global fallout due to historical nuclear weapons testing.

Results Summary

Atmospheric surveillance results are summarized in Table 5-4. All results were within the historical five year trend and below 1% of the dose standard.

Table 5-4 Summary of Maximum Radionuclide Concentrations in Air

Radionuclide	Number of Samples	Number of Detections	Maximum (pCi/m^3)	Equivalent to 1 mrem Dose (pCi/m^3)	Location of Maximum	Comments
Tritium	374	71	497	2,190	Approximate Center of SRS	Maximum concentration is expected at this location because this is the closest location to SRS tritium releases
Gross Alpha[a]	374	368	0.00392	Specific radionuclide values are applicable[a]	Highway 21/167, East Northeast SRS Perimeter	Maximum concentration is expected at this location because it is within the sector of less air mixing
Gross Beta[a]	374	374	0.0247	Specific radionuclide values are applicable[a]; EPA screening limit = 1 pCi/m^3	Highway 21/167, East Northeast SRS Perimeter	Maximum concentration is expected at this location because it is within the sector of less air mixing

Table 5-4 Summary of Maximum Radionuclide Concentrations in Air (Continued)

Radionuclide	Number of Samples	Number of Detections	Maximum (pCi/m^3)	Equivalent to 1 mrem Dose (pCi/m^3)	Location of Maximum	Comment
I-129	15	0	Less than MDA	0.319	Not Applicable	None
Cs-137	374	0	Less than MDA	9.18	Not Applicable	None
U-234	15	14	0.0000292	0.0111	Greenpond Road Northwest SRS Perimeter	Maximum concentration is expected at this location because air contains dust which contains natural uranium
U-235	15	0	Less than MDA	0.0125	Not Applicable	None
U-238	15	15	0.0000327	0.00134	Greenpond Road, Northwest SRS Perimeter	Low maximum value is expected because air contains dust which contains natural uranium
Am-241	15	9	0.00000973	0.001	Aiken Airport, 25 miles North of SRS	Low maximum value is expected because SRS operations release very low quantities in air
Cm-244	15	3	0.00000841	0.00155	Jackson, SC Northwest SRS Perimeter	Low maximum value is expected because SRS operations release very low quantities in air
Pu-238	15	0	Less than MDA	0.000908	Not Applicable	None
Pu-239	15	0	Less than MDA	0.000838	All Less than MDA	None

[a] See information below regarding gross alpha and beta screening
Note: DOE Dose Standard for all exposure pathways = 100 mrem

Gross Alpha and Beta-emitting Radionuclides

Gross alpha and beta results provide useful information for trending of the total activity in screening samples; however, these results cannot provide concentrations of specific radionuclides. If the gross analytical results appear to be elevated, SRS may perform analyses for specific radionuclides to investigate a potential problem, such as an unplanned release. There were no elevated screening levels of gross alpha and beta in air surveillance filters during 2013. Average gross alpha and beta results for 2013 were comparable to 2012 and the previous five years.

Gamma-emitting Radionuclides

Small amounts of cesium-137 and other gamma-emitting radionuclides are released into the air at SRS in quantities well below the DCS. Air filter and charcoal canister analytical results for 2013 indicated no detectable amounts of man-made gamma-emitting radionuclides in the environmental surveillance samples, which is consistent with 2012 and the previous historical results.

Alpha-emitting Radionuclides (Actinides)

During 2013, alpha-emitting radionuclides were comparable to 2012 and the previous five years showing low (less than 1% of the DCS) detectable levels of uranium-234, uranium-238, americium-241, and curium-244.

Iodine-129

Analytical results indicated no detectable levels of iodine-129 in environmental surveillance samples collected in 2013 consistent with 2012 and the previous historical trend.

Tritium-in-Air

Tritium-in-air results for 2013 were generally lower than those observed in 2012 and the previous five years consistent with the long-term range of statistical variability. Results showed detectable levels in 71 of the 374 (19%) samples for 2013. Maximum results for 2013 are summarized in Figure 5-4 with maximum levels decreasing to background levels once reaching offsite.

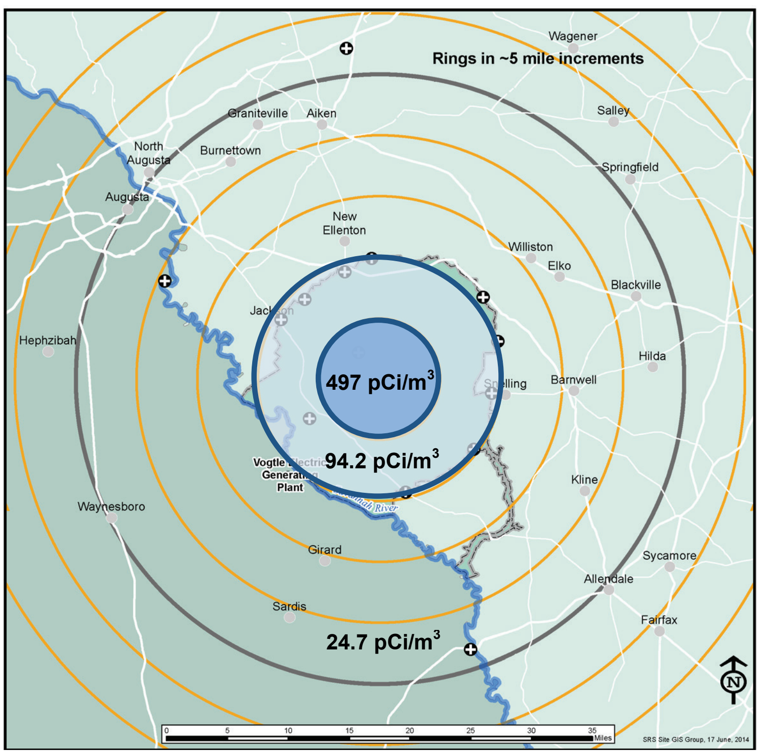


Figure 5-4 2013 Tritium in Air Maximum Concentrations (pCi/m^3)

Rainwater Monitoring

Rainwater is collected with pans located on top of the monitoring stations. Seven stations are equipped to sample for radionuclide deposition (except tritium), where the rainwater passes through an ion exchange resin column also known as a rain ion column. Dry deposition on the pan prior to rainfall is washed through the system with the rainfall; therefore, the sample represents both wet and dry deposition (Figure 5-5).

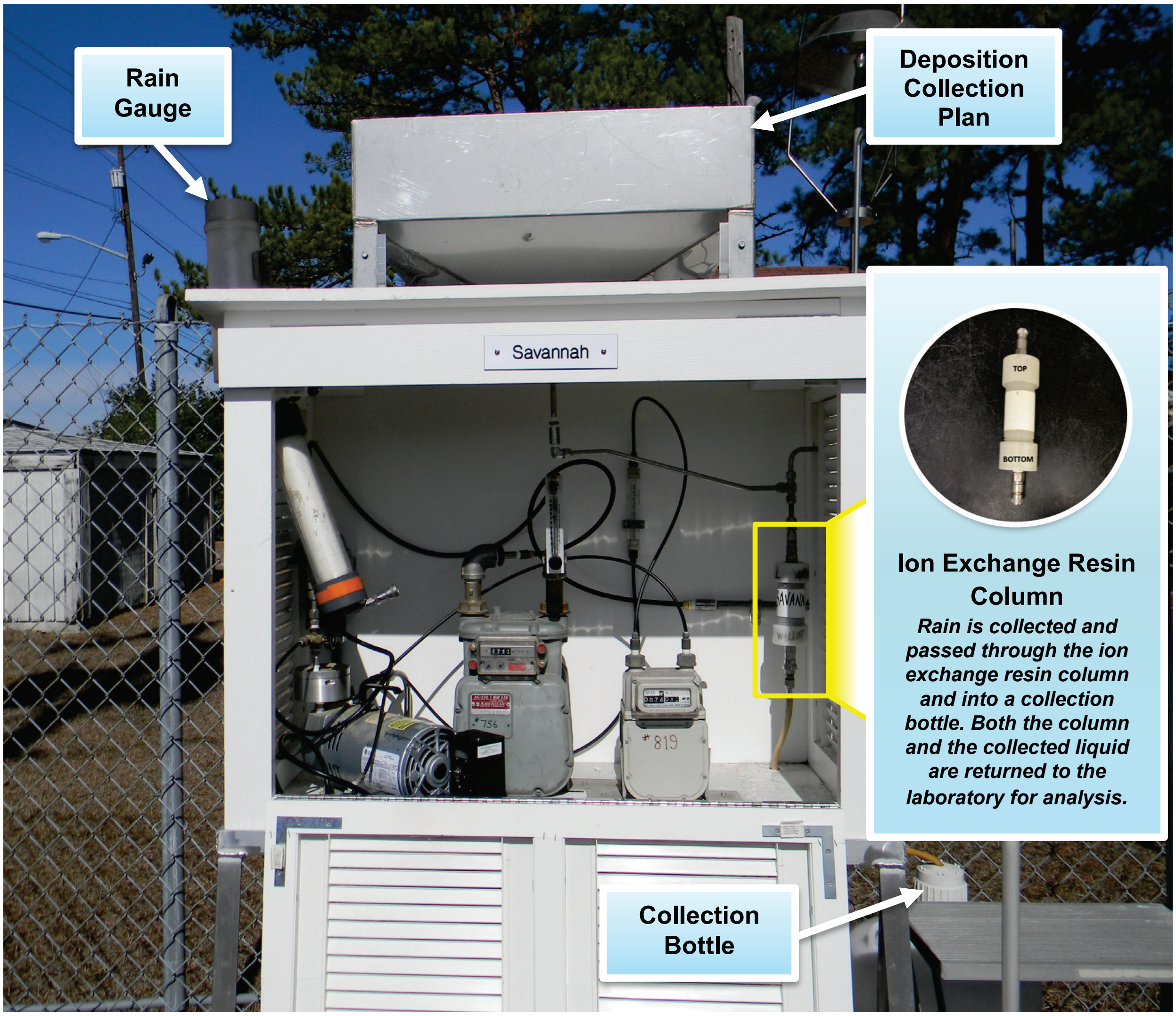


Figure 5-5 Rainwater Collection System at the Air Monitoring Stations

Tritium-in-Rainwater

Tritium-in-rainwater results showed detectable levels in 28 of the 202 rainwater samples (14%) for 2013 with levels similar or lower than 2012 and the previous five years. One tritium result from the D Area location had a tritium concentration two times the maximum observed over the previous five years. This followed several significant rain events totaling greater than 8.5 inches over the course of the month. Concentrations from all locations are below the EPA standard of 20,000 pCi/L. As in previous years, values were highest near the center of the SRS and decreased with distance from the Site (Table 5-5).

Table 5-5 2013 Tritium-in-Rainwater Concentrations (pCi/L)

Location	Location Description	Number of Samples	Number of Samples Greater than MDA	Maximum
Onsite (Center)	Approximate Center of SRS	14	14	4,780
Site Perimeter (Northwest)	Green Pond, SC	13	1	870
Site Perimeter (North)	Talatha Gate, SC	14	1	651
Site Perimeter (North)	East Talatha, SC	14	2	438
Site Perimeter (Northeast)	Darkhorse, SC	14	0	Not Applicable
Site Perimeter (East)	Highway 21/167, SC	14	1	332
Site Perimeter (South)	Barnwell Gate, SC	14	1	403
Site Perimeter (Southwest)	Patterson Mill Road, SC	14	2	424
Site Perimeter (South)	Allendale Gate, SC	14	0	Less than MDA
Site Perimeter (Southwest)	D-Area, SC	13	4	3,380
Site Perimeter (West)	Jackson, SC	14	2	411
25-miles from SRS (Northwest)	Augusta, GA	14	0	Not Applicable
25-miles from SRS (North)	Aiken Airport, SC	14	0	Not Applicable
25-miles from SRS (South)	Highway 301, GA (CONTROL)	14	0	Not Applicable
100-miles from SRS (Southeast)	Savannah, GA (CONTROL)	8	0	Not Applicable
EPA Drinking Water Standard for Tritium in Water = 20,000 pCi/L				

Gross Alpha and Beta-Emitting Radionuclides

Gross alpha and gross beta results from 2013 wet and dry deposition were consistent with those of 2012 and previous five year historical trend levels. Results in wet and dry deposition from rainfall ranged from below the minimum detectable activity (MDA) to a maximum of 31.9 pCi per square meter gross alpha and a maximum of 357 pCi per square meter gross beta. Levels are below the EPA drinking water risk level for potential health effects from long-term exposure.

Gamma-Emitting Radionuclides

No detectable levels of man-made gamma-emitting radionuclides, such as cobalt-60 and cesium-137, were observed in deposition samples during 2013, consistent with 2012 and the previous five years.

Alpha-Emitting Radionuclides-Actinides

Uranium-234 and uranium-238 ranged from below the MDA to 0.264 pCi per square meter at the Highway 301 location (about 25 miles south of the Site) and at the approximate center of SRS, respectively. Uranium is naturally occurring in soil and is expected to be present at low concentrations in deposition samples. Americium-241 results ranged from below the MDA to 0.139 pCi per square meter at the Darkhorse Site perimeter location.

Strontium

In 2013, none of the strontium-89, 90 results from wet and dry deposition were above the MDA, consistent with 2012 and the previous five years.

Ambient Gamma Surveillance

SRS has been monitoring ambient environmental gamma exposure rates with thermoluminescent dosimeter (TLDs) since 1965 to determine the impact of Site operations on the gamma exposure to the public, in the environment and to evaluate trends in exposure levels. Other uses include support of routine and emergency response dose calculations.

An extensive network of TLDs in and around SRS is used to monitor external ambient gamma exposure rates. The SRS ambient gamma radiation monitoring program has four subprograms: Site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor exposures from Georgia Power's VEGP). Most gamma exposure monitoring is conducted onsite and at the SRS perimeter. SRS conducts offsite monitoring in population centers within nine miles of the Site boundary, but only limited monitoring beyond this distance and at the 25 and 100-mile air surveillance stations.

Ambient Gamma 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 2013, ambient gamma exposure rates varied between 71 mR/yr (location NRC_2 near D Area) and 124 mR/yr (location Williston, SC) (Data Table 5-6, Maps Figure 6).

Ambient gamma results are consistent with the previous five year trends and indicate that no significant difference in average annual dose rates exists 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 higher natural background radiation levels emitted from materials present in buildings and roadways.

Stormwater Basin Surveillance

SRS performs surveillance of stormwater accumulating in the Site's stormwater basins (Maps Figure 2) for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides. There are no active processes discharging to stormwater basins onsite, hence the accumulations in the stormwater basins are primarily stormwater runoff. Monitoring for specific radionuclides occurs where previous operational history indicates the possible presence of certain radionuclides. The E-Area basins receive stormwater from the Solid Waste Disposal Facility (SWDF), E-Area Vault, and stormwater from the controlled clean-soil pit on the east side of E Area. F-Area Pond 400 receives stormwater from F Area and the Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area.

Figure 5-6 E-004 Stormwater Basin

In 2013, surveillance was conducted at six E-Area basins as well as at the Z-Area Stormwater Basin and F-Area Pond 400. Stormwater Basin E-004 is shown in Figure 5-6.

Results Summary

The Z-Area Stormwater Basin is designed for a 25-year flood event and does not discharge to the environment under normal rainfall conditions. However, there were several unusually heavy rainfall events in 2013 that resulted in increased runoff to the basin. Analytical results from basin water samples are summarized in Table 5-6. The elevated concentrations of radionuclides resulted from stormwater runoff from the nearby Saltstone Disposal Unit (SDU) 4, (formerly referred to as vaults). Although the concentration of radionuclides are higher than 2012 and the historical trend, the basin water results are below the DCS, which are based on a rolling twelve-month average for all detectable radionuclides. Analytical results from sediment samples from the basin are summarized in Table 5-7.

Unusually heavy rainfall events in 2013 caused the Z-Area Stormwater Basin to fill and overflow at the Z-01 Outfall location. SRS sampled water, sediment, and soil outside the basin and at McQueen's Branch to determine if radionuclides had migrated into the environment downstream of the basin. Results indicated that contamination existed in sediment near the Z-01 Outfall, as well as the sediments in McQueen's Branch but there was no downstream transport of sediments to Upper Three Runs. The dose impacts are discussed in Chapter 6, "Radiation Dose Assessments."

Table 5-6 Radionuclide Concentrations in Z-Area Stormwater Basin Water

Radionuclide	Average (pCi/L)	Maximum (pCi/L)
Cs-137	11,000	41,600
Tc-99	24.99	85.3
Sr-89, 90	0.635	1.93
U-238	0.045	0.078
U-234	0.045	0.111
Pu-238	0.0111	0.0332
Tritium	1,710	2,860

Table 5-7 Radionuclide Concentrations in Z-Area Stormwater Basin Sediment

Radionuclide	Result (pCi/g)
Gross Alpha	6.51
Gross Beta	1,680
Cs-137	2,880

SRS implemented steps to control radioactive contamination (i.e., installation of weather enclosures and enhanced facility operations at SDU-4, and installation of stormwater management controls). SRS maintains the basin as a radiological area in accordance with SRS radiological practices.

Gross alpha, beta, and tritium results for the other SRS stormwater basins are summarized in Table 5-8 below. Gross alpha concentrations ranged from below the MDA to a maximum of 79.5 pCi/L at Pond 400. Gross beta results ranged from below the MDA to a maximum of 55.7 pCi/L at Pond 400. The highest maximum tritium concentration was observed at the E-002 Basin, at 28,100 pCi/L, higher than the 20,000 pCi/L EPA drinking water maximum contaminant level (MCL), but consistent with the previous five years of historical results. This basin does not actively discharge to the environment. The stormwater basin radiological results can be found in Data Table 5-7.

Table 5-8 Radionuclide Concentrations Summary for Stormwater Basins

Basin Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
E-001	0.354	4.12	3,260	5,380
E-002	0.798	6.09	10,600	28,100
E-003	1.60	3.37	8,800	16,400
E-004	0.939	2.66	6,520	11,200
E-005	1.07	4.03	3,670	7,460
E-006	0.685	10.8	1,940	2,010
Pond 400	8.72	10.6	888	2,160

SRS Stream Surveillance

SRS conducts continuous surveillance of SRS streams downstream of several process areas to detect and quantify levels of radioactivity transported to the Savannah River by effluents and shallow groundwater migration. The five primary streams are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. During 2013, two locations on McQueen's Branch above and below Z-Area Stormwater Basin were added to the stream surveillance program. This is due to the Z-Area Stormwater Basin discharging from high rainfall events.

Figure 5-7 displays the radiological surface water sampling locations. The frequency and types of analyses reflect the upstream discharges and/or groundwater migration history of radionuclides.

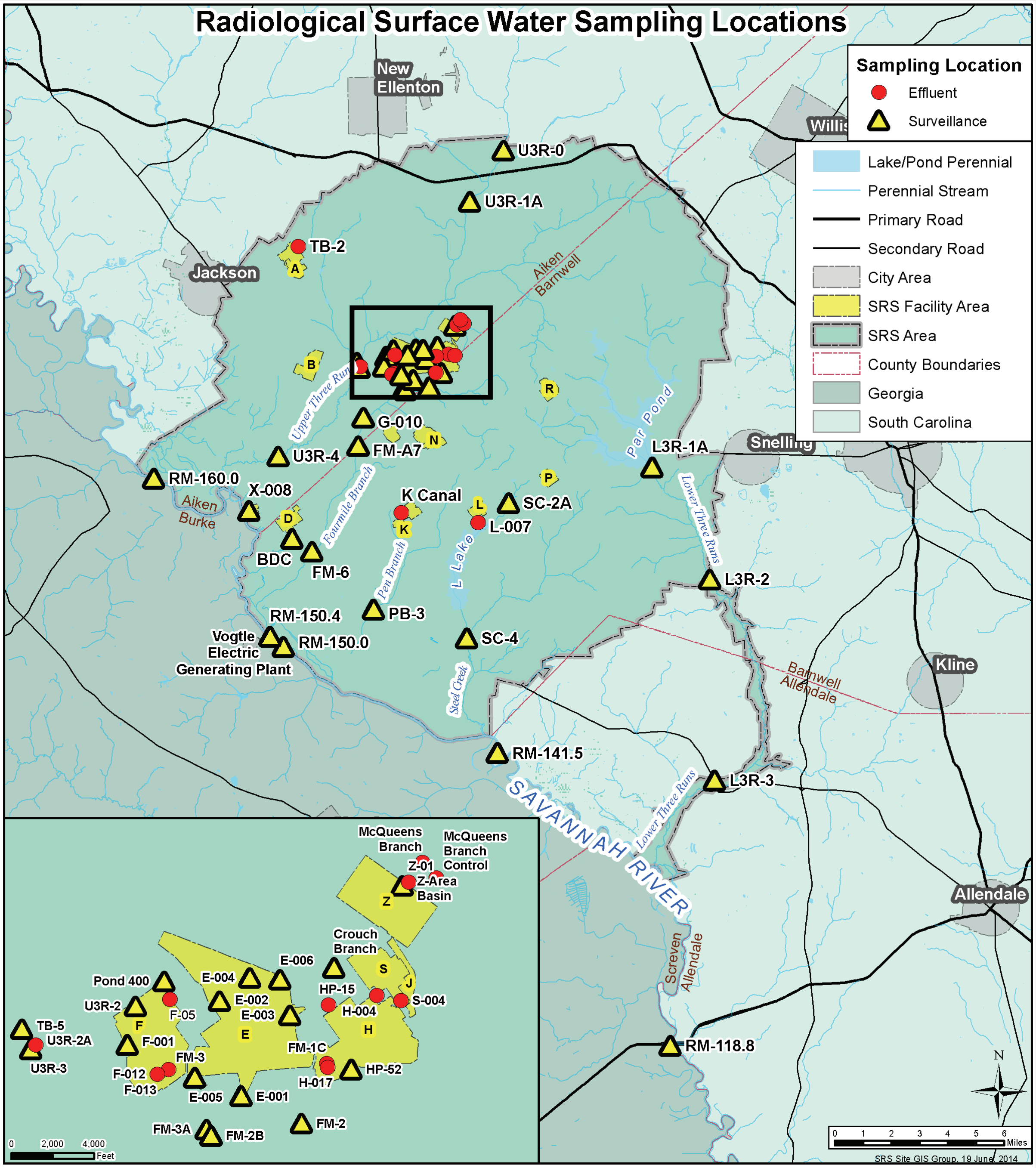


Figure 5-7 Radiological Surface Water Sampling Locations

Table 5-9 presents the average 2013 concentrations of gross alpha, gross beta, and tritium in SRS streams. All of the results are included in Data Table 5-8. SRS found detectable concentrations of tritium, the predominant radionuclide detected above background levels in SRS streams, at least once at all stream locations in 2013. The ten-year trend chart (Figure 5-8) for the average tritium levels in the streams shows a decreasing trend, which is due to a combination of decreases in Site releases and the natural decay of tritium. Figures 5-8 and 5-9 indicate that average tritium levels in Fourmile Branch are trending closer to the EPA standard of 20,000 pCi/L. Tritium levels are higher in Fourmile Branch compared to the other streams due to migration from the historical seepage basins and Solid Waste Disposal Facility. This is discussed further in the next section. Average tritium levels in Pen Branch are just below the standard and Upper Three Runs, Steel Creek, and Lower Three Runs are well below the EPA standard.

Table 5-9 Radionuclide Concetrations in SRS Streams by Location

Location	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
Onsite Stream Locations				
Tims Branch (TB-5)	9.76	3.25	563	1,220
Lower Three Runs (L3R-3)	1.04	2.13	987	2,240
Steel Creek (SC-4)	1.5	1.68	1,980	3,920
Pen Branch (PB-3)	0.272	1.19	16,500	26,800
Fourmile Branch (FM-6)	1.59	5.76	36,000	53,200
Upper Three Runs (U3R-4)	6.48	2.37	1,090	3,220
Onsite Control Locations (for comparison purposes)				
Upper Three Runs (U3R-1A)	6.61	2.15	313	838
Upper Three Runs (0)	4.19	0.935	470	473

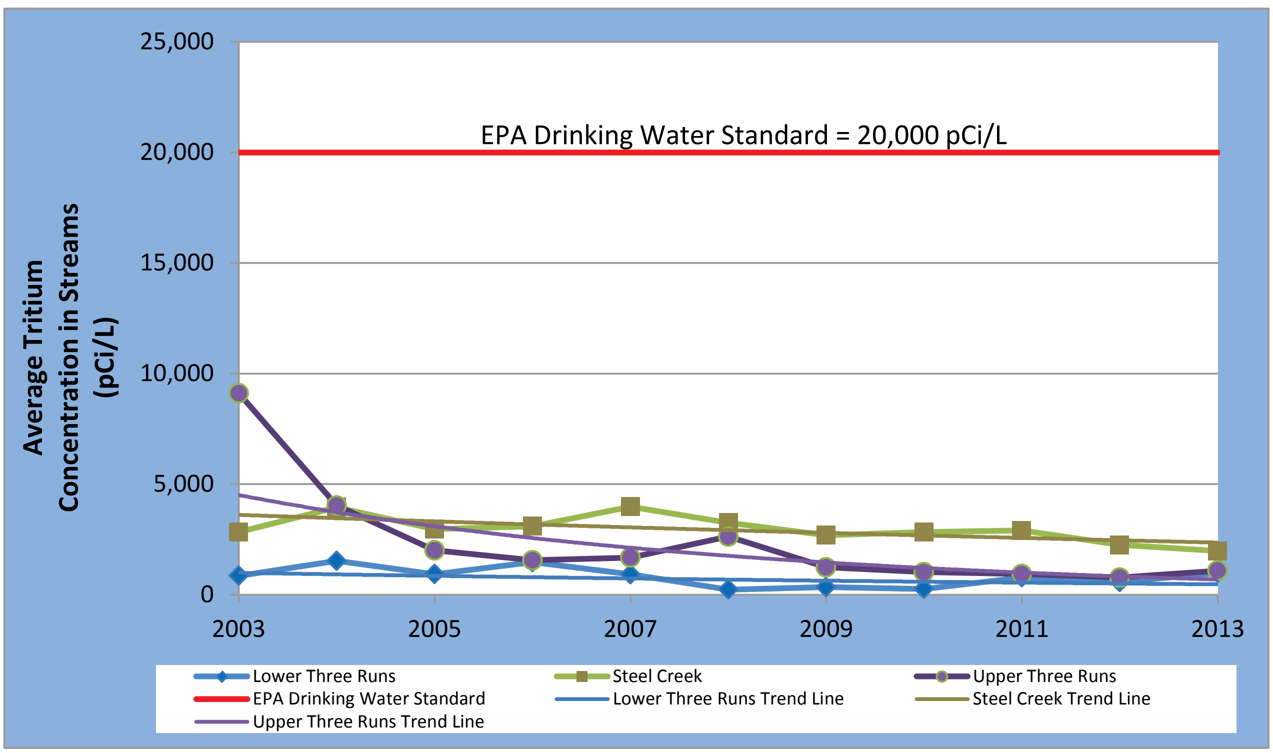


Figure 5-8 Ten-Year Trend of Tritium in Lower Three Runs, Steel Creek, and Upper Three Runs (pCi/L)

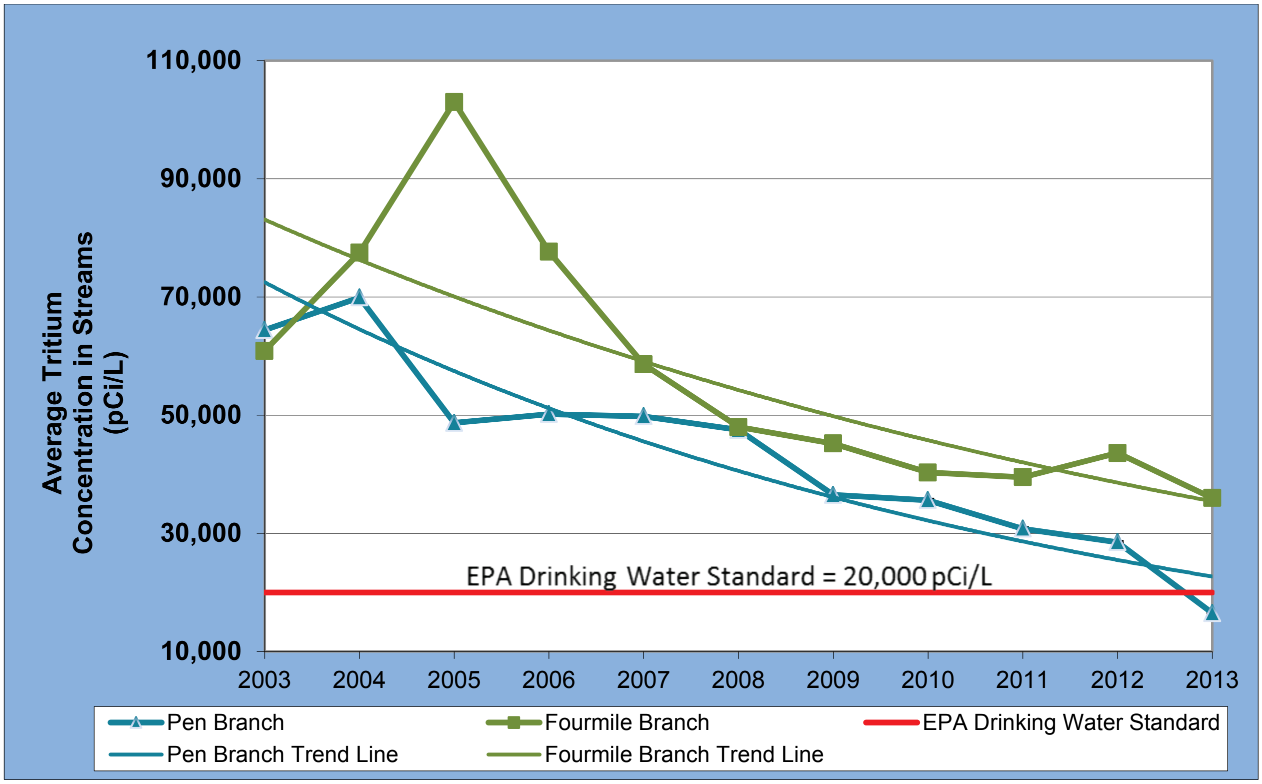


Figure 5-9 Ten-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

The radiological results are included in Data Table 5-8. There were higher levels of some radionuclides due to the increased amounts of rainfall during 2013 causing shallow groundwater migration, which is explained in the next section.

