SRNS-RP-2022-00001

2021

SAVANNAH RIVER SITE

Environmental Report

The cover of the *2021 SRS Environmental Report* features photographs by two Savannah River Site employees and a member of the community.

The photograph of the Carolina bay was taken by Aiken resident Mark Hudson. The photograph of the Augusta Canal, taken by Battelle Savannah River Alliance's Charles Crawford, and the hummingbird, taken by Savannah River Nuclear Solutions' Ross Fanning, were entries to the Snap SRS photography contest, which is open to Site employees.

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or go to the SRS Environmental Report webpage at
http://www.srs.gov/general/pubs/ERsum/index.html
and under the SRS Environmental Report 2021, complete the electronic Customer Satisfaction Survey.

SRNS-RP-2022-00001

Savannah River Site

Environmental Report 2021

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Acknowledgements

Environmental Compliance and Area Completion Projects within the Savannah River Nuclear Solutions, LLC (SRNS), produces this document. Savannah River Site (SRS) acknowledges with deep appreciation the efforts of the following individuals, who provided valuable resources, information, technical data, or management, administrative, field, or other support for the *SRS Site Environmental Report 2021* (contributors are with SRNS unless otherwise noted):

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Kane Bice
Kerri Crawford
Greta Fanning
Jason Hyer
Joyce Hopperton, Centerra-SRS
Natalia Johnson
Bill Lewis
Michael Lott
Lisa McCullough
Grace Miller
Winston Moore
Cap Nguyen
Julie Pica
Jesse Pierce
Angela Pizzino
Shane Shull
Mark Spires
Kristie Steelman
Rebecca Sturdivant
Elizabeth Wooten
Cindy Zilensky

Special thanks to University of Georgia's Savannah River Ecology Laboratory, its contributions; and to Josef Orosz and Tal Mims, of the U.S. Department of Agriculture Forest Service-Savannah River, for providing support material and photographs. Special thanks to Catherine Thomas, North Wind, for providing technical editing of this report. Her talent and diligence bring clarity to technical and complicated topics.

Thanks to Rachel Baker, Jeff Bussey, and Robert Seremak for providing computer hardware and software support. Thanks to Daniel Campbell for reviewing and approving the release of this document and all supporting documents. Marvin Stewart is acknowledged with appreciation for providing Internet expertise and computer software support.

Appreciation is extended to the *SRS Environmental Report* Team members, who, individually and as a group, dedicated a large portion of their time and attention to seeking out, collecting, and confirming the information that went into this report.

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To Our Readers

Highlights

The U.S. Department of Energy (DOE) Order 231.1B (Environment, Safety, and Health Reporting) requires Annual Site Environmental Reports (ASERs) to assess field environmental program performance, sitewide environmental monitoring and surveillance effectiveness, and to confirm sites are complying with environmental standards and requirements.

ASERs are prepared in a manner that addresses likely public concerns and to solicit feedback from the public and other stakeholders. The Savannah River Site (SRS) began publishing ASERs in 1959.

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

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

The *SRS Environmental Report 2021* is an overview of environmental management activities conducted on and in the vicinity of SRS from January 1 through December 31, 2021. This report includes the following:

- A summary of implemented environmental management systems that facilitate sound stewardship practices and demonstrate compliance with applicable environmental regulations and laws intended to protect air, water, land, and other natural and cultural resources that SRS operations have impacted.
- A summary of the results of nonradiological parameters. These results are compared to permit limits and applicable standards.
- A summary of the results of effluent monitoring and environmental surveillance of air, water, soil, vegetation, biota, and agricultural products to determine radioactivity in these media. SRS compares the results with historical data and background measurements, and to applicable standards and requirements to verify that SRS does not adversely impact the environment or the health of humans or biota.
- A discussion of the potential doses to members of the public from radioactive releases from SRS operations compared to applicable standards and regulations, and from special-case exposure scenarios.
- An explanation of the quality assurance and quality control program, which ensures that samples and data SRS collects and analyzes are reported with utmost confidence.

The report addresses three general levels of reader interest:

1) The first is a brief summary with a "take-home" conclusion. This is presented in the "Highlights" text box at the beginning of each chapter. There are no technical tables, figures, or graphs in the "Highlights."

2) The second level is a more in-depth discussion with figures, summary tables, and summary graphs accompanying the text. The chapters of the annual report represent this level, which requires some familiarity with scientific data and graphs.

3) The third level includes links to supplemental and technical reports and websites that support the annual report. The links to these reports may be found in the chapters or on the *SRS Environmental Report* 2021 webpage. Many of the reports mentioned in Chapter 3, *Compliance Summary*, are submitted to meet compliance requirements and are not available on the *SRS Environmental Report* 2021 webpage or through direct links. These reports may be obtained through a Freedom of Information Act request.

When a regulation or DOE Order requires reporting on a fiscal year (FY) basis, the information in this report is reported by FY. This allows for consistency with existing documentation. FY reporting is typically found in Chapter 2, *Environmental Management System*, and Chapter 3, *Compliance Summary*.

The *SRS Environmental Report* webpage contains reports from multiple years with the 2021 report being the latest. The report folders feature:

- The full report with hyperlinks to supplemental information or reports
- Maps with environmental sampling locations for the various media samples. These figures are identified as "Maps Figure" within the text of the report
- Annual reports from SRS organizations

Savannah River Nuclear Solutions, LLC (SRNS) develops this report as the management and operations contractor to the DOE at SRS. In addition to SRNS, the contributors to the annual report include the U.S. Department of Energy, the Savannah River Operations Office (DOE-SR); Savannah River Remediation (SRR); Parsons Government Services, Inc.; Centerra-SRS; Ameresco Federal Solutions; the Savannah River Ecology Laboratory (SREL); and the United States Forest Service-Savannah River (USFS-SR).

The photographs in this report and the accompanying Summary were taken both before the COVID-19 pandemic and in the months of 2021 when the virus was active in the United States. In many of the photographs throughout these two documents, you will see SRS workers distancing themselves from others, wearing masks, or doing both to protect against the spread of COVID-19. When masks and distancing are taking place, employees followed SRS guidelines from the Centers for Disease Control and Prevention, South Carolina Department of Health and Environmental Control, Georgia Department of Public Health, and the U.S. Department of Energy. If a photograph shows a worker interacting within 6 feet of another worker or not wearing a mask, they are following the appropriate safety protocol for the COVID-19 pandemic at the time the photograph was taken.

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Acronyms and Abbreviations

A

ACP	Area Completion Projects
AIM	American Innovation and Manufacturing
AIP	Agreement in Principle
ALARA	As Low As Reasonably Achievable
ARP/MCU	Actinide Removal Process and Modular Caustic Side Solvent Extraction Unit
ASER	Annual Site Environmental Report
ATTA	Advanced Tactical Training Academy

B

BJWSA	Beaufort-Jasper Water & Sewer Authority
BLLDF	Barnwell Low-Level Disposal Facility
BSRA	Battelle Savannah River Alliance
BWRE	Bulk Waste Removal Efforts

C

$CaCO_3$	Calcium Carbonate
C&D	Construction and Demolition
CA	Composite Analysis
CAA	Clean Air Act
CEC	Contaminant of Emerging Concern
CEI	Compliance Evaluation Inspection
CEPLT	Comprehensive Environmental Permits Linking Tool
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations

CMP	Chemicals, Metals, and Pesticides
COC	Contaminant of Concern
COVID-19	Coronavirus Disease 2019
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year

D

DCS	Derived Concentration Standard
DL	Detection Limit
DoD	United States Department of Defense
DO	Dissolved Oxygen
DOE	United States Department of Energy
DOECAP	DOE Consolidated Audit Program
DOE-EM	United States Department of Energy-Environmental Management
DOE-HQ	United States Department of Energy-Headquarters
DOE-SR	United States Department of Energy-Savannah River Operations Office
DWPF	Defense Waste Processing Facility

E

ECA	Environmental Compliance Authority
ECHO	Enforcement and Compliance History Online
ECM	Energy Conservation Measure
E. coli	Esherichia coli
EDAM	Environmental Dose Assessment Manual
EEC	Environmental Evaluation Checklist

EFCOG	Energy Facilitators Contractors Group
EIS	Environmental Impact Statement
EISA	Energy Independence Security Act
EM	Environmental Management
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ESA	Endangered Species Act
ESOP	Environmental Surveillance Oversight Program
ESPC	Energy Saving Performance Contracting
ETP	Effluent Treatment Project
E-85	85% Ethanol, 15% Unleaded Gasoline

F

FCA	Fast Critical Assembly
FDB	Federal Diversion Box
FERC	Federal Energy Regulatory Commission
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Act
FGR	Federal Guidance Report
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FR	Federal Register
FRS	Facility Register Service
FY	Fiscal Year

G

GHG	Greenhouse Gas

H

HFC	Hydrofluorocarbons
HLW	High-Level Waste
HWMF	Hazardous Waste Management Facility
HVAC	Heating, Ventilation, and Air Conditioning

I

IAEA	International Atomic Energy Agency
I&D	Industrial and Domestic
ICRP	International Commission on Radiological Protection
ILA	Industrial, Landscaping, and Agricultural
IOU	Integrator Operable Unit
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization

L

LED	Light-Emitting Diode
LLW	Low-Level Waste
LTR	Lower Three Runs

M

MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Level
MCMEU	Mission-Critical Military End Use
MDC	Maximum Detected Concentration
MEI	Maximally Exposed Individual
mrem	Millirem
MW	Mixed Waste
MWMF	Mixed Waste Management Facility

N

NA-MRF	North Augusta, South Carolina Material Recovery Facility
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NNIPS	Non-native Invasive Plant Species
NNSA	National Nuclear Security Administration
NOAV	Notice of Alleged Violation
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
NWP	Nationwide Permit

O

ORPS	Occurrence Reporting and Processing System
OSLD	Optically Stimulated Luminescence Dosimeters
OU	Operable Unit

P

PA	Performance Assessment
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PFAS	Per- and Polyfluoroalkyl Substances
pH	Potential of Hydrogen
PRB	P-Area Permeable Reactive Barrier
PUE	Power-Usage Effectiveness
PVC	Polyvinyl Chloride

Q

QA	Quality Assurance
QC	Quality Control

R

RCRA	Resource Conservation and Recovery
RESRAD	RESidual RADioactivity
RICE	Reciprocating Internal Combustion Engine
RM	River Mile
ROD	Record of Decision

RPD	Relative Percent Difference
RQ	Reportable Quantity
RSL	Regional Screening Levels
RSV	Refinement Screening Values

S

SARA	Superfund Amendment and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SDWA	Safe Drinking Water Act
SEER	Seasonal Energy Efficiency Ratio
SME	Subject Matter Expert
SNAP	Significant New Alternatives Policy
SQL	Standard Quantification Limit
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
SRS	Savannah River Site
SRSCRO	Savannah River Site Community Reuse Organization
SRTE	Savannah River Tritium Enterprise
SSP	Site Sustainability Plan
SST	Solvent Storage Tanks
STP	Site Treatment Plan
SWDF	Solid Waste Disposal Facility

SWPF	Salt Waste Processing Facility
SWPPP	Stormwater Pollution Prevention Plan

T

TCCR	Tank Closure Cesium Removal
TCE	Trichloroethylene
TFF	Tritium Finishing Facility
TNX	678-T Facilities
TOC	Total Organic Carbon
TRI	Toxic Release Inventory
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facilities
TSS	Total Suspended Solids

U

UGA	University of Georgia
U.S.	United States
USACE	United States Army Corps of Engineers
USC	University of South Carolina
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFS-SR	United States Forest Service-Savannah River
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank

V

VEGP	Vogtle Electric Generating Plant
VOC	Volatile Organic Compound
VSDS	Visual Survey Data System

W

WIPP	Waste Isolation Pilot Plant
WSRC	Westinghouse Savannah River Company
WTP	Water Treatment Plant

Z

ZVI	Zero-valent Iron

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Sampling Location Information

Note: This section contains sampling location abbreviations used in the text and 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
MCQBR	McQueens Branch
MHTW	Burke and Screven Counties Wells (Georgia)
MPTW	Burke and Screven Counties Wells (Georgia)
MSB	SRS Boundary Wells
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 and 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, Georgia Welcome Center at Highway 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 160.5; Demier 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

Chapter 1: **Introduction**

The "Savannah River Site (SRS) Environmental Report" is the primary document that the U.S. Department of Energy (DOE) uses to inform the public of environmental performance and conditions at SRS. This report meets the requirements of DOE Order 231.1B, "Environment, Safety, and Health Reporting." The "SRS Environmental Report" is also the principal document that demonstrates how the Site complies with the requirements of DOE Order 458.1, "Radiation Protection of the Public and the Environment."

The "SRS Environmental Report" summarizes the Site's environmental information and data to achieve the following:

- *Highlight significant Site programs*
- *Report environmental occurrences and responses*
- *Describe SRS's compliance with environmental standards and requirements*
- *Describe SRS's Environmental Management System and sustainability performance*
- *Provide the results from monitoring material containing residual radioactivity before its release from SRS*

Chapter Background

This chapter presents the following:

- A brief history of SRS, along with a summary of its current missions
- Highlights of SRS organizations and their primary responsibilities
- Descriptions of the physical characteristics and attributes of the environment in and around SRS
- Updates of SRS's primary mission and annual programs

1.1 HISTORY

On November 28, 1950, President Harry S. Truman tasked the E. I. Du Pont de Nemours Company to design, build, and operate what was then to be known as the Savannah River Plant. The construction project relocated citizens, homes, and businesses from the six South Carolina towns that had existed on the land. By 1953, SRS began producing the basic materials used to create nuclear weapons for the nation's defense. The work performed during the Site's early days was key to the United States winning the Cold War. For the seven decades since the Site's beginning, SRS has been a leader within the DOE complex.

An *Overview of the Savannah River Site,* available on the SRS website, details much of the Site's history and accomplishments.

1.2 MISSION AND CURRENT OPERATION

The SRS mission is to safely and efficiently protect public health and the environment while supporting the nation's nuclear deterrent programs and transforming the Site for future use. The Site is a recognized long-term national asset in the areas of environmental stewardship, innovative technology, national security, and energy independence. It acts with an inspired workforce and mature, efficient management processes, while sustaining public confidence in its employees and capabilities. The SRS core values include performing safe and effective operations, along with maintaining good relations with Site stakeholders. The Site's main activities are currently treating and processing waste, environmental cleanup and remediation, tritium processing, and protecting nuclear material.

The DOE Office of Environmental Management (DOE-EM) and the National Nuclear Security Administration (NNSA) oversee the Site mission. DOE-EM's primary mission at the Savannah River Operations Office is to ensure that SRS operations and the cleanup of legacy waste protect public health and the environment. DOE-EM executes this mission with the support of contractors and subcontractors, universities, and federal agencies. Additionally, DOE-EM has various agreements with the United States Forest Service-Savannah River (USFS-SR), the University of Georgia (UGA), the University of South Carolina (USC), and Ameresco (via contract) to manage and conserve the Site's environmental resources. The USFS-SR oversees SRS's natural resources through an interagency agreement with DOE-SR. UGA has operated the Savannah River Ecology Laboratory (SREL) since 1951, independently evaluating the environmental risk associated with Site activities. Since 1978, USC has overseen the Savannah River Archaeological Research Program (SRARP), a research unit that provides the technical expertise to manage SRS cultural resources. Ameresco Federal Solutions maintains a cogeneration power plant that uses renewable materials to supply steam, eliminating the need for coal.

The NNSA's Savannah River Field Office (SRFO) is responsible for the defense programs, and the NNSA Office of Defense Nuclear Nonproliferation is responsible for the nuclear nonproliferation elements of the national security missions.

Savannah River Nuclear Solutions (SRNS), Savannah River Remediation (SRR), Centerra-SRS, and Battelle Savannah River Alliance (BSRA) contract with DOE to directly contribute to both the DOE-EM and NNSA missions. SRNS, as the management and operations contractor, oversees and ensures safe and efficient operations at SRS, managing landlord services and supporting both DOE-EM cleanup (excluding liquid waste operations) and NNSA activities. SRR, the liquid waste operations contractor, treats and disposes radioactive liquid waste and is responsible for tank closures. SRR works closely with Parsons Government Services, Inc., a limited-service contractor to DOE-EM, to design, construct, and commission the Salt Waste Processing Facility (SWPF) to accomplish SRR's goals. Centerra-SRS provides a uniformed protective force and physical protection of DOE and NNSA security interests at the Site. In June, BSRA became the management and operations contractor for the Savannah River National Laboratory (SRNL), whose mission is applied research and development in environmental remediation and risk reduction, nuclear materials processing and disposition, nuclear detection and national security, and clean energy applications.

1.3 SITE LOCATION, DEMOGRAPHICS, AND ENVIRONMENT

SRS borders the Savannah River and encompasses about 310 square miles of Aiken, Allendale, and Barnwell counties in South Carolina. SRS is about 12 miles south of Aiken and 15 miles southeast of Augusta, Georgia (Figure 1-1). The Savannah River flows along the Site's southwestern border. The capital letters on the Figure 1-1 map reference the operational areas within the SRS borders.

Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of H Area is 1.4 million people. This translates to about 107 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area.

1.3.1 Water Resources

An Aerial View of the Savannah River as it Borders SRS

SRS activities potentially impact water resources, including the Savannah River, Site streams, and the underlying groundwater. The Savannah River bounds SRS on the southwest for 35 river miles. The upriver boundary of SRS 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. Commercial fishermen, sport fishermen, and boaters also use the river. The Savannah River is not currently used for any large-scale irrigation projects downriver of the Site. The groundwater at SRS migrates through the subsurface, primarily discharging into the Savannah River and its tributaries. SRS uses groundwater for both industrial processes and drinking water.

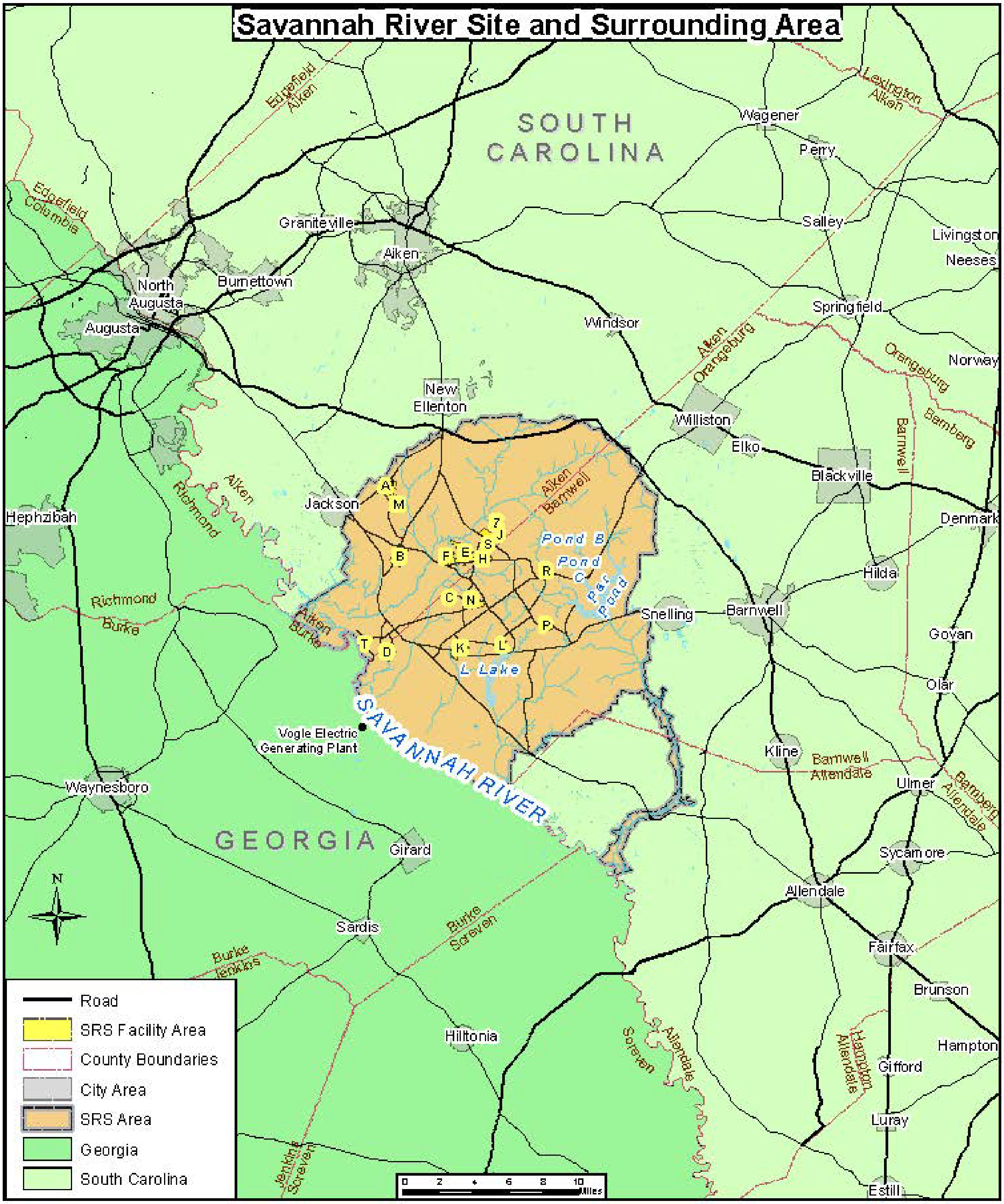

Figure 1-1 The Savannah River Site and Surrounding Areas

1.3.2 Geology

An Aerial View of a Carolina Bay at SRS

SRS is located on the southeastern Atlantic Coastal Plain in the Aiken Plateau. The center of SRS is about 25 miles southeast of the geologic fall line that separates the Coastal Plain from the Piedmont. The Aiken Plateau slopes gently to the southeast and is generally well-drained, although many poorly drained depressions exist. Elliptical-shaped Carolina bays, for example, are common on the Aiken Plateau. All major streams on SRS originate onsite, except for Upper Three Runs, which begins above the Site. All onsite streams drain into the Savannah River (Denham 1995).

1.3.3 Land and Forest Resources

About 10% of SRS's land is industrial; the remaining 90% consists of natural and managed forests that the USFS-SR plants, maintains, and harvests. SRS consists of four major forests: 1) mixed-pine hardwoods, 2) sandhills pine savanna, 3) bottomland hardwoods, and 4) swamp floodplain forests. These forests, as well as Carolina bays, are accessible to the public when visiting the Crackerneck Wildlife Management Area and Ecological Reserve near Jackson, South Carolina. Carolina bays provide important wetland habitat and refuge for many plants and animals. As many as 300 Carolina bays exist on SRS.

1.3.4 Animal and Plant Life

This Young Alligator, which is Part of the SREL Outreach Program, is One of the Many Reptiles Found at SRS.

SRS is home to many varieties of plants and animals, including

- More than 100 species of reptiles and amphibians
- Approximately 50 species of mammals
- Nearly 100 species of fish
- Nearly 600 species of aquatic insects
- Approximately 1,500 species of plants, of which at least 40 are of state or regional concern
- More than 250 species of birds, some of which are migratory and do not make SRS their permanent home

The Site also provides habitat for federally listed as threatened or endangered animal and plant species, including the wood stork, the red-cockaded woodpecker, the gopher tortoise, the pondberry, and the smooth coneflower.

1.4 DOE-EM PRIMARY SITE ACTIVITIES

DOE's Environmental Management Program oversees many Site activities. The following sections highlight key programs. Additional information is available on the SRS website.

1.4.1 Nuclear Materials Management

Nuclear Materials Management operations provide an interim storage location for a portion of the nation's excess plutonium. SRS has two facilities designated for the handling and extended safe storage of plutonium and other special nuclear materials. Facility infrastructure and security upgrades are being addressed to ensure safe plutonium storage until the Surplus Plutonium Project is fully implemented.

1.4.2 Nuclear Materials Disposition

H Canyon is the only operating radiologically shielded chemical separations facility in the United States. Since 2003, H Canyon has recovered highly enriched uranium from various sites across the DOE complex and from foreign test reactors. DOE now uses H Canyon to blend down highly enriched uranium into low-enriched uranium fuel. Blending down, or down blending, as it is sometimes referred, mixes the uranium with natural uranium to not only render it undesirable to use in nuclear weapons, but also to make it useable for commercial nuclear reactors. However, H Canyon has not shipped blended-down uranium since 2011, and DOE is evaluating the direct transfer of dissolved spent nuclear fuel, including uranium, into liquid waste batches for disposition.

1.4.3 Spent Nuclear Fuel Storage

SRS supports the DOE National Security mission by safely receiving and storing spent fuel elements from foreign and domestic research reactors, pending disposition. Currently, SRS stores spent nuclear fuel at the L-Area Complex.

1.4.4 Waste Management

SRS manages radiological and nonradiological waste created by legacy operations as well as newly generated waste from ongoing Site operations.

1.4.4.1 Radioactive Liquid Waste Management

SRS generates radioactive liquid waste as the byproduct of processing nuclear materials for national defense, research, and medical programs. The Site safely stores approximately 34 million gallons of radioactive liquid waste underground in the F-Tank Farm and H-Tank Farm in F Area and H Area, respectively. Closing these tanks is a high priority for DOE-EM. To do this, SRS must first remove the waste from the tanks, which is mostly salt waste, and then process and treat the waste before disposing of it.

SRS mixes the salt solution at the Saltstone Production Facility to make saltstone and disposes of this low-activity liquid waste in cylindrical tanks, known as Saltstone Disposal Units (SDUs). The Saltstone facilities processed and disposed of more than 3.14 million gallons of waste during 2021. SDU-6, the first mega-vault at SRS, continues to receive the saltstone for disposal, and SRS completed construction of SDU-7, the second of seven SRS mega-vaults. Construction of the next two mega-vaults, SDU-8 and SDU-9, continued in 2021.

DWPF is Key to Liquid Waste Processing. It Has Immobilized More Than 63 Million Ci of Radioactivity since 1996.

SRS uses the Defense Waste Processing Facility (DWPF) to process high-activity waste from the F-Tank Farm and H-Tank Farm. Since DWPF began operating in March 1996, it has produced more than 16.6 million pounds of glass—immobilizing 63.2 million curies (Ci) of radioactivity—and pouring more than 4,288 canisters. In 2021, DWPF produced 62 canisters of glass, weighing 230,000 pounds and immobilizing 1.06 million Ci of radioactivity.

SWPF is a major piece of the liquid waste system and will process most of the Site's salt waste inventory by separating the highly radioactive waste from the less radioactive salt solution. Hot commissioning of SWPF was completed in January 2021, and operations began on January 17, 2021. The primary focus in the first year was safe and successful operations of the new facility. During 2021, SWPF processed just over 2 million gallons of liquid waste.

1.4.4.2 Solid Waste Management

SRS manages the following types of solid waste:

- Low-level waste: ordinary items, such as coveralls, gloves, and hand tools, contaminated with small amounts of radioactive material
- Transuranic (TRU) waste: protective clothing, equipment, and job waste containing alpha-emitting isotopes with an atomic number greater than that of uranium (92)
- Hazardous waste (nonradiological): toxic, corrosive, reactive, or ignitable material that could affect human health or the environment
- Mixed waste: construction debris, laboratory samples, and soils containing both hazardous and radioactive components
- Sanitary waste: office waste, other wastes similar to household waste, and industrial or construction waste that is neither radioactive nor hazardous

SRS manages all solid waste it generates, including radioactive, hazardous, and nonhazardous, according to federal and state requirements. The Site disposes of all hazardous waste it generates in offsite RCRA-permitted facilities. The Site also emphasizes recycling and minimizing waste to reduce the waste volume that it must manage.

SRS packages TRU waste and transports it in U.S. Department of Transportation-approved containers for underground disposal at the Waste Isolation Pilot Plant (WIPP), DOE's geologic repository in New Mexico.

SRS began shipping TRU waste to WIPP in May 2001 and has made more than 1,670 shipments. It made eight TRU shipments in 2021.

DOE conducts annual reviews to ensure that Site operations are within DOE's performance standards. The annual reviews for the E-Area Low-Level Waste Facility Performance Assessment (PA) and the Saltstone Disposal Facility PA showed that SRS continued to operate these facilities in a safe and protective manner.

SRS Has Sent 1,670 TRU Waste Shipments to WIPP during the Last 20 Years.

1.4.5 Area Completion Projects

SRS's Area Completion Projects (ACP) is responsible for investigating and remediating waste units, surface water, and groundwater onsite. The EPA and SCDHEC have oversight of the remedial programs that reduce the footprint of legacy wastes and contamination, treat and immobilize contamination in soil and groundwater, and slow contaminate transport. Cleanup can include capping inactive waste sites; installing and operating efficient groundwater treatment units; deactivating and decomissioning excessed EM facilities; and using natural remedies, such as bioremediation (employing naturally occurring microbes).

1.4.6 Environmental Monitoring

SRS has an extensive environmental monitoring program, with records and documents from 1951, prior to the start of Site operations. Beginning in 1959, SRS made offsite environmental surveillance data available to the public. SRS reported onsite and offsite environmental monitoring separately until 1985, when it merged data from both programs into one publicly available document, the *U.S. Department of Energy Savannah River Plant Environmental Report for 1985.*

SRS continues to conduct an extensive environmental monitoring program to determine impacts, if any, from SRS to the surrounding communities and the environment, both on and offsite. In addition to the onsite environmental monitoring the Site conducts, SRS also monitors a 2,000-square-mile area beyond the Site boundary. This area includes neighboring cities, towns, and counties in South Carolina and Georgia. SRS collects samples of air, rainwater, surface water, drinking water, groundwater, food products, wildlife, soil, sediment, and vegetation. The Site evaluates these samples for radionuclides, metals, and other chemicals that could be in the environment because of SRS activities.

1.5 NNSA PRIMARY SITE ACTIVITIES

The NNSA operates tritium facilities at SRS to supply and process tritium, a radioactive form of hydrogen gas that is a vital component of nuclear weapons. SRS also plays a critical role in the NNSA's nonproliferation missions, helping the United States meet its commitments to security and disposing of plutonium and uranium.

1.5.1 Tritium Processing

SRS has the nation's only facility for extracting, recycling, purifying, and reloading tritium. SRS replenishes tritium by recycling it from existing warheads and by extracting it from target rods irradiated in nuclear reactors that the Tennessee Valley Authority operates. SRS purifies recycled and extracted gases to produce tritium used by the Department of Defense for nuclear weapons. Helium-3 gas, a byproduct of the tritium production process, is used for neutron-detection equipment. SRS is the sole producer of helium-3 gas in the United States.

In 2021, Savannah River Tritium Enterprise (SRTE) continued facility infrastructure improvements to ensure robust plant operation, contributing to overall efficiency and the ability to meet future mission needs.

SRS tritium facilities are part of the NNSA's Defense Program at SRS. The Defense Programs page of SRS's website includes more information.

1.5.2 Nuclear Nonproliferation

In continued support of nonproliferation goals, SRS continued carrying out the Surplus Plutonium Disposition mission to permanently dispose of weapons-grade plutonium declared excess to national security, with priority on disposition and removing plutonium previously consolidated onsite.

1.5.3 Pit Production

In June 2021, the NNSA announced approval for the recommended approach to produce at least 50 plutonium pits per year at the Savannah River Plutonium Processing Facility (SRPPF) project. The approval marked the completion of the project definition phase and the conceptual design as part of DOE's process for acquiring capital assets outlined in DOE's Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets.*

1.6 SPECIAL ENVIRONMENTAL STUDIES

SRS provides a unique setting for environmental study. Several organizations at the Site—SREL, USFS-SR, SRARP, and SRNL—conduct research to support a better understanding of human impact on both plants and animals.

SREL and USFS-SR provide annual reports on the environmental studies and research they conduct on SRS. These reports, available on the *SRS Environmental Report 2021* webpage, present and discuss environmental studies and research that occurred during the reporting year. Special environmental studies and research directly impacting the SRS environmental monitoring program and dose calculations are presented and discussed in their respective chapters.

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Chapter 2: **Environmental Management System**

The Savannah River Site (SRS) Environmental Management System (EMS) implements the U.S. Department of Energy (DOE) commitment to sound environmental stewardship policy and practices. These safeguards protect air, water, land, and natural resources, as well as archaeological and cultural resources that SRS potentially affects.

The EMS plans and evaluates SRS construction, operations, maintenance, and decommissioning activities to protect public health and the environment, prevent pollution, and comply with applicable environmental and cultural resource protection requirements. The way SRS conducts its actions demonstrates the Site's commitment to minimize waste, manage water, foster renewable energy, reduce greenhouse gases, acquire sustainable services, remediate with a focus on sustainability, and observe best management practices. All of these attributes are vital components of environmental management. The "SRS Site Sustainability Plan" contains more information on DOE and SRS goals and the progress the Site has made toward achieving these goals.

2021 Highlights

DOE sets objectives for carrying out its mission in an environmentally sustainable manner that supports a policy of national energy security and addresses global environmental challenges. SRS continues to make substantial progress in meeting the goals for the Site. Below are the highlights of the EMS program:

- **Pollution Prevention and Waste Minimization**—SRS recycled 51% (242 metric tons) of nonhazardous solid waste.
- **Greenhouse Gas Reduction**—SRS continued to reduce greenhouse gas emissions, exceeding federal goals. The Site has reduced emissions by more than 84.4% since 2008.
- **Transportation and Fleet Management**—SRS continued to exceed its fleet management goals. More than 87% of the current fleet of light-duty vehicles are hybrid, electric, or vehicles that use E-85 (85% ethanol, 15% unleaded gasoline) fuel.
- **Awards**—SRS received recognition as part of the DOE agency-wide Sustainability Awards, under the Innovative Approach to Sustainability Category for the P-Area Permeable Reactive Barrier Wall Project.

2.1 SRS ENVIRONMENTAL MANAGEMENT SYSTEM

DOE Order 436.1, *Departmental Sustainability*, requires federal facilities to use environmental management systems. SRS implements an EMS conforming to the International Organization for Standardization (ISO) 14001:2015 standard to fulfill compliance obligations and address risks and opportunities. By design, the "Plan-Do-Check-Act" approach of the ISO 14001:2015 standard continually improves environmental performance.

The SRS EMS has two areas of focus: environmental compliance and environmental sustainability. Environmental compliance consists of regulatory compliance and monitoring programs that implement federal, state and local requirements, agreements, and permits. Environmental sustainability promotes and integrates initiatives such as energy and natural resource conservation, waste minimization, green remediation, and using sustainable products and services.

Chapter 2—Key Terms

Environmental impacts *are any positive or negative changes to the environment caused by an organization's activities, products, or services.*

Environmental objectives *define the organization's environmental goals.*

Environmental sustainability *is interacting responsibly with the environment to conserve natural resources and promote long-term environmental quality. It includes reducing the amount of waste produced, using less energy, and developing processes that maintain the long-term quality of the environment.*

2.1.1 SRS Environmental Policy

The goal of the SRS Environmental Policy is to protect the public and future generations from any impacts from Site operations. SRS commits to this by doing the following:

- Promoting sound environmental stewardship
- Preventing pollution onsite and in surrounding communities
- Conducting science and energy research
- Continuing the national security mission

SRS accomplishes this through:

- Complying with environmental laws and regulations
- Continuing process improvements
- Conducting safe operations
- Communicating with the workforce, public, and stakeholders

2.1.2 Integration with Integrated Safety Management System

SRS incorporates the Integrated Safety Management System (ISMS) with an EMS to provide a comprehensive framework under which it manages the environmental, safety, and health programs. This makes it possible for the Site to accomplish all work while protecting the public, workers, and the environment. The integration confirms that SRS can evaluate work and associated hazards, and that the Site adapts standards, practices, and controls in a DOE-approved safety management system. Figure 2-1 depicts the relationship between the ISMS and EMS and how both management systems integrate.

ISMS execution involves five functions: 1) defining scope of work, 2) analyzing hazards, 3) developing and implementing controls, 4) performing work, and 5) providing feedback and improvement. Likewise, SRS accomplishes the EMS goals using the **Plan-Do-Check-Act** approach, where:

- **Plan**—encompasses defining work scope and objectives, identifying environmental aspects and analyzing hazards, and developing controls
- **Do**—encompasses implementing these controls and performing the work (operations)
- **Check**—involves evaluating performance (feedback) and management reviews
- **Act**—embodies corrective actions, improvements, and incorporating lessons learned into practices

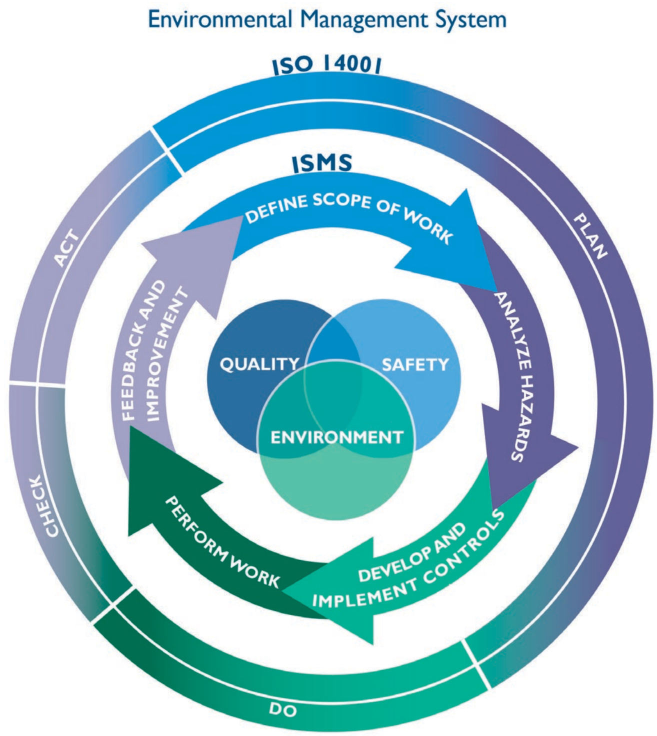


Figure 2-1 Integrated Safety Management System Continual Improvement Framework within the ISO 14001 Environmental Management System

2.2 EMS IMPLEMENTATION

The Plan-Do-Check-Act approach is interactive and iterative through the various work activities and functions, including policies, programs, and processes. It also is an integral part of the overall management of the Site's environmental compliance and performance.

2.2.1 Plan

The Site establishes environmental goals, objectives, and targets for each project and activity. Before SRS undertakes any actions or projects, it evaluates associated environmental aspects and their impacts (or potential environmental hazards) to ensure that SRS can control or mitigate the hazard or risk to reduce or eliminate impacts to the environment. The Site performs these evaluations against all applicable federal and state regulations, state permits, and local laws. These regulations and permits are the foundation for internal manuals, standard operating procedures, and standard requirement-implementing documents. SRS uses the Environmental Evaluation Checklist (EEC) for all federally proposed actions to take place onsite. The EEC evaluates all activities and projects to ensure what is presented considers and mitigates environmental aspects as necessary.

Another aspect of planning involves sitewide training for personnel, as well as training to perform specific tasks and activities within a project's scope. SRS trains all employees on various policies and job-related requirements. The Site requires General Employee Training or Consolidated Annual Training at a minimum, annually, for every employee so they will be aware of the potential hazards and risks associated with work onsite. Task- and project-specific training includes skills development and safe-work practices.

Incorporating training and evaluating environmental aspects and their impacts into work planning ensures SRS will perform activities in a manner that protects the public, workers, and the environment. Additionally, the Site generates regular and routine employee written and multimedia communications as a reminder of the SRS commitment to sustainability and the environment.

2.2.2 Do

Environmental Compliance Authorities (ECAs) and Environmental Subject Matter Experts (SMEs) support the facilities and programs in identifying and carrying out their environmental responsibilities. The SMEs communicate environmental regulatory requirements and required document submittals to the United States Environmental Protection Agency (EPA), the South Carolina Department of Health and Environmental Control (SCDHEC), and other stakeholders. The ECAs work with the facilities to ensure that they implement the regulatory requirements.

The Site develops the annual *SRS Environmental Report* for the public to summarize in a single document the Site's environmental performance against various applicable federal and state regulations, state permits, and local laws. Chapter 3, *Compliance Summary,* of this report describes SRS's environmental compliance and provides the number of National Environmental Policy Act (NEPA) reviews, the number of SRS construction and operating permits, and the status of key federal environmental laws. Chapter 7, *Groundwater Management Program,* identifies SRS efforts to monitor, conserve and protect groundwater, and to restore contaminated SRS groundwater to the EPA drinking-water quality standards while conforming to state and federal laws.

The Site plans and conducts emergency drills and exercises by implementing the EMS and ISMS principles and tools. Some of these drills include local, state, and federal emergency response organizations. Throughout the year, the Site performs safety drills for employees to ensure maximum participation through various weather, nuclear incident, environmental release, and fire scenarios.

2.2.3 Check

SRS assesses and evaluates internal work to make certain that personnel are performing it as planned, and that Site operations are not adversely impacting worker and public health and the environment. The environmental monitoring and environmental surveillance programs at SRS follow applicable requirements to collect and analyze samples across SRS and within a 25-mile radius extending from the center of the Site. This ensures the radiation dose to members of the public and radioactive releases to the environment are kept as low as reasonably achievable. Chapters 4, 5, and 6 of this report document the nonradiological environmental monitoring program, radiological environmental monitoring program, and the radiological dose assessment, respectively.

Every three years, as required by the ISO 14001 standard, a qualified party outside the control or scope of the EMS must perform a formal EMS audit. The Savannah River Nuclear Solutions, LLC (SRNS) EMS (which covers Savannah River Remediation [SRR]) conforms to ISO 14001, while Centerra-SRS (SRS's protective force services contractor) is registered to the ISO 14001 standard and has yearly audits. The next formal EMS compliance audit for SRNS will be conducted in 2024.

The Site also performs management field observations and program assessments to detect potential issues early to prevent performance shortfalls and to identify processes, practices, behaviors, roles, responsibilities, and organizational expectations that SRS needs to improve. Chapter 8, *Quality Assurance,* documents how SRS ensures the accuracy of its environmental data.

Various regulators also perform external assessments. SCDHEC conducts several inspections and audits annually to verify that the Site is complying with state permits. The EPA and SCDHEC participate in Federal Facility Act (FFA)-driven inspections. The EPA may participate alongside SCDHEC in compliance evaluation inspections for waste management. Chapter 3, *Compliance Summary,* lists and gives results of the annual external agency audits and inspections of the SRS Environmental Program.