Seepage Basin and Solid Waste Disposal Facility (SWDF) Radionuclide Migration Monitoring

SRS monitors and quantifies the migration of radioactivity from SRS seepage basins and the SWDF as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and K-Area Seepage Basin, which have been closed. SRS closed the F-Area and H-Area Seepage Basins in 1991 and the K-Area Seepage Basin during 2002.

Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF continues to migrate through the groundwater and enter Fourmile Branch and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch at locations FM-3A, FM-2B, and FM-A7 (Figure 5-7). Migration from the SWDF is not distinguishable from the H-Area Seepage Basins because of their close proximity. Groundwater contamination from K-Area Seepage Basin migrates into Pen Branch.

Results Summary

Results of migration into Fourmile Branch, Upper Three Runs, and Pen Branch are summarized in Data Table 5-9. Tritium, strontium-89, 90, technetium-99, iodine-129, and cesium-137 were detected.

Figure 5-10 is a graphical representation of releases of tritium via migration to Site streams from 2004 through 2013. As seen in the figure, migration releases of tritium generally have declined the past ten years, with year-to-year variability caused mainly by the amount of annual rainfall. A combination of an increased amount of rainfall and flow during 2013 contributed to the increase in the surface water migration measured in the streams (Figure 5-10). Accordingly, during 2013, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 912 Ci compared to 650 Ci in 2012, a 40% increase, however this total was lower than the ten-year trend (Figure 5-10 and Table 5-10).

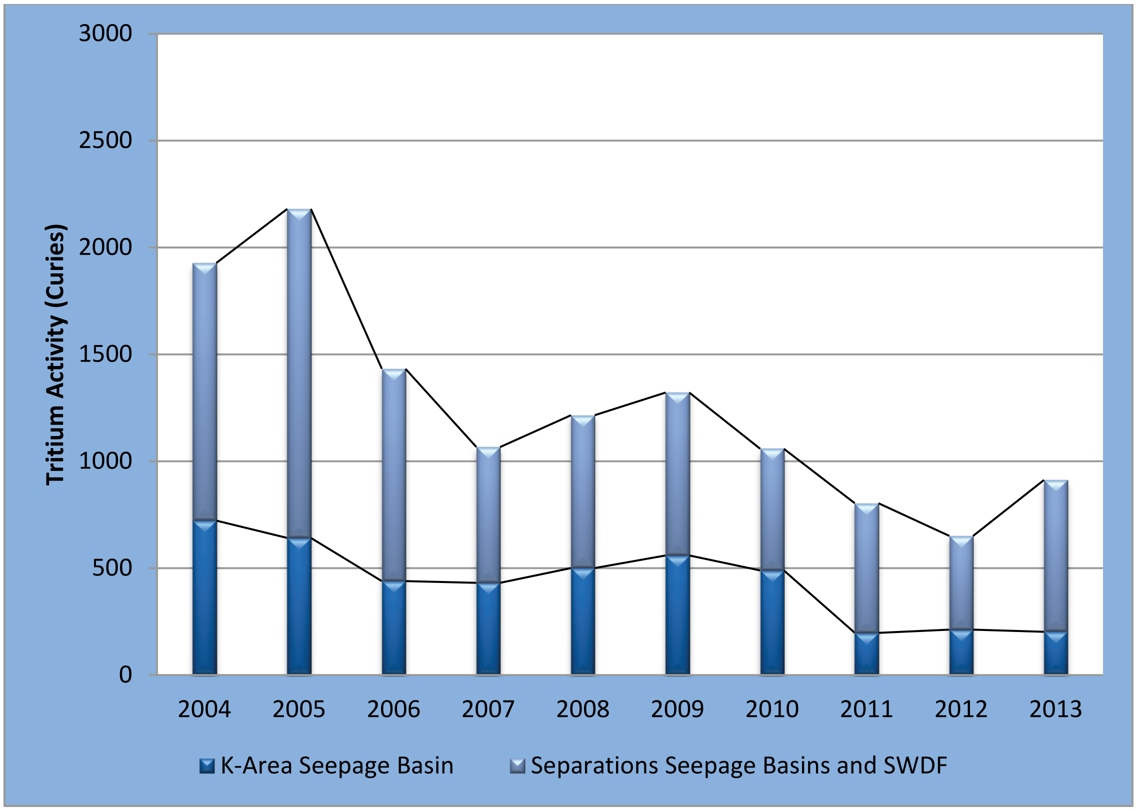


Figure 5-10 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

Table 5-10 Tritium Migration Total (Curies) From SRS Seepage Basins and SWDF

Year	K-Area Seepage Basin	Separations Seepage Basins and SWDF	Total
2004	722	1,205	1,927
2005	641	1,539	2,180
2006	439	993	1,432
2007	431	635	1,066
2008	500	715	1,215
2009	559	762	1,321
2010	489	569	1,058
2011	197	606	803
2012	212	438	650
2013	202	710	912

Of the 912 Ci of tritium migrating into SRS streams, 552 Ci were measured in Fourmile Branch (Table 5-11). Migration releases of other radionuclides vary from year-to-year but have remained below 0.1 Ci the past nine years. The summary of radionuclide migration into Fourmile Branch is included in Table 5-11.

Table 5-11 Migration into Fourmile Branch - Total (Curies)

	Year				
Radionuclide	**2009**	**2010**	**2011**	**2012**	**2013**
Tritium	694	500	538	368	552
Sr-89, 90	0.036	0.026	0.015	0.015	0.021
Tc-99	0.019	0.013	0.011	0.011	0.018
I-129	0.036	0.023	0.015	0.013	0.027
Cs-137	0.069	0.037	0.0195	0.046	0.0025

In order to reduce the tritium flux to Fourmile Branch, SRS conducts phytoremediation activities. Phytoremediation is the direct use of plants to clean up contamination, such as tritium, from soil and water. Using natural processes, plants can break down, trap and hold, or transpire (release to the atmosphere in a modified form) contaminants.

In late 2000, SRS started a phytoremediation project to manage the tritiated water. A sheet-pile dam was constructed to capture the water from springs prior to release to Fourmile Branch. The captured water is irrigated onto the forest to cause transfer of the water to the atmosphere. The transfer takes place by wetted surface evaporation, and evapotranspiration via the vegetation in the forest. Approximately 90% of the irrigated water is transferred to the atmosphere via this process. The tritium in water vapor in the atmosphere is rapidly dispersed and represents no significant dose to the facility workers or offsite residents. This project has been very effective, reducing the tritium flux to Fourmile Branch by about 65%.

SRS estimated tritium migration from the north side of SWDF and the General Separations Area (GSA) into Upper Three Runs in 2013 was 158 Ci, compared with 70 Ci in 2012. This increase is due to higher seasonal rainfall. (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.)

Sampling in Pen Branch measures the tritium migration from the seepage basin and the percolation field below the K-Area Retention Basin. The 2013 estimated migration of 202 Ci is comparable to the 212 Ci recorded in 2012.

Stream transport accounts for tritium migration releases from C-Area, L-Area, and P-Area Disassembly Basins (see "Tritium Transport in Streams" section of this chapter).

SRS streams are measured for alpha specific isotopes such as the actinides (uranium, plutonium, americium, and curium) when gross alpha results for the five major streams that deposit into the Savannah River are greater than the EPA screening level of 15 pCi/L gross alpha. This is performed to evaluate and characterize potential radionuclide migration into the streams. Some samples from Upper Three Runs and Fourmile Branch showed alpha levels above the EPA screening level. Overall, values for 2013 were consistent with historical data with some increases observed in Upper Three Runs due to a higher amount of rainfall during 2013 compared to previous years.

Savannah River Surveillance

SRS conducts continuous surveillance along the Savannah River (Figure 5-11) at locations above and below SRS streams, including a location at which liquid discharges from VEGP enter the river. During the increased periods of rainfall in the summer of 2013, the Savannah River flow rate was too high to safely obtain the samples. Therefore, either grab samples or two-week composites were obtained as an alternative sampling method during this timeframe.

Figure 5-11 Savannah River Mile 118.8 Sampling Location

Results Summary

Five locations (Figure 5-7 and Maps Figure 2) along the river continued to serve as environmental surveillance points in 2013. Samples are collected at these river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides (Data Table 5-10). The average 2013 concentrations of gross alpha, gross beta, and tritium at river locations are listed in Table 5-12. The tritium concentration levels are well below the EPA standard of 20,000pCi/L.

Table 5-12 Average Radionuclide Concentrations in the Savannah River

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)
RM-160 (CONTROL)	0.355	2.22	147
RM-150.4 (VEGP)	0.404	2.26	1,750
RM-150	0.296	2.52	457
RM-141.5	0.260	2.17	615
RM-118.8	0.411	2.16	580

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 flow rates at Savannah River Mile (RM) 118.8 were 2,482 Ci in 2013 compared to 1,874 Ci in 2012. In addition to the samples referenced above, SRS collects annual samples to provide a more comprehensive suite of radionuclides for analysis (strontium-89, 90, technetium-99, and actinides). SRS analyzed all annual samples from RM 118.8 and several other locations for uranium-234, uranium-238, and americium-241 in 2013. Gross alpha and beta averages are slightly lower than the average gross alpha and beta for the previous five years. Tritium averages for 2013 are consistent with the averages for the previous five years. Overall river results are within the historical trends of the previous five years.

Tritium Transport in Streams and Savannah River Surveillance

SRS production areas introduce tritium into SRS streams and the Savannah River. Because of the mobility of tritium in water and the quantities of the radionuclide released during the years of SRS operations, SRS performs a tritium balance comparison at various SRS stream and Savannah River monitoring locations. The tritium balance compares the following methods of calculation:

- Total direct tritium releases, including releases from facility effluent discharges and 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); and
- 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).

SRS tritium transport data from 1960-2013 (Figure 5-12), shows the history of direct releases, stream transport, and river transport. The history of tritium transport at SRS is included in Data Table 5-11. The ten-year trend analysis shows a decreasing trend over this period (Figure 5-13).

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

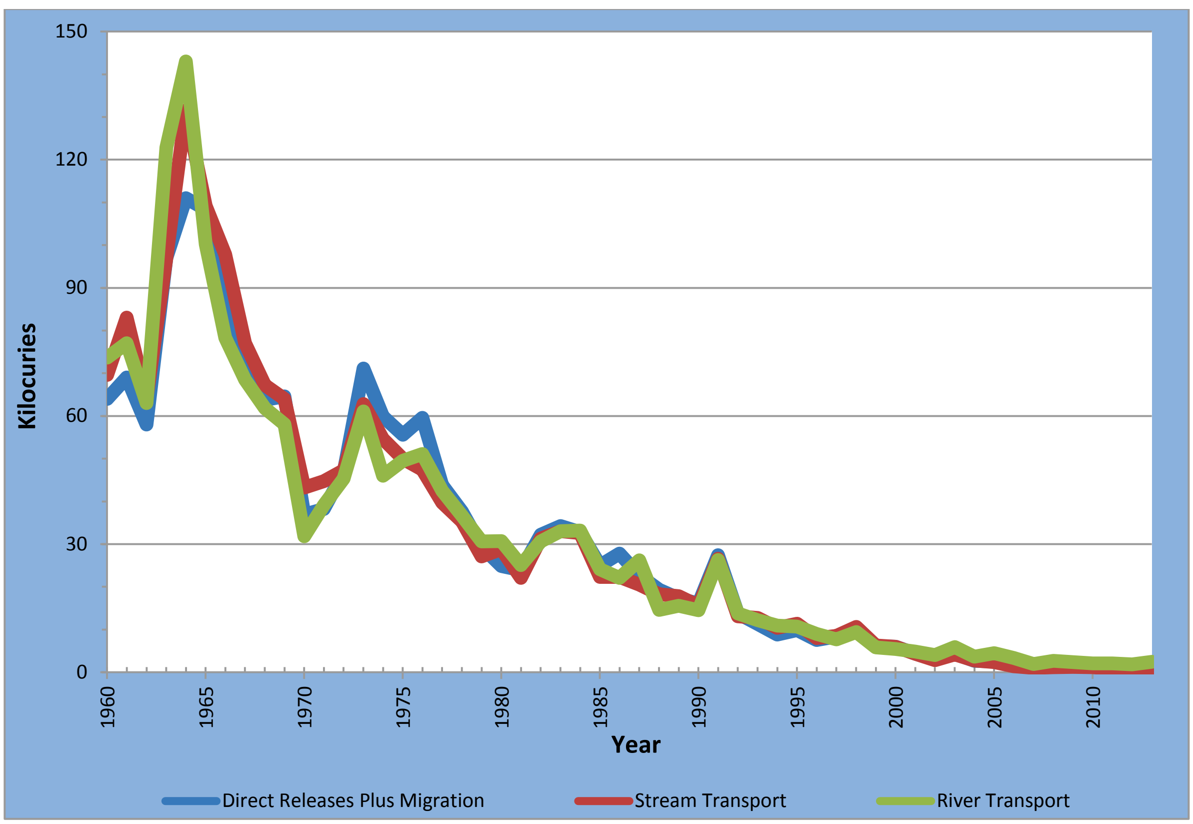


Figure 5-12 SRS Tritium Transport Summary

Figure 5-13 Ten-Year Trend of SRS Tritium Transport

Results Summary

In 2013, tritium levels showed an increase, specifically:

- The direct releases of tritium in 2013 increased by approximately 45% (from 746 Ci in 2012 to 1,082 Ci in 2013).
- The stream transport of tritium in 2013 increased by approximately 53% (from 690 Ci in 2012 to 1,057 Ci in 2013).
- The river transport of tritium in 2013 increased by approximately 33% (from 1,874 Ci in 2012 to 2,482 Ci in 2013). Both VEGP and SRS contributed to these values.

These increases are due mainly to the increased tritium migration that occurred in Upper Three Runs and Fourmile Branch following increased rainfall during 2013. These inventory levels for tritium are similar to what was measured in 2008 and 2009 with comparable migration levels observed in Fourmile Branch and Upper Three Runs.

For compliance dose calculations, the highest value between the SRS direct releases and stream transport measurements (which was 1,082 Ci in 2013) is used (see Chapter 6, "Radiological Dose Assessments").

In the past few years, a measurable amount of tritium has been detected from a non-SRS source, a low-level radioactive waste disposal facility operated by Energy Solutions, LLC. The tritium continues to enter the SRS stream system at Mary’s Branch, which deposits into Lower Three Runs. SRS monitors Lower Three Runs. The facility is privately owned and adjacent to SRS. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. SRS maintains a monitoring program for Lower Three Runs to evaluate tritium migration.

Drinking Water Monitoring

SRS collects drinking water samples from 13 locations at SRS and at four water treatment facilities that use water from the Savannah River as a source of drinking water (Maps Figure 12). SRS monitors potable water at offsite treatment facilities to ensure that SRS operations do not adversely affect the water supply and to provide assurance that drinking water does not exceed EPA drinking water standards for radionuclides.

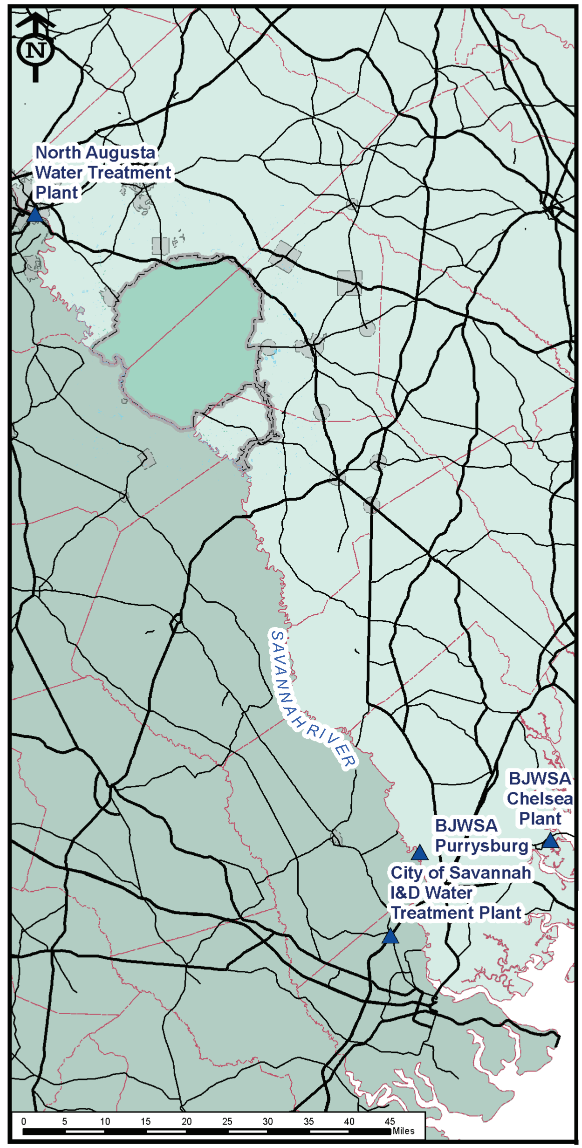


Figure 5-14 Offsite Drinking Water Sample Locations

Onsite drinking water sampling consisted of samples from large treatment plants in A Area and D Area and samples at wells and small systems. SRS collects samples offsite from the following locations (Figure 5-14):

- Beaufort-Jasper Water and Sewer Authority's Chelsea Water Treatment Plant,
- Beaufort-Jasper Water and Sewer Authority's Purrysburg Water Treatment Plant,
- City of Savannah Industrial and Drinking Water Supply Plant, and
- North Augusta (South Carolina) Water Treatment Plant.

On April 10, 2013, SCDHEC verified the closure of the D-Area domestic water system. The quarterly sampling performed at one well in D-Area was discontinued at that time. SRS collected annual samples at three wells in the D-Area domestic water system in January.

SRS suspended monthly sampling from the City of Savannah Industrial and Drinking Water Supply Plant (City of Savannah I&D) during April and May and resumed in June. The suspension occurred because of fiscal year 2013 budget shortfall and associated reduced work schedules. Program changes in mid-fiscal year 2013 resulted in discontinuing the bi-monthly composite sampling at the Beaufort-Jasper Water and Sewer Authority's Chelsea and Purrysburg Water Treatment Plants (WTPs) and the City of Savannah I&D in mid-April. Program changes effective October 1, 2013 reduced the offsite sampling locations to the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea WTP and the North Augusta (South Carolina) WTP. Only finished water was collected at these two WTPs, which is representative of the water consumed by the public. Previously, both raw and finished water were collected. The North Augusta WTP is the SRS control location. The intake for the BJWSA Chelsea WTP intake is the furthest SRS downriver sampling location. The program changes maintain the program objective to identify the potential for SRS impacts on the downriver water municipality.

Results Summary

In 2013, SRS performed gross alpha and gross beta screening on all onsite and offsite drinking water samples. No results exceeded EPA's 15 pCi/L alpha activity limit or 50 pCi/L beta activity limit. In addition, no onsite or offsite drinking water samples exceeded the 20,000 pCi/L EPA standard for tritium or the 8 pCi/L strontium-89, 90 MCL.

Figure 5-15 presents the average drinking water tritium concentrations for the local water treatment plants on the Savannah River upriver and downstream from SRS in comparison to the average of weekly river water samples collected at RM 118.8.

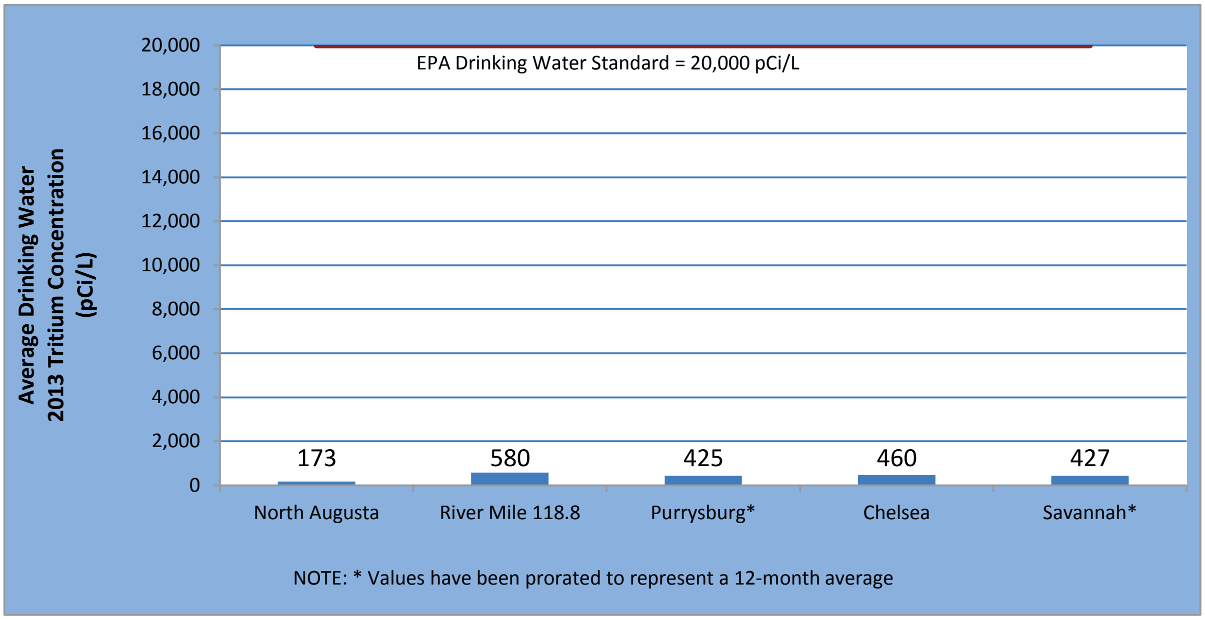


Figure 5-15 Tritium in Offsite Drinking Water and River Mile 118.8 (pCi/L)

Cobalt-60, cesium-137, strontium-89, 90, uranium-235, plutonium-238, plutonium-239, and curium-244 were not detectable in any drinking water samples. Sample results indicated detectable levels of americium-241 in one onsite sample and uranium-234 and uranium-238 in four onsite samples (Data Table 5-12). Concentrations are near the levels of detection for these three analytes. All analytical results are well below the EPA standard.

Food Product Surveillance

Terrestrial Food Products

The terrestrial food products surveillance program consists of radiological analyses of food product samples typically found in the Central Savannah River Area (CSRA) to determine whether SRS operations are affecting the public through the food chain. Agricultural products, livestock, and game animals for human consumption may contain radionuclides. SRS samples milk, meat, fruit, nuts, and green vegetables based on the potential to transport radionuclides to people via the food chain.

Samples of food are collected from locations within each of four quadrants surrounding SRS (e.g. northeast, northwest, southwest and southeast). SRS collects milk on a quarterly basis from nine dairies within a 25-mile radius of the SRS. During 2013, one dairy ceased operations, reducing the number of locations sampled for the entire year to eight. In general, as part of the food product surveillance, SRS conducts a three-year rotating schedule for sampling of meat, fruit, and green vegetables. Beef, collards, wheat, cabbage, and watermelon were sampled in 2013 as part of this program. Laboratory analysis of the food samples includes gamma-emitting radionuclides, tritium, strontium-89, 90, uranium-234, uranium-235, uranium-238, neptunium-237, plutonium-238, plutonium-239, americium-241, curium-244, technetium-99, gross alpha, and gross beta.

Results Summary

Results for terrestrial food products and dairy are included in Data Tables 5-13 and 5-14, respectively. Thirty-three milk samples and five samples of each food type were collected, with the exception of cabbage, as described below. Tritium releases from SRS and non-SRS sources are the primary contributors to tritium in food products. Four of the five cabbage samples were collected from the spring crop. The fifth and final planned cabbage sample could not be collected from the winter crop due to a poor harvest. In 2013, tritium was detected in cabbage, collards, and wheat as shown in Table 5-13 and in milk as shown in Table 5-14.

Tritium was detected above the MDA at one dairy located in Georgia that is in the SRS surveillance program. Review of the milk data indicated the results are consistent with historical trends and less than the standard equivalent to 1% of the DOE dose limit (Table 5-14).

In 2013, cesium-137 was the only gamma-emitting radionuclide detected in food products, as shown in Table 5-13. Analysis detected strontium-89, 90 in food products and strontium-90 in milk samples, as shown in Table 5-13 and Table 5-14, respectively. Three of the 17 milk samples from the Georgia dairies in the SRS surveillance program were above the MDA. Three of the 16 milk samples from the South Carolina dairies in the SRS surveillance program were above the MDA. The strontium-90 results are within the five year trend for the locations. Technetium-99, uranium-234, uranium-235, and uranium-238 were detected above the MDA as shown in Table 5-13.

The radioisotopes of uranium are naturally occurring in local soils. Gross beta activity was detected in all food products. No detectable levels of gross alpha were observed in any of the food products. The 2013 results appeared randomly distributed among the surveillance locations with no underlying spatial pattern.

Of the 2013 food products sample results; there is one new maximum value. The new maximum is plutonium-239 in beef sampled in the SE quadrant. This value is near the MDA.

Table 5-13 Radionuclides Detected in Food Products

Analyte	Food Product	Locations by Quadrant in which Analyte was Detected	Maximum Concentration (pCi/g)	Equivalent to 1 mrem Dose
Tritium	Cabbage	**NW**	0.0239	1,610
Tritium	Collards	**NW**, SE	0.0363	1,610
Tritium	Wheat	**NE**	0.18	1,610
Cs-137	Cabbage	NW, SE, **SE-25 mile**	0.091	2.54
Cs-137	Collards	NE, SW, **SE-25 mile**	0.0931	2.54
Cs-137	Wheat	**NE**	0.0078	2.54
Sr-89/90	Cabbage	**SE-25 mile**	0.357	0.938
Sr-89/90	Collards	NE, NW, SE, SW, **SE-25 mile**	0.509	0.938
Sr-89/90	Fruit (melons)	**SE**	0.0074	0.938
Pu-238	Collards	**SW**	0.0068	0.128
Pu-239	Beef	**SE**	0.00004	0.0116
Pu-239	Cabbage	**SE-25 mile**	0.0016	0.117
U-234	Beef	NW, **SE**, SW, SE-25 mile	0.0001	0.0574
U-234	Cabbage	NW, SE, **SW**, SE-25 mile	0.0393	0.581
U-234	Collards	**NE**, NW, SE, SW	0.0108	0.581
U-234	Wheat	**SE-25 mile**	0.00158	0.581

Table 5-13 Radionuclides Detected in Food Products (Continued)

Analyte	Food Product	Locations by Quadrant in which Analyte was Detected	Maximum Concentration (pCi/g)	Equivalent to 1 mrem Dose
U-235	Cabbage	**SW**	0.002	0.615
U-238	Beef	NE, NW, **SE**, SW, SE-25 mile	0.0001	0.0637
U-238	Cabbage	NW, SE, **SW**, SE-25	0.0369	0.645
U-238	Collards	**NE**, NW, SE, SW, SE-25 mile	0.01	0.645
Tc-99	Cabbage	NW, SE, SW, **SE-25 mile**	0.233	37.5
Tc-99	Collards	NE, NW, SE, SW, **SE-25 mile**	0.69	37.5
Tc-99	Fruit (melons)	**SE-25 mile**	0.0368	37.5

All quadrants, except as noted, are within 10 miles of the SRS boundary. Locations annotated in bold are the quadrants in which the maximum concentration was detected. No cabbage sample was collected in the NE quadrant (See text for additional information).
Note: DOE Dose Standard for all exposure pathways = 100 mrem

Table 5-14 Radionuclides Detected in Milk Products

Analyte	Number of Samples	Number of Detections	Maximum Concentration (pCi/L)	Equivalent to 1 mrem Dose
Sr-90	33	6	1.66	28.8
Tritium	33	1	284	49,300

Note: DOE Dose Standard for all exposure pathways = 100 mrem

Aquatic Food Products

The aquatic food product surveillance program includes freshwater and saltwater fish and saltwater shellfish. SRS maintains a program for collecting and analyzing fish from the Savannah River and surrounding freshwater bodies (Maps Figure 7). Various species of fish collected offsite from streams and tributaries are included in the determination of the potential dose and risk to the public from consumption. 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, Georgia. One surveillance point for the collection of freshwater fish is on the Edisto River at West Bank Landing. One surveillance point for the collection of saltwater fish is at the mouth of the Savannah River, near Savannah, Georgia. Composite samples composed of three to five fish of a given species are prepared for each species from each location. SRS uses three categories of freshwater fish: bass, panfish (bream), and catfish. Saltwater fish include composites of sea trout, red drum (spot tail bass), and mullet. Fish categories are selected based on the most common fish caught in the Savannah River. SRS analyzes two types of composites. They are edible (meat and skin only) and non-edible (bone) composites. Analyses conducted on edible composites include tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89, 90, technetium-99, iodine-129, and the actinide series. Strontium-89, 90 is the only analyses conducted on the non-edible composites.

The greater than average rainfall that impacted the Savannah River in July and August of 2013 led to higher than average water levels and faster than average river water flow rates. Closure of boat ramps used to access the river, potential safety issues while sampling, and limitations of the collection methods due to the river conditions, resulted in a hiatus in the sampling program for those two months. The shortened sampling schedule in 2013 resulted in SRS not sampling at Stokes Bluff on the Savannah River and at West Bank Landing on the Edisto River. Additionally, a reduced number of freshwater fish were collected at the Highway 17A Bridge location.

Figure 5-16 Field Technician Measures Length of Bass Caught in Savannah River

Results Summary

Aquatic food product results for saltwater fish are provided in Data Table 5-15. For freshwater fish, Data Table 5-16 provides detailed results. The results for shellfish are reported in Data Table 5-17. Figure 5-16 depicts post fish collection activities of measuring fish collected on the Savannah River. In 2012, SRS revised the method for computing the mean value. The mean is set to zero when the three composites for the species are below the MDA. The aquatic food product results were similar to levels recorded during the previous five years.

In 2013, the preparation method for the non-edible samples was modified. Previously, scraps of flesh attached to the bone were included in the analyses. Beginning with the 2013 samples, the non-edible sample was "cooked" to remove any flesh prior to processing the bone for analysis. The preparation method change resulted in an order of magnitude (roughly 10 times) increase in the concentration of Strontium-89, 90 in the non-edible samples at all locations and for all fish types.

Gross alpha results were below the MDA for all edible fish composites of saltwater and freshwater fish. Gross beta activity was detectable in all freshwater fish composites and saltwater red drum at maximum concentrations of 4.49 pCi/g and 3.22 pCi/g, respectively. This is most likely attributed to the naturally occurring radionuclide potassium-40.

Cesium-137 was detected above the MDA in 20 of 68 freshwater fish composites at a maximum of 0.330 pCi/g in bass. Cesium-137 average and maximum concentrations for bass at the mouth of Fourmile Branch have returned to within historical trends, as compared to the higher-than-average concentration reported in 2012. Average and maximum concentrations of cesium-137 for freshwater fish sampled are within historical trends. Analysis of saltwater fish found no man-made gamma-emitting radionuclides.

Strontium-89, 90 was greater than the MDA in 66 of 68 of the nonedible freshwater fish composites at a maximum of 2.07 pCi/g and in four of nine of the nonedible saltwater fish composites at a maximum of 0.957 pCi/g. Concentrations of uranium-234, uranium-235, uranium-238, and tritium in freshwater and saltwater fish composites were similar to those of previous years. For the saltwater fish composites, technetium-99 was below the MDA. For the freshwater fish, five of 68 of the composites contained technetium-99 above the MDA, with a maximum value of 0.082 pCi/g.

Plutonium-238 and plutonium-239 were detected at levels near the MDA in freshwater fish at locations from Fourmile Creek mouth downriver to the Highway 17 Bridge area, in eight of 68 and two of 68 of the composite samples, respectively. Maximum concentrations were 0.00022 pCi/g and 0.00008 pCi/g of Pu-238 and Pu-239, respectively. Neither radionuclide was detected in saltwater fish.

Iodine-129 was detected at levels greater than the MDA in two of 68 of the freshwater composites with a maximum concentration of 0.065 pCi/g in panfish. I-129 has been detected above the MDA in one to two fish at different locations and in different species each year for the period 2010 through 2012 with comparable activities. The data do not indicate any apparent trends. I-129 was not detected in levels above the MDA in saltwater fish.

Gross beta was detected in shellfish at a concentration of 1.68 pCi/g. There were no detectable levels of gross alpha in shellfish. These levels were within the historical statistical trends. Concentrations of uranium-234, uranium-235, and uranium-238 in shellfish were at levels similar to those of previous years. No detectable levels of strontium-89, 90, iodine-129, plutonium-238, plutonium-239, americium-241, and curium-244 greater than the MDA were present in shellfish.

Calculations of risk from the consumption of fish from the Savannah River are included in Chapter 6 "Radiological Dose Assessments."

Wildlife Surveillance

Deer, Hog, and Coyote

Annual game animal hunts, open to members of the public, are conducted to reduce animal-vehicle collisions and control SRS's deer, coyote, and feral hog populations. The FY 2013 budget shortfall resulted in reduced hunts onsite. Prior to releasing any animal to a hunter, SRS uses portable sodium iodide detectors to perform field analyses for cesium-137. SRS collects samples for laboratory analysis of cesium-137 concentrations in deer (muscle and bone) samples based on (1) a set frequency, (2) the cesium-137 levels, or (3) exposure limit considerations. Figure 5-17 shows a coyote stalking prey at SRS.

Figure 5-17 Savannah River Site Coyote

Cesium-137 is chemically similar to and behaves like potassium in the environment. It has a half-life of about 30 years and tends to persist in soil. If it is in soluble form, it 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 is present at low levels in all environmental media.

SRS has an administrative dose limit for the consumption of game animals set at 22 mrem per year. The doses from deer and hog consumption are quantified and reported in Chapter 6, "Radiological Dose Assessments."

Results Summary

A total of 156 deer, 62 feral hogs, and seven coyotes were harvested during the 2013 SRS hunts. With the exception of five coyotes not wanted by the hunters, all animals were released to the hunters. As observed during previous hunts, cesium-137 was the only man-made gamma-emitting radionuclide detected in muscle tissue during laboratory analysis. Strontium-89, 90, a beta-emitting radionuclide was detected in both bone and muscle tissue.

Generally, cesium-137 concentrations measured by field detectors and laboratory methods were similar. Field measurements for cesium-137 from all released animals ranged from the lowest default value of 1.00 pCi/g (assigned to field results less than 1.00 pCi/g) to 5.19 pCi/g while laboratory measurements ranged from 0.14 pCi/g to 2.22 pCi/g. Laboratory measurement results are included in Data Tables 5-18 and 5-19 for deer tissue and bone. No samples were taken from hogs in 2013. Results of field and laboratory measurements are summarized in Table 5-15. The muscle and bone samples from a subset of the animals returned to the laboratory for cesium-137 analysis are analyzed for strontium-89/90. Because of its chemistry, strontium exists at higher concentration in bone than in muscle tissue.

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past 50 years, as well as the last ten years. The historical trend analysis is in Figure 5-18.

Table 5-15 Cesium-137 Results for Laboratory and Field Measurements in Wildlife

2013	Number of Animals	Field Gross Average Cs-137 (pCi/g)	Field Maximum Cs-137 (pCi/g)	Lab Average Cs-137 (pCi/g)	Lab Maximum Cs-137 (pCi/g)
Deer	156	1.12	3.09	1.20	2.22
Hog	62	1.32	5.19	-----	-----
Coyote	7	1.02	1.11	-----	-----

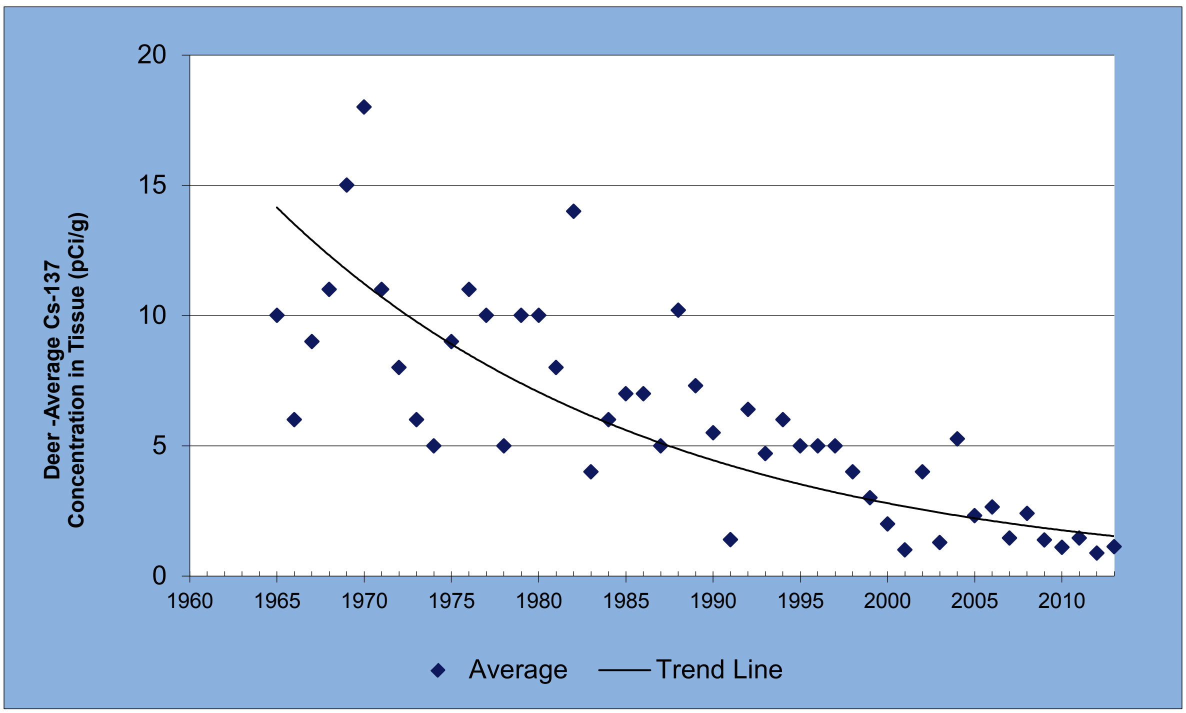


Figure 5-18 Historical Trend of Cesium-137 Concentration in Deer (pCi/g)

In 2013, all 27 deer bone samples had detectable levels of strontium-89, 90 greater than the MDA with an average of 6.64 pCi/g and a maximum of 28.6 pCi/g. For the deer muscle tissue samples, four out of the 27 muscle tissue samples had detectable levels greater than the MDA for strontium-89, 90 with a maximum of 0.0176 pCi/g. These average results are similar to those of previous years.

Turkey

SRS hosted a special turkey hunt during April 2013 for hunters with mobility impairments. Thirty-two turkeys were harvested, monitored (Figure 5-20), and released to hunters. Figure 5-19 displays Eastern Wild Turkeys at SRS.

Figure 5-19 Eastern Wild Turkeys at SRS

Figure 5-20 Field Technician Monitors Turkey at an SRS Hunt

Results Summary

All field measurement results for the 32 turkeys harvested had cesium-137 levels below 2.00 pCi/g. The average cesium-137 concentration was 1.09 pCi/g and the maximum was 1.84 pCi/g.

Alligator

The American alligator, as shown in Figure 5-21, lives in the southeastern region of the United States. Georgia and South Carolina have a flourishing population of alligators managed through a regulated hunting season. On SRS, alligators are abundant in the Savannah River, its swamp and tributaries, L-Lake, Par Pond, and other reservoirs on the Site (SREL 2014). Even though SRS is closed to public access and alligator hunting is prohibited on the Site, larger alligators can leave the Site's boundaries and move onto public lands where they could be harvested (Brisbin et al. 1992; 1997). SRS analyzes donated samples from alligators harvested by local hunters in the Savannah River or other locations adjacent to the Site.

Figure 5-21 Mature American Alligator Harvested from the Savannah River

Results Summary

In 2013, samples were analyzed from two alligators. Both animals were harvested from the Savannah River one near Little Hell Landing in South Carolina and the other south of Plant Vogtle in Georgia. Naturally occurring radionuclides potassium-40 and uranium-238 (Table 5-16) were identified in both alligators harvested in 2013 (samples GA-001100 and SC-10697), as well as the samples collected in 2010 and 2011. These previously collected samples are included due to the small size of the data set. The alligator cesium-137 results were compared to results from edible fish. Based upon the samples from 2010, 2011 and 2013, the level of cesium-137 observed in alligator are consistent with observations from fish collected in the Savannah River (Figure 5-22). In addition, naturally occurring radionuclides potassium-40 and uranium-238 (Table 5-16) were identified in both alligators harvested in 2013 (samples GA-001100 and SC-10697). Radiological and nonradiological results for all alligator samples (2010, 2011, and 2013) are summarized in Table 5-16. The entire data set is available in Data Table 5-20.

Table 5-16 Summary of Radionuclides and Total Mercury from American Alligators Harvested from the Savannah River

	Alligator GA-0003766	Alligator SC-12113	Alligator GA-001100	Alligator SC-10697
Harvest Date	9/24/2010	9/25/2011	9/18/13	10/11/13
Length	8 ft 8 in	6 ft 5 in	9 ft 2 in	5 ft 9 in
Mercury (ug/g)	0.70	0.50	0.90	0.59
Cesium-137 (pCi/g)	0.0433	0.0689	0.0725	0.0552
Potasium-40 (pCi/g)	2.07	2.69	3.25	3.12
Uranium-234 (pCi/g)	0.00198	0.000248	ND	ND
Uranium-238 (pCi/g)	0.00175	0.000282	0.000167	0.000115
ND – Indicates that isotope was not detectable above the MDA.				

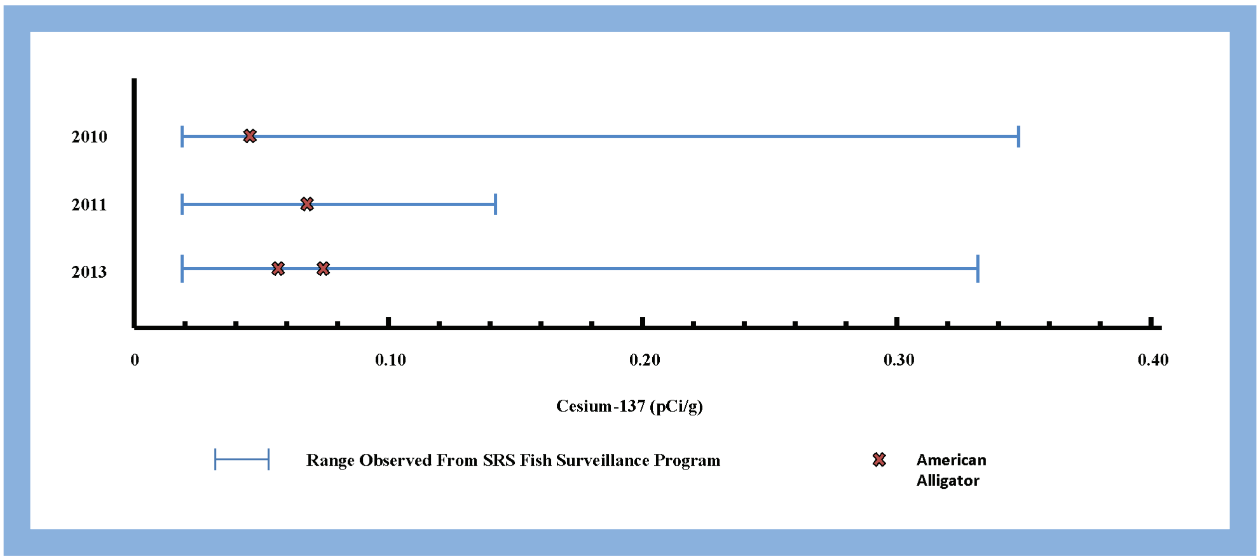


Figure 5-22 Comparison of Cesium-137 Observed in American Alligator with Range Observed in Edible Freshwater Fish

Soil Surveillance

SRS conducts soil surveillance to provide:

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

Locations are shown on Maps Figure 8. Concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and retention and transport in different types of soils. Therefore, a direct comparison of data from year-to-year could be misleading. However, the data is evaluated for long-term trend analysis.

Figure 5-23 Field Technician Collects a Soil Sample

Soil sampling involves the use of hand augers, shovels, or other similar devices for collection to a depth of 3 inches (Figure 5-23). The samples are analyzed for gamma-emitting radionuclides, strontium-89, 90, and the actinides.

Results Summary

In 2013, radionuclides were detected in soil samples from all 22 sampling locations (five onsite, 12 at the perimeter, and five offsite). Table 5-17 provides a summary of the results compared to the SRS control location.

Table 5-17 Summary of Radiological Results of Soil

Radionuclide	Number of Detections	Maximum (pCi/g)	SRS Soil Control Location Maximum (pCi/g)
Cesium-137	19 of 22	54.9	Less than MDA
Uranium-234	22 of 22	1.74	0.584
Uranium-235	22 of 22	0.093	0.020
Uranium-238	22 of 22	1.72	0.581
Plutonium-238	13 of 22	0.048	0.002
Plutonium-239	19 of 22	0.10	Less than MDA
Neptunium-237	4 of 22	0.014	Less than MDA
Strontium-89, 90	0 of 22	Less than MDA	Less than MDA
Americium-241	18 of 22	0.015	Less than MDA
Curium-244	1 of 22	0.004	Less than MDA

The concentrations at these locations are consistent with historical results, with the maximum cesium-137 concentration found at the Creek Plantation Swamp Trail #1 (Data Table 5-21). No soil concentrations at the SRS perimeter or offsite exceeded the limit used at SRS for posting Soil Contamination Areas (SCA) (150 pCi/g for beta and gamma radionuclides). Uranium is naturally occurring in soil and therefore expected to be present in soil samples. The remaining radionuclides are slightly higher than the upstream SRS control location in Upper Three Runs, but lower than any SCA limits and comparable to natural background levels.

Sediment Surveillance

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds 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 riverbeds (or because of slight variations in sampling locations), but the data obtained can be used to observe long-term environmental trends. Sediment samples were collected at eight Savannah River locations and 32 onsite stream, basins, ponds, or swamp discharge locations during 2013 (Maps Figure 9).

Results Summary

Results for 2013 sediment sampling are summarized in Table 5-18 below and in more detail in Data Table 5-22. The maximum of each radionuclide is included in Table 5-18 below compared to the SRS control location.

Table 5-18 Summary of Radiological Results of Sediment

Radionuclide	Number of Detections	Maximum (pCi/g)	Location	SRS Sediment Control Location Maximum (pCi/g)
Cesium-137	25 of 32	2,880	Z-Area Stormwater Basin	0.316
Uranium-234	32 of 32	6.24	Fourmile Creek A-7	1.15
Uranium-235	30 of 32	0.514	Fourmile Creek A-7	0.070
Uranium-238	32 of 32	7.59	Fourmile Creek A-7	1.28
Plutonium-238	18 of 32	1.52	Fourmile Creek A-7	0.00427
Plutonium-239	22 of 32	2.16	R-Area	0.0106
Neptunium-237	5 of 32	0.030	Fourmile Creek A-7	0.00511
Strontium-89,90	5 of 32	0.787	Z-Area Stormwater Basin	Less than MDA
Americium-241	16 of 32	1.84	R-Area	0.00551
Curium-244	10 of 32	0.726	Fourmile Creek A-7	0.00422

The maximum cesium-137 concentration was observed in the Z-Area Stormwater Basin, a posted SCA. More information on the Z-Area Stormwater Basin is discussed in the stormwater basin section of this chapter. For the river and stream sediments, cesium-137 ranged from below the MDA to 497 pCi/g at R-Canal (100-R Location) which also is a posted SCA. Other than the Z-Area sediment and R-Area location, all other locations were below the SCA levels. The highest level from the river, 0.614 pCi/g, was from RM 129 (Lower Three Runs River mouth); the lowest levels were below detection. Generally, cesium-137 concentrations were higher in stream sediments than in river sediments, reflecting the Site operations since SRS streams receive radionuclide containing liquid effluents from SRS. Most radionuclides settle out and deposit on the streambeds or at stream entrances to swamp areas along the river. The remaining radionuclides are slightly higher than the upstream SRS control location in Upper Three Runs, but lower than any SCA limits.

Differences observed when these data are compared to those of previous years are most likely attributable to the effects of resuspension and deposition, which occur constantly in sediment media.

Settleable Solids Surveillance

A measure of settleable solids in water is required to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems. DOE limits the radioactivity levels in settleable solids to 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). Samples containing TSS levels below 40 parts per million (ppm) comply with DOE settleable solids limits.

Results Summary

In 2013, all TSS sample results were below 40 ppm. The 2013 TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

Grassy Vegetation Surveillance

SRS conducts the radiological program for grassy vegetation from onsite and offsite locations to complement soil and sediment samples for evaluation of 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 for surveillance because of its importance as a pasture grass for dairy herds. Vegetation sample locations include:

- Locations where soil radionuclide concentrations are expected to be higher than normal background levels,
- Locations receiving water that has the potential to be contaminated, and
- All air sampling locations.

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

Results Summary

SRS detected radionuclides in the grassy vegetation samples collected during 2013 in all 15 locations (one onsite, 10 at the perimeter, and four offsite; Maps Figure 10). The results are summarized in Table 5-19.

Table 5-19 Summary of Radiological Results of Grassy Vegetation

Radionuclide	Number of Detections	Maximum (pCi/g)	Maximum Location	SRS Control Location Maximum (pCi/g)
Tritium	3 out of 15	0.133	Talatha Gate, Northwest Perimeter	Less than MDA
Gross Alpha	1 out of 15	1.32	Highway 21/167, Northeast Perimeter	Less than MDA
Gross Beta	15 out of 15	24.3	Savannah, Southeast 100 Miles	24.3
Cesium-137	7 out of 15	0.497	Highway 21/167, Northeast Perimeter	Less than MDA
Uranium-234	15 out of 15	0.0546	Approximate Center of SRS	0.0129
Uranium-235	2 out of 15	0.00286	Highway 301, South 25 Miles	Less than MDA
Uranium-238	14 out of 15	0.0438	Approximate Center of SRS	Less than MDA
Technetium-99	15 out of 15	1.30	Allendale Gate, Southeast Perimeter	0.454
Strontium-89/90	14 out of 15	0.727	Highway 21/167, Northeast Perimeter	Less than MDA

Table 5-19 Summary of Radiological Results of Grassy Vegetation (Continued)

Radionuclide	Number of Detections	Maximum (pCi/g)	Maximum Location	SRS Control Location Maximum (pCi/g)
Plutonium-238	0 out of 15	Less than MDA	Barnwell Gate (East Perimeter) and Hwy 21/167 (Northeast Perimeter)	Less than MDA
Plutonium-239	0 out of 15	Less than MDA	Approximate Center of SRS	Less than MDA
Americium-241	0 out of 15	Less than MDA	Talatha Gate, Northwest Perimeter	Less than MDA
Curium-244	0 out of 15	Less than MDA	Augusta Lock and Dam, Northwest 25 Miles	Less than MDA

Results for all radionuclides are within the trends of the previous ten years. (Data Table 5-23).