An external recertification audit of the Centerra EMS program was conducted in 2021, and a conformity audit of the SRNS program was executed in 2021.

In 1995, SCDHEC enrolled in an Agreement in Principle (AIP) program with the Department of Energy at SRS. As a result, SCDHEC created the Environmental Surveillance Oversight Program (ESOP). Through the AIP grant, ESOP evaluates the adequacy of DOE activities related to environmental monitoring and reporting and confirms that DOE's activities have not adversely impacted public health and safety and the environment.

2.2.4 Act

SRS enhances environmental performance and the health of the EMS through corrective actions and continual improvement. The Site establishes, implements, and maintains the corrective action program in accordance with an internal manual for contractor assurance. It deals with actual or potential conditions of nonconformity, such as Notices of Violation or findings and opportunities for improvement from internal assessments and audits. Chapter 8, *Quality Assurance,* summarizes annual improvements to the Site's Environmental Monitoring Program and laboratory performance in various proficiency and certification programs.

Communication is vital throughout all programs and activities in order to facilitate feedback and to incorporate lessons learned for improvement. This report and the accompanying *SRS Environmental Report Summary* also serve as communication tools with stakeholders (such as the public, academia, SRS Citizen's Advisory Board, regulators, and other DOE sites) and to communicate with the public.

2.3 SUSTAINABILITY AND STEWARDSHIP GOALS AND IMPLEMENTATION

DOE Order 436.1, *Departmental Sustainability*, defines DOE Sites' requirements and responsibilities to manage operations and activities necessary for sustainability and ensure that they are carrying out the DOE mission in a manner that addresses energy efficiency goals, greenhouse gas reductions, waste minimization, and pollution prevention. SRS has integrated environmental stewardship projects into many remediation and closure activities, addressing requirements for resource conservation, pollution reduction, and environmental surveillance.

Executive Order No. 13834, *Efficient Federal Operation,* signed in May 2018, sets forth energy and environmental performance goals—based on statutory requirements—for agencies with respect to managing facilities, vehicles, and operations. Sustainability reporting in this chapter is in accordance with this executive order.

SRS uses the Site Sustainability Plan to document the sustainability goals SRS plans to achieve, providing a roadmap, strategies, and essential activities. The goals, which DOE sets annually for all sites, include the following:

- Reducing total energy use
- Increasing renewable energy use
- Reducing water use
- Purchasing environment-friendly, or "green," products and services
- Generating less solid waste
- Increasing the number of sustainable buildings
- Reducing fleet and petroleum use
- Using energy-compliant electronic devices

Sustainability Goals

ISO 14001:2015 requires SRS to establish and document measurable environmental objectives consistent with SRS's Environmental Policy and SRS's strategic direction. Appendix A presents these objectives in the fiscal FY 2021 EMS Goals and Objectives flowchart. This chart names sustainability goals as well as environmental compliance goals for 2021, identifies the related environmental objectives and strategies for implementation, and provides the status of SRS's progress toward achieving them. This chapter contains additional information on how SRS is making progress in supporting DOE objectives.

The following topics summarize the major accomplishments the SSP discusses. Updated annually, the SRS SSP outlines the strategies in place and identifies the Site's contributions toward meeting DOE's sustainability targets outlined in the Sustainability Report and Implementation Plan. DOE maintains an online graphical dashboard that tracks the progress of facilities in the complex in meeting their sustainability goals. The DOE's Sustainability Dashboard is the source of the goal performance information in Table 2-1. This table summarizes specific metrics and SRS's FY 2021 performance against the sustainability goals to complement the more general discussion in the text that follows.

Table 2-1 FY 2021 Sustainability Goals, Metrics, and SRS Performance

Energy Management	
Goal: 25% energy intensity reduction by FY 2025 from FY 2015 baseline	**Goal on Track**—Energy intensity dropped 31.9%. The increase in telework due to the COVID-19 pandemic contributed to this reduction. SRS conducted Energy Independence and Security Act of 2007 (EISA) energy and water audits on 16 buildings and identified 32 Energy Conservation Measures (ECMs). SRS implemented 30 ECMs, including 12 light-emitting diode (LED) lighting upgrades, 25 heating and cooling unit replacements with higher Seasonal Energy Efficiency Ratio (SEER) units, 1 electrical meter installation, and 3 rightsizing projects.
Interim Target (FY 2021): 15% reduction from FY 2015 baseline	**Interim Target Met**
Renewable Energy	
Goal: 30% renewable energy as a percentage of total agency electric use by FY 2025	**Goal Met** —31.9% of electric consumption in FY 2021 is from renewable resources (Biomass Cogeneration Facility).
Interim Target (FY 2021): 20%	**Interim Target Met**
Water Management	
Goal: 36% reduction in potable water intensity by FY 2025 from FY 2007 baseline	**Goal on Track**—29.7% potable water intensity from FY 2007. Continued reducing nonpotable water intensity by using the Biomass Cogeneration Facility and WaterSense® products
Interim Target (FY 2021): 28% reduction from FY 2007 baseline	**Interim Target Met**
Performance Contracting	
Goal: Evaluate performance contracting with energy provider for utility scale solar panel farm.	**Goal Met**—An evaluation on the feasibility of solar power generation on a large (utility size) scale is in process. SRS, with Dominion Energy, will evaluate the potential for a Utility Energy Service Contract to implement a 75-100 megawatt (MW) solar panel farm that will utilize hydrogen technology for storage. SRS has ongoing Energy Saving Performance Contracting projects with Ameresco to provide steam and electricity through biomass facilities.
Sustainable Buildings	
Goal: 17% of owned existing buildings comply with Guiding Principles for Sustainable Buildings by FY 2025.	**Goal at Risk**—1.4% of SRS's buildings (two buildings) qualify as sustainable.
Interim Target (FY 2021): 16%	**Interim Target Not Met**

Waste Management	
Goal for Solid Waste: Divert at least 50% of nonhazardous solid waste (excluding construction and demolition [C&D] debris)	**Goal for Solid Waste Met**—475 metric tons of office and municipal type waste generated, 242 metric tons (51%) recycled.
Interim Target (FY 2021): 50%	**Interim Target Met**
Goal for C&D Waste: Divert at least 50% of C&D material and debris	**Goal for C&D Waste Not Met**—SRS diverted 3% of waste from the 632-G Construction and Demolition Debris Landfill by recycling items such as metals and office furniture identified in Table 2-2.
Interim Target (FY 2021): 50%	**Interim Target Not Met**
Fleet Management	
Goal for Petroleum Reduction: 20% reduction in petroleum use by FY 2015 and thereafter relative to FY 2005 baseline	**Goal for Petroleum Reduction Exceeded**—SRS reduced petroleum consumption by 32.7%.
Interim Target (FY 2021): 20%	**Interim Target Met**
Goal for Alternative Fuel Use: 10% increase in alternative fuel use by FY 2015 and thereafter relative to FY 2005 baseline	**Goal for Alternative Fuel Use Exceeded**—SRS's alternative fuel usage increased by 35.5% relative to the FY 2005 baseline.
Interim Target (FY 2021): 10%	**Interim Target Met**
Goal for Fleet Greenhouse Gas Emissions Per Mile: 30% reduction in per-mile greenhouse gas emissions from FY 2014 baseline	**Goal for Greenhouse Gas Emissions Exceeded**—SRS reduced per-mile greenhouse gas emissions by 89.5%.
Acquisition and Procurement	
Goal: 95% of new contract actions for products and services meet sustainable acquisition requirements.	**Goal Met**—SRS reviewed 100% purchase-order line descriptions of eligible contract actions to determine whether the products met the BioPreferred® definition.
Interim Target (FY 2021): 95%	**Interim Target Exceeded**
Electronics Stewardship	
Goal for Environmentally Sustainable Electronics Acquisition: 100% of eligible electronics procurements must be environmentally sustainable (for example, Electronic Product Environmental Assessment Tool [EPEAT]).	**Goal for Environmentally Sustainable Electronics Acquisition Met**—100% of eligible electronics procured (including 1,360 computers purchased and 1,144 iPhones) are environmentally sustainable, meeting EPEAT standards
Interim Target (FY 2021): 95%	**Interim Target Met**
Goal for Disposal of Electronics: 100% of electronics disposed through government programs and certified recyclers	**Goal for Disposal of Electronics Met**—100% of used electronics reused (through donations to schools or nonprofit organizations) or recycled using authorized recycling companies.
Interim Target (FY 2021): 100%	**Interim Target Met** ***Note***: SRS recycled 131,086 pounds of scrap electronics in calendar year 2021.

Electronics Stewardship (continued)	
Goal for Power Management: 100% of eligible computers (desktops and laptops) and monitors implement and actively use power management features.	**Goal for Power Management Met**—100% of eligible desktops, laptops, and monitors have power management enabled.
Interim Target (FY 2021): 100%	**Interim Target Met**
Goal for Duplex Printing: 100% of eligible printers implement and actively use duplex printing features.	**Goal for Duplex Printing Met**—All eligible computers and imaging equipment are set up to automatically print on both sides of paper.
Interim Target (FY 2021): 100%	**Interim Target Met**
Data Center Efficiency	
Goal: Implement practices that promote energy efficient management of servers and federal data centers.	**Goal on Track**—SRS utilizes power usage effectiveness (PUE) for data centers that have meters to obtain a baseline of energy-use effectiveness.
Resiliency	
Goal: Enhance the resilience of the federal infrastructure and operations and enable more effective accomplishment of its mission.	**Goal Met**—SRS utilized an Active Risk Manager tool to prioritize risks and opportunities so that strategies and executable plans could be established. In response to the COVID-19 pandemic, SRS also established the SRS Infectious Disease Response Team to update and guide Site employees during the pandemic.
Greenhouse Gas Management	
Goal for Direct GHG Emissions: 50% reduction in direct greenhouse gas (GHG) emissions by FY 2025 from FY 2008 baseline	**Goal for Direct GHG Emissions Exceeded**—SRS reduced direct GHG emissions by 84.1%.
Interim Target (FY 2021): 37%	**Interim Target Met**
Goal for Indirect GHG Emissions: 25% reduction in indirect GHG emissions by FY 2025 from FY 2008 baseline	**Goal for Indirect GHG Emissions Exceeded**—SRS reduced indirect GHG emissions by 92%.
Interim Target (FY 2021): 17%	**Interim Target Met**

2.3.1 Energy Management

Executive Order No. 13834, *Efficient Federal Operations*, directs agencies to meet statutory requirements regarding reducing the amount of energy per square foot (energy intensity) used in an identified class of buildings and to establish an agency target for decreasing energy intensity annually.

In order to reduce energy intensity, SRS has implemented a wide variety of energy-efficient strategies. These include upgrading utility systems; minimizing boiler water use for winter heating; operating the Biomass Cogeneration Facility and the biomass steam plants in A Area, K Area, and L Area; using more energy-efficient equipment in facilities (for example, lighting timers, lighting sensors, and programmable thermostats); and upgrading various small-scale light fixtures to light-emitting diodes (LEDs). SRS has also reduced the overall square footage of the Site by deactivating and decommissioning many facilities, including entire areas (such as TNX), multiple buildings, land, and associated waste disposal areas. Additionally, SRS has consolidated employee-occupied office space into fewer buildings.

Conducting energy audits of buildings under Section 432 of the Energy Independence and Security Act of 2007 (EISA) is another effective strategy SRS uses to improve energy intensity. Under this program, SRS has identified 63 Site buildings that are responsible for 76.3% of the Site's energy consumption. Focusing on these buildings allows EISA audits, which identify energy conservation measures (ECMs), to be most effective.

During 2021, SRS implemented a review in the contract bidding process for each new planned roof installation to determine whether a cool roof may be cost effective to install. No cool roofs were installed in 2021.

By the end of FY 2021, SRS reduced energy intensity by 31.9% from FY 2015, thereby meeting the interim target for reducing energy intensity by 1% year-over-year. While the strategies discussed—such as timers, sensors and programmable thermostats, and cool roof installations—contribute to reducing energy intensity, these actions did not play a major role reducing energy use in 2021. SRS's response to the COVID-19 pandemic played a significant role in meeting the interim energy intensity reduction goal. Many Site employees during FY 2021 were teleworking in response to the COVID-19 pandemic, which equated to less use of energy in the buildings. This explains the major shift from the interim goal being at risk in FY 2019 to being on track in FY 2020 and FY 2021.

2.3.2 Renewable Energy

Executive Order No. 13834, *Efficient Federal Operations,* directs agencies to meet statutory requirements relating renewable energy and electricity consumption. As identified in the DOE Sustainability Dashboard, managed by DOE's Sustainability Performance Division, the goal is for SRS to increase renewable energy as a percentage of total agency electric consumption. SRS has exceeded the renewable energy goal by generating power onsite from biomass. SRS no longer uses coal to generate energy. Using renewable energy at the Site is a high-level priority. The Biomass Cogeneration Facility, which uses wood chips as its primary fuel source and fuel oil and tires as a secondary fuel source, is in its eighth year of fully operating and plays a significant role in supporting renewable goals.

2.3.3 Water Management

Executive Order No. 13834, *Efficient Federal Operations*, requires agencies to reduce potable and nonpotable water use and to comply with stormwater management requirements. The Site has been significantly decreasing its potable water use over many years. By installing a new SRS primary domestic water system and continuing to replace old and leaky piping, the Site has saved several hundred million gallons of water annually. SRS also installed water meters on the main supply lines and periodically conducts a water balance to monitor use and help detect leaks.

The water management sustainability goal does not account for potable water conservation measures such as the new primary domestic water system installed prior to 2007. It will be more difficult for SRS to decrease potable water usage in the future because it has already achieved large decreases in the programs that have the biggest impact. Potable water use fluctuates from year-to-year based on various factors, such as the number of employees and the amount of potable water used for nonpotable purposes.

SRS has been using WaterSense® products and other water-conserving products, including low-flow toilet flush valves, low-flow urinal flush valves, and low-flow faucets. In recent years, the Site has substituted several hundred less-efficient faucets and flush valves with more-efficient low-flow units as they needed replacing.

Executive Order No. 13834 requires DOE as an agency to reduce nonpotable water consumption—mostly industrial, landscaping, and agricultural (ILA) water—but there are no specific targets. DOE has achieved long-term reductions in ILA water use due to the biomass facility operating, which consumes significantly less water than the previously used coal-fired power plant. For example, in FY 2010 when the coal-fired power plant was operating, SRS consumed more than 2.3 billion gallons of nonpotable or potable water, compared to only 620 million gallons in FY 2021.

As previously indicated, the number of employees onsite affects the amount of potable water used; therefore, it is logical to anticipate potable (drinking) water use to decline with the decrease of onsite population due to COVID-19 pandemic-related teleworking in FY 2021. Potable water use decreased 13.7% from FY 2020 to FY 2021. The amount of water used is also dependent on facilities such as H Canyon, F-Tank Farm and H-Tank Farm, Savannah River National Laboratory, and Salt Waste Processing Facility, which have processes that require potable water.

2.3.4 Performance Contracting

Executive Order 13834, *Efficient Federal Operations*, requires agencies to utilize performance contracting to achieve energy, water, building modernization, and infrastructure goals. The Executive Order requires agencies to set annual targets for the number of contracts they award and the investment value each fiscal year.

SRS has used Energy Saving Performance Contracting (ESPC) to engage Ameresco Federal Solutions in several projects that conserve energy and water. ESPC funds energy- and water-saving building improvements with future energy savings. Ameresco Federal Solutions operates the Biomass Cogeneration Facility at SRS. This facility produces steam and electricity on a 24-hour, full-time basis. Through an ESPC project, Ameresco also operates steam-only biomass plants for heating buildings in two areas at SRS.

2.3.5 Sustainable Buildings

Executive Order 13834, *Efficient Federal Operations*, requires agencies to ensure that new construction and major renovations conform to applicable building energy-efficiency requirements and sustainable design principles, consider building efficiency when renewing or entering into leases, implement space utilization and optimization practices, and assess and report annually on building conformance to sustainable metrics.

The Executive Order requires SRS to prioritize actions that reduce waste, cut costs, enhance the resilience of federal infrastructure and operations, and enable more effective accomplishment of its mission. In general, SRS's aging buildings are not cost-effective to upgrade. However, the SRS emphasis on maintenance, repairs, and energy conservation measures identified in EISA audits (for example, LED lighting upgrades and more efficient heating ventilation, and air conditioning [HVAC] systems) supports the goals detailed in the directive.

2.3.6 Waste Management

Executive Order 13834, *Efficient Federal Operations*, requires agencies to implement waste prevention and recycling and comply with all federal requirements for solid, hazardous, and toxic waste management and disposal.

Pollution prevention is a commitment in the SRS Environmental Policy as required under the ISO 14001:2015 standard. Environmentally safe and cost-effective reuse or recycling diverts pollutants and wastes from the waste stream. Pollution prevention at SRS reduces wastes, mitigates health risks, and protects the environment.

SRS uses the North Augusta Material Recovery Facility (NA-MRF) to recycle office paper and municipal-type waste. In addition, SRS contracts with a vendor to shred and recycle sensitive office paper. SRS continues to work with the NA-MRF to enhance the process to attain and improve upon a 50% recovery rate. SRS continues to monitor this waste stream for opportunities to recycle materials. Overall, waste generation was down in FY 2021 relative to FY 2020 (475 metric tons versus 579 metric tons, respectively), likely due to employee teleworking in response to the COVID-19 pandemic. Similarly, with more teleworking, the Site generated only 4 metric tons of sensitive office paper in FY 2021, the same amount as in FY 2020.

Other waste streams at SRS include construction and demolition (C&D) debris and universal waste. C&D debris includes waste generated from constructing, remodeling, repairing and deconstructing buildings, roads, bridges, and drainage and sewage systems. This debris is often concrete, asphalt, glass, metal, plastic, and land-clearing scrap. SRS has improved the diversion rate of waste streams from the C&D landfill by initiatives such as recycling nonradioactive scrap metal, scrap furniture, and used storage drums. Universal waste includes batteries, mercury-containing equipment, and light bulbs. It must be recycled when generated by businesses, otherwise the waste must be sent to a Resource Conservation and Recovery Act-permitted facility. Table 2-2 breaks down the recycled waste amounts for FY 2021.

Table 2-2 SRS Recycling and Sustainability in FY 2021 by Amount

Items Recycled in FY 2021	Amount Recycled
Silver Fixative	40 gallons
Rechargeable Batteries	3,547 pounds
Lead Salvage	0 pounds
Fluorescent Tubes	17,060 pounds
Batteries (lead acid)	59,948 pounds
Furniture and Cabinets	284,360 pounds
Mixed Metal	1,183,230 pounds
Mixed Paper	533,519 pounds
Used Tires	20,260 pounds
Used Motor Oil	0 gallons
Consumer Electronics (including cell phones)	131,086 pounds
Toner Cartridges	15,820 pounds
Industrial Sludge (land applied)	0 cubic yards
Universal Waste Mercury Containing Devices	19 pounds

2.3.7 Fleet Management

Executive Order 13834, *Efficient Federal Operations*, instructs agencies to meet statutory requirements related to energy and environmental performance of vehicles in a manner that increases efficiency, optimizes performance, and reduces waste and costs.

The primary goal for DOE fleet management is to use less petroleum and more alternative fuel, as Figure 2-2 illustrates. SRS has met and exceeded these goals since FY 2000. Figure 2-3 shows SRS FY 2021 performance in meeting key fleet-management goals.

SRS installed two 85% ethanol (E-85) fueling stations in October 1999 and added a third in FY 2015. In FY 1999, the year prior to installing the fueling stations, the Site consumed more than 700,000 gallons of unleaded gasoline and no E-85 alternative fuel. As Figure 2-2 shows, over time SRS has continued to reverse this trend and consume more E-85 while decreasing unleaded gasoline and diesel use. Overall gallons consumed (for all three fuel types) is less than that of the FY 1999 unleaded gasoline consumption.