NONRADIOLOGICAL SURVEILLANCE

SRS conducts nonradioactive surveillance sampling and analysis of surface water, drinking water, rainwater/wet disposition, air, sediment, groundwater (Chapter 7, "Groundwater"), and fish, according to water and air quality standards and potential contaminants pathways into the environment. Table 5-20 summarizes the nonradiological sampling media frequencies.

Table 5-20 SRS Nonradiological Sampling Frequencies

Media		Sampling Frequency		
		Monthly	Quarterly	Annually
Surface Water	Water quality downstream of NPDES outfalls (stream and river)	✓		
Sediment	Surveillance for existence and possible buildup of the inorganic contaminants			✓
Fish	Bioaccumulation of nonradiological contaminants in fish			✓
Drinking Water	Safe Drinking Water Act compliance	✓	✓	✓

Surface Water Surveillance

SRS streams and the Savannah River are classified as "Freshwaters" by South Carolina Regulation 61-69, "Classified Waters." Freshwaters are defined in Regulation 61-68, "Water Classifications and Standards" as:

- 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, and
- Industrial and agricultural uses.

Surface water samples are collected from five Savannah River and 11 SRS stream locations and are analyzed for various chemical and physical properties which include but are not limited to dissolved oxygen, pH, temperature, hardness, metals, mercury, pesticides/herbicides, and total organic carbon. (Figure 5-24 and Maps Figure 11).

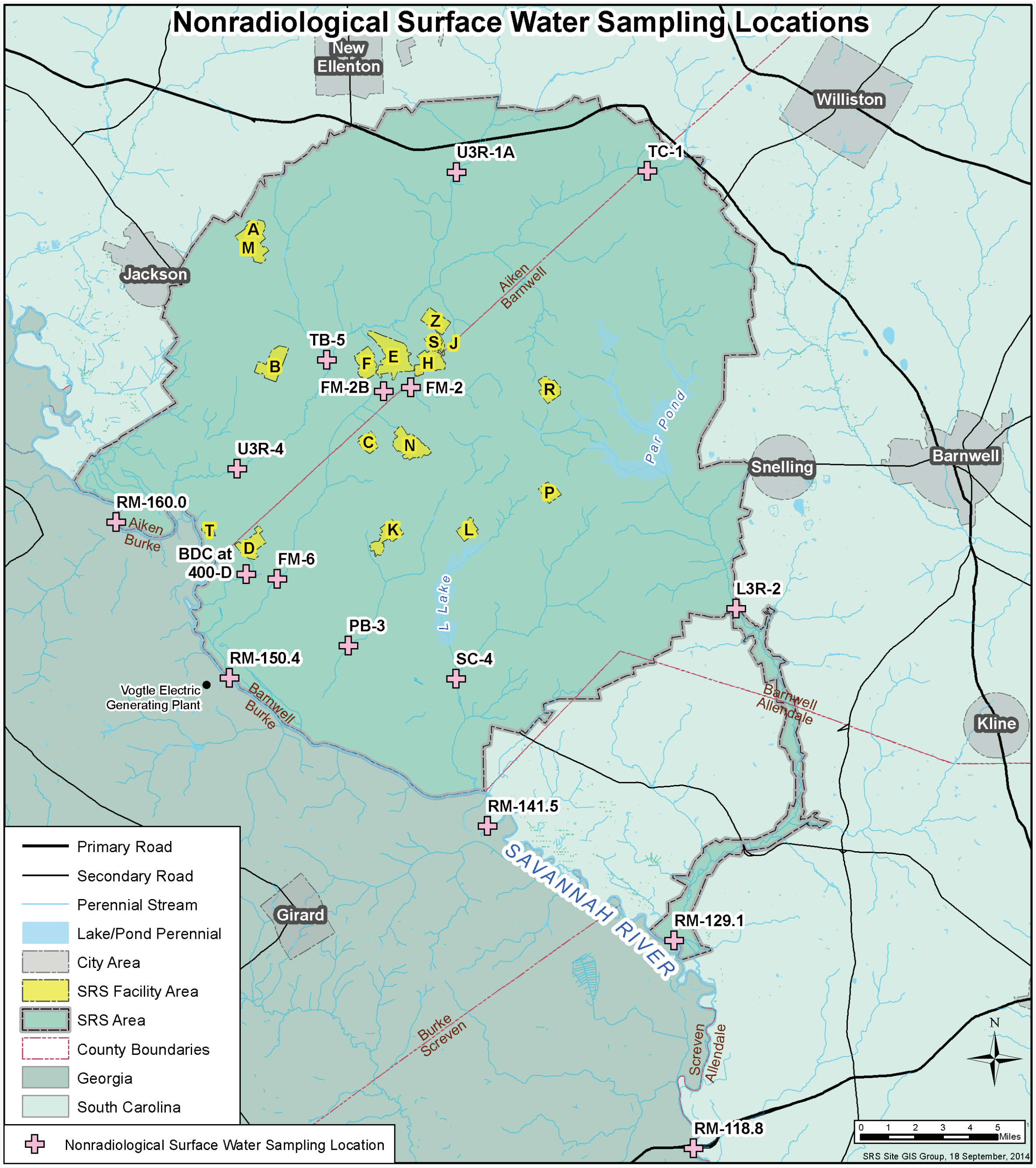


Figure 5-24 Nonradiological Surface Water Sampling Locations

Results Summary

Water quality parameters were measured at all 16 sampling locations in SRS streams and along the Savannah River during 2013 and metals were detected in at least one sample at each location. With the exception of the pesticide, 4,4'-DDT (dichlorodiphenyltrichloroethane) detected in January 2013 at Upper Three Runs-1A, no other sample results showed detectable levels of pesticides, herbicides, or aroclors (PCBs). These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the river (Data Table 5-24).

Dewatering of the D-Area Settling Basin occurred in October 2013 providing flow to Beaver Dam Creek. Otherwise, there was no industrial contribution to the creek in 2013.

Drinking Water Surveillance

Treatment plants in A Area and D Area supply most of the drinking water at SRS. The SRS also has 12 small drinking water facilities, each of which serves populations of fewer than 25 people. During 2013, the D Area water supply was permanently taken out of service.

Results Summary

All samples collected from SRS drinking water systems during 2013 were in compliance with SCDHEC and EPA water quality standards. The Safe Drinking Water Act section of Chapter 3, "Compliance Summary" provides additional information.

Sediment Surveillance

SRS's nonradiological sediment surveillance program provides a method to determine the deposition and accumulation of nonradiological contaminants in stream systems (Maps Figure 13).

The nonradiological sediment program consists of the collection of sediment samples at eight onsite stream locations and three Savannah River locations. The samples are analyzed for various inorganic contaminants (metals) and pesticides/herbicides.). 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 and herbicides. SCDHEC performs duplicate sampling at various locations onsite as a quality control check of the SRS program. Those results are included with the routine SRS sediment sampling results in Data Table 5-25.

Results Summary

In 2013, no mercury was detected at any of the locations, as in previous years. Metals analysis showed some metals with levels greater than the practical quantitation limit for 2013 but were consistent with those seen in soil samples and comparable to those of the previous five years (Data Table 5-25).

Fish Surveillance

SRS collects and analyzes fish caught from the Savannah and Edisto Rivers to determine concentrations of mercury, arsenic, cadmium, manganese, and antimony in the fish. The fiscal year 2013 budget shortfall and associated reduced work schedules resulted in the temporary suspension of metals analysis of fish collected during April and May 2013.

Results Summary

In 2013, SRS analyzed 190 fish at six locations on the Savannah River, including where SRS streams enter the Savannah River, for mercury, cadmium, arsenic, antimony, and manganese. Results for mercury and metals in fish are included in Data Tables 5-26 and 5-27, respectively.

A summary of the 2013 results for freshwater and saltwater fish are provided in Tables 5-21 and 5-22, respectively. The maximum concentration of each metal, except manganese, was found in freshwater fish collected near the mouth of Fourmile Branch. As indicated in Tables 5-21 and 5-22, the maximum concentration of metals was found in all three species of both freshwater and saltwater fish, respectively. Review of mercury data for the period 2009 through 2013 (Figure 5-25) shows a consistent trend by species with levels decreasing from bass to catfish to panfish and by location with concentrations decreasing at most locations beginning in 2009. 2013 results show that the trend is continuing. SRS compared the data to the trigger levels used by SCDHEC and the SC Department of Natural Resources to issue fish advisories (SCDHEC 2014). The mercury results for fish are consistent with the levels for the SCDHEC-issued fish species advisories for the Savannah River.

Table 5-21 Summary of Metal Results for Freshwater Fish Tissue Collected from the Savannah River

Analyte	Number of Samples	Number of Detections	Maximum Concentration (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration	Location of Maximum Concentration
Mercury	191	189	1.004	0.02	Bass	Fourmile Branch
Arsenic	189	32	1.526	0.45	Catfish	Fourmile Branch
Cadmium	189	9	0.640	0.045	Catfish	Fourmile Branch
Manganese	189	151	2.454	0.09	Bass	New Savannah Bluff Lock & Dam
Antimony	189	46	0.966	0.45	Panfish	Fourmile Branch

Table 5-22 Summary of Metal Results for Saltwater Fish Tissue Collected from the Savannah River between River Miles 0-8, Near Savannah, GA

Analyte	Number of Samples	Number of Detections	Maximum Concentration (ug/g)	MDC (ug/g)	Fish Type with Maximum Concentration
Mercury	41	28	0.291	0.02	Red Drum
Arsenic	41	8	1.168	0.45	Red Drum
Cadmium	41	2	0.050	0.045	Sea Trout
Manganese	41	22	0.188	0.09	Mullet
Antimony	41	2	0.468	0.45	Mullet

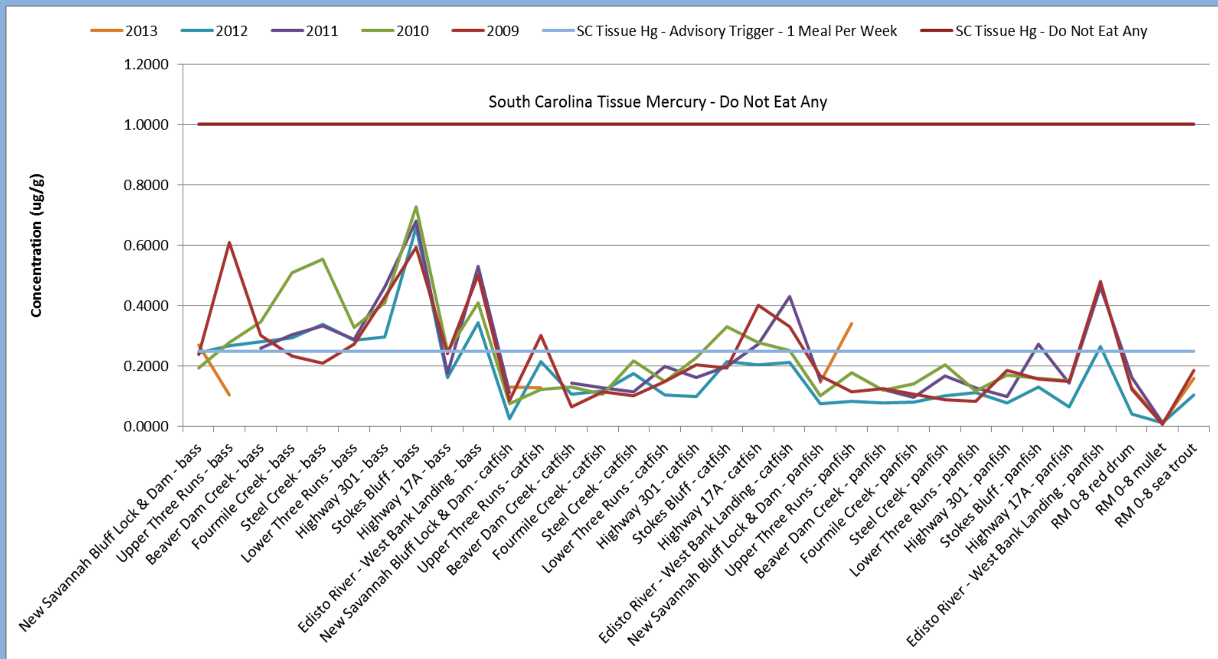


Figure 5-25 Mercury Concentrations in Fish by Location and Species

Alligator Surveillance

SRS analyzes alligator samples donated by hunters who have harvested alligators from the Savannah River near the Site. Mercury analysis is conducted as mercury is known to bioaccumulate in alligator.

<u>Results Summary</u>

Two alligator samples collected during 2013 were analyzed for mercury. The mercury results for the 2013 samples in addition to the two samples collected in 2010 and 2011 are provided in Data Table 5-20. Figure 5-26 indicates the mercury results in the alligator samples are consistent with the results for freshwater fish collected in the Savannah River.

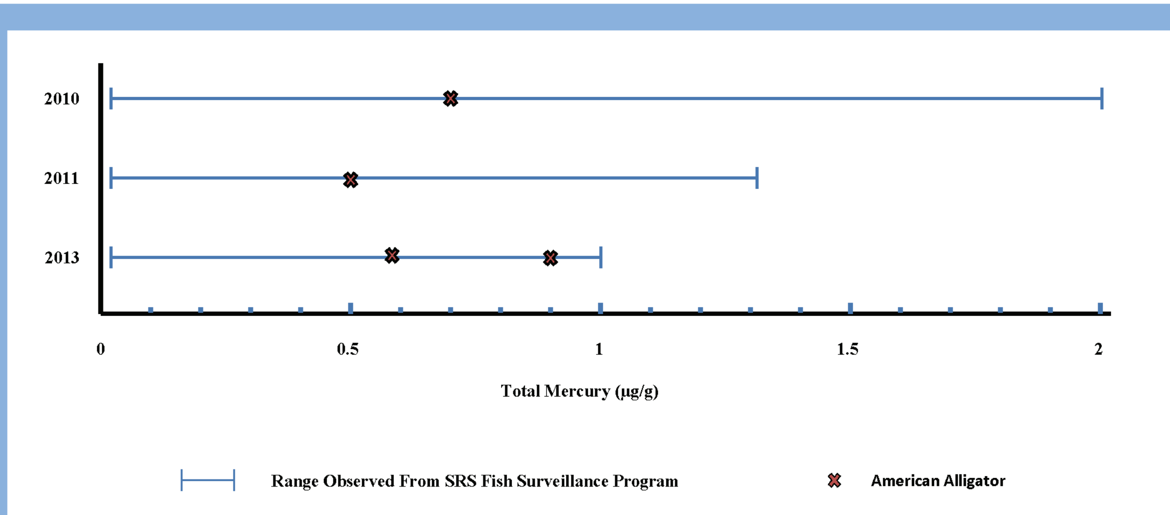


Figure 5-26 Comparison of Mercury in American Alligator with Range Observed in Freshwater Fish

Precipitation Chemistry and Deposition

SRS sponsors a collection station in support of the National Atmospheric Deposition Program (NADP). This station is located near the center of the SRS at the Savannah River National Laboratory Central Climatology facility. Weekly precipitation samples from this station are collected and submitted to NADP laboratories for chemical analysis. Beginning in 2001, this station has been part of the Mercury Deposition Network (MDN) of the NADP. The MDN 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. Beginning in 2012, the station at SRS was added to the National Trends Network (NTN). This network tracks changes in acid deposition from rain and dry particulates. Sample analysis associated with this network includes free acidity, conductance, calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, and ammonium. In addition to supporting national scale observations relating to trends in precipitation chemistry, results from this surveillance provides specific information related to the chemistry of precipitation at SRS.

Results Summary

During calendar year 2012 (the last year for which data are available) the average (volume weighted) concentration of total mercury in precipitation was 11.1 ng/L and the wet deposition rate was 12.0 µg/m^2. Data from 2013 will not be available until the fall of 2014. Additional information on the MDN is accessible via the following link: http://nadp.sws.uiuc.edu/mdn/.

Calendar year 2012 marked the first year that precipitation samples from SRS were submitted to the NTN. The results from this surveillance are presented in the Table 5-23. Additional information on the NTN is accessible via the following link: http://nadp.sws.uiuc.edu/NTN/.

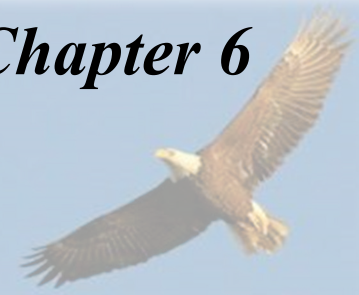
Table 5-23 Precipitation Results of SRS National Trends Network Station

Analyte	Precipitation Weighted Concentration	Deposition
Calcium (Ca^{2+})	0.07 mg/L	0.78 kg/ha
Magnesium (Mg^{2+})	0.025 mg/L	0.271 kg/ha
Potassium (K^+)	0.018 mg/L	0.195 kg/ha
Sodium (Na^+)	0.168 mg/L	1.823 kg/ha
Ammonium (NH_4^+)	0.20 mg/L	2.17 kg/ha
Nitrate (NO_3^-)	0.68 mg/L	7.41 kg/ha
Chloride (Cl^-)	0.30 mg/L	3.20 kg/ha
Sulfate (SO_4^{2-})	0.70 mg/L	7.62 kg/ha
pH (free acidity H^+)	4.91	0.132 kg/ha

ha = hectare – a metric unit of area defined as 10,000 square meters.

RADIOLOGICAL DOSE ASSESSMENTS

Chapter 6



Timothy Jannik
Kenneth L. Dixon
Savannah River National Laboratory

U.S. Department of Energy (DOE) Order 458.1, "Radiation Protection of the Public and the Environment," establishes an annual public dose limit and biota dose limits that are at levels that would provide protection of the public and environment from the effects of radiation resulting DOE activities. The Savannah River Site (SRS) calculates the potential doses to members of the public from atmospheric and liquid radioactive releases and from special-case exposure scenarios such as the consumption of onsite wildlife to verify that these releases and exposures do not exceed the DOE public dose limits.

Routine SRS operations result in releases of radioactive materials to the environment by atmospheric and liquid pathways. These releases could result in a radiation exposure to people offsite. To confirm that this exposure is below public dose limits, SRS calculates annual dose estimates using environmental monitoring and surveillance data combined with relevant site-specific data (such as meteorological conditions, population characteristics, and river flow). SRS also confirms that the potential doses to plants and animals (biota) living onsite remain below the DOE biota dose limits. This chapter explains radiation doses, describes how doses are calculated, and presents the estimated doses from SRS activities for 2013.

Chapter 6 Key Terms

Reference person *is a hypothetical age and gender averaged individual that is a combination of human (male and female) physical and physiological characteristics arrived at by international consensus for the purpose of standardizing radiation dose calculations.*

Representative person *is a hypothetical individual receiving a dose that is representative of the more highly exposed individuals in the population. At SRS, this person is based on the 95th percentile of applicable national human usage radiation exposure data.*

Typical person *is a hypothetical person receiving a dose that is typical of the population group – established at the 50th percentile (or median) level of national radiation exposure data.*

All dose calculation results are in data tables located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2013* on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

SRS used the data generated by the programs described in Chapter 4, "Effluent Monitoring," and Chapter 5, "Environmental Surveillance" to calculate the potential doses to the public. For a complete description of how SRS calculates potential doses, see the *SRS Environmental Dose Assessment Manual* (SRS EDAM 2012).

WHAT IS A DOSE?

Dose is the amount of energy absorbed by the human body as a result of a radioactive source; it is measured in rem (which equals 0.01 sievert (Sv)) or in millirem (mrem), which is one-thousandth of a rem, and is the unit typically used in this report. Unless otherwise noted, the generic term "dose" used in this report is the total effective dose to a person, which includes both the committed effective dose (a dose that accounts for continuing exposures expected to be received over a long period of time (such as 50 or 70 years) from radioactive materials that were deposited inside the body) and the effective dose (the dose from sources external to the body).

Use of the total effective dose allows doses from different types of radiation and to different parts of the body to be expressed on the same basis.

Humans, plants, and animals potentially receive radiation doses from natural and man-made occurrences. The average annual "background" dose for all people living in the United States is 625 mrem; this includes an average background dose of 311 mrem from naturally occurring radionuclides found in our bodies and in the earth, and from cosmic radiation. Man-made sources include medical procedures (300 mrem), consumer products (13 mrem), and less than 1 mrem from industrial and occupational exposures.

DOE has established dose limits to the public so that DOE operations will not contribute significantly to this average annual exposure. DOE Order 458.1 (DOE 2011) establishes 100 mrem/yr (1 mSv/yr) as the annual dose limit to a member of the public. Exposure to radiation primarily occurs through the following pathways, as shown in Figure 6-1:

- Inhalation,
- Ingestion,
- Skin absorption, and
- Direct (external) exposure to radionuclides in soil, air, and water.

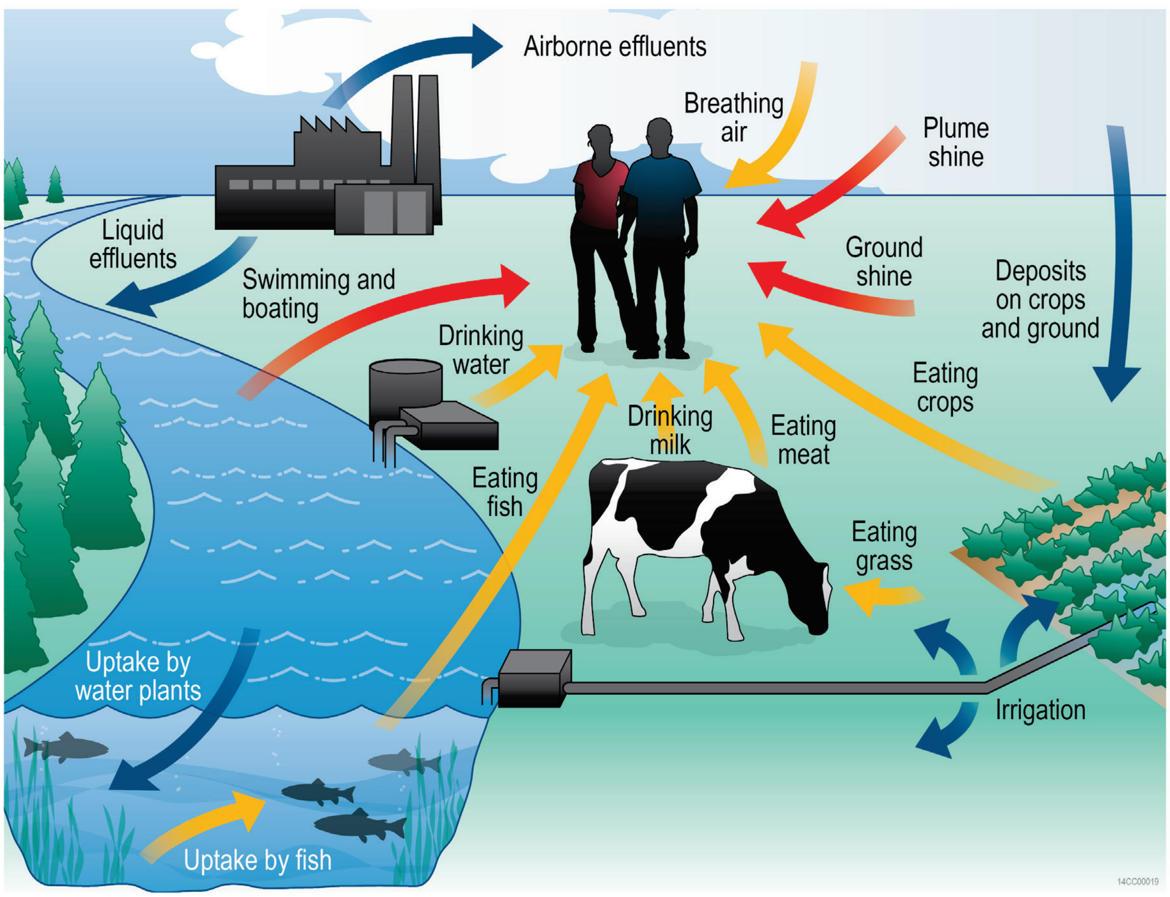


Figure 6-1 Exposure Pathways to Humans from Atmospheric and Liquid Effluents

CALCULATING DOSE

In compliance with DOE Order 458.1, dose is calculated to the maximally exposed individual (MEI) or to a representative person. In the past, SRS used the MEI concept for dose compliance using adult dose coefficients and adult male usage parameters. Since 2012, SRS has used the representative person concept for dose compliance.

The representative person dose is based on reference person usage parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The applicable national and regional data used are from the Environmental Protection Agency's *EPA Exposure Factor Handbook*, 2011 Edition (EPA 2011).

The reference person is weighted based on sex and age and this weighting is based on the six age groups documented in International Commission on Radiation Protection (ICRP) Publication 89, (2002): Infant (0 years), 1 year, 5 years, 10 years, 15 years, and Adult. The various age- and gender-specific intake rates from EPA (EPA 2011) were proportioned to correspond with these age groupings. SRS developed usage parameters at the 50^{th} percentile to use in calculating dose to a "typical" person for determining collective doses. The SRS-specific reference and typical person usage parameters were developed by Stone and Jannik (2013) and are provided in Table 6-1. All other applicable land and water use parameters used 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 other human usage parameters required in the SRS dosimetry models. In addition, SRS documents the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations in this report. Data Tables 6-1 and 6-2 provide a summary of the site-specific input parameters that are the most important to the dose calculations for the liquid and airborne pathways, respectively.

Table 6-1 SRS Reference and Typical Person Usage Parameters

	Unit	Reference Person	Typical Person
Air	m^3/y	6,400	5,000 [a]
Water	L/y	800	300 [b]
Meat	kg/y	81	32 [c]
Leafy Vegetables	kg/y	31	11
Other Produce	kg/y	289	89
Milk/Dairy	L/y	260	69
Freshwater Fish	kg/y	24	3.7
Saltwater Invertebrate	kg/y	9.0	1.5

[a] 1 cubic meter = 1.3 cubic yards
[b] 1 liter = 1.06 quarts
[c] 1 kilogram = 2.2 pounds

For determining compliance with DOE public dose requirements, SRS calculates the potential offsite doses from SRS effluent releases of radioactive materials (atmospheric and liquid) for the following scenarios:

- Representative person living at the SRS boundary, and
- Population living within a 50-mile (80-kilometer [km]) radius of SRS.

To show compliance with the DOE Order 458.1 all pathway dose standard of 100 mrem/yr, 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.

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

SRS has assessed the potential effects of routine radioactive releases annually since operations began. Since 1972, SRS has published annual offsite dose estimates 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 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 (representative person and population, respectively) and LADTAP XL© is used for liquid releases. These models are described in the *SRS Environmental Dose Assessment Manual* (2012).

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE [1988]. In 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72, (ICRP 1996) and the external dose conversion factors were updated to the dose factors provided in *Federal Guidance Report 12*, (EPA 1993). Beginning in 2012, the dose to a representative person is based on 1) the SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data, which are documented in Stone and Jannik (2013), 2) the reference person (gender and age averaged) ingestion and inhalation dose coefficients provided in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011a), and 3) the external dose coefficients provided in the DC_PAK3 toolbox, which can be accessed at http://www.epa.gov/rpdweb00/federal/techdocs.html. Currently, there are no age-specific external dose factors available.

Meteorological Database

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). To show compliance with EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (EPA 2002a), only the H-Area meteorological database was used in the calculations because the EPA-required dosimetry code (CAP88 PC version 4.0), is limited to a single release location.

In 2013, SRS updated the five-year meteorological datasets used in dose calculations. The new datasets cover the period 2007 through 2011. The updated datasets differ from previous five-year datasets in that they now 1) estimate atmospheric stability using the standard deviation of the vertical wind velocity and 2) use an updated surface roughness factor for SRS. The 2007 through 2011 meteorological database for H Area is provided in Data Table 6-3. In Figure 6-2, the 2007-2011 H-Area wind rose shows that the wind blows towards the East Northeast the highest percentage time (about 9%).

Atmospheric stability is defined as the vertical mixing strength of the atmosphere. Previously, SRS used the standard deviation of the horizontal wind velocity measurement for determining atmospheric stability. However, it is now generally believed that the standard deviation of the vertical wind velocity is more appropriate for determining stability. For the 2007 through 2011 meteorological data, SRS revised the methodology used to determine atmospheric stability to make use of the standard deviation of the vertical wind velocity. Once the revised stability estimates were made, SRS followed the methods used for previous meteorological datasets to adjust the stability estimates following EPA guidance (EPA 2000a) by using wind speed, the current estimated surface roughness length at SRS (1.6 m), and a measurement height of 61 m. The effect of predicting atmospheric stability in this manner compared to previous methods is a shift toward more neutral conditions, which limits daytime diffusion of a plume, leading to higher concentrations and, consequently, higher estimated doses for the standard center of site and H-Area meteorology scenario. Using these revised methods caused an increase in the estimated off site dose of about 50% compared to the previous (2002 through 2006) meteorological data.

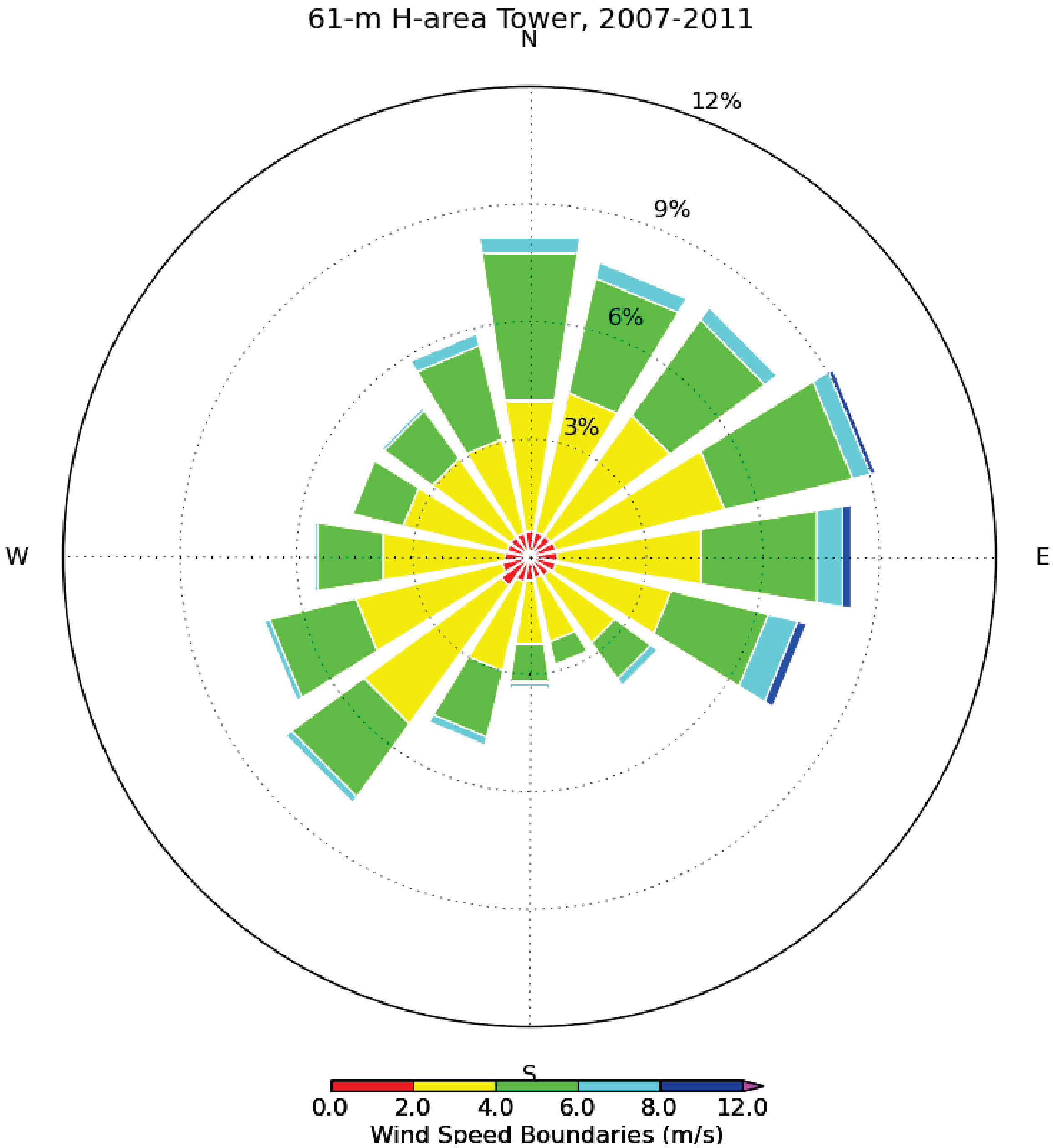


Figure 6-2 2007-2011 Wind Rose for H Area (Direction is toward which the wind blows)

Population Database and Distribution

SRS calculates the collective (population) doses from atmospheric releases for the population within a 50-mile radius of the Site. 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. 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 shown 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 (City of Savannah I&D), near Port Wentworth, Georgia, and for 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 City of Savannah I&D facility during 2013 was 26,300 people, while the population served by the BJWSA Chelsea facility was 77,000 people and by the BJWSA Purrysburg facility, 58,000 people. The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories: 1) BJWSA water consumers, 2) City of 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 foodstuffs using river water near River Mile (RM) 118.8 (U.S. Highway 301 bridge).

River Flow Rate Data

Savannah River flow rates, recorded at a gauging station near RM 118.8 are based on the measured water elevation. The river flow rates measured at this location from 1954 through 2013 are provided in Data Table 6-5 and show that the mean river flow rate for these years is 10,024 cubic feet per second (cfs). 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 from RM 118.8 and from 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 is more conservative (that is, it results in higher estimates) than the use of measured flow rates because it accounts for less dilution.

For 2013, SRS used the RM 118.8 calculated (effective) flow rate of 5,752 cfs in the dose calculations. This flow rate was about 61% more than the 2012 effective flow rate of 3,579 cfs. For comparison, the 2013 annual average flow rate, as measured by the U.S. Geological Survey (USGS), was 8,479 cfs. The 2013 calculated effective flow rates were 7,813 cfs for the City of Savannah I&D facility, 7,252 cfs for the BJWSA Chelsea facility, and 7,849 cfs for the BJWSA Purrysburg facility.

DOSE CALCULATION RESULTS

Liquid Pathway

<u>Liquid Release Source Terms</u>

The 2013 radioactive liquid release quantities used as the source term in SRS dose calculations, discussed in Chapter 4, "Effluent Monitoring," and Chapter 5, "Environmental Surveillance," are shown by radionuclide in Table 6-2, and shown 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% of the total amount of radioactivity released from the Site to the Savannah River. In 2013, SRS released a total of 1,082 curies of tritium to the river, a 45% increase from the 2012 amount of 746 curies. Most of this increase is attributed to heavy rainfall events during the summer of 2013, which increased the amount of tritium that entered Site streams (see Chapter 5, "Environmental Surveillance" for details).

In 2013, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 1,897 curies to the Savannah River for an overall total (SRS plus VEGP) of 2,979 curies, which is a 55% increase over the combined total of 1,927 curies in 2012.

Table 6-2 2013 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCL)

Nuclide	Curies Released	12-Month Average Concentration (pCi/L)				
		Below SRS [(a)]	BJWSA Chelsea [(b)]	BJWSA Purrysburg [(b)]	City of Savannah I&D[(c)]	EPA MCL[(e)]
H-3[(d)]	1.08E+03	5.80E+02	4.60E+02	4.25E+02	4.27E+02	2.00E+04
C-14	6.13E-03	1.19E-03	9.46E-04	8.74E-04	8.79E-04	2.00E+03
Sr-90	2.39E-02	4.65E-03	3.69E-03	3.41E-03	3.43E-03	8.00E+00
Tc-99	1.85E-02	3.60E-03	2.86E-03	2.64E-03	2.65E-03	9.00E+02
I-129	2.70E-02	5.26E-03	4.17E-03	3.85E-03	3.87E-03	1.00E+00
Cs-137	3.34E-02	6.50E-03	5.16E-03	4.76E-03	4.79E-03	2.00E+02
U-234	4.54E-02	8.84E-03	7.01E-03	6.48E-03	6.51E-03	1.03E+01
U-235	2.63E-03	5.12E-04	4.06E-04	3.75E-04	3.77E-04	4.67E-01
U-238	5.50E-02	1.07E-02	8.49E-03	7.85E-03	7.88E-03	1.00E+01
Np-237	5.05E-07	9.83E-08	7.80E-08	7.20E-08	7.24E-08	1.50E+01
Pu-238	6.27E-04	1.22E-04	9.68E-05	8.94E-05	8.99E-05	1.50E+01
Pu-239	4.81E-05	9.36E-06	7.43E-06	6.86E-06	6.89E-06	1.50E+01
Am-241	4.27E-03	8.31E-04	6.59E-04	6.09E-04	6.12E-04	1.50E+01
Cm-244	2.23E-05	4.34E-06	3.44E-06	3.18E-06	3.20E-06	1.50E+01
Alpha	5.18E-03	1.01E-03	8.00E-04	7.39E-04	7.42E-04	1.50E+01
Beta	4.12E-02	8.02E-03	6.36E-03	5.88E-03	5.90E-03	8.00E+00

[a] Near Savannah River Mile 118.8, downriver of SRS at the U.S. Highway 301 bridge

[b] Beaufort-Jasper, South Carolina, drinking water

[c] Port Wentworth, Georgia, drinking water

[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 the 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

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

SRS measures the concentrations of tritium in Savannah River water and cesium-137 in Savannah River fish 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 their concentration in the Savannah River usually cannot be detected 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 RM 118.8 and at the City of Savannah I&D and BJWSA water treatment facilities are shown in Table 6-2, as are the calculated concentrations for the other released radionuclides. These downriver tritium concentrations include tritium releases from SRS and the neighboring VEGP. Also shown in Table 6-2 is a comparison of these concentrations to the Safe Drinking Water Act, 40 CFR 141 (EPA, 2000) maximum contaminant level (MCL) for each radionuclide.

In 2013, the 12-month average tritium concentration measured in Savannah River water near RM 118.8 was 580 picocuries per liter (pCi/L). This reflects a slight decrease from the 603 pCi/L measured in 2012. Even though the amount of tritium released to the Savannah River from SRS and VEGP increased 55% in 2013, there was a decrease in the annual average tritium concentration because of the 85% increase in river flow from 2012 to 2013. The 2013 concentrations at the BJWSA Chelsea (460 pCi/L) and Purrysburg (425 pCi/L) facilities and at the City of Savannah I&D (427 pCi/L) water treatment plant were proportionately lower than in 2012 and remained well below the EPA drinking water MCL of 20,000 pCi/L.

Table 6-2 indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at RM 118.8, were below the EPA MCLs. Because SRS releases more than one radionuclide 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 0.0310 at the BJWSA Chelsea facility, 0.0286 at the BJWSA Purrysburg facility, and 0.0287 at the City of Savannah I&D facility. These are below the 1.0 sum-of-the-fractions requirement.

For 2013, the sum of the fractions at the RM 118.8 location was 0.0390. This is provided only for comparison because RM 118.8 is not a community drinking water system location.

Radionuclide Concentrations in Fish — At SRS, an important dose pathway for the representative person is from the consumption of fish. Fish exhibit a high degree of bioaccumulation for certain elements. For cesium (including radioactive isotopes of cesium), the bioaccumulation factor for Savannah River fish is 3,000, meaning that 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 RM 118.8, the assumed location of the hypothetical representative person. As shown in Data Table 6-10, the LADTAP XL© dose model calculated concentration of cesium-137 in fish (0.00829 pCi/g), based on measured SRS effluent releases, was determined to be less than the actual measured concentration in fish. To be conservative, the higher measured concentration of cesium-137 in fish (0.0195 pCi/g) was used in the 2013 dose determinations.

Dose to the Representative Person

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, the doses from the irrigation pathway are included in the totals for the SRS representative person and collective doses.

As shown in Data Table 6-11, the 2013 dose to the representative person from all liquid pathways including irrigation was estimated at 0.14 mrem (0.0014 mSv), which was about 39% less than the comparable dose in 2012 of 0.23 mrem (0.0023 mSv). This decrease is mainly attributed to the 61% increase in the effective Savannah River flow rate during 2013. Table 6-3 shows that this total dose is 0.14% of the all-pathway public dose standard of 100 mrem/yr (1 mSv/yr). A five-year history of SRS doses is provided in Data Table 6-12.

Table 6-3 Potential Dose to the Representative Person from SRS Liquid Releases in 2013

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.05		
Irrigation Pathways	0.09		
Total Pathways	0.14	100[a]	0.14
[a]All-pathway dose standard: 100 mrem/yr (DOE Order 458.1)			

Over 63% of the 2013 total dose to the representative person resulted from the irrigation pathway (ingestion of meat, milk, and vegetables). The fish consumption pathway accounted for 21% and the drinking water pathway, 15%. As shown in Figure 6-3, cesium-137 and technetium-99 (18% each), tritium oxide (17%), and iodine-129 (13%) were the major contributors to the total dose (Data Table 6-11).

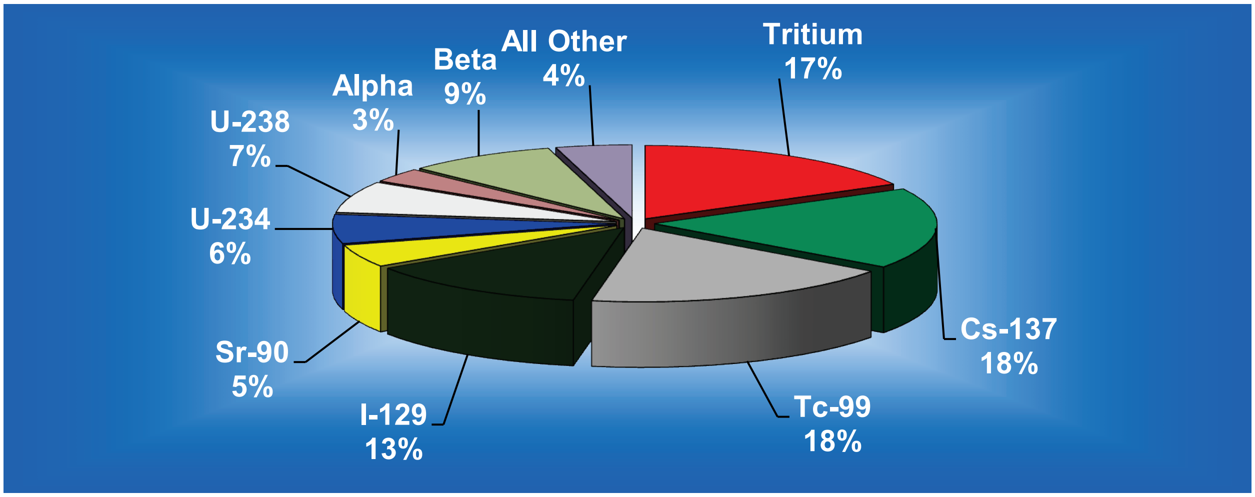


Figure 6-3 Radionuclide Contributions to the 2013 SRS Total Liquid Pathway Dose of 0.14 mrem (0.0014mSv)

Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactivity released from the Site. Tritium in downriver drinking water represented the majority of the dose (about 60%) received by customers of the three downriver water treatment plants (Data Tables 6-13 and 6-14).

Based on SRS-only releases, the maximum potential drinking water dose during 2013 was determined to be 0.017 mrem (0.00017 mSv) (Data Table 6-13). This dose is 32% less than the 2012 dose of 0.025 mrem (0.00025 mSv). There is not a separate drinking water dose standard. Offsite public drinking water systems are regulated by the EPA under 40 CFR 141 (EPA 2000).

Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the discrete population groups served by the BJWSA and City of Savannah I&D water treatment plants. Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are devoted to each of the major food types grown in the SRS area (vegetables, milk, and meat), with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels. 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 was 2.5 person-rem (0.025 person-Sv) in 2013. This is 34% less than the comparable 2012 collective dose of 3.8 person-rem (0.038 person-Sv). This decrease is mainly attributed to the 61% increase in the effective Savannah River flow rate for 2013 causing more dilution to occur.

Air Pathway

Atmospheric Source Terms

The 2013 radioactive atmospheric release quantities used as the source term in SRS dose calculations are discussed in Chapter 4, "Effluent Monitoring," and are in Data Table 6-16. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required, for demonstrating compliance with EPA regulations. Data Table 6-17 provides a five-year history of SRS atmospheric releases.

Atmospheric Concentrations

SRS uses calculated radionuclide concentrations instead of measured concentrations for dose determinations because most radionuclides released from SRS were not detected (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 are detected and are compared with calculated concentrations as a verification of the dose models in Data Table 6-18.

Dose to the Representative Person

The 2013 estimated dose from atmospheric releases to the representative person (calculated with MAXDOSE-SR) was 0.052 mrem (0.00052 mSv), 0.52% of the DOE Order 458.1 air pathway standard of 10 mrem per year. Table 6-4 compares the representative person dose with the DOE standard. The 2013 dose was about 93% more than the 2012 dose of 0.027 mrem (0.00027 mSv). This increase is mainly attributed to 1) the change in methods for developing the new 5-year meteorological datasets (previously discussed) and 2) the 52% increase in the Site's overall (measured plus calculated) tritium oxide releases from 2012 to 2013. Refer to Data Table 6-17 and to Chapter 4, "Effluent Monitoring" for additional information. A five-year history of SRS air pathway doses is in Data Table 6-12.

Table 6-4 Potential Doses to the Representative Person and to the MEI from SRS Atmospheric Releases in 2013 and Comparison to the Applicable Dose Standard

	MAXDOSE-SR	CAP88-PC NESHAP
Calculated dose (mrem)	0.052	0.038
Applicable Standard (mrem)	10[a]	10[b]
Percent of Standard (%)	0.52	0.38

[a] DOE: DOE Order 458.1
[b]EPA: (NESHAP) 40 CFR 61, Subpart H

The 2013 atmospheric doses by both radionuclide and pathway are provided in Data Table 6-19. As shown in Figure 6-4, tritium oxide releases accounted for nearly 70% of the dose to the representative person. Cesium-137, unspecified beta, and unspecified alpha accounted for 17%, 5%, and 4%, respectively. No other individual radionuclide accounted for more than 3% of the representative person dose.

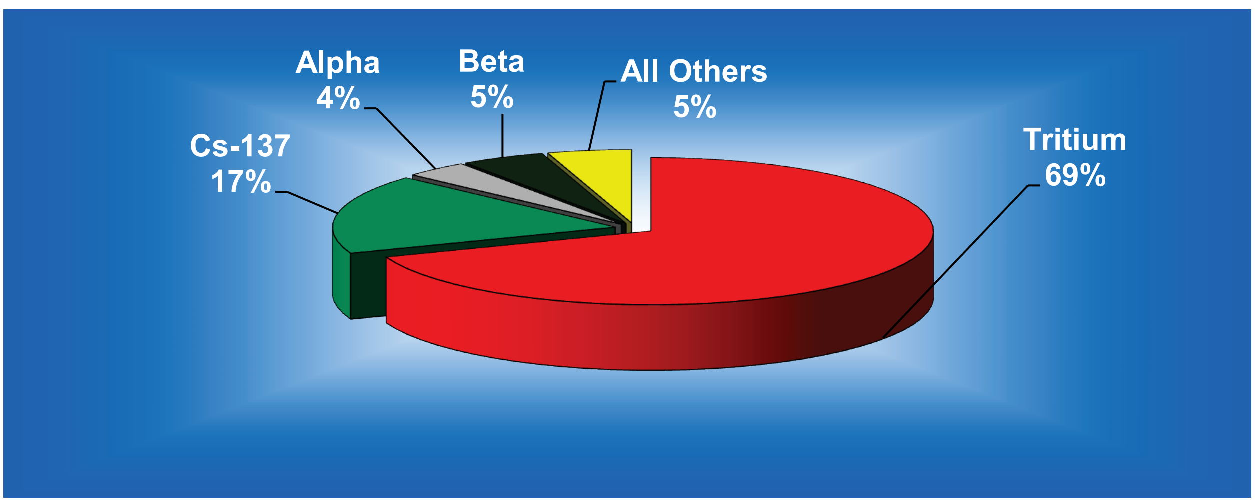


Figure 6-4 Radionuclide Contributions to the 2013 SRS Air Pathway Dose of 0.052 mrem (0.00052 mSv)

The major pathways contributing to the representative person dose from atmospheric releases were inhalation (33%), vegetable consumption (32%), cow milk consumption (18%), and ground shine (15%). As shown in Data Table 6-20 and in Maps Figure 14, the due north sector of the Site was the location of the highest dose to the representative person. Because of the potential in the SRS vicinity for the consumption of goat milk, additional calculations of the dose to the representative person were performed substituting goat milk for the customary cow milk pathway. As shown in Data Table 6-21, the potential dose to the representative person using the goat milk pathway was estimated to be 0.058 mrem (0.00058 mSv). This dose is provided for reference only.

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 2013, the airborne-pathway collective dose (calculated with POPDOSE-SR) was estimated at 2.2 person-rem (0.022 person-Sv), less than 0.01% of the annual collective dose received from natural sources of radiation (about 234,000 person-rem).

The 2013 air-pathway collective doses by radionuclide and pathway are provided in Data Table 6-22. Tritium oxide releases accounted for nearly 62% of the collective dose. The 2013 collective dose was about three times more than the 2012 collective dose of 0.76 person-rem (0.0076 person-Sv). Again, this increase is attributed to 1) the change in methods for developing the new five-year meteorological datasets and 2) the 52% increase in the Site's airborne tritium releases from 2012 to 2013.

NESHAP Compliance

To demonstrate compliance with NESHAP regulations (EPA 2002a), MEI and collective doses were calculated using 1) the CAP88 PC version 4.0 computer code, 2) the 2013 airborne-release source term (Data Table 6-23), and 3) site-specific input parameters (Data Table 6-24). EPA requires the use of the MEI and does not allow use of the reference person concept at this time. Most input parameters in CAP88 PC are hard coded in the program and cannot be changed without specific EPA approval. The SRS specific parameters used are in Data Table 6-24.

For 2013, SRS implemented the use of the newly released CAP88 PC version 4.0 (version dated January 20, 2014) to demonstrate compliance with EPA's 10 mrem per year (0.1 mSv per year) public dose standard for airborne emissions. CAP88-PC version 4.0 introduces a new code architecture that conforms to updated coding standards and data formats allowing for substantially improved simulation times compared to the previous version 3.0. CAP88-PC version 4.0 uses the radionuclide physical data, dose factors, risk factors, and decay chain information provided by Oak Ridge National Laboratory in the DCFPAK Version 2.2 data release. Other changes noted in version 4.0 include 1) a reduction in the inhalation and human food consumption rates, 2) a reduction in the tritium oxide dose coefficient from the organically bound tritium dose coefficient to the tritium vapor dose coefficient, and 3) changes to the ground surface buildup/depletion calculations. As previously discussed, SRS also updated the five-year (2007 through 2011) meteorological datasets used by CAP88-PC version 4.0.

In general, the results of these changes and improvements in CAP88 PC version 4.0 were to reduce the estimated doses from the alpha and beta emitting radionuclides such as tritium oxide, strontium-90, and plutontium-239. This reduction is directly related to the reduction in the inhalation and food consumption rates. Tritium oxide doses were further reduced due to the change in its dose coefficient. For gamma emitters like cesium-137 and cobalt-60, the overall doses went up substantially (by up to a factor of 100) due to the change in the buildup calculations.

For 2013, using the CAP88 PC version 4.0 code, the MEI dose was estimated at 0.038 mrem (0.00038 mSv), 0.38% of the 10-mrem per year EPA standard, as shown in Table 6-4. The 2013 doses by radionuclide are provided in Data Table 6-25. Tritium oxide releases accounted for about 60% of the MEI dose and elemental tritium accounted for 7%. The 2013 NESHAP compliance dose (MEI dose) was about 5% less than the 2012 dose of 0.040 mrem (0.00040 mSv). SRS mainly attributes the decrease to the changes EPA made in the CAP88 PC version 4.0 code.