SRS continues to implement the Site Vehicle Allocation Methodology Plan completed in 2016. This plan helps organizations eliminate fleet vehicles that are unnecessary, oversized, or not fuel-efficient. SRS updates its plan at least every five years. Each year, SRS emphasizes leasing alternative fuel vehicles in the light-duty fleet. In FY 2021, more than 87% of the light-duty fleet ordered used E-85. At the end of FY 2021, SRS managed an inventory of 950 vehicles for DOE, SRNS, and SRR; 827 (87% of the fleet) are

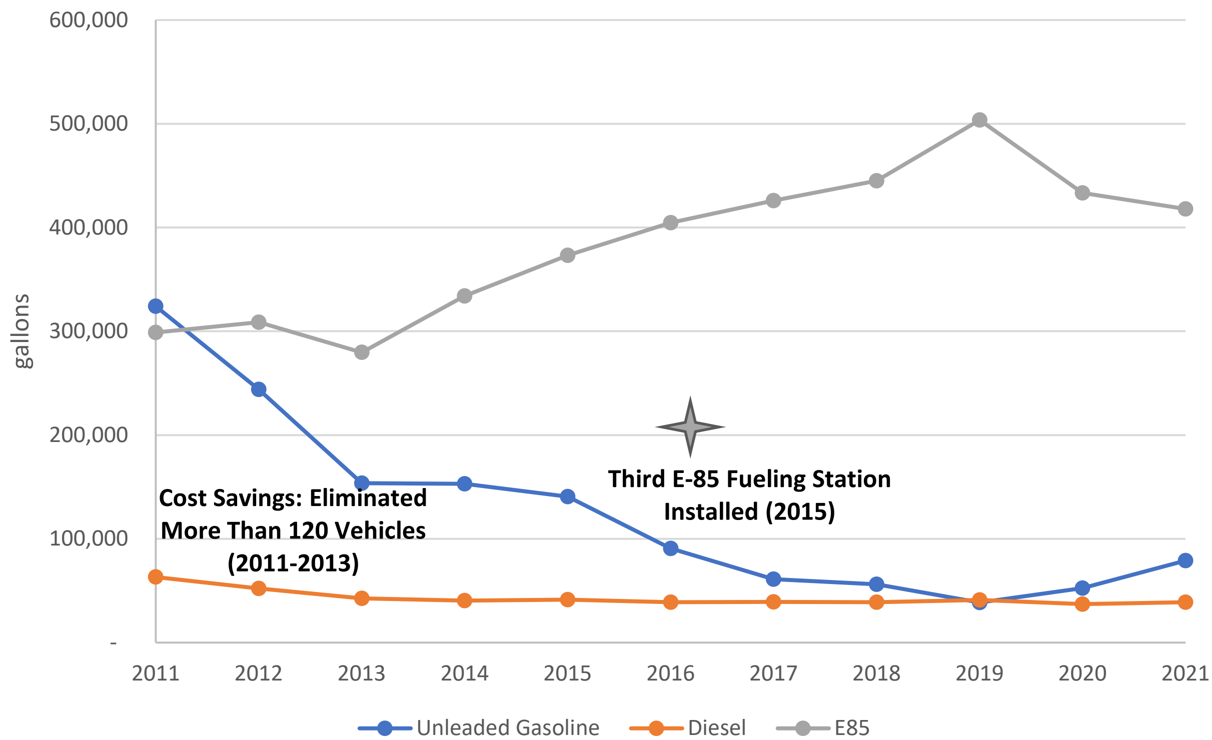
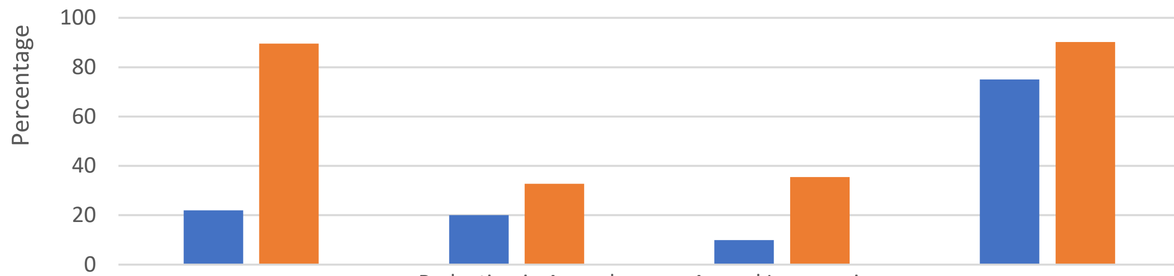


Figure 2-2 GSA Fuel Consumption by Type, FY 2011 to FY 2021



	Fleet-wide Per-mile GHG Emissions (% Reduction by FY 2025)	Reduction in Annual Petroleum Consumption (% Reduction Against FY 2005 Baseline)	Annual Increase in Alternate Fuel Consumption (% Increase Against FY 2005 Baseline)	Percent Light duty Vehicle Acquisitions being Alternate Fuel—FY 2021 Goal
Goal	22	20	10	75
FY 2021	89.5	32.7	35.5	90.2

Figure 2-3 SRS Performance in Meeting Fleet Management and Transportation Goals

either E-85, hybrid, or electric. In FY 2021, SRS ordered 119 vehicles; however, due to the COVID-19 pandemic and impacts to global logistics, the vehicle orders were delayed and only 6 vehicles arrived onsite. Of those ordered, one ethanol and five unleaded vehicles have been received. Of the 113 remaining vehicles, 110 are ethanol and 3 are diesel.

2.3.8 Acquisition and Procurement

Executive Order 13834, *Efficient Federal Operations*, requires agencies to acquire, use, and dispose of products and services (including electronics) according to statutory mandates for purchasing preference, federal acquisition regulation requirements, and other applicable federal procurement policies. DOE's goal is to track and make improvements with targets to be determined. These statutory mandates require purchases to include:

- Products that meet minimum requirements for recycled content as the EPA identifies
- Products that the United States Department of Agriculture (USDA) designates as biobased or BioPreferred®
- Products that the U.S. EPA'S ENERGY STAR® program or the Federal Energy Management Program designate as having the potential to generate significant energy savings

Agencies must also maximize substituting alternatives to ozone-depleting substances identified under the EPA's Significant New Alternatives Policy (SNAP).

SRS procurement personnel review purchase-order line descriptions of eligible contract actions to determine whether the product meets the USDA's definition of BioPreferred®.

Procurement has established sustainable practices related to purchasing environmentally preferable products (EPP) to meet sustainable acquisition requirements. The EPP purchases have led to practices, as outlined below:

- The SRS Chemical Management Center reviews and approves chemical acquisitions. This review monitors hazardous chemicals use and, where appropriate, recommends EPPs.
- SRS has procured EPP substitutions under various new and existing contracts, including bulk janitorial supplies (cleaners, paper products) and safety items (earplugs, filters).

2.3.9 Electronics Stewardship

Executive Order 13834, *Efficient Federal Operations*, instructs agencies to manage electronics to reduce energy and environmental impacts.

SRS implements many strategies to reduce energy use, waste, and costs associated with electronics by:

- Purchasing computers rather than leasing
- Procuring desktops, laptops, and monitors that meet Electronic Product Environmental Assessment Tool (EPEAT) standards and copiers that are ENERGY STAR®-compliant
- Setting up all eligible computers and imaging equipment to automatically print on both sides of paper (duplex printing)
- Programming all eligible desktops, laptops, and monitors to default to power-save mode when in standby

The Site either recycles or reuses electronics in an environmentally sound manner by donating to schools and nonprofit organizations or by recycling through authorized vendors. SRS recently extended the “workstation refresh cycle” from three to five years. This is the timeframe for replacing a computer. A longer timeframe reduces the number of computers being retired and the amount of generated scrap electronics.

2.3.10 Data Center Efficiency

Data centers are energy-intensive operations that contribute to agency energy and water use and costs. Executive Order 13834, *Efficient Federal Operations*, encourages implementing practices that promote managing servers and federal data centers in an energy-efficient manner.

One measure of energy efficiency for data centers is power-usage effectiveness (PUE), which is the ratio of total energy used by a computer data center facility to the energy delivered to the computing equipment. While no specific target PUEs have been set, agencies are collecting data. Of the nine data centers at SRS, two have established the PUEs. Other data centers do not have electrical meters, so determining the PUE is not yet possible.

2.3.11 Resiliency

Executive Order 13834 directs agencies to prioritize actions that enhance the resilience of federal infrastructure and operations. Resilience is the ability of an agency to adapt to changing conditions and withstand or recover from disruptions. SRS ensures that federal operations and facilities can continue to protect and serve citizens in a changing climate. SRS uses global climate model projections and data as the starting point to assess the impact of climate change to Site buildings and outdoor workers and has developed studies that describe its specific threat to Site operations. The SRS Emergency Response Organization also has regularly scheduled facility and sitewide drills and exercises involving accidents, spills, and natural disaster scenarios to better respond and recover from such disruptions should they occur.

2.3.12 Greenhouse Gas Management

Executive Order 13834, *Efficient Federal Operations*, directs agencies to track and report on a variety of performance measures, including greenhouse gas (GHG) emissions. The DOE goal is to continue to track and reduce GHG.

SRS reduces GHG as reported in previous years’ *SRS Environmental Reports*. Scope 1 GHG emissions consist of direct emissions from sources that DOE owns or controls, such as onsite combustion of fossil fuels and fleet fuel consumption. Scope 2 GHG emissions consist of indirect emissions from sources that DOE owns or controls, such as emissions from generating electricity, heat, or steam DOE purchases from a utility provider. Scope 3 GHG emissions are from sources DOE does not own or directly control but are related to DOE activities, such as employee travel and commuting.

The following inventoried sources at SRS currently generate Scope 1 and 2 emissions:

- Purchased electricity
- Wood (biomass)
- Fuel oil
- Propane
- Gasoline
- Diesel
- E-85 (ethanol)
- Jet fuel
- Fugitive emissions

Biomass Cogeneration Facility

SRS continues to substantially reduce Scope 1 and 2 GHGs due to Biomass Cogeneration Facility and three additional biomass facilities, one each in A Area, L Area, and K Area. DOE tracks GHG data from various impact sources (such as Site energy use, alternative workplace arrangements and space optimization, as well as vehicle and equipment use). SRS continues to reduce Scope 3 GHG emissions by such efforts as using webinars and conference calls to reduce business travel and by promoting employee carpooling. Increased employee teleworking due to the COVID-19 pandemic also contributed to reducing Scope 3 GHG emissions.

2.4 EMS BEST PRACTICES

2.4.1 2021 DOE Sustainability Awards: The P-Area Permeable Reactive Barrier Wall Project Receives Recognition

The P-Area Permeable Reactive Barrier (PRB) project received a DOE Sustainability Award Recognition in the Innovative Approach to Sustainability Category. This project is one of only three DOE Environmental Management (DOE-EM) projects that DOE Headquarters recognized during a Sustainability Awards Ceremony that was part of the Energy Facility's Contractors Group's (EFCOG's) Sustainability and Environmental Subgroup annual (virtual) meeting on August 19, 2021.

SRS uses an innovative remedial technology known as a permeable reactive barrier (PRB) to treat contaminated groundwater. The PRB is constructed of zero-valent iron (ZVI) from recycled engine blocks and injected into the subsurface to intercept and destroy solvent contamination in the groundwater as it passes through the barrier. The groundwater contamination that is being remediated is associated with the closed P-Area Reactor facility. The PRB works passively for decades in the subsurface with no moving parts. It is anticipated that the PRB will provide energy and project cost savings of more than $35 million over three decades of operation.

Regulators included SCDHEC's FFA personnel out of the Aiken and Columbia Offices and U.S. EPA-Region IV.

2.4.2 Sustainability Campaign

SRS continues to implement its "One Simple Act of Green" environmental awareness campaign. The program empowers SRS employees with the information, tools, and programs needed to reduce the Site's footprint on the environment. Employees practice simple acts, such as turning off lights when leaving a room or workspace, which promote environmental stewardship.

2.4.3 Earth Day

For 2021, SRS chose the Earth Day theme "Restore our Earth." Due to the COVID-19 pandemic, SRS was unable to hold an onsite Earth Day celebration. However, an SRS video featured interviews with DOE-EM, National Nuclear Security Administration (NNSA), and SCDHEC personnel, who shared what each employee could do as their responsibility at work and at home to help restore and maintain the plan.

2.4.4 Reuse or Recycling of Equipment and Materials

SRS is partnering with Savannah River Site Community Reuse Organization (SRSCRO) to turn excess equipment and material into money to benefit the Aiken, Allendale, and Barnwell counties in South Carolina and Richmond and Columbia counties in Georgia. Surplus material includes the following:

- Small items such as office equipment, valves, and glassware for laboratory experiments
- Large items of potentially much greater value such as electrical turbines, diesel-powered pumps, and fire engines
- Hundreds of thousands of tons of metal

The SRSCRO is the interface organization that takes in items that the Site no longer needs through the Asset Transition Program and Asset Removal Projects. The SRSCRO sells these items and uses the proceeds for the economic good of numerous businesses throughout the large region surrounding SRS. In FY 2021, SRS dispositioned to the SRSCRO more than $14.6 million in usable assets for reuse and recovery. Based on the SRSCRO's 2021 annual report, this partnership's program and projects generated approximately $472,154 during the organization's fiscal year (July 1, 2020—June 30, 2021).

2.4.5 Sustainable Environmental Compliance and Environmental Remediation

SRS continues to excel in sustainable remediation. Of the 40 remediation systems currently operating, 21 are completely passive, requiring no energy to implement, and 14 are low-energy systems. These low-energy systems use sustainable technologies (such as solar-powered MicroBlowers and barometric pressure-driven BaroBalls™) to pump volatile organic contaminants from the subsurface, thus reducing contamination. SRS is also using the HydraSleeve sampling methodology for more than 251 wells, which significantly reduces the volume of purge water managed as waste.

In 2021, SRS continued monitoring to ensure the effectiveness of the lower-energy, innovative methods to address groundwater cleanup implemented in 2019. These included:

- Injecting a vegetable-oil microbe mixture into the subsurface to intercept a groundwater plume and break down trichlorethylene (TCE)
- Injecting recycled iron into a series of wells to form a permeable reactive barrier that intercepts the groundwater plume and breaks down TCE

Both examples use the natural flow of the groundwater plume, so the systems are low energy and do not require pumps or equipment to move groundwater. SRS anticipates the vegetable oil to be effective for three to five years before it needs to reinject into the subsurface, and the iron by design is effective for decades with little maintenance.

A Subcontractor Loads Zero-Valent Iron Filings during Injections to Support Installation of the P-Area Reactive Barrier

SRS deploys innovative methods to address compliance efforts. Initiated in 2018, SRS continues to implement a commercially available Comprehensive Environmental Permits Linking Tool (CEPLT) to ensure SRS meets regulatory and DOE commitments. Features of the CEPLT include tracking permit requirements and conditions and associated regulatory commitments, notification of upcoming regulatory documents and reports due, and display of permit requirements and tasks on a map at the associated compliance point (for example, outfall, landfill). SRS expanded the CEPLT in 2021 to include other Site tenants.

SRS continues to use remotely operated devices (drones and wireless stormwater sampling equipment) discussed in *SRS Environmental Reports* from previous years. Not only do these devices address environmental compliance, improve worker safety, and increase productivity, but they also decrease vehicle and fuel use, thereby supporting fleet management goals.

SRS provided input on all seven focus areas in DOE's *"Conservation Action Plan"* and its driver, Executive Order 14008, *"Tackling the Climate Crisis at Home and Abroad."* The plan's focus areas are:

- Create more parks and safe outdoor opportunities in nature-deprived communities
- Support tribally led conservation and restoration priorities
- Expand collaborative conservation of fish and wildlife habitats and corridors
- Increase access for outdoor recreation
- Create jobs by investing in restoration and resilience
- Incentivize and reward the voluntary conservation efforts of fishers, ranchers, farmers, and forest owners
- Other action supportive of the "America the Beautiful" campaign

The "America the Beautiful" plan is a national collaborative with a goal to conserve and restore lands, waters, and wildlife that support and sustain the nation. It covers environmental, natural, and cultural resources highlighting objectives, planning, actions taken, collaborations and partnerships, and metrics used to track progress.

2.4.6 Challenges and Barriers to Implementation

In 2021, SRS continued to conserve and manage resources to meet the sustainability goals in the Site Sustainability Plan. However, infrastructure continually presents challenges to initiating sustainable projects. Achieving new goals is becoming significantly difficult with the high cost of implementing sustainability upgrades at SRS's many aging facilities (administrative, shops, laboratories, warehouses). SRS reduces potable water use by continuing to install water-efficient toilet systems when repairs indicate the need. However, sitewide retrofitting with low-flow flush valves and faucets is not cost-effective. Likewise, SRS reduces energy intensity when possible in maintenance and repair situations through such actions as replacing fluorescent lighting with more efficient LED lighting, replacing HVAC systems with higher Seasonal Energy Efficiency Ratio (SEER) units, and rightsizing pumps. Retrofitting entire buildings or systems is not typically cost-effective. Sustainability efforts related to energy management will require additional guidance as SRS conducts EISA audits for Site infrastructure and performs feasibility studies on possible energy projects with limited resources and competing priorities. While the interim energy intensity goal was met in FY 2021, this is likely due to the impacts of the COVID-19 pandemic and teleworking. Following the return of the workforce onsite after COVID-19, it is expected that meeting reduction of energy intensity goals will continue to be a challenge as before the COVID-19 pandemic.

In 2021, SRS identified the following program challenges while implementing the latest version (2015) of the ISO 14001 standard:

- SRNS and SRR ISO 14001:2015 environmental scope and policy
- The criteria for determining significant environmental aspects could be more rigorously defined
- Sustainability could be more systematically integrated in the EMS and should be more organizationally focused in the EMS(s)
- Conformance to ISO 14001:2015 programmatic requirements could be enhanced by increasing the number of responsible personnel trained for ISO 14001:2015 implementation.

This work continued in 2021 as SRS integrated and promoted awareness of the EMS principles in daily work practices.

The Site will continue to study, track, and discuss the sustainability requirements to ensure implementation. For example, as discussed previously, while SRS is inserting sustainable acquisition clauses in all applicable solicitations, there is work to be done tracking sustainable acquisition purchases (BioBased, SNAP, and others). SRS continues to determine and implement ways to increase end-user awareness of sustainable acquisitions.

Chapter 3: **Compliance Summary**

The Savannah River Site (SRS) implements programs to meet the requirements of applicable federal and state environmental laws and regulations, as well as U.S. Department of Energy (DOE) Orders, notices, directives, policies, and guidance. The Site's goal is to comply with regulatory requirements and eliminate or minimize any environmental impacts. SRS has a decades-long commitment to environmental compliance and protecting human health and the environment.

2021 Highlights

COVID-19 Pandemic

- SRS continued to be proactive in managing COVID-19 pandemic impacts.
- All environmental compliance reports and documents were submitted to the South Carolina Department of Health and Environmental Control (SCDHEC) or the U.S. Environmental Protection Agency (EPA), as required.
- SRS maintained full regulatory compliance.

Permitting

SRS managed 532 operating and construction permits. SRS did not receive any Notices of Violation (NOVs).

Remediation (Environmental Restoration and Cleanup)

As of December, SRS completed the cleanup of 412 of the 515 waste units containing or having contained solid or hazardous waste. An additional eight waste units are currently being remediated.

Radioactive Waste Management

- The annual reviews for the E-Area Low-Level Waste (LLW) Facility Performance Assessment (PA) and the Saltstone Disposal Facility (SDF) PA showed that SRS continued to operate these facilities in a safe and protective manner.
- SRS sent eight transuranic (TRU) waste shipments to the Waste Isolation Pilot Plant (WIPP) for deep geologic disposal.

Resource Conservation and Recovery Act (RCRA)

- On November 30, SCDHEC issued the Final Permit Decision for hazardous waste activities at the
  - M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities (HWMFs)
  - F-Area HWMF
  - H-Area HWMF
  - Solvent Storage Tanks (SSTs) Facility

2021 Highlights (continued)

The permit also addressed the postclosure care period for the Mixed Waste Management Facility (MWMF) and two solid waste management units. This permit decision became effective on December 15.

- SCDHEC conducted the unannounced RCRA Compliance Evaluation Inspection (CEI) for fiscal year (FY) 2021 at selected RCRA facilities on July 27. The inspection did not reveal any deficiencies.
- The EPA and SCDHEC conducted the unannounced RCRA CEI for FY 2022 at select RCRA facilities on December 1-2. The inspection noted one deficiency that was corrected on the spot.
- SCDHEC performed a Comprehensive Groundwater Monitoring Evaluation on September 28, inspecting groundwater monitoring systems and corrective actions at the M-Area and Metallurgical Laboratory HWMFs, Sanitary Landfill, MWMF, and F- and H-Area HWMFs. The inspection did not note any deficiencies.
- The SCDHEC annual underground storage tank (UST) inspection on December 16 found that all 17 of the USTs were in compliance.

Air Quality and Protection

- SRS met all Clean Air Act (CAA) requirements.
- SCDHEC issued the Air Operating Permit (Title V) for Air Quality and Protection for the Site on January 19 with an effective date of April 1, 2021.

Water Quality and Protection

- All 36 SRS Industrial stormwater outfalls in the General Permit covered under the Site's Stormwater Pollution Prevention Plan (SWPPP) complied with plan requirements. The SWPPP describes how SRS prevents contamination and controls sedimentation and erosion.

Radiation Protection of the Public and the Environment

- SRS air and water discharges containing radionuclides were well below the DOE public dose limit of 100 millirem (mrem) per year. (Chapter 6, *Radiological Dose Assessment*, explains the public dose.)

Environmental Protection and Resource Management

- SRS conducted 966 National Environmental Policy Act (NEPA) reviews to identify potential environmental impacts from proposed federal activities. SRS identified 875 of these as Categorical Exclusions (CXs) that did not require action from the Site under NEPA.

2021 Highlights (continued)

- SRS continued to comply with many other federal laws, including the Emergency Planning and Community Right-to-Know Act (EPCRA); the Superfund Amendments and Reauthorization Act (SARA), Title III; the Endangered Species Act (ESA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); the National Historic Preservation Act (NHPA); and the Migratory Bird Treaty Act (MBTA).

Release Reporting

- SRS reported one release exceeding the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Reportable Quantity (RQ). A polyvinyl chloride (PVC) pipe valve leak led to a release of 1,773.3 pounds of sodium hydroxide; the RQ is 1,000 pounds. Absorbent pads were used at the leak site and were properly disposed. SCDHEC and the National Response Center were notified at the time as required. The regulatory agencies did not require further action. More information on the release is in Section 3.3.9.