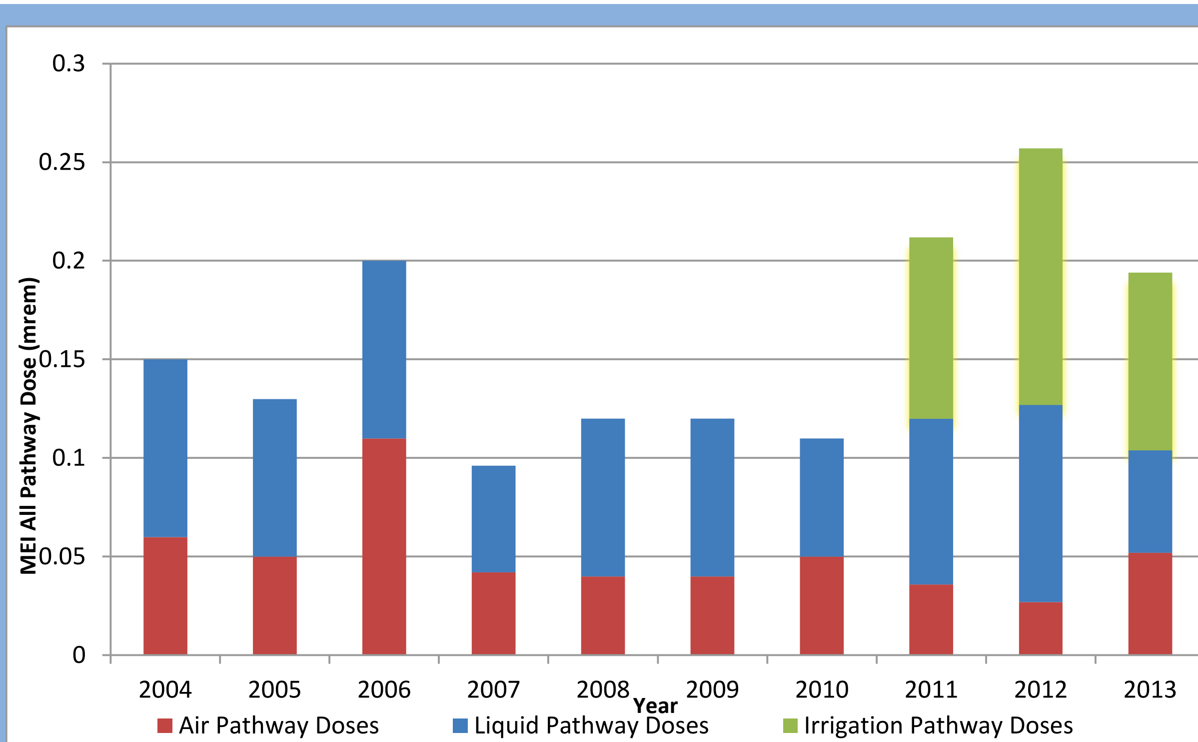
For NESHAP, the dose from diffuse and fugitive releases is required to be reported separately. Data Table 6-26 shows the MEI dose from diffuse and fugitive releases was about 0.013 mrem (0.00013 mSv) and it accounts for 34% of the total 2013 MEI dose. Estimated cesium-137 releases accounted for 60% of the diffuse and fugitive dose.

The CAP88 PC-determined collective (population) dose for 2013 was estimated at 5.3 person-rem (0.053 person-Sv), which is 42% more than the 2012 collective dose of 3.7 person-rem (0.037 person-Sv). Tritium releases accounted for nearly 65% and cesium-137 releases accounted for 22% of the collective dose. Comparisons (by pathway and major radionuclides) of the CAP88 PC-determined MEI and collective doses with the MAXDOSE-SR and POPDOSE-SR representative person doses are provided in Data Tables 6-27 and 6-28, respectively. As shown in Data Table 6-27, the CAP88 PC version 4.0 code now estimates a lower dose for the MEI because of the changes EPA made in version 4.0. However, for the population dose, the CAP88 PC version 4.0 estimates a higher dose because it 1) assumes the general population has the same inhalation and consumption rates as the maximally exposed individual, and 2) assumes a one-to-one ratio between tritium oxide in air and tritium oxide in plant leaves, whereas POPDOSE-SR assumes a 50% ratio.

All-Pathway Dose

As stated in the DOE Order 458.1, the all-pathway dose standard is 100 mrem/yr. SRS conservatively combines the representative person 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, the SRS all-pathway liquid dose includes the irrigation pathway dose estimate.

For 2013, the potential representative person all-pathway dose was 0.19 mrem (0.0019 mSv), 0.05 mrem from air pathways plus 0.05 mrem from the standard liquid pathways and 0.09 mrem from the irrigation pathways. The all-pathway dose is 0.19% of the 100 mrem/yr DOE dose standard. The 2013 all-pathway dose is about 27% less than the 2012 total dose of 0.26 mrem (0.0026 mSv). This decrease is mainly attributed to the 61% increase in the Savannah River effective flow rate for 2013, which caused more dilution to occur. Figure 6-5 graphically shows a ten-year history of SRS's all-pathway (airborne pathways plus liquid pathways) doses to the MEI/representative person. A five-year history of SRS all-pathway doses is in Data Table 6-12.



1. **Beginning in 2011, the irrigation pathway dose is included in the liquid pathway dose. Previous years do not include the irrigation pathway dose.**
2. **Beginning in 2012, the representative person dose is used instead of the MEI dose.**

Figure 6-5 Ten-Year History of SRS Maximum Potential All-Pathway Doses

Sportsman Dose

DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem/yr includes doses a person receives from routine DOE operations through all exposure pathways. Non-typical exposure pathways, not included in the standard calculations of the doses to the representative person, 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 ("creek-mouth fish") or to unique scenarios such as onsite hunters.

In addition to deer, hog, fish, and turkey consumption, the following exposure pathways were considered for an offsite hunter and an offsite fisherman on Creek Plantation, a privately owned portion of the Savannah River Swamp.

- External exposure to contaminated soil,
- Incidental ingestion of contaminated soil, and
- 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 2013, the maximum dose that could have been received by an onsite hunter was estimated at 5.0 mrem (0.05 mSv), or 5% of DOE's 100 mrem/yr all-pathway dose standard (Table 6-5). This dose was determined for an actual hunter who harvested five animals (two deer and three hogs) during the 2013 hunts. The hunter-dose calculation is based on the conservative assumption that this hunter individually consumed the entire edible portion, about 80 kilogram (kg) (176 pounds) of the animals that the hunter harvested from SRS in 2013.

Turkey Consumption Pathway — SRS hosts a special turkey hunt during April for hunters with mobility impairments. Thirty-two turkeys were harvested in 2013. 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 2013, 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 pathways considered were for hypothetical offsite individuals whose entire intake of meat (81 kg) during the year was either deer or hog meat. It was assumed that these 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 (1.12 pCi/g) and hogs (1.32 pCi/g) harvested from SRS during 2013, the potential maximum doses from this pathway were estimated at 2.5 mrem (0.0025 mSv) for the offsite deer hunter and 3.3 mrem (0.013 mSv) for the offsite hog hunter. These dose calculations are provided in Data Table 6-29.

Beginning in 2013, a background cesium-137 concentration of 0.5 pCi/g is now subtracted from the onsite average concentrations before calculating the offsite hunter doses. The previous background value was 1.0 pCi/g. The 0.5 pCi/g background concentration is based on the median value determined by South Carolina Department of Health and Environmental Control (SCDHEC) for South Carolina deer from 2008 through 2012 (SCDHEC 2013).

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 2013 was estimated using the RESRAD code (Yu et al., 2001 and SRS EDAM 2012). 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.

Table 6-5 2013 Representative Person All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard

	Committed Dose (mrem)	Applicable Standard	Percent of Standard (%)
Representative Person Dose			
All-Pathways (Liquid Plus Airborne Pathways)	0.19	100	0.19
Sportsman Dose			
Onsite Hunter	5.0	100	5.0
Creek-Mouth Fisherman[b]	0.21	100	0.21
Savannah River Swamp Hunter			
Offsite Hog Consumption	3.3		
Offsite Deer Consumption	2.5		
Soil Exposure[c]	2.9		
Total Offsite Deer/Hog Hunter Dose	6.2	100	6.2
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.21		
Soil Exposure[d]	0.07		
Total Offsite Fisherman Dose	0.28	100	0.28

[a] **All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)**

[b] **In 2013, 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 and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek**

Using the worst-case radionuclide concentrations from the most recent comprehensive survey, which was conducted in 2013, 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 6-5, the offsite hog consumption pathway and the Savannah River Swamp hunter soil exposure pathway were conservatively added together to obtain a total offsite hunter dose of 6.2 mrem (0.062 mSv). This potential dose is 6.2% of the DOE 100 mrem/yr all-pathway dose standard.

Offsite Fisherman Dose

Creek-Mouth Fish Consumption Pathway — For 2013, radioanalyses were conducted on 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 6-30. At least one of the three composites has to have a significant result for an average concentration to be reported. SRS reports the maximum dose from this combination of creek-mouth fish. As shown in Table 6-5, SRS estimated the maximum potential dose from this pathway at 0.21 mrem (0.0021 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 2013, a fisherman consumed 24 kg (53 lb) of bass caught exclusively from the mouth of Steel Creek. About 90% 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 calculated 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, SRS estimated 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 to be 0.07 mrem (0.007 mSv).

As shown in Table 6-5, the maximum Steel Creek fish consumption dose (0.21 mrem) and the Savannah River Swamp fisherman soil exposure pathway were conservatively added together to obtain a total offsite fisherman dose of 0.28 mrem (0.0028 mSv). This potential dose is 0.28% of the DOE 100 mrem/yr 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, the Georgia Department of Natural Resources (GDNR), and SCDHEC. This plan ensures the assessment of radiological risk from the consumption of Savannah River fish, and requires a summary of the results be presented in the Annual SRS Environmental Report.

Risk Comparisons — For 2013, the maximum potential radiation doses and lifetime fatal and non-fatal cancer risks from the consumption of SRS creek-mouth fish for 1-year, 30-year, and 50-year exposure durations are compared to the radiation risks associated with the DOE Order 458.1 all-pathway dose standard of 100 mrem/yr (1.0 mSv/yr) in Table 6-6. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA, 1999a). The assumed maximum fish consumption rate is 24 kg per year (Table 6-1).

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

	Committed Dose (mrem)	Potential Risk[a]
2013 Savannah River Fish		
1-Year Exposure	0.21	1.6E-07
30-Year Exposure	6.3	4.8E-06
50-Year Exposure	10.5	8.0E-06
Dose Standard		
100 mrem/yr 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.

For 2013, the maximum recreational fisherman dose was caused by the consumption of bass collected at the mouth of Steel Creek. Figure 6-6 shows a ten-year history of the annual potential radiation doses from consumption of Savannah River fish. Over the past ten years, no apparent trends can be identified from these data because of large variability in the cesium-137 concentrations measured in fish from the same location due to differences in the following:

- Size of the fish collected each year,
- Mobility and location within the stream mouth from which they are collected,
- Time of year they are collected,
- Amount of cesium-137 (and other radionuclides) available in the water and sediments at SRS, and
- Water quality at each SRS stream mouth, caused by annual changes in stream flow rates (turbulence) and water chemistry.

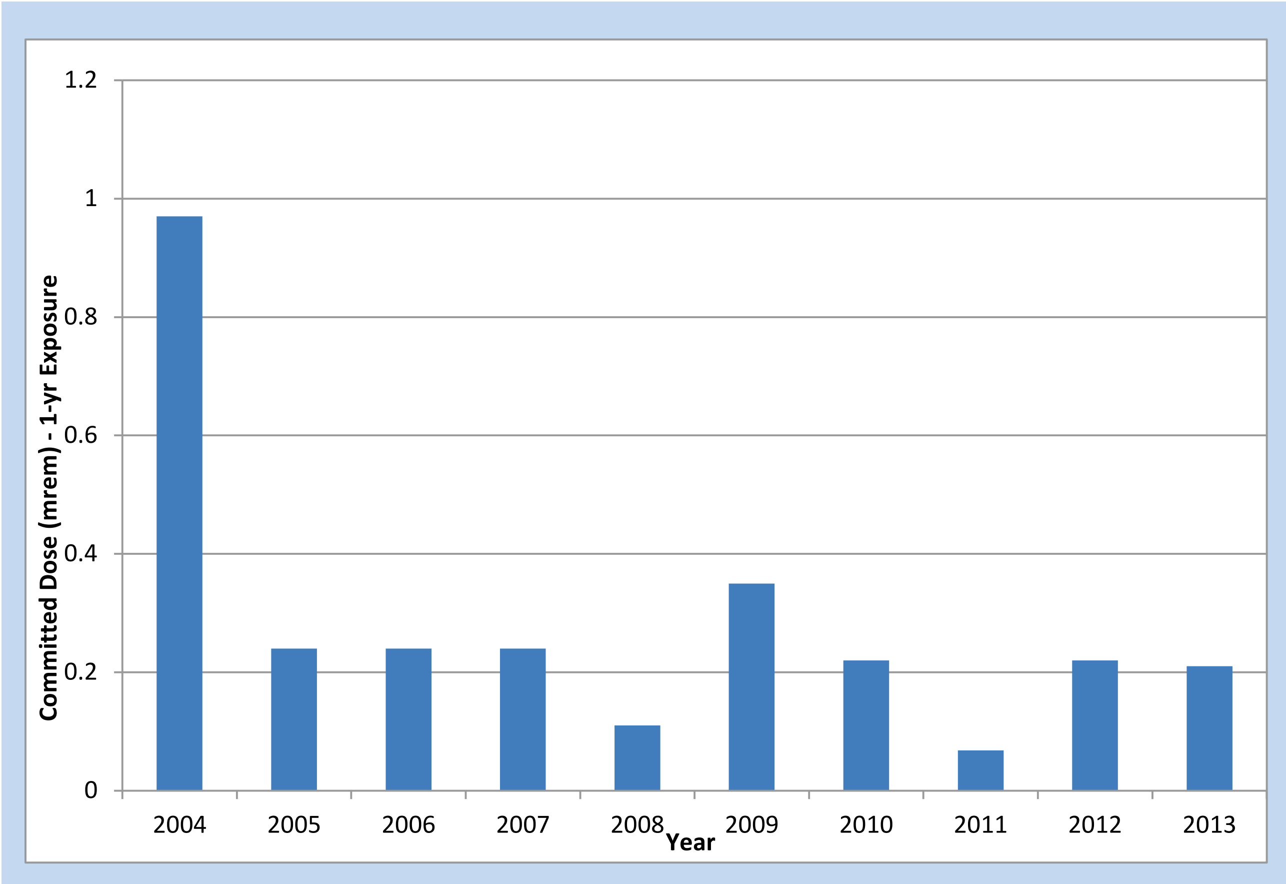


Figure 6-6 Ten-Year History of SRS Creek-Mouth Fisherman's Doses

As indicated in Table 6-6, the 50-year maximum potential lifetime risk from consumption of SRS creek-mouth fish was 8.0E-06, below the 50-year risk (3.7E-03) associated with the 100 mrem/yr 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 ensure that the potential risk from Site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) is kept ALARA (SRS EM Plan 2013).

RELEASE OF MATERIAL CONTAINING RESIDUAL RADIOACTIVITY

DOE Order 458.1 provides for the establishment of authorized surface contamination limits, which in turn allow unconditional release of personal and real property. This order defines personal property as "*property of any kind, except for real property*" and real property is defined as "*land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached.*" Unconditional release of real property at SRS is handled on a case-by-case basis, which requires specific approval from DOE. No real property was released from SRS in 2013, so the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that an annual summary of cleared property must be prepared and submitted to the Field Element Manager (i.e., DOE-SR Manager).

Property Release Methodology

Unconditional release of equipment and material at SRS is governed by procedures. Following a radiological survey, SRS specific limits are used to determine if an item can be unconditionally released. For items meeting unconditional release criteria, a form must be filled out and electronically attached to the applicable radiological survey via the Visual Survey Data System. SRS compiled the electronic forms and coordinated a sitewide review to determine the amount of material and equipment released from SRS facilities in 2013.

A total of 3,706 items of personal property were unconditionally released from radiological areas by SRS in 2013. Most of these items (3,242) did not leave the Site. All of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria (the recently implemented DOE Order 458.1 allows the use of DOE Order 5400.5 derived supplemental limits for unconditional release of equipment and materials).

In 2003, DOE approved a SRS request to use supplemental limits for releasing material from the Site with no further DOE controls. These supplemental release limits, provided in Data Table 6-31, are dose-based, and are such that if any member of the public received any exposure, it would be less than 1 mrem/yr. 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 waste facility. In 2013, SRS did not release any material from the Site using the supplemental release limits volume concentration criteria.

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 2013.

These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

DOE Order 458.1 requires that SRS conduct Site operations in a manner that protects the local biota from adverse effects due to radiation and radioactive material releases. Evaluations to demonstrate compliance with this requirement must be done in at least one of three approved ways. At SRS, the approved DOE Standard, DOE-STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," is the method used (DOE 2002). The biota dose rate limits specified in this standard are:

- Aquatic Animals 1.0 rad/day (0.01 gray/day),
- Riparian Animals 0.1 rad/day (0.001 gray/day),
- Terrestrial Plants 1.0 rad/day (0.01 gray/day), and
- Terrestrial Animals 0.1 rad/day (0.001 gray/day).

DOE Biota Concentration Guides

SRS conducts evaluations of biota doses for aquatic and terrestrial systems using the RESRAD Biota model (version 1.5) (SRS EDAM 2012), which directly implements the DOE (2002) guidance.

For the aquatic systems evaluation, SRS performed initial screenings in 2013 using maximum radionuclide concentration data from the 12 SRS environmental monitoring stream and sediment sampling locations. The combined water-plus-sediment biota concentration guide (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.

Data Table 6-32 presents the results of the 2013 biota dose assessment. Except for the McQueen's Branch location, all other locations passed the initial screen. The McQueen's Branch sum of the fractions was 2.27.

As per DOE (2002) guidance, a level 2 screening was performed using mean concentrations instead of maximum concentrations and this location passed with a sum of the fractions of 0.334. No further evaluations were required.

For the terrestrial systems evaluation, initial screenings were performed using concentration data from the five onsite radiological soil sampling locations. Typically, only one soil sample per year is collected and analyzed for radioactivity from each location. For 2013, all terrestrial locations passed their initial pathway screenings (Data Table 6-32).

GROUNDWATER Chapter 7

Sadika O'Quinn
Savannah River Nuclear Solutions, LLC

The groundwater monitoring program at the Savannah River Site (SRS) achieves the following objectives:

- *Ensuring groundwater contamination is not occurring,*
- *Monitoring groundwater to identify areas of contamination,*
- *Remediating groundwater contamination as needed, and*
- *Conserving groundwater.*

In the past, some SRS operations released chemicals and radionuclides that contaminated the groundwater adjacent to and beneath hazardous waste management facilities and waste disposal sites. The movement of water from the ground's surface into the groundwater can carry contamination along with it, resulting in underground plumes of contaminated water (Figure 7-1).

Because of these past releases, SRS operates extensive groundwater monitoring and groundwater remediation programs. The monitoring program consists of wells for sampling and monitoring contaminant locations and concentrations. SRS plans and mobilizes sampling events, and collects and ships samples to South Carolina Department of Health and Environmental Control (SCDHEC) certified laboratories. Wells are monitored regularly to meet sampling requirements in Federal Facilities Agreement (FFA) related approved monitoring plans and Resource Conservation and Recovery Act (RCRA) permits. Monitoring well data show that the majority of contaminated groundwater is located in the central areas of the SRS and does not extend beyond the SRS boundary. Documents summarizing the groundwater data are submitted to the regulatory agencies, and if necessary, appropriate actions are taken (i.e., remediation or removal activities). The remediation program uses several technologies to remediate groundwater that has unacceptable levels of contaminants (i.e., maximum contaminant level [MCL]). Remediation strategies include closing waste units to reduce the potential for contaminants to reach groundwater and actively treating contaminated water. Agreement among Department of Energy (DOE) and the regulatory agencies is required for final disposition of the waste units.

Chapter 7 Key Terms

Groundwater *is water found underground in cracks and spaces in soil, sand, and rocks.*

Surface water *is water that has not penetrated below the surface of the ground.*

Plume *is a volume of contaminated water originating at a waste source (e.g., a hazardous waste disposal site). It extends downward and outward from the waste source.*

Remediation *is the assessment and cleanup of sites contaminated with waste due to historical activities.*

Waste unit *refers to a particular area that is or may be posing a threat to human health or the environment. They range in size from a few square feet to tens of acres and include basins, pits, piles, burial grounds, landfills, tank farms, disposal facilities, process facilities, and groundwater contamination.*

Groundwater corrective action operations focus on remediating volatile organic compounds (VOCs) and tritium. VOCs, mainly trichloroethylene (TCE) and tetrachloroethylene (PCE), come from their use as degreasing agents in industrial operations at SRS. Tritium came primarily from reactor operations, which ceased in 1991. SRS groundwater corrective action operations have been successful in removing VOCs from the groundwater and reducing tritium releases from groundwater into SRS streams and the Savannah River using surface water management and phytoremediation technologies.

This chapter describes the site-wide programs in place for protecting, monitoring, remediating, and using the groundwater.

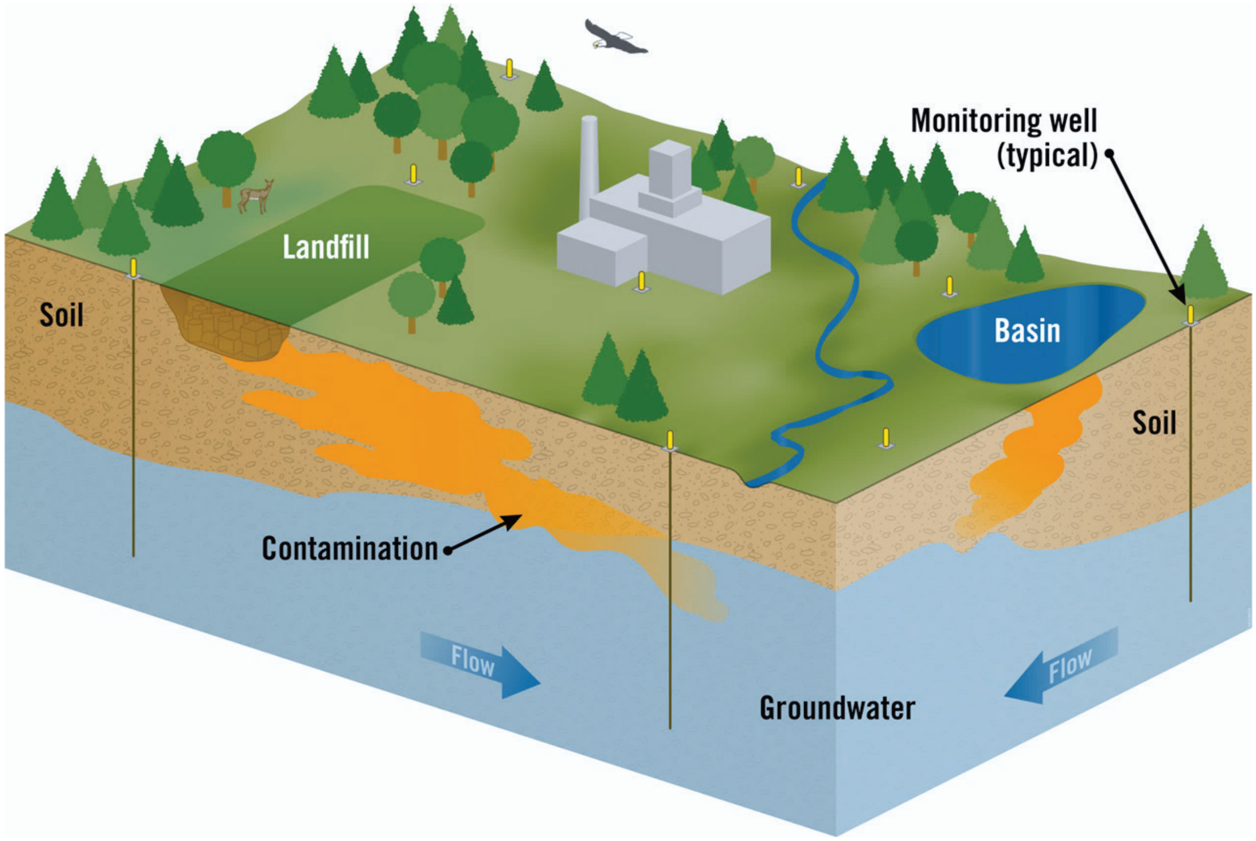


Figure 7-1 How Contamination Gets to Soil and Groundwater

GROUNDWATER PROTECTION PROGRAM AT SRS

SRS has designed and implemented a groundwater protection program to cleanup past groundwater contamination and meet federal and state laws and regulations, DOE orders, and SRS policies and procedures. It contains the following elements:

- Protecting SRS groundwater,
- Remediating contaminated SRS groundwater,
- Monitoring SRS groundwater, and
- Using SRS groundwater.

Protecting SRS Groundwater

SRS is committed to protecting the groundwater resources beneath the Site to protect the community from exposure to contaminants and for groundwater use onsite. A variety of activities contributes to this endeavor, including:

- Prevention or control of sources of groundwater contamination from construction sites and waste management facilities,
- Groundwater and surface water monitoring programs to detect contaminants, and
- Groundwater cleanup program to reduce contaminants in existing areas.

You will find details concerning the integrated program for groundwater protection, management, monitoring, and restoration at SRS in the *Savannah River Site Groundwater Protection Program* (SRNS 2012) at http://www.srs.gov/general/programs/soil/gen/geninf.html.

Monitoring SRS Groundwater

Monitoring the groundwater around SRS facilities and known waste disposal sites is the best way to detect and track groundwater contamination so SRS can implement appropriate remedial or corrective actions. The purpose of monitoring groundwater is to observe and evaluate the changes in the groundwater quality over time, and establish, as accurately as possible, the baseline quality of the groundwater occurring naturally in the aquifers.

The SRS groundwater monitoring program includes two primary components: waste unit monitoring associated with remediation; and groundwater surveillance monitoring. SRS evaluates groundwater monitoring data on a regulatory-approved frequency to identify whether new groundwater contamination exists or if current monitoring programs require modification in order to maintain an optimal monitoring program.

The SRS groundwater waste unit monitoring data is used to determine the effects of Site operations on groundwater quality. The program supports:

- Compliance with environmental regulations and DOE directives,
- Evaluation of the current status of groundwater plumes,
- Evaluation of the suitability of a new facility location, and
- Basic and applied research projects.

Surveillance monitoring efforts at SRS focus on the collection and analysis of data to characterize the groundwater flow and the presence or absence of contaminants. Characterization efforts at SRS include the following activities:

- Collecting soil and groundwater samples using cone penetrometer technology. SRS obtains additional information 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 maps to help define groundwater flow in the subsurface,
- Performing various types of tests to obtain in situ estimates of hydraulic parameters in order to estimate groundwater velocities,
- Analyzing groundwater on a regional scale to provide a comprehensive understanding of SRS groundwater movement and the transport of contaminants near facilities and individual waste units; and
- Characterizing regional surface water flow to assess contaminant risk to perennial streams, the receptors of groundwater discharge.

Figure 7-2 shows the groundwater plumes associated with SRS.

Sample Frequency and Collection

SRS samples approximately 2,000 wells and numerous direct-push holes each year. Sampling occurs at most wells twice a year, but some wells are sampled monthly, quarterly, or annually. The results are included in Data Table 7-1, which is located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2013* on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

Permits or regulatory documents may require analysis of non-radioactive constituents, including metals, herbicides, pesticides, VOCs, and field parameters (such as temperature and pH), 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.