External Environmental Audits and Inspections

- The EPA and SCDHEC conducted audits, inspections, and site visits to various SRS environmental programs to ensure regulatory compliance. The Federal Energy Regulatory Commission (FERC) performed a dam safety inspection in September.
- The third-party audit of the Environmental Management System (EMS) was performed in April. The audit results were satisfactory with DOE declaring the EMS conformant to the International Organization for Standardization (ISO) 14001:2015 Standard.

Tank Closure (Radioactive Liquid Waste Processing and Dispositioning)

- The Salt Waste Processing Facility (SWPF) treated more than 2 million gallons of salt solution.
- More than 3.14 million gallons of waste was processed into grout and disposed of in the SDF.
- The Defense Waste Processing Facility (DWPF) filled 62 canisters with 230,000 pounds of glass waste mixture, immobilizing 1.06 million curies (Ci) of high-level radioactive waste.
- The H-Area Effluent Treatment Project (ETP) processed approximately 7.25 million gallons of treated wastewater.

3.1 INTRODUCTION

Complying with environmental regulations and DOE Orders is integral to SRS operations. This chapter summarizes how SRS complies with applicable environmental regulations and programmatic requirements.

3.2 FEDERAL FACILITY AGREEMENT

The 1993 *Federal Facility Agreement (FFA) for the Savannah River Site*, a tri-party agreement between DOE, the EPA, and SCDHEC, integrates CERCLA and RCRA requirements to achieve a comprehensive remediation strategy and to coordinate administrative and public participation requirements. The FFA governs remedial actions, sets annual work priorities, and establishes milestones for cleanup and tank closure. SRS conducts remediation and closure activities as the FFA identifies and in accordance with applicable regulations, whether they are from the state, the federal government, or both. Additional information regarding FFA commitments discussed in this section can be found on the SRS and Savannah River Remediation (SRR) web pages.

3.2.1 Remediation (Environmental Restoration and Cleanup)

SRS has 515 waste units subject to the FFA, including RCRA and CERCLA units, site evaluation areas, and facilities the SRS RCRA permit covers. At the end of FY 2021, SRS had completed the surface and groundwater cleanup of 412 of these units and was in the process of remediating an additional 8 units. Appendix C, *RCRA/CERCLA Units List*; Appendix G, *Site Evaluation List*; and Appendix H, *Solid Waste Management Units* of the FFA list all of SRS's 515 waste units. The *Federal Facility Agreement Annual Progress Report for Fiscal Year 2021* explains the status of FFA activities at SRS for FY 2021.

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan require remedy reviews every five years for sites that have hazardous substances remaining at levels that do not allow for unrestricted use of the area after a remedy is in place. Due to the rising number of SRS remedial decisions requiring five-year remedy reviews and new EPA guidance and format requirements, DOE, the EPA, and SCDHEC agreed in 2014 to submit future SRS Five-Year Remedy Review Reports in a phased approach rather than combining all operable unit (OU) reviews into a single document. The OUs are in groups of the following five remedy types: 1) native soil cover or land-use controls, or both; 2) groundwater remedies; 3) engineered cover systems; 4) geosynthetic or stabilization and solidification cover systems; and 5) operating equipment. To ensure that SRS completes reviews of all remedy types within five years, it looks at a different remedy type each year. The Site evaluates remedies to determine whether they are functioning as designed and are still protecting human health and the environment.

SRS prepared the following reports to satisfy CERCLA requirements:

- *Sixth Five-Year Remedy Review Report for Savannah River Site Operable Units with Engineered Cover Systems*: The EPA and SCDHEC approved it on July 7 and July 27, respectively. SRS issued it to the public on December 21.
- *Sixth Five-Year Remedy Review Report for Savannah River Site Operable Units with Geosynthetic or Stabilization/Solidification Cover Systems*: DOE submitted it to SCDHEC and the EPA on December 15.

SRS issued the Record of Decision (ROD) for an Integrator Operable Unit (IOU) and is conducting a treatability study to aid in remediating the D-Area groundwater.

Lower Three Runs Integrator Operable Unit

DOE, SCDHEC, and EPA signed the ROD Remedial Alternative Selection for the Lower Three Runs (LTR) IOU, and it was issued to the public on December 21. This is the first IOU ROD agreed upon between SRS, the regulators, and the public. It is significant because it is also the first ROD to outline the final closure for a large parcel of stream systems. During 2022, SRS will submit two post-ROD documents to SCDHEC and the EPA for review and comment. These documents will be approved before scheduled Remedial Action start in April 2023.

LTR is a large stream that originates in the northeast portion of SRS (just above P and R Reactor [PAR] Pond) and winds its way along a southerly direction for approximately 25 miles, discharging into the Savannah River. The corridor consists of PAR Pond, 9 miles of canals adjacent to the pond, and the LTR stream system.

The LTR IOU is the surface water body and associated wetlands and floodplains that correspond to the LTR watershed (Figure 3-1). The LTR IOU is delineated into Upper, Middle, and Lower subunits for administrative purposes. The Upper subunit is upgradient of the PAR Pond Dam and includes PAR Pond, Pond B, and the precooler ponds and canal system that served the P- and R-Area Reactors during their operation (Figure 3-2). The Middle and Lower subunits are below the PAR Pond Dam.

The ROD agreement specifies what protective and cleanup actions are required, along with assurances of long-term monitoring to ensure the corridor remains within environmentally safe standards. This ROD acknowledges the successful completion of a comprehensive SRS cleanup strategy following the decommissioning and closure of both P and R Areas. P and R Reactor facility operations contributed to the LTR stream corridor contamination.

D-Area Groundwater Treatability Study

SRS began implementing a groundwater treatability study in D Area to reduce the acidic conditions in groundwater. The coal being stored in the former 484-17D D-Area Coal Storage Area and its runoff into the 489-D Coal Pile Runoff Basin caused the acidic conditions. The groundwater beneath and downgradient of these areas has been acidified and will continue to be so even though the coal was removed from 2012 to 2013.

Flange on Injection Well Head

A low pH environment, which is expected to last for decades under natural groundwater conditions, has impacted the vadose zone and the groundwater in this area. The low-pH groundwater is currently outcropping into the D-Area Effluent Discharge Canal, which later converges with Beaver Dam Creek and flows through the Savannah River Floodplain to the Savannah River. If the pH of the aquifer can be raised to be more natural and less acidic, the groundwater and surface water conditions in the D-Area Effluent Discharge Canal would improve. This study is testing the viability of a two-prong remediation:

- Using injection wells to add potable water with a higher pH, sourced from production wells in D Area, into the aquifer upgradient of the plume. The injected production well water will aid in neutralizing acidic conditions currently present in the water table aquifer and will create a hydraulic head that will displace the low-pH groundwater within in the aquifer.
- Treating the low-pH surface water that outcrops into the D-Area Effluent Discharge Canal by adjusting the pH with calcium carbonate ($CaCO_3$) reactive structure(s) within the canal

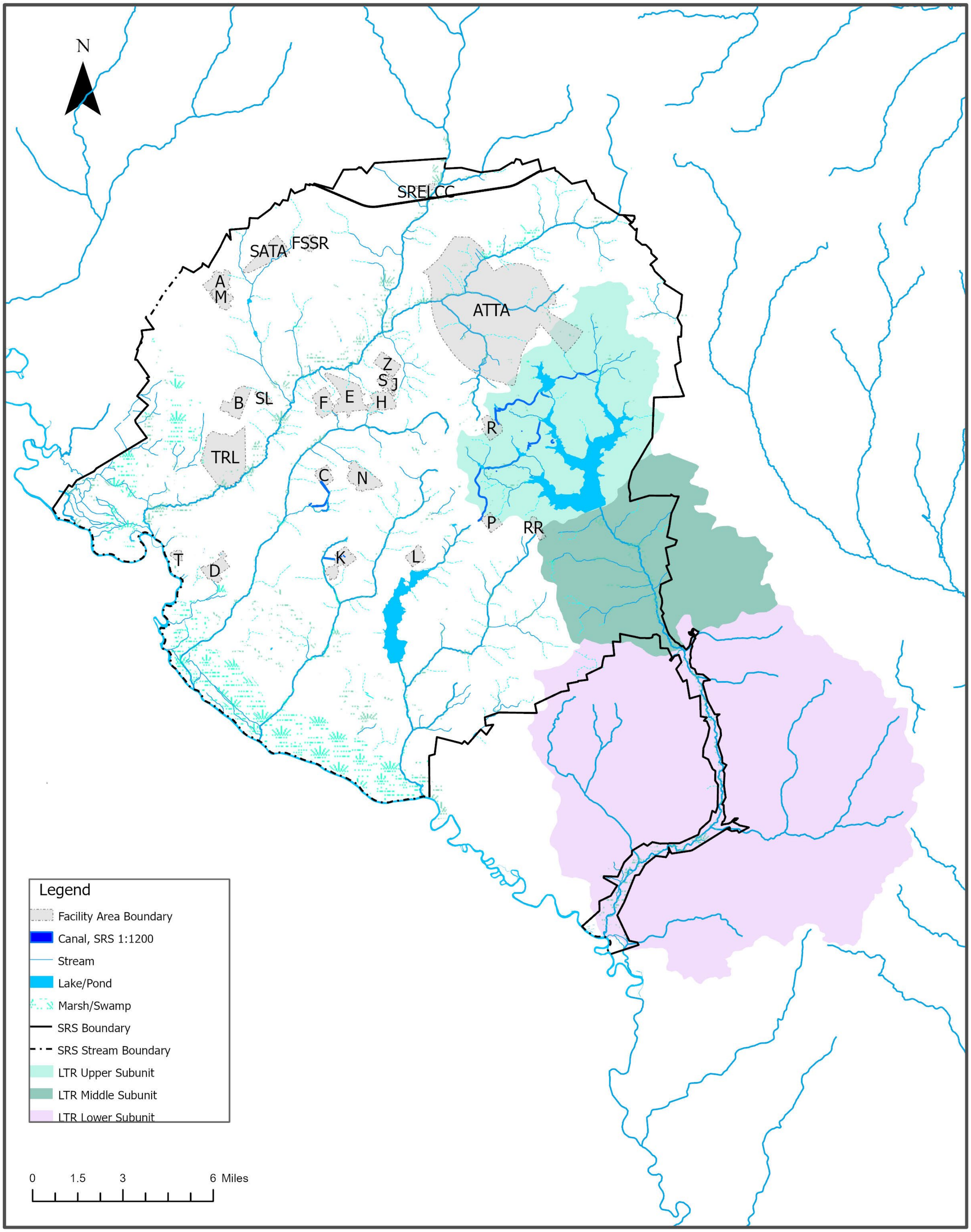


Figure 3-1 Lower Three Runs IOU (Upper, Middle, and Lower Subunits)

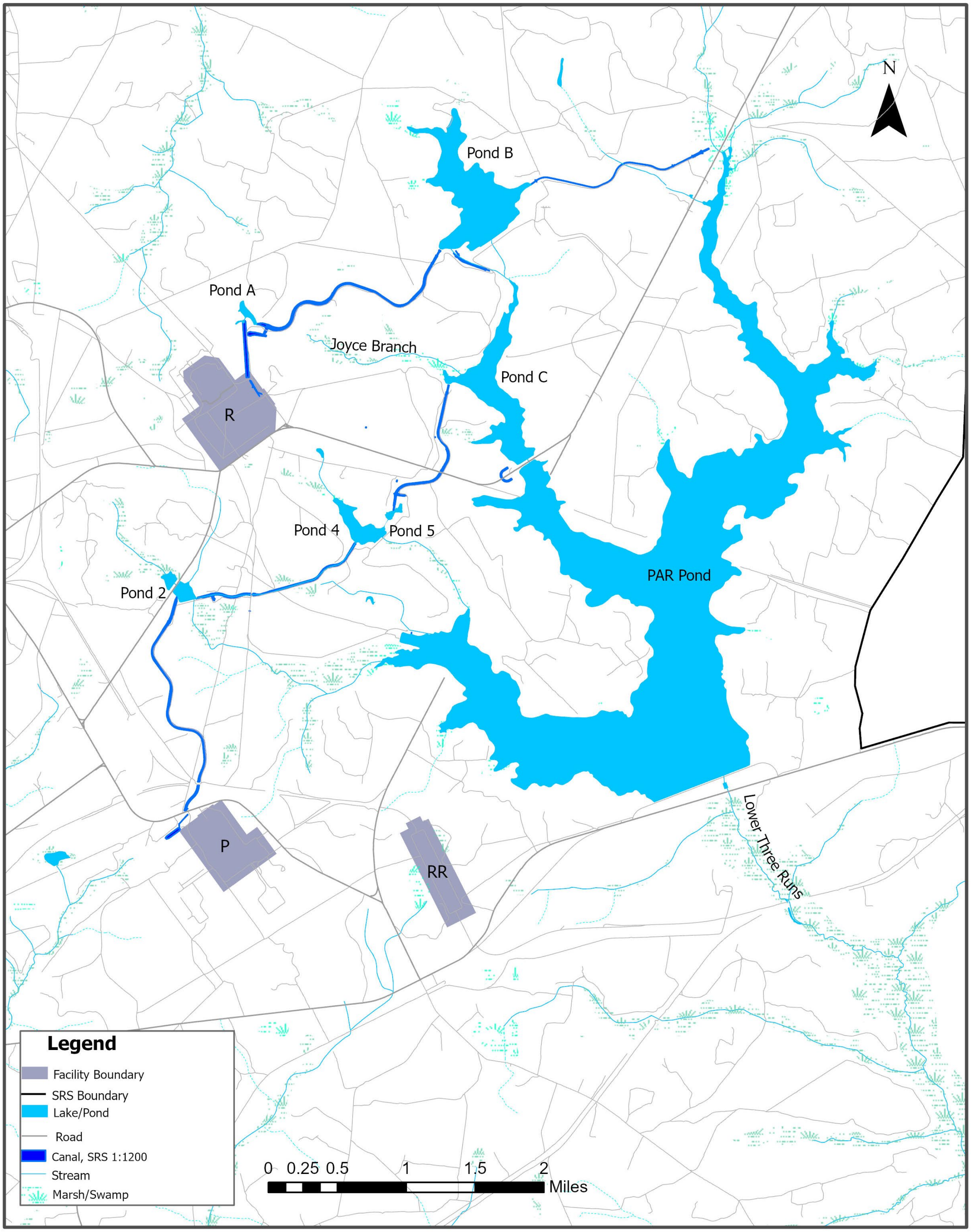


Figure 3-2 Lower Three Runs IOU (Upper Subunit)

Artesian Well

Pipe Run Looking South

To date, SRS has installed 10 injection wells, including 5 new wells during 2021. Installation of the piping network to deliver the artesian groundwater to the injection wells will be completed in 2022. SRS continues to monitor and evaluate the effects of the $CaCO_3$ reactive structures in raising the pH of the groundwater seep as it is conveyed through the D-Area Effluent Discharge Canal.

3.2.2 Tank Closure (Radioactive Liquid Waste Processing and Dispositioning)

SRS generates liquid radioactive waste as a byproduct of processing nuclear materials. The waste is stored in underground waste tanks in F Area and H Area grouped into two tank farms (F-Tank Farm and H-Tank Farm). While in the tanks, sludge settles on the bottom of the tank, and a liquid salt waste rises to the top. The waste removed from the tanks feeds the sludge and salt waste processing programs, as Figure 3-3 depicts.

3.2.2.1 Tank Closure

SRS operates F-Tank Farm and H-Tank Farm under SCDHEC industrial wastewater regulations; however, FFA Section IX, *High-Level Radioactive Waste Tank System(s)*, establishes requirements to prevent and mitigate releases from these tank systems. The FFA also contains enforceable closure schedules for the liquid waste tanks. Tank closures are subject to DOE Order 435.1, *Radioactive Waste Management*; federal regulations; and Section 3116 of the *Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005.*

NDAA Section 3116(a) is legislation that allows the Secretary of Energy to consult with the Nuclear Regulatory Commission (NRC) to determine that certain waste from spent fuel reprocessing is not high-level radioactive waste and does not need to be disposed of in a deep geologic repository. The NRC coordinates with SCDHEC to monitor the steps DOE takes to dispose of the waste to assess whether it is complying with the performance objectives of 10 Code of Federal Regulations (CFR) Part 61, Subpart C. Additionally, the EPA may participate in the NRC's monitoring. *Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site* (DOE 2012) and *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site* (DOE 2014) demonstrate that the stabilized tanks and ancillary structures in F-Tank Farm and H-Tank Farm meet the necessary criteria and will not need to be permanently isolated at a deep geologic repository.

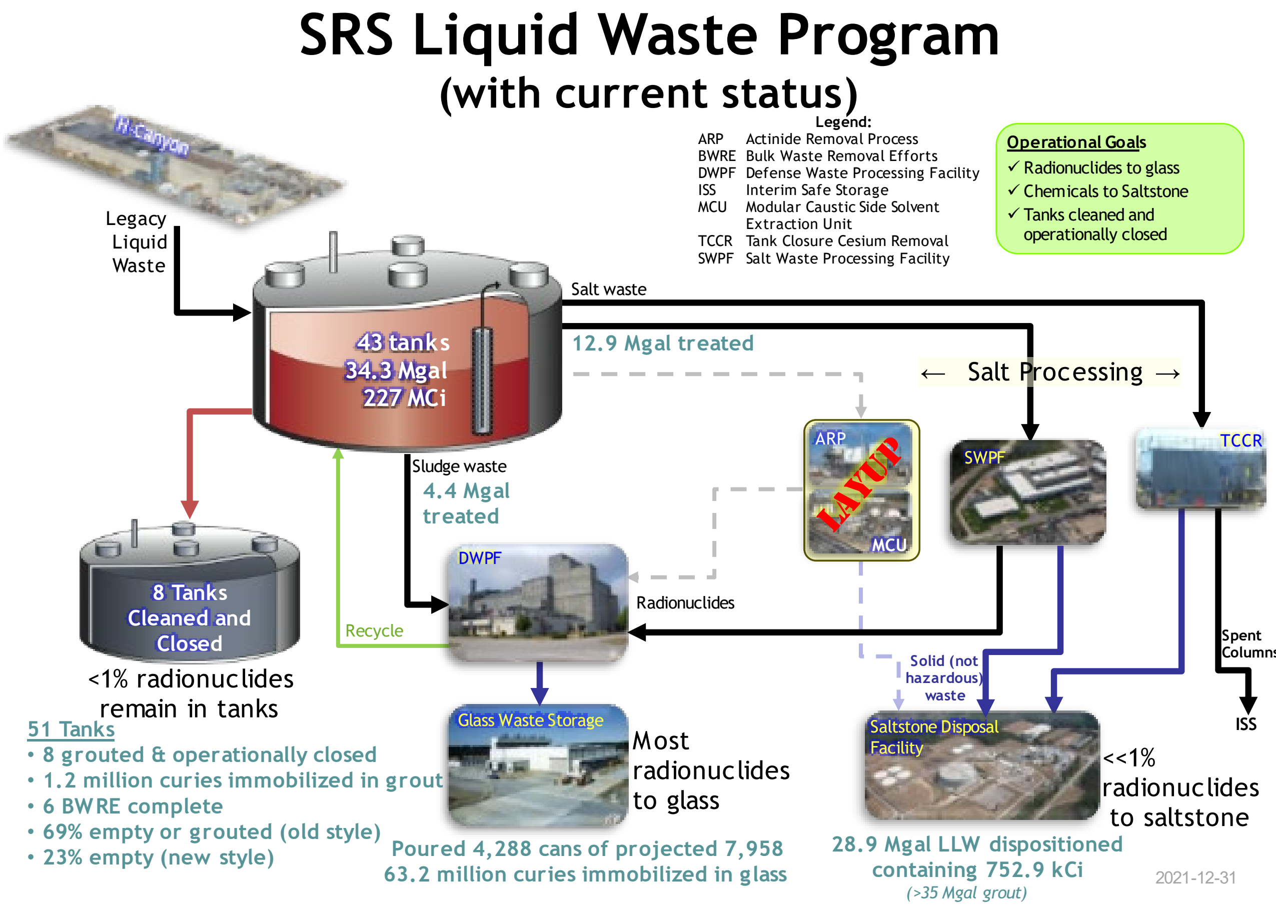


Figure 3-3 Processing and Dispositioning Radioactive Liquid Waste at SRS

During 2021, DOE supported the NRC in its monitoring role of F-Tank Farm and H-Tank Farm under Section 3116 of the NDAA by providing routine documentation (for example, groundwater monitoring reports, PA maintenance plan), as the NRC requested. The NRC did not conduct any onsite observation visits for F-Tank Farm and H-Tank Farm in 2021. Prior to SRS closing the tanks, they undergo an extensive waste removal process that includes specialized mechanical cleaning and isolation from the waste transfer and chemical systems. Once these steps are complete, DOE receives regulatory confirmation that the tanks are ready to be stabilized by grouting.

The first step in this process is Bulk Waste Removal Efforts (BWRE). Preparing for BWRE is typically a multiyear engineering and waste removal process that involves installing specialized equipment that meets strict nuclear safety standards. There were no BWRE or other FFA tank closure commitments required for 2021, and follow-up negotiations are scheduled to be completed in 2022 for additional BWRE and tank closure milestones.

Internal Grouting of FDB-6

In 2021, SRS made significant progress towards the first operational closures of ancillary structures in F-Tank Farm and H-Tank Farm. Internal grouting of F-Area Diversion Box (FDB)-5 was completed in 2021, and internal grouting of FDB-6 was initiated and will be complete in 2022. SRS has an FFA commitment to operationally close these two structures by the end of 2022.

3.2.2.2 Salt Processing

SRS is using several processes to dispose of the salt waste from the liquid waste tanks, as Figure 3-3 shows. The Actinide Removal Process and Modular Caustic Side Solvent Extraction Unit (ARP/MCU) was an interim salt waste processing system. SCDHEC permitted the ARP/MCU under South Carolina industrial wastewater regulations. The salt form of the liquid waste is 90% of the waste volume stored in the tanks and contains about half of the radioactivity. Before SWPF, the ARP/MCU process removed actinides, strontium, and cesium from the salt waste taken from F-Tank Farm and H-Tank Farm. The facilities underwent lay-up activities to be placed in a safe, stable suspended operations state in 2019, which allowed SRS to complete final SWPF tie-ins. The ARP/MCU has remained in a suspended operations state since that time.

With the construction phase of the SWPF project complete, SRS received approval to begin facility operation in 2020. Hot commissioning of SWPF was completed in January 2021, and Parsons Corporation, which designed and built the first-of-a-kind facility, began its one year of operations on January 17, 2021. SWPF processed more than 2 million gallons of salt solution in 2021.

SRS procured the Tank Closure Cesium Removal (TCCR) system to treat salt waste, increase salt processing capability, and to expedite tank closure. The Site completed TCCR design and fabrication in 2017, and installation and readiness assessments in 2018. The TCCR started operating in January 2019. It did not process any salt solution in 2021.

3.2.2.3 Salt Disposition

After ARP/MCU and TCCR interim processing, the decontaminated salt solution is processed into grout waste at the Saltstone Production Facility and disposed of in the SDF. SCDHEC permits the SDF to operate under South Carolina solid waste industrial landfill regulations. SRS disposes of treated low-level salt waste in the SDF, based on the Secretary of Energy's determination pursuant to *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site* (DOE 2006). NDAA Section 3116(b) requires the NRC, in coordination with SCDHEC, to monitor the disposal actions DOE takes to assess whether it is complying with the objectives of 10 CFR Part 61.

Construction in Progress on SDU-8 and SDU-9

During 2021, DOE supported the NRC monitoring the SDF under Section 3116 of the NDAA by providing routine documentation (for example, groundwater monitoring reports, PA maintenance plan), as the NRC requested. The NRC conducted one onsite observation visit for salt waste disposal during 2021.

In 2021, SRS continued permanently disposing of waste, processing more than 3.14 million gallons into grout and disposing of it in cylindrical concrete Saltstone Disposal Units (SDUs), including SDU-6, which is a 32.8 million-gallon, 375-foot in diameter rubber-lined mega-vault. In 2021, SRS completed SDU-7, another mega-vault, and continued constructing the next two mega-vaults, SDU-8 and SDU-9.

3.2.2.4 Sludge Waste Processing—Vitrification of High-Activity Waste

SCDHEC permits DWPF to operate under South Carolina industrial wastewater regulations. The sludge waste makes up less than 10% of the waste volume stored in the tanks and contains about half of the radioactivity, as Figure 3-3 shows. At DWPF, SRS combines the high-activity portion of both the sludge and salt waste from F-Tank Farm and H-Tank Farm with frit before sending the mixture to the plant's melter. The melter heats the mixture to nearly 2,100 degrees Fahrenheit, until molten, and pours the resulting glass-waste mixture into stainless steel canisters to cool and harden. This process, called "vitrification," immobilizes the radioactive waste into a solid glass form suitable for long-term storage and disposal. SRS stores these canisters temporarily in the Glass Waste Storage Buildings to prepare for final disposal in a federal repository.

DWPF produced 62 canisters collectively containing 230,000 pounds of glass and immobilizing 1.06 million Ci of radioactivity during 2021. Since DWPF began operating in March 1996, it has produced more than 4,288 canisters, collectively containing 16.6 million pounds of glass and immobilizing 63.2 million Ci of radioactivity.

3.2.2.5 Low-Level Liquid Waste Treatment

The H-Area ETP treats low-level radioactive wastewater from F-Tank Farm and H-Tank Farm. ETP removes chemical and radioactive contaminants from the water before releasing it into Upper Three Runs Creek, an onsite stream that flows to the Savannah River. The point of discharge is a South Carolina National Pollutant Discharge Elimination System (NPDES)-permitted outfall. ETP processed approximately 7.25 million gallons of treated wastewater in 2021. SCDHEC permitted ETP under the South Carolina industrial wastewater regulations. ETP remained in compliance with the industrial wastewater permit and the NPDES permit throughout 2021.

3.3 REGULATORY COMPLIANCE

This section summarizes how SRS complies with the applicable federal and state environmental laws and regulations.

3.3.1 Atomic Energy Act/DOE Order 435.1, *Radioactive Waste Management*

SRS waste and materials management is complex and includes numerous facilities that DOE Orders and federal and state regulations govern. DOE Order 435.1 covers all radioactive waste management (LLW, high-level waste [HLW], and TRU waste) to protect the public, workers, and the environment. LLW is the only radioactive waste SRS disposes of onsite, at the E-Area LLW Facility and the SDF. LLW is radioactive waste not classified as HLW or TRU waste and not containing any RCRA hazardous waste.

DOE Manual 435.1-1, *Radioactive Waste Management Manual,* requires DOE to prepare PAs to evaluate the potential impacts of low-level radioactive waste disposal and closure activities (for example, F-Tank Farm and H-Tank Farm) to the workers, the public, and the environment. The PAs provide the technical basis and evaluation needed to demonstrate compliance with DOE Order 435.1. The order also requires a composite analysis (CA) to assess the combined impact of multiple LLW disposal facilities and other interacting sources of radioactive material after closure.

TRU Drum Ready for Characterization in Real-time Radiography Unit

SRS performs a comprehensive annual PA review for disposal facilities. This review ensures any developing information does not alter the original PA conclusions and that there is a reasonable expectation the facility will continue to meet the performance objectives of the DOE Order. In addition, SRS performs an annual CA review to evaluate the adequacy of the 2010 SRS CA and verify that SRS conducted activities within the bounds of the 2010 analysis. The FY 2020 annual reviews for the E-Area Solid Waste Management Facility, the SDF, and the SRS CA determined that SRS continues to comply with the performance objectives of DOE Order 435.1. Based on the reporting and approval cycle for the PA and CA annual reviews, there is a one-year lag in reporting this information in the annual *SRS Environmental Report.*

TRU waste is another category of radioactive waste that SRS generates. DOE Orders define TRU waste as waste containing more than 100 nanocuries of alpha-emitting TRU isotopes (elements with atomic numbers greater than uranium) per gram of waste with radiological half-lives greater than 20 years. At SRS, TRU waste consists of job waste such as clothing, tools, rags, residues, debris, and other items contaminated with trace amounts of plutonium. SRS sends its TRU waste to WIPP, a deep geologic repository located near Carlsbad, New Mexico for permanent disposal. Many different federal and state agencies (the EPA, NRC, DOE, and the State of New Mexico), along with multiple regulations, govern TRU waste management and disposal. SRS manages TRU waste under DOE Orders and federal and state hazardous waste regulations. SRS sent eight TRU shipments to WIPP for disposal in 2021.

3.3.2 Resource Conservation and Recovery Act (RCRA)

RCRA establishes regulatory standards to generate, transport, store, treat, and dispose of solid waste, hazardous waste (such as flammable or corrosive liquids), and USTs. SRS has a RCRA hazardous waste permit, multiple solid waste permits, and multiple UST permits, as Section 3.3.10 identifies.

Capping the SSTs

3.3.2.1 <u>Hazardous Waste Permit Activities</u>

Under RCRA, the EPA establishes requirements for treating, storing, and disposing of hazardous waste. EPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste, and issue permits to implement RCRA.

Through the SCDHEC-issued RCRA hazardous waste permit, SRS closed the referenced SSTs S33–S36 and submitted the final certification of closure to SCDHEC in October 2019. In November 2020, SCDHEC conducted the onsite verification of the closure. SCDHEC recognized that SRS had satisfied the conditions of the approved closure plan in early 2021. The SST Facility was added to the postclosure portion of the SRS Hazardous and Mixed Waste Permit issued by SCDHEC on November 30 (effective on December 15). This section of the permit requires the SST Facility to submit a postclosure plan to SCDHEC by December 2022. Until final closure, the area surrounding the SSTs is a designated Underground Radioactive Material Area.

Total Covering Over Tank Tops

Final View of the SSTs

SRS submitted the 2013 RCRA Permit Renewal Application, M-Area and Met Lab HWMFs Post-closure (Volume III), to SCDHEC on January 14, 2020. SCDHEC reviewed the Revision 0 Permit Renewal Application and provided comments on May 22, 2020. Subsequently, SRS submitted Revision 1 of the 2013 RCRA Permit Renewal Application, M-Area and Met Lab HWMFs Postclosure (Volume III) to SCDHEC on August

25, 2020. SCDHEC reviewed the application and submitted its completeness determination on October 2, 2020. SCDHEC issued the Draft Permit Renewal for a 45-day public comment period that began on July 22, 2021 and initially ended on September 7, 2021. After two requests for a public hearing, SCDHEC extended the public comment period to end on October 22, 2021. SCDHEC conducted the public hearing on October 7, 2021. SRS submitted comments on the Draft Permit Renewal on October 21, 2021. SCDHEC did not receive any other comments on the Draft Permit Renewal. SCDHEC issued the Final Permit Decision on November 30, 2021. This decision became effective on December 15, 2021, allowing for the permanent shutdown of the A-2 Air Stripper and associated recovery wells. The Final Permit Decision also included changes to some of the Groundwater Protection Standards, extension of the postclosure care period, and updates on the planned groundwater corrective actions. To ensure consistency with the Final Permit Decision, SRS is required to submit revised application pages within 60 days of the effective date of the permit (or February 13, 2022). SRS submitted the revised pages to SCDHEC on February 7, 2022.

A-2 Air Stripper

SRS certified the 2013 RCRA Permit Renewal Applications for both the F-Area HWMF and the H-Area HWMF in December 2020. Changes for these renewal applications include revising the corrective action goals by adding management strategy specific to the goals and creating RCRA Permit Appendix 8, which retains relevant information regarding both facilities' histories for all subsequent permit renewal applications. The F-Area HWMF (Volume IV) and H-Area HWMF (Volume V) Permit Renewal Applications were submitted on January 5, 2021. SCDHEC completed its review of Part A of the Revision 0 Permit Renewal Application (Volumes IV and V) and provided comments on February 5, 2021. SRS submitted Revision 1 pages for Volumes IV and V to SCDHEC on March 22, 2021. After receipt of the Revision 1 pages, SCDHEC completed the technical review of the two volumes and provided comments on May 5, 2021. In the May 5 letter, SCDHEC requested that the MWMF (Volume VII) be revised to extend the postclosure care period for an additional 30 years. The Revision 2 pages for the F-Area HWMF (Volume IV) and H-Area HWMF (Volume V) and Revision 3 pages for the MWMF (Volume VII) were submitted on June 7, 2021. SCDHEC reviewed these volumes of the application and submitted its conditional completeness determination on June 18, 2021. Subsequently, SCDHEC issued the Draft Permit Renewal for a 45-day public comment period that began on July 22, 2021, and initially ended on September 7, 2021. After two requests for a public hearing, SCDHEC extended the public comment period to end on October 22, 2021. SCDHEC conducted the public hearing on October 7, 2021. SRS submitted comments on the Draft Permit Renewal on October 21, 2021. SCDHEC did not receive any other comments on the Draft Permit Renewal. SCDHEC issued the Final Permit Decision on November 30, 2021. This decision became effective on December 15, 2021. To ensure consistency with the Final Permit Decision, SRS is required to submit revised application pages within 60 days of the effective date of the permit (or February 13, 2022). SRS submitted the revised pages to SCDHEC on February 7, 2022.

3.3.2.2 Solid Waste Permit Activities

SRS has solid waste permits for the 632-G Construction and Demolition (C&D) Debris Landfill; the 288-F Industrial Solid Waste Landfill; and the SDF, identified as the Z-Area Saltstone Industrial Solid Waste Landfill in its permit (Section 3.2.2.3.). All the solid waste landfills were active and operated in compliance with their permits during 2021. SCDHEC conducted quarterly landfill inspections of the 632-G and 288-F landfills during 2021 and found no issues of noncompliance.

Infectious Waste is Treated and Disposed of in Accordance with SCDHEC Regulations.

3.3.2.3 Underground Storage Tank (UST) Permits

Subtitle I of RCRA regulates USTs containing usable petroleum products. Currently, SRS has 17 permitted USTs; they each require an annual compliance certificate from SCDHEC. On December 16, SCDHEC performed its annual inspection and found all tanks in compliance. This annual inspection also confirmed the USTs supporting emergency power generators for DWPF, H Canyon, and Utilities and Operating Services successfully completed system testing and upgrades to meet the SCDHEC UST Release Detection regulations. The SCDHEC permit required an annual Tank Release Detection System Operability Test; it was performed late at the 754-5A Diesel Generator Facility UST. SCDHEC was informed of the late test via telephone; no immediate action or concerns were stated. The UST passed its inspection.

3.3.3 Federal Facility Compliance Act (FFCA)

The FFCA was signed into law in October 1992, as an amendment to the Solid Waste Disposal Act. It adds provisions to apply certain requirements and sanctions to federal facilities. SRS obtained and implemented a Site Treatment Plan (STP) Consent Order (95-22-HW, as amended) in 1995, as required by the FFCA. The consent order required annual updates to the STP.

Personnel from SRS and SCDHEC met on June 17 to discuss the 2021 update. As an outcome of that meeting, the format for STP Volumes I and II was streamlined and updated to reflect treatment capacities and technologies associated with current and anticipated future waste streams. The 2006 update of the STP will serve as the archive reference for STP Volumes I and II. SRS submitted the Site Treatment Plan, 2021 Update to SCDHEC on November 15.

In October 2003, SCDHEC executed a Statement of Mutual Understanding for Cleanup Credits allowing SRS to earn credits for certain accelerated cleanup actions. Credits can then be applied to the STP commitment schedules. In 2021, SRS and SCDHEC held STP Cleanup Credit validation meetings in February, May, August, and November. SRS earned 883 validated Cleanup Credits during FY 2021.

3.3.4 Toxic Substances Control Act (TSCA)

SRS complies with TSCA regulations when storing and disposing of lead, asbestos, and organic chemicals, including polychlorinated biphenyl compounds (PCBs). SRS disposes of routinely generated nonradioactive PCBs at an offsite EPA-approved disposal facility within the regulatory defined period of one year from the date of generation. SRS made two shipments of PCB waste to offsite hazardous waste facilities in 2021. SRS also generates radioactive waste contaminated with PCBs. Low-level radioactive PCB bulk product waste is disposed of onsite. PCB waste that is contaminated with TRU requires disposal at WIPP. SRS made two shipments of PCB-containing TRU waste to WIPP in 2021.

As required by TSCA regulations, SRS must prepare an annual written log by July 1 covering the previous calendar year (January through December). From the written annual log, SRS prepares an annual report, which must be submitted to EPA by July 15 of each year for the preceding calendar year. For this reporting period, the 2021 annual report was submitted to EPA on July 11, 2022.

In July 2021, SRS identified a previously unknown PCB-contaminated transformer within a nonoperational switchgear during dismantling activities in H Canyon. The unit was intact, not leaking, and had no visible signs of leaks or spills. It contained about 35 gallons of liquid. SRS took immediate action to properly manage and dispose of the unit. SRS met with the EPA and voluntarily disclosed this information on July 29, 2021. SRS conducted a sitewide review, which identified no additional PCB or PCB-contaminated equipment of concern.

3.3.5 South Carolina Infectious Waste Management Regulation

SRS generates a large quantity of infectious waste registered under the SCDHEC Infectious Waste Management Program. SRS contracted with a vendor to pick up infectious waste every four weeks. In 2021, the vendor picked up 13 shipments. Once offsite, the vendor treats and disposes of the waste in accordance with the SCDHEC regulations. In 2021, SRS managed all infectious wastes in compliance with the state regulations, including waste generated by two COVID-19 testing stations and a COVID-19 vaccination station.

3.3.6 Air Quality and Protection

3.3.6.1 Clean Air Act (CAA)

The EPA has delegated regulatory authority for all types of air emissions to SCDHEC. SRS is required to comply with SCDHEC Regulation 61-62, *Air Pollution Control Regulations and Standards*. SRS facilities currently have the following air permits regulating activities on the Site:

- Part 70 Air Quality Permit (TV-0080-0041)
- 784-7A Biomass Boiler Construction Permit (TV-0080-0041a-CG-R1)
- 784-7A Oil Boiler Construction Permit (TV-0080-0041a-CF-R1)
- Building 235-F D&D Construction Permit (TV-0080-0041-C1)
- N-Area Lead Melters Construction Permit (TV-0080-0041-C2)
- Saltstone Baghouse CD-B 0017 Construction Permit (TV-0080-0041-C3)
- Ameresco Federal Solutions, Inc. (“Ameresco”) Biomass Facilities Permit (TV-0080-0144)

- Surplus Plutonium Disposition Project Construction Permit (TV-0080-0041-C4)

The CAA considers SRS a "major source" of nonradiological air emissions; therefore, the Site falls under the CAA Part 70 Operating Permit Program. The Part 70 Operating Permit regulates stationary sources with the potential to emit five tons or more per year of any criteria pollutant (six of the most common air pollutants: ozone precursors, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead). These major stationary sources are subject to operating and emission limits, as well as emissions monitoring and record-keeping requirements.

The EPA sets the National Ambient Air Quality Standards air pollution control standards, and SCDHEC regulates them. The Air Quality Permit requires SRS to demonstrate compliance through air dispersion modeling and by submitting an emissions inventory of air pollutant emissions every three years.

SRS received a renewal to its CAA Air Quality Operating Permit (TV-0080-0041), which became effective April 1, 2021. The Site had previously been operating under an application shield SCDHEC granted in September 2007, as its previous Title V operating permit expired March 31, 2008. After the Title V permit became effective on April 1, the conditions contained in the construction permits were no longer pertinent except for those in the Surplus Plutonium Disposition Project 0080-0041-C4, which is still in effect.

3.3.6.2 Accidental Release Prevention Program

The CAA Amendments of 1990, Section 112(r) require any facility that maintains specific hazardous or extremely hazardous chemicals in quantities above-specified threshold values to develop a risk management plan. SRS has maintained hazardous and extremely hazardous chemical inventories below each threshold value; therefore, the CAA does not require SRS to develop a risk management plan. Additionally, no reportable 112(r)-related hazardous or extremely hazardous chemical releases occurred at SRS in 2021.

3.3.6.3 Ozone-Depleting Substances

Section 608 of the CAA prohibits knowingly releasing refrigerant during maintenance, service, repair, or disposal of air-conditioning and refrigeration equipment. Refrigerants include ozone-depleting substances and substitute refrigerants such as hydrofluorocarbons (HFCs). Releases of chemical gases widely used as refrigerants, insulating foams, solvents, and fire extinguishers cause ozone depletion or contribute to greenhouse gas emissions. SRS complied with 40 CFR Part 82 in 2021 to ensure it did not knowingly or willfully release refrigerants into the atmosphere.

EPA issued 40 CFR 84 on October 5, 2021, to implement certain provisions of the American Innovation and Manufacturing (AIM) Act, as enacted on December 27, 2020. The AIM Act mandated phasing down HFCs, which are potent greenhouse gases, by 85% over a period ending 2036. The requirements of 40 CFR 84 focus on reducing HFC manufacturing and importing. SRS does not manufacture or import HFCs; however, refrigerant-containing appliances and fire-suppression systems contain HFCs, thereby affecting the Site.

The Savannah River Tritium Enterprise (SRTE) established a relationship with the Department of Defense (DoD) to identify a pathway to request a Mission-Critical Military End Use (MCMEU) application-specific allowance from the DoD. An MCMEU is the use of a regulated HFC, which has a direct impact on mission capability, by a federal agency responsible for national defense. Under the regulation, the DoD has the authority to issue, manage, and assign MCMEU-specific allowances. MCMEU allowance requests are made annually for the following calendar year and do not guarantee the availability of the regulated HFC covered. They allow only for the quantity to be manufactured and imported under EPA regulations.

SRS initiated efforts to review and revise procedures used in designing new systems and equipment to ensure it incorporated the impacts of the AIM Act into the design process.

3.3.6.4 Air Emissions Inventory

SCDHEC Regulation 61-62.1, Section III (*Emissions Inventory*), requires SRS to compile an air emissions inventory to locate all sources of air pollution and to define and characterize the various types and amounts of pollutants.

The schedule for submitting the inventory is either every year or every three years, depending upon the emission thresholds in the regulations. SRS emissions have dropped below the threshold that requires an annual air emissions inventory; therefore, SRS reports on a three-year cycle for permit TV-0080-0041. SRS submitted the inventory for 2020 on March 29. The next required inventory for 2023 will be submitted before March 31, 2024.

3.3.6.5 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.