SRS typically collects groundwater samples via pumps or bailers dedicated to each individual well to prevent cross-contamination between the wells. SRS uses portable sampling equipment when decontamination between wells is required.

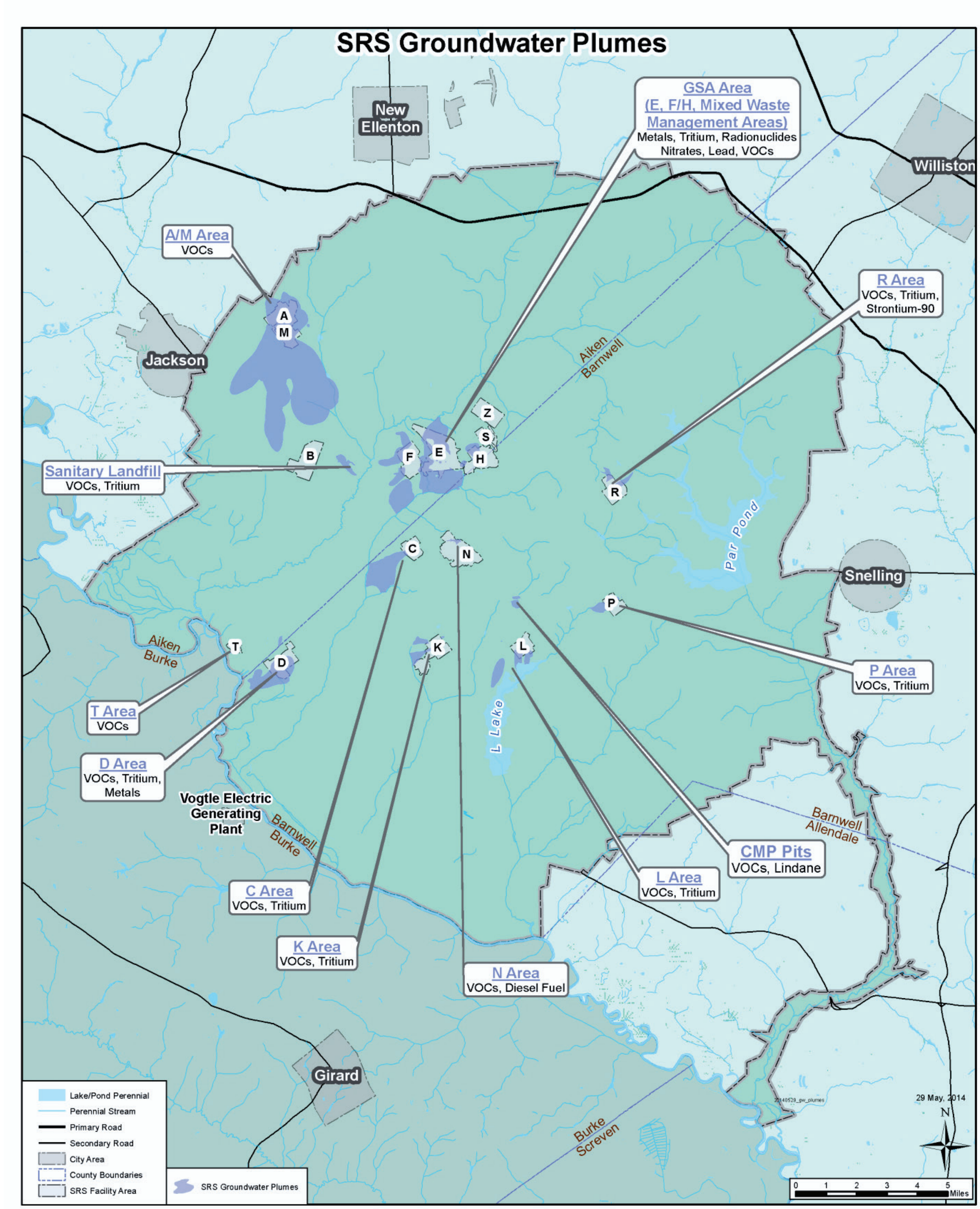


Figure 7-2 Groundwater Plumes at SRS

Procedures and equipment for sampling and shipping are consistent with U.S. Environmental Protection Agency (EPA), SCDHEC, and U.S. Department of Transportation guidelines. SRS uses EPA-recommended preservatives and sample-handling techniques for sample storage and transportation to onsite and offsite analytical laboratories. SRS screens potentially radioactive samples for total activity prior to shipment to determine appropriate packaging and labeling requirements.

One-hundred sixty-nine deviations from scheduled sampling and analysis for 2013 (e.g., dry wells, inoperative pumps, etc.) were entered into the SRS groundwater database and issued in appropriate reports.

Results Summary

There is a significant plume beneath A/M Area. SRS uses more than 150 wells to monitor this plume. Some of these monitoring wells lie within a half-mile of the northwestern boundary of SRS. The major component of groundwater flow in the area parallels the Site boundary; however, groundwater flow direction can fluctuate. Because of this pattern, SRS pays particular attention 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 7-3). The 2013 data show no exceedances of drinking water standards in the groundwater in these wells. In the majority of wells, there is no detectable contamination.

Although most of the contaminated groundwater plumes at SRS do not approach the Site boundary, the potential to impact Site streams does exist. In some instances, Site geology allows for groundwater to outcrop into nearby streams. Groundwater contamination that is outcropping into Site streams is carefully monitored, evaluated, and remediated, as appropriate. In conjunction with stream monitoring, SRS conducts extensive monitoring adjacent to and near SRS waste units and operating facilities, regardless of their proximity to the boundary.

Details concerning groundwater monitoring and conditions at individual sites are discussed in the *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2011) http://www.srs.gov/general/programs/soil/gen/gw_mgmt_strategy_and_implementation_plan.pdf and the *Environmental Monitoring Program Management Plan*, SRS Manual 3Q1, Procedure 101, Revision 2 (SRNS 2013).

REMEDIATING SRS GROUNDWATER

SRS's environmental remediation program has been in place for more than 20 years. The remediation and monitoring of contaminated groundwater is regulated under RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as specified in the *Savannah River Site Federal Facility Agreement* (FFA) (FFA 1993).

For each remediation project, SRS determines the degree and extent of contamination through characterization. After completing characterization, SRS and the regulatory agencies decide upon a strategy for remediating, if warranted, the contaminated groundwater to its original beneficial use.

SRS often applies remedial actions to the groundwater contamination source. For instance, soil vapor extraction, pulling contaminated soil vapor from the subsurface, is widely used at SRS to remove VOCs from the unsaturated (vadose) zone above the water table.

SRS has implemented and is implementing several groundwater remedial technologies. These technologies are intended to manage contaminant flux and reduce contaminant exposure risk to human health and ecological receptors. Thirty-nine remediation systems are currently operating. Seventeen groundwater treatment systems are no longer in use. In 2013, 7,590 lbs. of VOCs and 168 curies of tritium were removed from SRS groundwater. Additional information concerning the SRS remediation systems can be found in the *Soil and Groundwater Closure Projects Technology Descriptions* (WSRC 2007) (http://www.srs.gov/general/programs/soil/gen/sgcp_tech_descriptions.pdf). Overall, the size, shape, and volume of most SRS groundwater plumes are shrinking since the majority of the contaminant sources have been remediated.

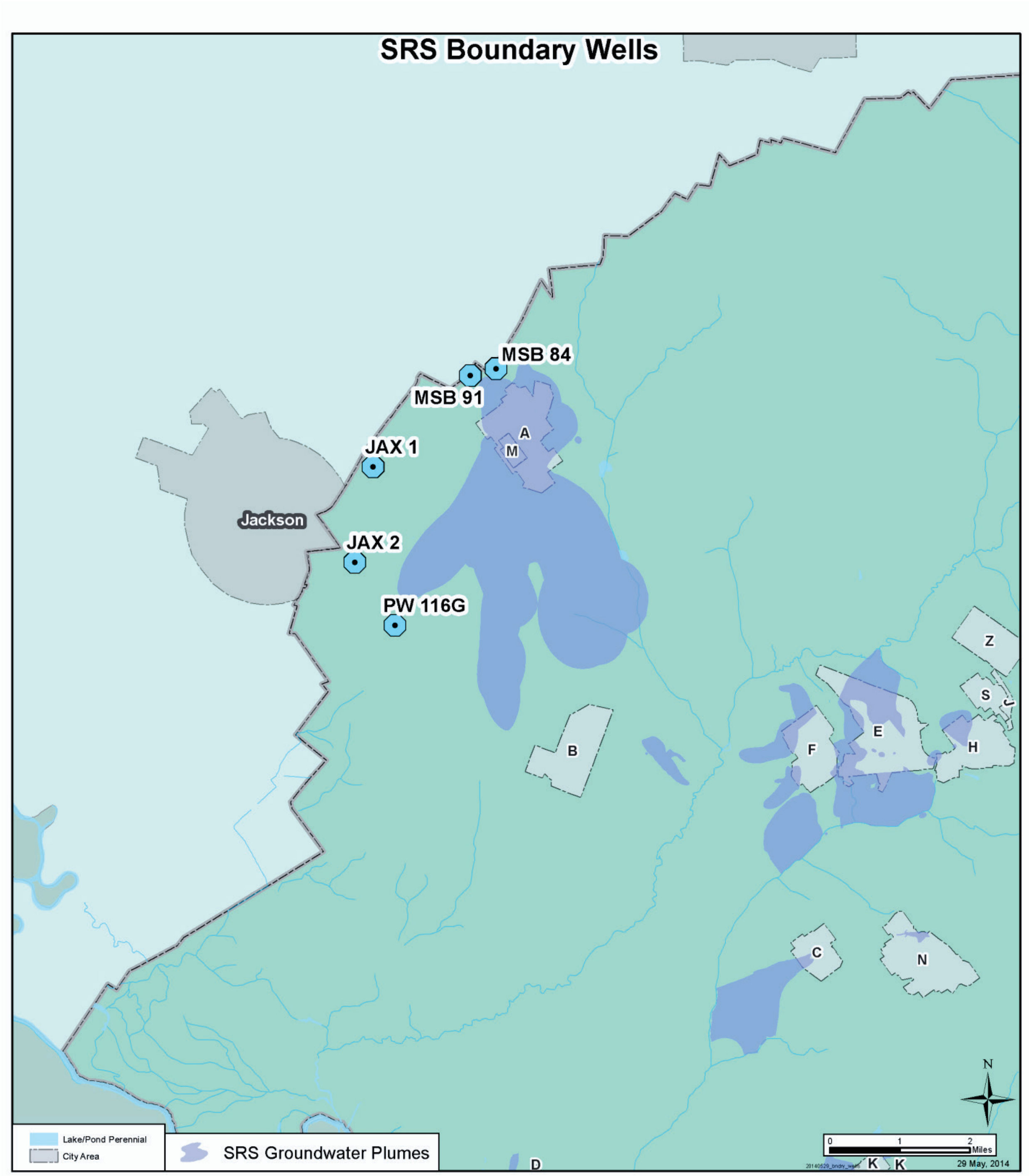


Figure 7-3 Location of Site Boundary Wells at SRS - Between A/M Areas and Jackson, South Carolina (Nearest Population Center)

Table 7-1 presents a general summary of the most contaminated groundwater conditions at SRS, based on 2013 monitoring data. The table shows the 2013 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 PCE) and radionuclides (tritium, gross alpha, and nonvolatile beta emitters). Table 7-2 describes the major contaminants of concern at SRS and their significance.

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

Location	Major Contaminant	Units	2013 Maximum Concentration	Well	Drinking Water Standard	Likely Discharge Point
A/M Area	Tetrachloroethylene	µg/L	49,400	RWM 1	5	Tims Branch/Upper Three Runs in Swamp in West
	Trichloroethylene	µg/L	42,000	MSB101B	5	
	Vinyl Chloride	µg/L	20	MSB 23BR	2	
C Area	Tetrachloroethylene	µg/L	10.9	CRP 5C	5	Fourmile Branch and Castor Creek
	Trichloroethylene	µg/L	701	CRW020D	5	
	Tritium	pCi/mL	8,320	CTA003D	20	
CMP Pits (G-Area)	Tetrachloroethylene	µg/L	460	CMP 45D	5	Pen Branch
	Trichloroethylene	µg/L	340	CMP 10C	5	
	Lindane	µg/L	2.4	CMP 35D	0.2	
D Area	Tetrachloroethylene	µg/L	28	DOB 12	5	Savannah River Swamp
	Trichloroethylene	µg/L	291	DCB 62	5	
	Vinyl Chloride	µg/L	47	DOB 12	2	
	Tritium	pCi/mL	296	DCB 26AR	20	
E Area (MWMF)	Trichloroethylene	µg/L	310	SWP 1C	5	Upper Three Runs/ Crouch Branch in North; Fourmile Branch in South
	Tritium	pCi/mL	23,300	SWP 1C	20	
	Gross Alpha	pCi/mL	52.3	BSW 3D2	15	
F Area	Trichloroethylene	µg/L	28	FGW005C	5	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
	Tritium	pCi/mL	31.9	FNB 13	20	
	Gross Alpha	µg/L	1,220	FGW005C	15	
	Nonvolatile Beta	µg/L	451	FGW005C	4 mrem/yr[a]	
F-Area (HWMF)	Trichloroethylene	µg/L	22.8	FSB 78C	5	Fourmile Branch
	Tritium	pCi/mL	2,760	FSB 94C	20	
	Gross Alpha	pCi/mL	597	FSB 94DR	15	
	Nonvolatile Beta	pCi/mL	1,240	FSB 78C	4 mrem/yr[a]	
F-Area Tank Farm	Manganese	µg/L	2,060	FTF009R	50	Fourmile Branch
	Tritium	pCi/mL	81.3	FTF030D	20	
	Nonvolatile Beta	pCi/mL	921	FTF 28	4 mrem/yr[a]	
H Area	Trichloroethylene	µg/L	6.64	HGW 2D	5	Upper Three Runs/Crouch Branch in North; Fourmile Branch in South
	Gross Alpha	pCi/mL	19	HAA15A	15	
	Nonvolatile Beta	pCi/mL	80.2	HAA 15A	4 mrem/yr[a]	
	Tritium	pCi/mL	29.6	HGW2D	20	
H-Area (HWMF)	Trichloroethylene	µg/L	45.6	HSB120C	5	Fourmile Branch
	Tritium	pCi/mL	1,980	HSB153D	20	
	Gross Alpha	pCi/mL	171	HSL 6D	15	
	Nonvolatile Beta	pCi/mL	928	HSB102D	4 mrem/yr[a]	
H-Area Tank Farm	Manganese	µg/L	1,280	FTF009R	50	Fourmile Branch
	Tritium	pCi/mL	79	HAA 12C	20	
K Area	Tetrachloroethylene	µg/L	17	KRP 9	5	Indian Grave Branch
	Trichloroethylene	µg/L	12.3	KRP 9	5	
	Tritium	pCi/mL	339	KRP 2	20	

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

Location	Major Contaminant	Units	2013 Maximum Concentration	Well	Drinking Water Standard	Likely Discharge Point
L Area	Tetrachloroethylene	µg/L	59	LSW 25DL	5	L-Lake
	Trichloroethylene	µg/L	6.9	LAC 8DL	5	
	Tritium	pCi/mL	557	LSW 25DL	20	
P Area	Trichloroethylene	µg/L	NA	NA	5	No samples collected during 2013
	Tritium	pCi/mL	NA	NA	20	
R Area	Trichloroethylene	µg/L	12	RAG008DL	5	Mill Creek in Northwest; Tributaries of PAR Pond
	Tritium	pCi/mL	1,090	RPS004C	20	
	Strontium-90	pCi/L	213	RSE 10	8	
Sanitary Landfill	1,4-Dioxane	µg/L	301	LFW 62C	6.1	Upper Three Runs
	Trichloroethylene	µg/L	5.34	LFW 59C	5	
	Vinyl Chloride	µg/L	9.67	LFW 61C	2	
TNX	Trichloroethylene	µg/L	172	TBG 3	5	Savannah River Swamp
Z-Area	Technetium-99	pCi/L	84.2	ZBG 2	4 mrem/yr[a]	Upper Three Runs
	Nonvolatile Beta	pCi/L	68	ZBG 2	4 mrem/yr[a]	

[a] The activity (pCi/L or pCi/mL) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample

Note: MWMF is the Mixed Waste Management Facility; HWMF is the Hazardous Waste Management Facility; TNX is the 678-T facilities.

Table 7-2 Major Contaminants of Concern and Their Significance

Constituents	Sources	Significance
Radium-226, 228	Dominant radioactive isotopes detected in natural waters. Radium-226 (an alpha particle emitter) is a disintegration product of uranium-238, and radium-228 (a beta particle emitter) is a disintegration product of thorium-232.	Radium-226 plus 228 has a primary standard of 5 pCi/L. Radium is deposited in the bones. Excessive levels of radium in water may cause bone and bone marrow cancers in humans.
Gross Alpha	Alpha radiation is the emission of positively charged particles from the disintegration (radioactive decay) of certain elements such as uranium, thorium, and radium, among others. Alpha radiation in drinking water can be in the form of dissolved minerals, or in the case of radon, as a gas.	Gross alpha has a primary drinking water standard of 15 pCi/L. Cannot penetrate a piece of paper or human skin, but is very dangerous when ingested or inhaled. The amount of potential damage to organ tissues depends upon how long the tissues were exposed and the dosage of radiation.
Tritium	Radioactive isotope of hydrogen with a half-life of 12.3 years. It emits a very weak beta particle and behaves like water.	Tritium has a MCL of 20 pCi/mL. It primarily enters the body when people swallow tritiated water. Causes increased risk of cancer.
TCE/PCE	Volatile organic compound used primarily to remove grease from fabricated metal parts.	TCE/PCE has an MCL of 5 µg/L. Causes increased risk of cancer.
Vinyl Chloride	Volatile organic compound; degradation product of TCE/PCE.	Vinyl chloride has an MCL of 2 µg/L. Causes increased risk of cancer.
Nonvolatile Beta	Beta decay commonly occurs among neutron-rich fission byproducts produced in nuclear reactors**.**	MCL for beta particles is 4 mrem/yr. Causes increased risk of cancer.

MONITORING GROUNDWATER IN GEORGIA

Since the early 1990s, SRS has directed considerable effort at assessing the likelihood of flow beneath the Savannah River from South Carolina to Georgia. A groundwater model developed by the U.S. Geological Survey (USGS) indicates there is no mechanism by which groundwater could flow under the Savannah River and contaminate Georgia wells (Cherry 2006). SRS continues to monitor for tritium in groundwater wells in Georgia (Figure 7-4). Samples are collected on an annual basis during the third quarter of the year (Data Table 7-1). Detections of tritium in groundwater in these offsite wells have been below 1.5 pCi/mL, which is below the tritium MCL of 20 pCi/mL, since 1999 (Figure 7-5). The MCL, or drinking water standard, for tritium is 20 pCi/mL. Tritium concentrations of 1 pCi/mL or less are consistent with aquifer recharge from rainfall in the Central Savannah River Area. The overall trend of the data continues to show a gradual decline in levels of tritium in the groundwater samples collected in Georgia.

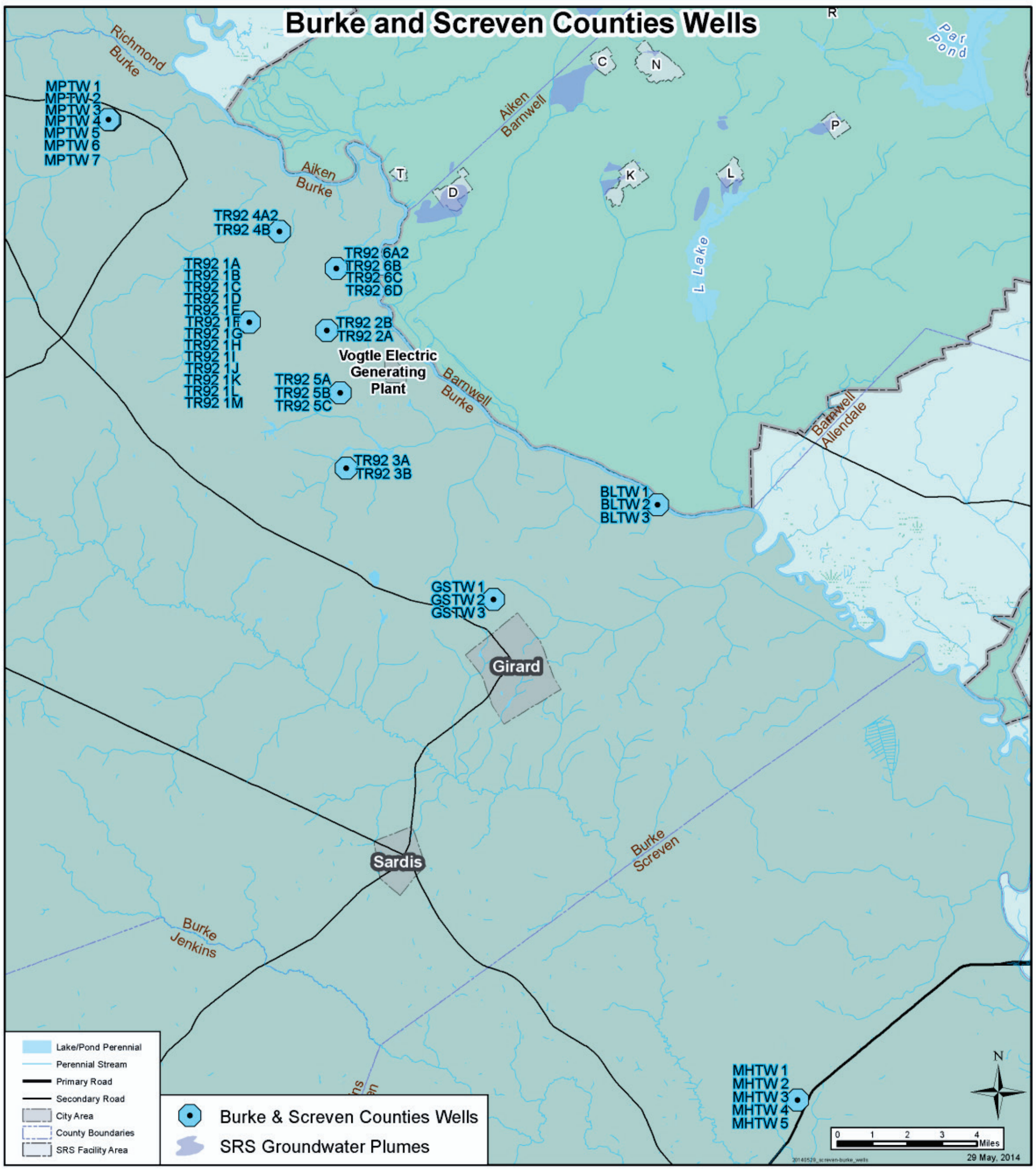


Figure 7-4 Location of Tritium Wells Sampled in Burke and Screven Counties, Georgia

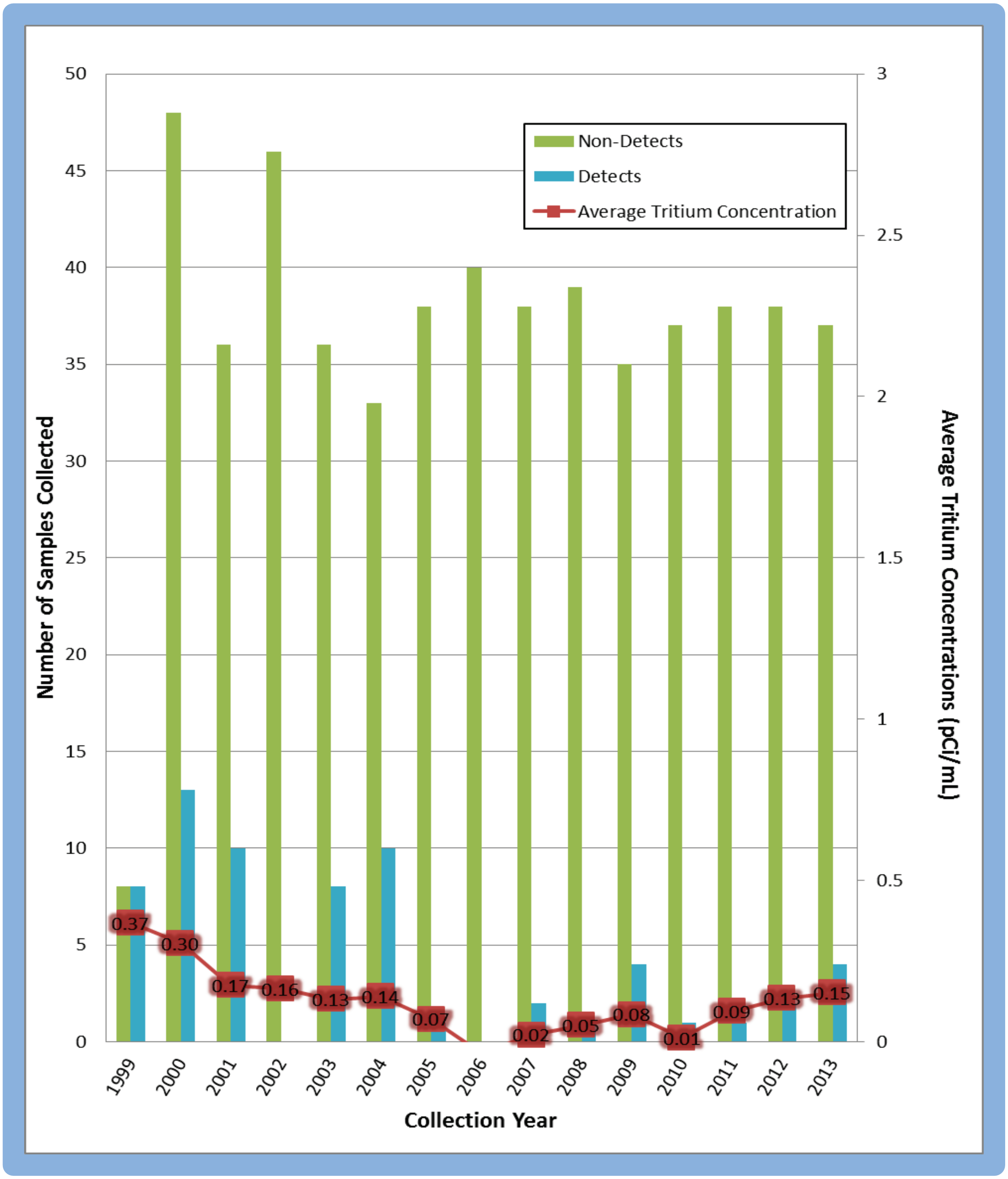


Figure 7-5 Results of Tritium Concentration in Wells Sampled in Burke and Screven Counties, Georgia

SRS collected groundwater samples from 40 of the 44 offsite wells during 2013. Three wells were not sampled because they were dry (i.e., no water available); and one well could not be sampled due to damage to the well casing. Of the 40 samples collected in 2013, 36 had no detectable concentrations of tritium. Tritium was detected in four samples, at concentrations below 1 pCi/mL (0.61, 0.431, 0.349, and 0.344 pCi/mL), which is below the MCL of 20 pCi/mL for tritium.