3.3.6.5.1 NESHAP Radionuclide Program

SRS complies with the NESHAP Radionuclide Program by performing all required inspections and maintaining monitoring systems. Additionally, Subpart H of NESHAP regulations requires SRS to determine and report annually the highest effective radiological dose from airborne emissions to any member of the public at an offsite point. The report is due by June 30 each year. The 2021 annual report will be submitted in June 2022. SRS transmitted the *SRS Radionuclide Air Emissions Annual Report for 2020* on June 22, 2021, to EPA, SCDHEC, and DOE Headquarters.

There were no unplanned radiological releases to the atmosphere during 2021.

SRS estimated the maximally exposed individual effective dose equivalent during 2021 to be less than 1% of the EPA standard of 10 mrem per year. Chapter 6, *Radiological Dose Assessment*, contains details on this dose calculation.

3.3.6.5.2 NESHAP Nonradionuclide Program

In 2013, New Source Performance Standards (NSPS) under NESHAP were added (or became effective) for RICE equipment such as portable generators, emergency generators, and compressors. In 2021, SRS continued to operate in compliance with NSPS and NESHAP standards.

3.3.6.5.3 NESHAP Asbestos Abatement Program

Work involving asbestos at SRS falls under SCDHEC and federal regulations. These activities—which include operation and maintenance repairs, removing asbestos, and demolishing buildings—require an asbestos notification, a renovation permit, or a demolition permit.

SRS issued 181 asbestos notifications and conducted 12 permitted renovations and demolitions involving asbestos in 2021. Table 3-1 summarizes these removals. Certified personnel removed and disposed of friable (easily crumbled or pulverized) and nonfriable asbestos. All disposal sites for nonradiological asbestos waste are SCDHEC-approved landfills for disposing regulated and nonregulated asbestos.

SRS maintains a SCDHEC Temporary Storage Containment Area License that facilitates removing and disposing of waste generated from nonradiological operations and maintenance, as well as smaller projects. Additionally, SRS maintains a SCDHEC Asbestos Group License that allows SRNS and SRR to operate as long-term, in-house asbestos abatement contractors for DOE-Savannah River.

Table 3-1 Summary of Quantities of Asbestos Materials Removed in 2021

Asbestos Type	Nonradiological, Friable	Nonradiological, Nonfriable	Radiologically Contaminated Asbestos
Linear Feet Disposed	301	1,253	178
Square Feet Disposed	87	11,065	19
Cubic Feet Disposed	3	21	0
Disposal Site	Three Rivers Solid Waste Authority Landfill	632-G Construction and Demolition Debris Landfill	SRS E-Area LLW Facility

3.3.7 Water Quality and Protection

3.3.7.1 Clean Water Act (CWA)

Except for Ameresco, which has its own CWA NPDES permit, SRS operated pursuant to the following CWA permits in 2021:

- Land Application Permit (ND0072125)
- General Permit for Stormwater Discharges Associated with Industrial Activities (except construction) (SCR000000)
- Permit for Discharge to Surface Waters (SC0000175 and SC0047431)
- General Permit for Stormwater Discharges from Construction Activities (SCR100000)
- General Permit for Utility Water Discharges (SCG250000)
- General Permit for Discharges from Application of Pesticides (SCG160000, SCG160118, and SCG160155)
- General Permit for Vehicle Wash Water Discharges (SCG750000)

3.3.7.1.1 National Pollutant Discharge Elimination System (NPDES)

SCDHEC administers the NPDES program, which protects surface waters by limiting releases of pollutants into streams, reservoirs, and wetlands. As the previous section explains, SCDHEC issued multiple NPDES permits to SRS to govern different types of discharges to surface water. A major goal of the NPDES program is to control or eliminate discharges of toxic pollutants, oil, hazardous substances, sediment, and contaminated stormwater to protect the quality of the nation's water. To achieve this goal, SCDHEC requires SRS to prepare the following plans:

- Best Management Practices Plan to identify and control the discharge of hazardous and toxic substances
- Industrial Stormwater Pollution Prevention Plan (SWPPP) to address the potential discharge of pollutants in stormwater
- Spill Prevention, Control, and Countermeasures Plan to minimize the potential for discharges of oil, including petroleum, fuel oil, sludge, and oily wastewater

SRS has two NPDES permits for industrial activities that discharge to surface water: one covering D Area (SC0047431) and the other for the remainder of the Site (SC0000175). Throughout the year, SRS monitors 16 of 28 NPDES-permitted industrial wastewater outfalls across the Site on a frequency the permits specify. The remaining 12 industrial wastewater outfalls have no current flow and will be removed when the next permit is issued. Monitoring requirements vary from as much as once a day at some locations to once a quarter at others, although typically they are conducted once a month. For each outfall, SRS measures physical, chemical, and biological parameters and reports them to SCDHEC in SRS monthly discharge monitoring reports, as the permits require. Chapter 4, *Nonradiological Environmental Program,* provides additional information about NPDES permit-required sampling at SRS to remain compliant.

The following are highlights of the NPDES program at SRS:

- The SRS SWPPP for the 36 SRS industrial stormwater outfalls and related facilities will be updated in 2022, following issuance of the new general permit.
- SCDHEC did not require construction stormwater monitoring on any of the active construction projects underway at SRS during 2021.
- SRS undertook permitting actions for industrial wastewater treatment facilities pursuant to the CWA and the South Carolina Pollution Control Act. Facilities permitted are broad in scope and include those involved with groundwater remediation, radioactive liquid waste processing, and nuclear nonproliferation. In 2021, SCDHEC approved SRS closure plans for the A-2 Air Stripper System and the D-Area Sanitary Wastewater Treatment Plant and closed the permit for the Cooling Water Treatment Facility in D Area.
- In April 2021, SRS submitted a Discharge Monitoring Report for Industrial Stormwater Outfall H-07B, indicating no discharge during the previous year.

Chapter 4 of this report summarizes the sampling results of both industrial and stormwater outfalls.

3.3.7.1.2 Section 404(e) Dredge and Fill Permits

Wetlands make up 25% of the total SRS area, or 48,973 acres. SRS wetlands account for more than 80% of the wetlands across the entire DOE complex nationwide. CWA Section 404 requires SRS to obtain a permit when it will conduct work in a wetland area. The U.S. Army Corps of Engineers (USACE) authorizes development in wetlands through a Nationwide Permit (NWP) program. The program is for projects that have minimal impact on the aquatic environment.

SRS wetlands staff reviewed 63 site use applications for potential wetland impacts and helped review pertinent Environmental Evaluation Checklists (EECs) in 2021. During this time, SRS permitted the following actions under the NWP program:

- Abandonment in place of certain outfall sampling platforms under NWP 5—Scientific Measurement Devices

- Maintaining a domestic water line access road under NWP 58—Utility Line Activities for Water and Other Substances
- Erosion studies under NWP 5—Scientific Measurement Devices

3.3.7.2 Safe Drinking Water Act (SDWA)

SCDHEC regulates drinking water facilities under the SDWA. SRS uses groundwater sources to supply drinking water to onsite facilities. The A-Area drinking water system supplies most Site areas. Remote facilities, such as field laboratories, barricades, and fire stations, use small drinking water systems or bottled water. All 2021 bacteriological samples for the A-Area drinking water system that SRS collected met state and federal drinking water quality standards. During November 2021, SCDHEC collected a sample from the Advanced Tactical Training Academy (ATTA) drinking water system that tested positive for total coliform. The well and distribution system were disinfected, and all subsequent samples have shown no indication of the presence of coliform bacteria. An assessment of the system was performed in December 2021. The assessment showed that the system is well operated and maintained with no obvious sources for the introduction of total coliform bacteria. Bacteriological sampling on this system will increase from annually to quarterly for 2022.

SCDHEC requires SRS to collect 10 bacteriological samples each month from the domestic water system that supplies drinking water to most areas at SRS. The Site exceeds this requirement by collecting and analyzing approximately 15 samples each month throughout the system. The sample results consistently meet SCDHEC and EPA drinking water quality standards, confirming the absence of harmful bacteria.

The most recent lead and copper sampling event was in 2019; the results met all state and federal drinking water standards. SRS samples domestic water systems for lead and copper on a three-year, rotating cycle. Based on this cycle, SRS will sample 30 locations across the Site in 2022.

SCDHEC conducted an inspection of the SRS A-Area drinking water systems in 2021. The system received SCDHEC's highest rating of "Satisfactory." No sanitary surveys of the SRS drinking water systems are expected in 2022. It is expected that the A-Area and ATTA drinking water systems will be the next to be inspected in 2023.

3.3.7.3 Water Withdrawal

The South Carolina Groundwater Use and Reporting Act protects and conserves groundwater resources of the state. The act allows SCDHEC to designate certain geographic areas of the state as Capacity Use Areas, requiring that a groundwater withdrawal permit be in place to withdraw or use groundwater equal to or greater than 3 million gallons in any month in these areas. The Western Capacity Use Area comprises all of Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg counties. As the Site is within the Western Capacity Use Area, SRS has groundwater withdrawal permits from SCDHEC for systems (water supply, process, and remedial) located in A, B, D, H, S, T, and Z Areas. The act and permits require SRS to report annual water use to SCDHEC. In 2021, SRS groundwater use was within permitted limits.

The South Carolina Surface Water Withdrawal, Permitting Use, and Reporting Act regulates surface water withdrawals. This act applies to anyone withdrawing surface water more than 3 million gallons during any one month. SRS has a surface water withdrawal permit and reports annual water use to SCDHEC. In 2021, SRS surface water use was within permitted limits.

3.3.8 Environmental Protection and Resource Management

3.3.8.1 National Environmental Policy Act (NEPA)

The NEPA process identifies the potential environmental consequences of proposed federal activities and the alternatives that support informed and environmentally sound decision-making regarding designing and implementing the proposed activities.

The SRS NEPA program complies with 10 CFR 1021, DOE regulations for compliance with NEPA. SRS initiates the required NEPA evaluation by completing an EEC for new projects or changes to existing ones. 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 proposed activity.

SRS conducted 966 NEPA reviews of proposed activities in 2021 (Table 3-2). Categorical Exclusion (CX) determinations accounted for more than 90% of completed reviews. The SRS NEPA web page contains additional information on SRS NEPA activities.

The following major NEPA reviews were either completed or in progress in 2021:

- *Supplement Analysis for the Disposition of Fast Critical Assembly Plutonium (DOE/EIS-0283-S2-SA-02*). On January 12, the National Nuclear Security Administration (NNSA), a semiautonomous agency within DOE, prepared *Supplement Analysis for the Disposition of Fast Critical Assembly Plutonium (DOE/EIS-0283-S2-SA-02)* for a proposed change in the disposition method for up to 350 kilograms of stainless-steel clad plutonium from Japan's Fast Critical Assembly (FCA) reactor. Instead of using the WIPP alternative analyzed in *Surplus Plutonium Disposition Supplemental EIS (DOE/EIS-0283-S2, 2015),* the NNSA proposes to use the H-Canyon/HB-Line to DWPF alternative. Based on the supplement analysis, the NNSA determined that there are no substantial differences in environmental impacts and that no additional NEPA review is required to dispose of FCA fuel via electrolytic dissolution in H Canyon, subsequent immobilization at DWPF, and storage at the Glass Waste Storage Building pending shipment to a geologic repository.
- *Amended Record of Decision for the Disposition of Fast Critical Assembly Plutonium (DOE-EIS-0283-S2).* On March 8, NNSA amended its decision to dispose of up to 350 kilograms of stainless-steel clad plutonium from Japan's FCA reactor. Instead of preparing this material for emplacement in WIPP as analyzed in *Surplus Plutonium Disposition Supplemental EIS (DOE/EIS-0283-S2, 2015),* the NNSA decided on disposition by electrolytic dissolution in H Canyon, vitrification with high-level radioactive waste at DWPF, and storage at SRS until a geologic repository is available. The NNSA prepared *Supplement Analysis for the Disposition of Fast Critical Assembly Plutonium (DOE/EIS-0283-S2-SA-02, January 2021)* to inform this amended decision and determined that no additional NEPA review is required.
- *Final Environmental Assessment for the Tritium Finishing Facility at the Savannah River Site (DOE/EA-2151).* On March 1, NNSA prepared this final environmental assessment (DOE/EA-2151) to analyze the potential environmental impacts from constructing and operating the Tritium Finishing Facility (TFF) at SRS. The TFF would be used to inspect, store, finish, assemble, and package the gas transfer systems, which contain the tritium reservoirs used in a nuclear weapon. The NNSA's Proposed Action is to construct and operate the TFF at SRS. On March 24, a Finding of No Significant Impact was issued for a proposal to construct and operate the TFF at SRS.

- *Draft Environmental Assessment for the Commercial Disposal of Savannah River Site Contaminated Process Equipment (DOE/EA-2154).* On December 21, DOE published the *Draft Environmental Assessment for the Commercial Disposal of Savannah River Site Contaminated Process Equipment*. The draft environmental assessment evaluates the potential impacts from a proposed action to dispose of certain SRS-contaminated process equipment at a commercial LLW disposal facility outside of South Carolina, licensed by either the NRC or an Agreement State pursuant to NRC's regulations for land disposal of radioactive waste.

The following drafts are in progress and not included in Table 3-2:

- The *Draft Environmental Assessment for the South Carolina Army National Guard Proposal to Construct and Operate Training Facilities and Infrastructure on 750 Acres at the Department of Energy Savannah River Site (DOE/EA-1999)*
- The *Draft Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin Deinventory Mission for H-Canyon at the Savannah River Site (DOE/EIS-0279-SA-07*)

Table 3-2 Summary of 2021 NEPA Reviews

Type of National Environmental Policy Act (NEPA) Review	Number
Categorical Exclusion (CX) Determinations[a]	875
"All No" Environmental Evaluation Checklist (EEC) Determinations[a]	46
Previous NEPA Review[a]	42
Environmental Impact Statement (EIS)	0
Supplement Analysis (SA)	1
Interim Action	0
Revised Finding of No Significant Impact	0
Environmental Assessment	2
Total	**966**

[a] Proposed action that requires no further NEPA action

3.3.8.2 Emergency Planning and Community Right-to-Know (EPCRA)/Superfund Amendment Reauthorization Act (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 Release Inventory (TRI) report to include waste management. SRS complies with the applicable EPCRA reporting requirements and incorporates the applicable TRI chemicals into its pollution prevention programs.

As required by Section 312, Chemical Inventory Reporting of EPCRA, SRS completes an annual Tier II Chemical Inventory Report for all hazardous chemicals exceeding specified quantities present at SRS during the calendar year. The inventory is due by March 1 each year. The 2021 report was submitted on February

23, 2022. SRS submitted the 2020 hazardous chemical storage information to state and local authorities on February 18, 2021. The 2020 report included 53 reportable chemical categories.

As required by Section 313, Toxic Chemical Release Inventory, of EPCRA, SRS must file an annual TRI facility report each year by July 1 for the previous year. SRS calculates chemical releases to the environment for each regulated chemical and reports those above each threshold value to EPA. SRS submitted the annual report for this reporting period on June 23, 2022. SRS submitted the 2020 annual report on June 28, 2021, for each of the following regulated chemicals: ammonia, chromium compounds, lead compounds, manganese compounds, mercury compounds, naphthalene, nitrate compounds, nitric acid, and sodium nitrite. Details are on the EPA TRI Program website.

3.3.8.3 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The objective of FIFRA is to provide federal control of pesticide distribution, sale, and use. EPA must register all pesticides used in the United States. Use of each registered pesticide must be consistent with directions contained on the package's label. SRS must comply with FIFRA and, on a state level, the South Carolina Pesticide Control Act.

SRS must also comply with the South Carolina NPDES General Permit for discharges from the application of pesticides. This permit authorizes applying pesticides to surface water according to limitations set forth in the NPDES general permit.

SRS procedures implement the FIFRA requirements for pesticide application, application recordkeeping, storage, and disposing of empty containers and excess pesticides. General-use pesticides (ready-to-use products that are available for public use) are applied at SRS per the label instructions. SRS applies restricted-use pesticides on a limited basis, following label requirements and using state-certified pesticide applicators. SRS generates and maintains application records for general use and restricted use pesticides for each application.

3.3.8.4 Endangered Species Act (ESA)

Since 1973, ESA has protected fish, wildlife, and plant species in danger of, or threatened with, extinction and strives to conserve the ecosystems upon which they depend. Several federally listed animal species exist at SRS, including the wood stork, the red-cockaded woodpecker, the shortnose sturgeon, and the Atlantic sturgeon, as well as plant species, including the pondberry and the smooth coneflower. Additionally, SRS is home to the gopher tortoise, a candidate for listing under ESA and listed as endangered by the state of South Carolina.

SRS is the only DOE site to conduct experimental translocations of gopher tortoises. Tortoises are captured, transported, and released to other locations. A study on SRS by the Savannah River Ecology Laboratory (SREL) demonstrated that long-term (12 months) penning was an effective way to promote site fidelity, dramatically increasing the number of tortoises that settled into the release site. Conservation organizations use protocols developed from these SRS translocation studies to establish viable populations elsewhere in the species' range.

Adult Carolina Gopher Frog

SREL Researcher Recording Tortoise Location after Release on SRS

South Carolina's State Wildlife Action Plan of 2015 recognizes additional plants and animals not on the federal list to encourage conservation of these species. Those found on SRS include the Carolina gopher frog and the southern hognose snake, as well as numerous other animals and plants considered species of conservation concern. South Carolina lists gopher frogs as endangered, with SRS being one of two population strongholds in the state. The United States Forest Service-Savannah River (USFS-SR) considers these species sensitive (some the U.S. Fish and Wildlife Service [USFWS] lists as at-risk species) and considers them when developing forest management plans. SREL is collaboratively head-starting efforts to increase survival of captive-bred gopher frogs released into the wild and conducting wetland assessments to define ideal habitats for the frogs and informing management of findings.

While the bald eagle is no longer federally listed, the Bald and Golden Eagle Protection Act protects nesting bald eagles and wintering golden eagles. Bald eagles nest on SRS and are considered year-round residents; golden eagles use SRS as wintering habitat. In 2021, two golden eagles were recorded scavenging at SRS. The 2021 mid-winter bald eagle survey reported 13 bald eagles with 1 active nest and 2 golden eagles on SRS.

The USFS-SR actively manages more than 65,000 acres in the red-cockaded woodpecker habitat management areas. It further improved red-cockaded woodpecker habitat in 2021 by prescribe burning 16,600 acres and removing brush and small hardwood vegetation from more than 288 acres by mechanical or chemical treatments to control vegetation. By restoring the natural fire regime, native plant diversity is improved in the understory, enhancing the native longleaf pine and wiregrass communities. Additionally, USFS-SR inserts artificial cavities into living pine trees to increase the number of available cavities for roosting and nesting. From 1985 through 2021, active red-cockaded woodpecker clusters increased from 5 to 150 due to successful habitat restoration. As of 2021, USFS-SR managed 180 cluster sites for the red-cockaded woodpecker, with an average expected population growth rate of 5% each year. The growth rate over the past 5 years at SRS has been an outstanding average of 12%. In addition to managing endangered wildlife species, USFS-SR actively manages six endangered plant populations: four smooth coneflower and two pondberry.

The USFS-SR continues to perform biological evaluations to determine whether forest implementation plans are likely to affect federally listed endangered or threatened species due to beneficial, insignificant, or discountable effects.

3.3.8.5 Migratory Bird Treaty Act (MBTA)

The MBTA prohibits taking, possessing, importing, exporting, transporting, selling, purchasing, bartering, or offering for sale any migratory bird or its eggs, parts, and nests, except as the U.S. Department of the Interior authorizes under a valid permit. To support migratory bird monitoring, a one-day Christmas Bird Count is conducted annually in December. The 2021 SRS count found 84 species, which is down from the number of species normally observed. A one-day bald eagle survey is conducted every year in January; the 2021 bald eagle survey found 13 bald eagles.

A Killdeer (*Charadrius vociferus*) with a Nest and Eggs in front of Building 730-4B

In 2021, SRS conducted walkdowns of 66 bird nests at 41 locations for MBTA compliance. The walkdowns identified 52 active nests with incubating eggs or chicks and 12 nests without eggs or chicks. The active nests were being used by Northern mockingbirds (*Mimus polyglottos*), barn swallows (*Hirundo rustica*), house finches (*Haemorhous mexicanus*), common grackles (*Quiscalus quiscula*), Mourning Doves (*Zenaida macroura*), Killdeer (*Charadrius vociferus*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), and Eastern Bluebird (*Sialis sialis*).

SRS allowed active nests to complete the nesting cycle and barricaded them when deemed appropriate. SREL relocated one active nest in an active work area under permit authorization from the USFWS.

Also in 2021, the USFS-SR found an osprey (*Pandion haliaetus*) nest on a platform staff built in 2014. This marked the sixth year that ospreys nested on the platform after their nest had been moved from a power pole at the L-Lake Dam.

3.3.8.6 Invasive Species Management

The purpose of Executive Order 13751, *Safeguarding the Nation from the Impacts of Invasive Species,* is to prevent introducing and spreading invasive species, and to support efforts to eradicate and control established invasive species. The Site is surveying invasive plant and animal species and taking steps to control their populations.

Many of the former home and community sites that area residents left nearly 70 years ago to allow for the government to construct SRS have since become primary sources of non-native invasive plant species (NNIPS). Escaping cultivation and containment for decades, aggressive plant species such as Chinese privet (*Ligustrum sinensis*), wisteria (*Wisteria sinensis*), chinaberry (*Melia azedarach*), and kudzu (*Pueraria montana*) now threaten native species onsite. Invasive species such as these are a major threat to National Forests in the 21st century. NNIPS contribute to long-term ecosystem degradation due to the loss of diversity and their direct competition with native species. They also provide unwanted ladder fuels that can increase fire intensity during prescribed burning or wildfire.