USING AND CONSERVING SRS GROUNDWATER

SRS manages its own drinking and process water supply from groundwater located beneath the SRS. No contaminated water is used in the SRS water systems. Approximately 40 production wells in widely scattered locations across the Site supply SRS domestic and process water systems; eight of these wells supply the primary drinking water. A map of the SRS domestic water system can be found in the "Environmental Data/Maps - 2013" folder for the SRS Environmental Report for 2013 on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

The production wells 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 SCDHEC. Since that time, SRS water usage has dropped from 10.8 million gallons per day, during 1983-1986, to 2.56 million gallons per day in 2013. The consolidation of the SRS domestic water systems, completed in 1997, accounts for the majority of this decrease in water usage. You will find other examples of water conservation in Chapter 2, "Environmental Management System." The D-Area domestic water system was shutdown in April 2013 with the closure of the D-Area coal-fired powerhouse. The A-Area domestic water system now supplies treated water to most Site areas. The 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. Remote facilities, such as field laboratories, barricades, and pump houses, utilize small drinking water systems and bottled water. The SRS domestic water systems meet state and federal drinking water quality standards. SCDHEC samples the systems quarterly for chemical analyses. Monitoring of the A-Area water system for bacteriological analyses occurs monthly. SCDHEC performs sanitary surveys every two years on the A-Area system and inspects the smaller systems every three years. All 2013 water samples were in compliance with SCDHEC and EPA water quality standards.

The process water systems are located in A, F, H, and S Areas and meet the SRS 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. Process water wells ranging in capacity from 100 to 1,500 gallons per minute supply water to these systems. In K Area, L Area, and Z Areas, the domestic water system supplies the process water system. 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.

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QUALITY ASSURANCE Chapter 8

Karen Vangelas, Lori Coward, Teresa Eddy
Robert Kemmerlin, Ted Millings
Savannah River Nuclear Solutions, LLC

Sherrod Maxwell
Savannah River National Laboratory

The Quality Assurance (QA)/Quality Control (QC) program at the Savannah River Site (SRS) ensures that environmental data accurately represent SRS discharges and the surrounding environment. It is important to ensure that sample results are accurate so that SRS can assess with confidence the impacts SRS activities may have on human health and the environment.

The environmental monitoring QA/QC program is a process designed to continuously improve the methods and techniques used to collect and analyze the environmental data that are the basis for this annual report and to prevent errors in the generation of those data. The QA/QC program is comprised of continuous assessment activities, precision checks, and accuracy checks, as shown in Figure 8-1. The results of activities in one area provide input to assessments or checks conducted in the other two areas in an ongoing process resulting in quality data. By combining continuous assessment of field, laboratory, and data management performance with checks for accuracy and precision, SRS ensures that all monitoring and surveillance data are within acceptable ranges. The glossary contains definitions for each term presented in Figure 8-1.

Chapter 8 presents a summary of improvements identified through QA activities and a summary of performance identified through QC activities conducted to monitor the performance of the sampling activities and the analytical laboratories that support the environmental monitoring program. Some elements of the QA/QC program are inherent within the environmental monitoring standard procedures and practices. Those elements are assessed as part of the continuous assessment process. They are audited as part of the Department of Energy Consolidated Audit Program (DOECAP). Those elements of Figure 8-1 discussed in this chapter are highlighted in bold text.

Chapter 8 - Key Terms

Quality assurance *is an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure quality in the processes by which products are developed. The goal of QA is to improve processes so that defects do not arise when the product is produced. It is proactive.*

Quality control *is a set of activities for ensuring quality in products by identifying defects in the actual products. The goal of QC is to identify and correct defects in the finished product before it is made available to the customer. QC is a reactive process.*

Stated another way, Quality Assurance makes sure you are doing the right things, the right way. Quality Control makes sure the results of what you have done are what you expected.

Data from the Ameresco biomass plants are not included in the Annual Environmental Report because the facilities operate under environmental permits issued directly to Ameresco by the South Carolina Department of Health and Environmental Control (SCDHEC).

The data tables identified in this chapter are located in the "SRS Environmental Data/Maps" folder for the *SRS Environmental Report for 2013* on the SRS webpage located at http://www.srs.gov/general/pubs/ERsum/index.html.

BACKGROUND

DOE Order 414.1D, "Quality Assurance," requires an integrated system of management activities to ensure that the results of the environmental monitoring program meet the requirements of federal and state regulations and DOE Order 458.1, "Radiation Protection of the Public and the Environment." SRS uses field and laboratory procedures to guide activities such as sample collection, laboratory analysis, data evaluation, and reporting. SRS uses an integrated testing system to ensure the integrity of analyses performed by SRS and offsite laboratories. In addition, SRS uses QA and QC procedures to verify and control environmental monitoring activities to ensure the resulting data provide a representative evaluation of SRS operational impacts on the health and safety of the public, workers, and the environment.

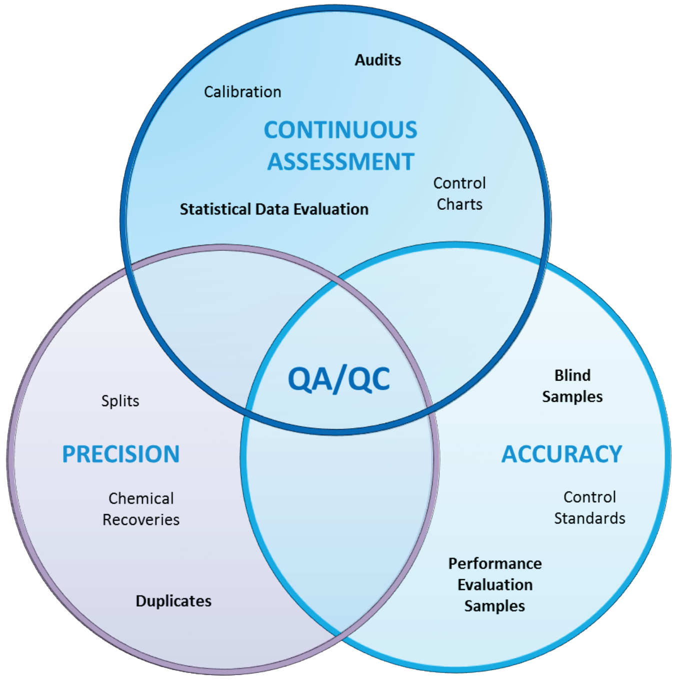

Figure 8-1 Interrelationship of QA/QC Activities

QUALITY ASSURANCE PROGRAM SUMMARY

The environmental monitoring QA/QC program focuses on minimizing errors through ongoing assessment and control of the program components. The QA and QC activities are interdependent. For example, QC detects an ongoing problem with the quality of the product and provides feedback to QA personnel that there is a problem in the process. QA determines the root cause of the problem and changes the process to eliminate the problem and improve product quality.

QA activities focus on the processes implemented to produce the data presented in this report. In 2013, QA activities associated with the environmental monitoring program that resulted in program improvements were:

- Monitoring and reporting changes,
- Evaluating the impacts of changes in regulatory requirements, and
- Auditing of laboratories supporting SRS environmental monitoring through participation in DOECAP.

QC activities are those tests and checks that ensure compliance with defined standards. In 2013, these QC activities associated with the environmental monitoring program included:

- Participation in the Mixed Analyte Performance Evaluation Program (MAPEP) by laboratories used by SRS,
- Participation in laboratory proficiency testing for laboratories performing National Pollutant Discharge Elimination System (NPDES) analyses, and
- Collection and analysis of QC samples (duplicates and blind samples) associated with field sampling activities.

These programs and activities are described on the following pages.

ENVIRONMENTAL MONITORING PROGRAM QA ACTIVITIES

In 2013, SRS initiated data quality improvements replacing pencil and paper with handheld tablets, as shown in Figure 8-2, for collection of environmental field data (e.g. stream-flow measurements in streams; soil, groundwater, and air samples). The use of hand held devices has allowed SRS to electronically implement the sampling processes and minimize field input errors. The handheld devices provide field technicians the ability to print bottle labels and chains of custody in the field and the ability to directly compare current data to historical data and provide QC set points and limits. The immediate feedback allows the technical team to respond to unexpected conditions in the field. The transition to handheld tablets improves the data integrity and overall quality of the SRS environmental monitoring program by improving the process by which data is recorded and reported.

An important aspect of the QA program is to use laboratories certified by the SCDHEC Office of Laboratory Certification for those environmental monitoring program parameters that are reportable to SCDHEC. The SRS onsite laboratories and offsite subcontract laboratories are certified by SCDHEC for a large variety of environmental analyses. In May 2012, the Environmental Protection Agency (EPA) issued a final rule to require new and revised analytical methods for the analysis of wastewater, referred to as the "Methods Update Rule II." This rule affects laboratories certified to perform wastewater NPDES analyses under the Clean Water Act. SRS reports NPDES data as part of the effluent monitoring program described in Chapter 4, "Effluent Monitoring." SRS implemented the revised methods in 2013, as prescribed by the schedule issued by SCDHEC, and received amended certificates for the affected onsite laboratories. Compliance with the Methods Update Rule II enables the laboratories to maintain their certification to perform NPDES analyses.

Figure 8-2 Technician Inputs Field Data into the Handheld Device

The DOECAP is a comprehensive audit program for contract and subcontract laboratories with the intent of conducting consolidated audits to eliminate redundant audits previously conducted independently by DOE field sites and to achieve standardization in audit methodology, processes, and procedures. DOECAP performs an audit of each subcontract laboratory annually to ensure the laboratories demonstrate technical capability and proficiency and compliance with DOE QA program requirements. The audit evaluates laboratory performance including sample receipt, instrument calibration, analytical procedures, data verification, data reports, records management, nonconformance and corrective actions, preventive maintenance and sample disposal. Within these topic areas, the proper use of control charts, control standards, chemical recoveries, performance evaluation samples, blind samples, duplicates, and splits are reviewed and assessed. In 2013, DOECAP conducted audits at three SRS subcontract laboratories, resulting in no findings of sufficient magnitude to render the audited facility unacceptable to provide service to DOE (Priority I findings) and 20 findings related to deficiencies in procedures, practices, or non-requirement-based issues (Priority II findings). An example of a Priority II finding is that storage area inspections are not documented in accordance with requirements. Definitions of Priority I and II findings are provided in the glossary. The findings for 2013 are distributed evenly among the SRS subcontract laboratories. Each affected laboratory submitted corrective action responses to DOECAP. The findings and corrective actions will be reviewed during the next annual laboratory audit (scheduled for 2014). Additionally during the 2013 audit, the laboratories submitted corrective action responses that addressed each finding identified during 2012, thereby closing 18 of the 22 Priority II findings. There were no Priority I findings in 2012.

ENVIRONMENTAL MONITORING PROGRAM QC ACTIVITIES

QC Sampling

SRS personnel collect several types of QC samples periodically throughout the year, including blinds and field duplicates, to evaluate the source of any measurement error. SRS personnel routinely conduct blind sample analyses for field measurements of pH to assess the quality and reliability of field data measurements. All of the 2013 blind sample analyses were within the acceptable limit of less than a 0.4 pH unit difference between the original and blind samples. A blind sample is a sample with a composition known to the submitter, but not to the analyst. It is used to test the analyst's proficiency in performing the analysis. Data Table 8-1 contains the results of the blind pH samples.

The results of SRS onsite and subcontract laboratory blind and duplicate sample analyses associated with the NPDES program, as summarized in Table 8-1, indicate that although there were some differences, there were no consistent problems with the laboratory sample analyses during 2013. Data Tables 8-2 and 8-3 contain the field blind and duplicate sample program results.

SRS's water quality program requires checks of 10% of the samples to verify analytical results. SRS onsite and subcontract laboratories continued to analyze duplicate samples from SRS streams and the Savannah River in 2013, as summarized in Table 8-1. Though results for the water quality field duplicate sampling program indicate there were some differences between duplicates, there was no impact on conclusions made with the data. Data Table 8-4 contains detailed SRS stream and Savannah River field duplicate sample results.

Table 8-1 Summary of Laboratory Blind and Duplicate Sample Analyses

Program and Sample Type	Number of Samples Analyzed	Number of Samples with Difference > 20%
NPDES Blind	71	1
NPDES Duplicate	81	1
Water Quality River/Stream Duplicate	585	37

Laboratory Proficiency Testing

SRS laboratories performing NPDES analyses maintained state certification for all analyses after achieving acceptable results in SCDHEC-required proficiency testing. Proficiency testing is also known as comparative testing and is an evaluation of a laboratory's performance against pre-established criteria by means of inter-laboratory comparisons. The proficiency testing is required per state regulation 61-81 "State Environmental Laboratory Certification Program." All laboratories used proficiency testing providers accredited by the American Association of Laboratory Accreditation. During 2013, the subcontract laboratories participated in various water pollution performance evaluation studies. The onsite and subcontract laboratories reported acceptable proficiency testing results for an average 97.7% and 98.5% of the parameters tested, respectively; therefore, maintaining SCDHEC certification for all analyses.

All laboratories that perform environmental analytical measurements in support of the DOE Environmental Management activities are required to participate in MAPEP. SRS laboratories continued to participate in MAPEP, a laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE. MAPEP performance evaluation (PE) samples, as shown in Figure 8-3, include water, soil, air filter, and vegetation matrices all with environmentally important stable inorganic, organic, and radioactive constituents. MAPEP offered two separate studies in 2013. The Savannah River National Laboratory (SRNL) Environmental Laboratory participated in both studies with 100% acceptable results for all four matrices for MAPEP 28 and 98.8% for MAPEP 29. MAPEP results for SRS subcontract laboratories were also satisfactory, with an average percent of passing parameters of 99.3% for water matrix, 97.8% for soil matrix, and 81.5% for vegetation matrix. The laboratories evaluate the cause of the failed analyses and develop corrective actions to prevent a recurrence.

Figure 8-3 MAPEP Performance Evaluation Samples in Various Media

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APPENDIX A

RADIONUCLIDE NOMENCLATURE

Nomenclature and Half-Life for Radionuclides					
Radionuclide	**Symbol**	**Half-life[a,b]**	**Radionuclide**	**Symbol**	**Half-life[a,b]**
Actinium-228	Ac-228	6.15 h	Iodine-129	I-129	1.57×10^{7} y
Americium-241	Am-241	432.7 y	Iodine-131	I-131	8.023 d
Americium-243	Am-243	7.37×10^{3} 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	27 m
Barium-133	Ba-133	10.538 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	2.14×10^{6} y
Bismuth-214	Bi-214	19.9 m	Neptunium-239	Np-239	2.356 d
Carbon-14	C-14	5,715 y	Nickel-59	Ni-59	7.6×10^{4} 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	2.0×10^{4} 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	2.410×10^{4} y
Cobalt-57	Co-57	271.8 d	Plutonium-240	Pu-240	6.56×10^{3} y
Cobalt-58	Co-58	70.88 d	Plutonium-241	Pu-241	14.29 y
Cobalt-60	Co-60	5.271 y	Plutonium-242	Pu-242	3.75×10^{5} y
Curium-242	Cm-242	162.8 d	Potassium-40	K-40	1.25×10^{9} y
Curium-244	Cm-244	18.1 y	Praseodymium-144	Pr-144	17.28 m
Curium-245	Cm-245	8.5×10^{3} y	Praseodymium-144m	Pr-144m	7.2 m
Curium-246	Cm-246	4.77×10^{3} y	Promethium-147	Pm-147	2.6234 y
Europium-152	Eu-152	13.54 y	Protactinium-231	Pa-231	3.28×10^{4} y
Europium-154	Eu-154	8.60 y	Protactinium-233	Pa-233	26.967 d
Europium-155	Eu-155	4.75 y	Protactium-234	Pa-234	6.69 h

[a] m = minute; h = hour; d = day; y = year
[b] Reference: Chart of the Nuclides, 17th edition, revised 2010, Lockheed Martin Company

Nomenclature and Half-Life for Radionuclides (Continued)					
Radionuclide	**Symbol**	**Half-life[a,b]**	**Radionuclide**	**Symbol**	**Half-life[a,b]**
Radium-226	Ra-226	1,599 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	$2.3x10^{5}$ y
Ruthenium-106	Ru-106	1.017 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	$2.95x10^{5}$ y	Uranium-233	U-233	$1.592x10^{5}$ y
Sodium-22	Na-22	2.604 y	Uranium-234	U-234	$2.46x10^{5}$ y
Strontium-89	Sr-89	50.61 d	Uranium-235	U-235	$7.04x10^{8}$ y
Strontium-90	Sr-90	28.8 y	Uranium-236	U-236	$2.342x10^{7}$ y
Technetium-99	Tc-99	$2.13x10^{5}$ y	Uranium-238	U-238	$4.468x10^{9}$ 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	244.0 d
Thorium-230	Th-230	$7.56x10^{4}$ y	Zirconium-85	Zr-85	7.9 m
Thorium-232	Th-232	$1.40x10^{10}$ y	Zirconium-95	Zr-95	64.02 d

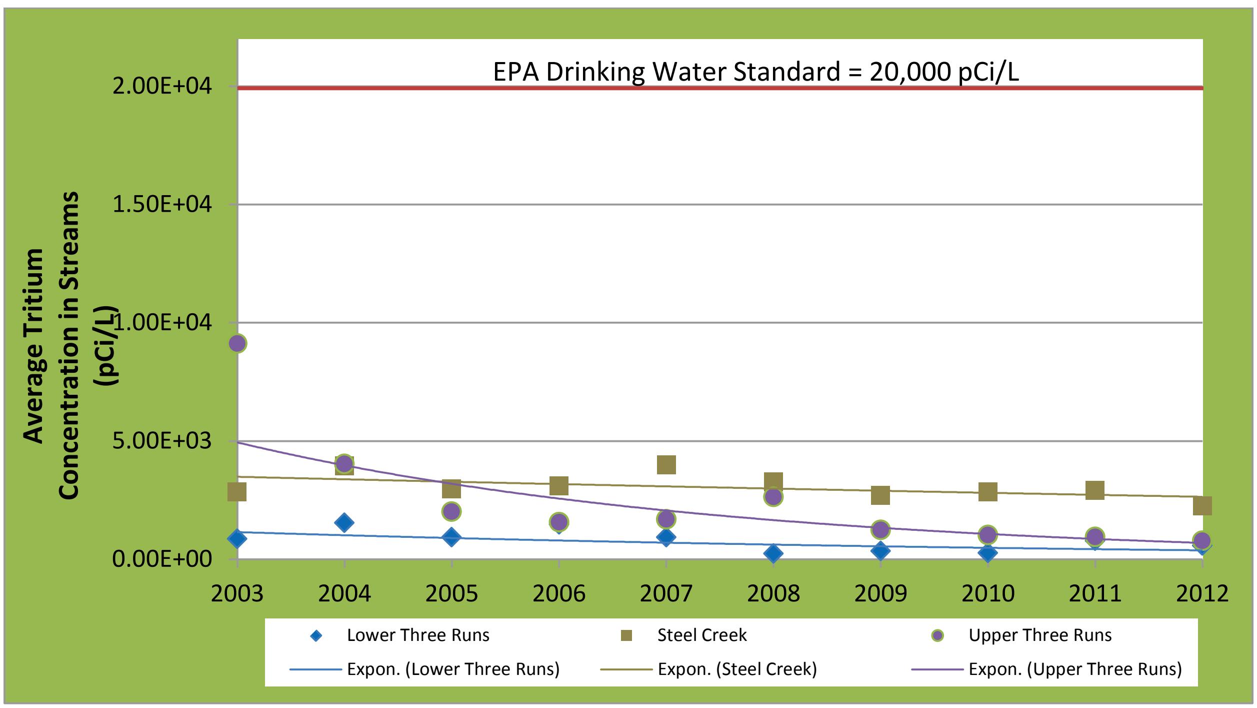
[a] m = minute; h = hour; d = day; y = year
[b] Reference: Chart of the Nuclides, 17th edition, revised 2010, Lockheed Martin Company

APPENDIX B
ERRATA

The following entries correct information that was reported inaccurately in the *Savannah River Site Environmental Report for 2012 (SRNS-STI-2013-00024):*

Chapter 5 results summary for water quality on page 5-30 incorrectly stated that endosulfan II was detected. No sample results for water quality showed detectable levels of pesticides or herbicides.

Figure 5-7 presented in Chapter 5 on page 5-13 depicts the drinking water standard line at 2,000 pCi/L which should have been 20,000 pCi/L. A revised graph is provided below.



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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.

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.

Area Completion Program – 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.

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.

Audit – A systematic evaluation to determine the conformance to quantitative specifications of some operational function or activity.

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 – A second sample taken from the same well at the same time as the primary sample and assigned an alias well name, as a quality control check.

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.

chemical recovery – That portion of an analyte, or surrogate, added to a sample that is recovered by testing.

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 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.

continuous assessment – Evaluation of a program or employee carried out on a fixed interval (e.g. weekly, monthly, annually)

control chart – A graph of some measurement plotted over time or sequence of sampling, together with control limit(s) and, usually, a central lime and warning limit(s). Control charts provide a graphical representation of accuracy and precision, a long-term mechanism for self-evaluation of analytical data, and an assessment of analytical capability of the laboratory analyst.

control standard – A standard prepared independently of and run with the calibration. It is used to verify the accuracy of the calibration.

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 dioxide, nitrogen oxides, and lead. The Environmental Protection Agency is required by the Clean Air Act to set National Ambient Air Quality Standards for these six pollutants.

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

- **kilocurie (kCi)** – 10^{3} Ci, one thousand curies; 3.7 x 10^{13} disintegrations per second.
- **millicurie (mCi)** – 10^{-3} Ci, one-thousandth of a curie; 3.7 x 10^{7} disintegrations per second.
- **microcurie (µCi)** – 10^{-6} Ci, one-millionth of a curie; 3.7 x 10^{4} disintegrations per second.
- **picocurie (pCi)** – 10^{-12} Ci, one-trillionth of a curie; 0.037 disintegrations per second.

D

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

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

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 standard – 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). The guides for radionuclides in air and water are given in U.S. Department of Energy Derived Concentration Technical Standard (DOE-STD-1196-2011).

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.

direct push – A direct-push machine pushes tools and sensors into the ground without the use of drilling to remove soil.

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

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

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

DOECAP – A comprehensive audit program for contract laboratories with the intent of conducting consolidated audits to eliminate redundant audits previously conducted independently by DOE field element sites and to achieve standardization in audit methodology, processes, and procedures.

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).
- **equivalent dose** – Product of the absorbed dose (rad) in tissue and a radiation weighting factor. Equivalent dose is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).
- **effective dose** – Sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate tissue weighting factor.
- **committed effective dose** – Is the effective dose integrated over time, usually 50-years. Committed effective dose is expressed in units of rem (or sievert).
- **collective dose** – Sum of the effective dose of all individuals in an exposed population within a 50-mile (80-km) radius, and expressed in units of person-rem (or person-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 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 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 Environmental Protection Agency and the South Carolina Department of Health and Environmental Control that denotes a report value is more than the 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).

groundwater – Water found underground in cracks and spaces in soil, sand, and rocks.

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.

hazardous waste – Any waste which is a toxic, corrosive, reactive, or ignitable material that could affect human health or the environment.

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 analyte-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.

low level waste – Waste that includes protective clothing, tools, and equipment that have become contaminated with small amounts of radioactive material.

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.

manmade radiation – Radiation from sources such as consumer products, medical procedures, and nuclear industry.

MAPEP – A laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE.

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 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.

mixed waste – Waste that has both hazardous and radioactive components.

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.

performance evaluation (PE) sample – A sample, the composition of which is unknown to the analytical, that is provided to test whether the analyst/laboratory can produce analytical results within specified performance limits.

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 water originating at a waste source (e.g., a hazardous waste disposal site). It extends downward and outward from the waste source.

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.

precision – A estimate of the degree to which a set of observations or measurements of the property, usually obtained under similar conditions agree. It is a data quality indicator.

Priority I finding – Documents a deficiency that is of sufficient magnitude to render the audited facility unacceptable to provide the affected service to DOE.

Priority II finding – Documents a deficiency that is not of sufficient magnitude to render the audited facility unacceptable to provide services to DOE.

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

proficiency testing – An evaluation of a laboratory's performance against pre-established criteria by means on inter-laboratory comparison. It is also known as comparative testing.

purge – To remove water prior to sampling, generally by pumping or bailing.

Q

quality assurance (QA) – An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure quality in the processes by which products are developed.

quality control (QC) – A set of activities for ensuring quality in products by identifying defects in the actual products.

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.

reference person – A hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus for the purpose of standardizing radiation dose calculations.

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 times 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 sites contaminated with waste due to historical activities.

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.

Representative Person – An individual receiving a dose that is representative of the more highly exposed individuals in the population.

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.

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.

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.

splits or split sample – Two or more representative portions taken from a single sample and analyzed by different analysts or laboratories. Split samples are used to replicate the measurement of the parameters 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.

statistical data evaluation – A collection of methods used to process large amounts of data and report overall trends.

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 – Water that has not penetrated below the surface of the ground.

T

tank farm – Installation of interconnected underground tanks for storage of high-level radioactive liquid wastes.

temperature – Thermal state of a body, considered with its ability to communicate heat to other bodies.

terrestrial – Living or growing on the land.

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., cesium-137 and strontium-90) radionuclides from the measured gross alpha and beta values, respectively.

utility water – Once-through non-contact cooling water, recirculated non-contact cooling water, boiler blowdown, steam condensate, air conditioning condensate, and other uncontaminated heating, ventilation and air conditioning or compressor condensates.

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 – A particular area that is or may be posing a threat to human health or the environment. Waste units range in size from a few square feet to tens of acres and include basins, pits, piles, burial grounds, landfills, tank farms, disposal facilities, process facilities, and groundwater contamination.

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, swamp, bog, Carolina bay, floodplain bottom, where land is covered by shallow water at least part of the year and is characterized by somewhat mucky soil.

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	***Radioactivity***	
ft	foot	Ci	curie
in	inch	cpm	counts per minute
km	kilometer	mCi	millicurie
m	meter	μCi	microcurie
mm	millimeter	pCi	picocurie
μm	micrometer	Bq	becquerel
Mass		***Radiation Dose***	
g	gram	mrad	millirad
kg	kilogram	mrem	millirem
mg	milligram	Sv	sievert
μg	microgram	mSv	millisievert
Area		μSv	microsievert
mi^2	square mile	R	roentgen
ft^2	square foot	mR	milliroentgen
Volume		μR	microroentgen
gal	gallon	Gy	gray
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	***Systeme 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	0.945	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)

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