Before 2012, there had been no sitewide effort to document NNIPS as part of the watershed prescription process. However, recently conducted plant surveys include recording observations and locations for NNIPS. This information is now being captured geospatially to include in compartment stand maps and geographic information system layers for management planning. Historical records and image interpretations from photos and maps, compartment folders, and stand exam data helped identify developed openings, old home sites, and community places (churches, schools, cemeteries) that may contain robust sources of introduced NNIPS communities.

The USFS-SR contracts botanical surveys annually of 5,000 to 7,000 acres, which include 40-50 species of plants considered to be non-native and invasive. The USFS-SR chemically treats an average of 57 acres each year to control across target areas that either contain former homesites and community areas or that are in proximity to red-cockaded woodpecker colony sites. When a forest stand is cut and regenerated, The USFS-SR treats NNIPS populations discovered as part of the site preparation for replanting. In 2021, the USFS-SR treated approximately 40 acres of NNIPS for control, eradication, or both. This included 10 acres of treatment in proximity to an endangered plant population and 20 acres of NNIPS infestations into endangered red-cockaded woodpecker habitat.

Wild Pigs at SRS

Wild pigs are considered an invasive species in the United States and abroad. As of 2016, the U.S. Department of Agriculture estimated that in the United States alone, these animals cost $1.5 billion each year in damages and control costs. On SRS, wild pigs present safety hazards due to vehicle collisions and disease transmission, and ecological impacts by negatively affecting water quality, disturbing soil, and constantly threatening rare and endangered plant populations. The USFS-SR has two dedicated wildlife technicians who oversee two wildlife contractors who trap and remove wild pigs on SRS. In 2021, the USFS-SR removed 1,523 pigs primarily through baiting and trapping. Additionally, the USFS-SR and the Southern Research Station, part of the U.S. Forest Service Research and Development organization, are collaborating with SREL to research ways to control the wild pig population.

3.3.8.7 National Historic Preservation Act (NHPA)

The NHPA requires all federal agencies to consider the impacts to historic properties in all their undertakings. SRS ensures it complies with the NHPA through several processes. For example, SRS uses the

Site Use Program, the *Cold War Programmatic Agreement,* and *SRS's Cold War Built Environment Cultural Resource Management Plan* to ensure it is complying with the NHPA. The Savannah River Archaeological Research Program (SRARP) guides DOE in managing its cultural resources to ensure it fulfills its compliance commitments. SRARP also serves as a primary organization to investigate archaeological research problems associated with cultural development within the Savannah River valley. DOE uses the results to manage more than 2,000 known archaeological sites at SRS.

SRARP evaluates and documents all locations DOE is considering for activities, such as construction, to ensure that they do not affect archaeological or historic sites. In 2021, SRARP investigated 387 acres of land on SRS for cultural resource management, including conducting 26 field surveys and testing. It recorded 24 newly discovered sites and revisited 6 previously recorded sites.

3.3.9 Release Reporting

Federally permitted releases to the air, water, and land must comply with legally enforceable licenses, permits, regulations, or orders. If an unpermitted release to the environment of an amount greater than or equal to a Reportable Quantity (RQ) of a hazardous substance (including radionuclides) occurs, EPCRA, CERCLA, CWA, and CAA require SRS to send a notice to the National Response Center and applicable state agencies.

In 2021, SRS reported one release exceeding a CERCLA RQ. On March 13, a PVC pipe valve leak at the bottom of a container on a skid pan led to a release of 1,773.3 pounds of sodium hydroxide (25% solution); the RQ is 1,000 pounds. SRS Operations Center was notified, and the Fire Department Hazmat Team responded. Absorbent pads were used at the leak site and were properly disposed. SCDHEC and the National Response Center were notified as required. No further action was required by regulatory agencies.

3.3.10 Permits

SRS had 532 construction and operating permits in 2021 that specified operating levels to each permitted source. Table 3-3 identifies the number of permits by the permit type.

Table 3-3 SRS Permits

Type of Permit	Number of Permits
Air	8[a]
U.S. Army Corps of Engineers (USACE—Nationwide Permits)	3
Asbestos Demolition Licenses/Abatement Licenses/Temporary Storage of Asbestos Waste Notices	217
Asbestos Abatement Group License	1
Asbestos Temporary Storage of Waste License	1
Domestic Water	97
Industrial Wastewater Treatment	56
National Pollutant Discharge Elimination System (NPDES) Permits	10
Construction Stormwater Grading Permit	7
Resource Conservation and Recovery Act (RCRA) Hazardous Waste	1
Solid Waste	3
Underground Storage Tank	7
Sanitary Wastewater	91
South Carolina Department of Health and Environmental Control (SCDHEC) 401	0
SCDHEC Infectious Waste Registration	1
SCDHEC Bureau of Drug Control Controlled Substances Registration	4
Nondispensing Drug Outlet License	4
SCDHEC Navigable Waters	0
Underground Injection Control	10
U.S. Fish and Wildlife Service (USFS) Scientific Collecting Permit	1
Groundwater Withdrawal	9
Surface Water Withdrawal	1
Total	**532**

[a] This count includes the CAA permits for Ameresco (TV-00800-144), the Part 70 Air Quality Operating Permit (TV-0080-0041), and construction permits.

Additional information on SRS permitting and compliance can be found in the EPA's Enforcement and Compliance History Online (ECHO) database. The following SRS facilities are identified on ECHO:

Enforcement and Compliance History Online (ECHO) Facility Identification	Facility Registry Service (FRS) Identification	Program Area
DOE AMERESCO Savannah River Site Biomass Cogen	110046328693	Air/Water
DOE/Westinghouse Savannah River Company (WSRC) Savannah River Site	110001120000	RCRA
Savannah River Site	110013700904	Air/Water
U.S. DOE Savannah River Site	110006909248	Air/Water

3.4 MAJOR DOE ORDERS FOR ENVIRONMENTAL COMPLIANCE

SRS complies with the following major DOE Orders in addition to state and federal regulations for environmental compliance:

- DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. This order requires DOE to provide oversight related to protecting the public, workers, environment, and national security assets effectively through continuous improvement.
- DOE Order 231.1B, *Environment, Safety and Health Reporting*, requires the Site to prepare this *SRS Environmental Report*.
- DOE Order 232.2, *Administrative Change 1, Occurrence Reporting and Processing of Operations Information*. This order requires DOE to use the designated system called Occurrence Reporting and Processing System (ORPS). The ORPS ensures that the DOE complex and the NNSA are informed of events that could adversely affect the health and safety of the public and workers, the environment, DOE missions, or DOE's credibility.
- DOE Order 414.1D, *Quality Assurance*. See Chapter 8, *Quality Assurance,* of this report.
- DOE Order 435.1, *Change 2, Radioactive Waste Management*. See Section 3.3.1 in this chapter of this report.
- DOE Order 436.1*, Departmental Sustainability*. See Chapter 2, *Environmental Management Systems,* of this report.
- DOE Order 458.1, *Administrative Change 4, Radiation Protection of the Public and the Environment*. See Chapter 5, *Radiological Environmental Monitoring Program*, and Chapter 6, *Radiological Dose Assessment,* of this report.

3.5 REGULATORY SELF-DISCLOSURES

SRS made one regulatory self-disclosure in 2021 to EPA regarding the previously unknown PCB-contaminated transformer as discussed in Section 3.3.4 and one regarding a UST test performed late as discussed in Section 3.3.2.3; no further action was required.

3.6 ENVIRONMENTAL AUDITS

The Federal Energy Regulatory Commission (FERC), SCDHEC, and the EPA inspected and audited the SRS environmental program for regulatory compliance. Table 3-4 summarizes the results of the 2021 audits and inspections.

SCDHEC performed recertification inspections of the Domestic Water Lab, Environmental Analysis Lab, and the Environmental Bioassay Lab in May. All inspected laboratories were recertified for three years. See Chapter 8 for details about laboratory recertification.

The third-party audit of the Environmental Management System (EMS) was performed in April. The audit results were satisfactory with DOE declaring the EMS conformant to the ISO 14001:2015 Standard. Chapter 2 explains the details about this audit.

During 2021, multiple internal audits were conducted for various programs at facilities throughout SRS. As part of continuous improvement efforts, these reviews help identify opportunities for improvement.

Table 3-4 Summary of 2021 External Agency Audits/Inspections of the SRS Environmental Program and Results

Audit/Inspection	Action	Results
632-G Construction and Demolition (C&D) Debris Landfill and 288-F Ash Landfill Inspections	South Carolina Department of Health and Environmental Control (SCDHEC) conducted four quarterly inspections of the 632-G and 288-F landfills.	No compliance issues or violations resulted from the quarterly inspections.
Federal Energy Regulatory Commission (FERC) Inspection	FERC performed the annual inspection of PAR Pond Dam and Steel Creek Dam, and Ponds 2, 4, and 5 in September.	FERC visually inspected the dams and found no conditions indicating a concern for the immediate safety and permanence of the structures. FERC noted SRS adequately operates and maintains the facility, and the dams were in satisfactory condition based on visual inspection. It also noted improvements in routine maintenance.
Environmental Management System (EMS) Audit	The third-party audit of the EMS was performed in April.	The audit results were satisfactory with DOE declaring the EMS conformant to the International Organization for Standardization (ISO) 14001:2015 standard.
Environmental Laboratory Certification Onsite Evaluations	SCDHEC performed recertification inspections of the Domestic Water Lab, Environmental Analysis Lab, and the Environmental Bioassay Lab on May 13.	All inspected laboratories were recertified for three years.
Comprehensive Groundwater Monitoring Evaluation	SCDHEC inspected groundwater facilities associated with the F- and H-Area Seepage Basins, M-Area Settling Basin, Metallurgical Laboratory Basin, Mixed Waste Management Facility, and Sanitary Landfill on September 28. SCDHEC also completed a records review of groundwater-related files.	The inspection noted no problems or concerns.
SCDHEC Sanitary Survey of SRS Drinking Water Systems	SCDHEC inspects the wells, tanks, and treatment systems supporting the primary SRS A-Area Drinking Water system biannually. SCDHEC also inspects four of the smaller SRS Drinking Water systems (ATTA Range, Central Sanitary Wastewater Treatment Plant, PAR Pond Lab, and L-Area Fire Station) on either a three- or a five-year rotation, depending on the classification of the system. SCDHEC conducted a Sanitary Survey of the A-Area SRS Drinking Water system in April 2021.	Each Drinking Water system received a “Satisfactory” rating.

Table 3-4 Summary of 2021 External Agency Audits/Inspections of the SRS Environmental Program and Results (continued)

Audit/Inspection	Action	Results
Interim Sanitary Landfill and the F-Area Railroad Crosstie Pile Landfill Post-Closure Inspection	SCDHEC conducted an annual review of the landfills in September.	SCDHEC identified no compliance issues.
Air Compliance Inspection	SCDHEC did not conduct any onsite inspections in 2021.	Not applicable
Resource Conservation and Recovery Act (RCRA) Compliance Evaluation Inspection (CEI)	SCDHEC conducted the unannounced RCRA CEI for FY 2021 on July 27. The Environmental Protection Agency and SCDHEC conducted the unannounced RCRA CEI for FY 2022 on December 1-2.	SCDHEC did not observe any deficiencies during the FY 2021 inspection. The inspectors identified one labeling deficiency during the FY 2022 inspection. The CEI labeling deficiency was corrected on the spot.
Underground Storage Tank (UST) CEI	SCDHEC inspected 17 USTs on December 16.	No issues were identified.
Saltstone Disposal Facility (SDF), identified in the permit as Z-Area Saltstone Solid Waste Landfill, Inspections	SCDHEC performed monthly inspections of the SDF. This included reviewing facility procedures and performing walkdowns of the SDF.	No issues were noted.
National Pollutant Discharge Elimination System (NPDES) CEI (3560)	SCDHEC did not conduct a Compliance Sampling Inspection (3560) in 2021 covering permits SC0000175, ND0072125, and SC0047431.	Not applicable

3.7 KEY FEDERAL LAWS COMPLIANCE SUMMARY

The CFR implements Federal laws and state regulations that a federal agency has delegated to the state. Additional information is on the EPA website. Table 3-5 summarizes SRS's 2021 compliance status with applicable key federal environmental laws.

Table 3-5 Status of Key Federal Environmental Laws Applicable to SRS

Regulatory Program Description	2021 Status
The Atomic Energy Act/DOE Order 435.1 grants DOE the authority to develop applicable standards (documented in DOE Orders) to protect the public, workers, and environment from radioactive materials.	The FY 2020 Performance Assessment (PA) and Composite Analysis (CA) annual reviews for SRS showed that radioactive low-level waste (LLW) operations were within the required performance envelope, and the facilities continued to comply with performance objectives.
The 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 received a renewal to its CAA Air Quality Operating Permit (TV-0080-0041), which became effective April 1. The Site previously operated under an application shield granted by South Carolina Department of Health and Environmental Control (SCDHEC) in September 2007 as its previous Title V operating permit expired March 31, 2008.
The Clean Water Act (CWA) regulates liquid discharges at outfalls (for example, drains or pipes) that carry effluent to streams (National Pollutant Discharge Elimination System [NPDES], Section 402). It also regulates dredge and fill operations in Waters of the United States (Section 404) and water quality for those activities (Water Quality Criteria, Section 401).	The SRS NPDES program complies with all NPDES Permits.
The 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.	SRS continues to comply with CERCLA and the requirements of the Federal Facility Agreement (FFA).
The Emergency Planning and Community Right-to-Know Act (EPCRA), also referred to as Superfund Amendments and Reauthorization Act (SARA), Title III, requires SRS to report hazardous substances and their releases to the Environmental Protection Agency (EPA), state emergency response commissions, and local planning units.	SRS continues to comply with all reporting and emergency planning requirements.
The Endangered Species Act (ESA) prevents the extinction of federally listed endangered or threatened species and conserves critical habitats.	SRS continues to protect these species and their habitats as outlined in the Natural Resource Management Plan for SRS.
The FFA for SRS between the EPA, DOE, and SCDHEC integrates CERCLA and Resource Conservation and Recovery Act (RCRA) requirements to achieve a comprehensive remediation strategy and sets annual work priorities and establishes milestones to clean up and close the high-level radioactive waste tanks at SRS.	SRS continues to meet all the commitments contained within the FFA (54 commitments met on or ahead of schedule in FY 2021).

Table 3-5 Status of Key Federal Environmental Laws Applicable to SRS (continued)

Regulatory Program Description	2021 Status
The Federal Facility Compliance Act (FFCA) requires federal agencies to comply with federal, state, and local solid and hazardous waste laws.	SRS continues to comply with the FFCA.
The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates restricted-use pesticides through a state-administered certification program.	SRS continues to comply with FIFRA requirements.
The Migratory Bird Treaty Act (MBTA) protects migratory birds, including their eggs and nests.	SRS continues to comply with the MBTA.
The National Defense Authorization Act (NDAA) 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 requiring deep geologic disposal if it meets the criteria set forth in Section 3116. Section 3116(b) addresses monitoring by NRC and SCDHEC.	SRS provided routine documents as requested by the NRC to support monitoring of SRS facilities in accordance with NDAA 3116(b). The NRC did not conduct any onsite monitoring observation visits to F-Tank Farm or H-Tank Farm and conducted one visit to Saltstone Disposal Facility.
The 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 implementing programs and projects.	SRS continues to comply with NEPA.
The National Historic Preservation Act (NHPA) protects historical and archaeological sites.	The Savannah River Archaeological Research Program provides cultural resource management guidance to DOE to ensure continued compliance with the NHPA.
RCRA governs hazardous and nonhazardous solid waste management and underground storage tanks (USTs) containing petroleum products, hazardous materials, and wastes. RCRA also regulates universal waste and recyclable used oil.	SRS continues to manage hazardous waste, nonhazardous solid waste, and USTs in compliance with RCRA. SRS is performing groundwater monitoring and corrective actions at the F- and H-Area Hazardous Waste Management Facilities (HWMFs), the M-Area and Metallurgical Laboratory HWMFs, the Sanitary Landfill and the Mixed Waste Management Facility, and performs surveillance and maintenance at closed HWMFs in accordance with the SRS RCRA Permit Renewal.

Table 3-5 Status of Key Federal Environmental Laws Applicable to SRS (continued)

Regulatory Program Description	2021 Status
The Safe Drinking Water Act (SDWA) protects drinking water and public drinking water resources.	All drinking water samples of the A-Area Drinking Water System taken in 2021 met drinking water quality standards. SCDHEC collected a sample from the ATTA Drinking Water System in November, which was positive for total coliform. After disinfection of the system and two confirmed negative samples, the system was placed back into normal operation. SCDHEC increased bacteriological sampling of this system by from annually to quarterly for 2022.
The Toxic Substances Control Act (TSCA) regulates polychlorinated biphenyls (PCBs), radon, asbestos, and lead, and requires users to evaluate and notify the EPA when they use new chemicals and when significant new uses of existing chemicals occur.	SRS manages all regulated materials in compliance with TSCA requirements.

3.8 ENVIRONMENTAL COMPLIANCE SUMMARY

SRS was not involved in any environmental lawsuits during 2021. No Notices of Violation (NOVs) were issued in 2021. Table 3-6 summarizes the NOVs/Notices of Alleged Violation (NOAVs) SRS received from 2017–2021.

Table 3-6 NOV/NOAV Summaries, 2017 to 2021

Program Area	Notice of Violation (NOV)/Notice of Alleged Violation (NOAV)				
	2017	2018	2019	2020	2021
Clean Air Act (CAA)	3	1[a]	0	0	0
Clean Water Act (CWA)	2	0	1	1	0
Resource Conservation and Recovery Act (RCRA)	0	1[b]	0	0	0
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	0	0	0	0	0
Others	0	0	0	0	0
Total	**5**	**2**	**1**	**1**	**0**

[a]This NOV was issued to Ameresco, a direct contractor to DOE.

[b]NOAV

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Chapter 4: **Nonradiological Environmental Monitoring Program**

The Savannah River Site (SRS) nonradiological environmental monitoring program serves two purposes: it confirms the Site is complying with state and federal regulations and permits, and it monitors any effects SRS has on the environment, both onsite and offsite. SRS monitors permitted point-source discharges from onsite facilities for nonradiological parameters to ensure it is complying with regulations and permit requirements. SRS collects and analyzes environmental media such as air, water, sediment, and fish for nonradiological parameters to evaluate the effect of Site operations on the environment.

2021 Highlights

Effluent Releases

- Nonradiological effluent releases for all categories except industrial wastewater met permit limits and applicable standards.
- SRS reported only 3 exceptions out of 2,357 analyses at SRS National Pollutant Discharge Elimination System (NPDES) industrial wastewater outfalls, a 99.9% compliance rate.
- All SRS industrial stormwater outfalls under the South Carolina general industrial stormwater permit were compliant.

Onsite Drinking Water

All SRS drinking water systems complied with South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (EPA) water quality standards.

Surveillance Program

- SRS industrial wastewater and industrial stormwater discharges are not significantly affecting the water quality of onsite streams and the Savannah River.
- Sediment results from SRS streams, stormwater basins, and the Savannah River were consistent with the background control locations and were comparable with historical levels.
- Fish flesh sample results were consistent with historical levels.

4.1 INTRODUCTION

> ### *Chapter 4—Key Terms*
>
> ***Effluent*** *is a release to the environment of treated or untreated water or air from a pipe or a stack. Liquid effluent flows into a body of water, such as a stream or lake. Airborne effluent (also called emission) discharges into the air.*
>
> ***Effluent monitoring*** *is the collection of samples or data from the point a facility discharges liquids or releases gases.*
>
> ***Environmental surveillance*** *is the collection of samples beyond the effluent discharge points and from the surrounding environment.*
>
> ***Outfall*** *is a place where treated or untreated water flows out of a pipe or ditch.*

Environmental monitoring programs at SRS examine both radiological and nonradiological constituents that Site activities could release into the environment. Chapter 5, *Radiological Environmental Monitoring Program,* discusses the radiological components of this monitoring program, while this chapter focuses on the nonradiological constituents.

The nonradiological monitoring program collects and analyzes air, water, sludge, sediment, and fish samples from numerous locations throughout SRS and the surrounding area. The program consists of two focus areas: 1) effluent monitoring, and 2) environmental surveillance. The objective of the effluent monitoring program is to demonstrate the Site is complying with permits, and the focus of the environmental surveillance program is to assess the environmental impacts of Site operations on the surrounding area. SRS determines sampling frequency and analyses based on permit-mandated monitoring requirements and federal regulations.

SRS conducts nonradiological environmental monitoring on the following categories:

- Atmospheric (airborne emissions and precipitation with a special focus on mercury deposition)
- Water (wastewater, stormwater, sludge, onsite drinking water, and river and stream water quality)
- River, stream, and stormwater basin sediment
- Fish

Figure 4-1 shows the types and typical locations (for example, upstream and downstream of SRS influence) of the nonradiological sampling SRS performs.

This chapter summarizes the nonradiological environmental monitoring programs and data results. Section 8.4, *Environmental Monitoring Program QA Activities,* and Section 8.5, *Environmental Monitoring Program QC Activities,* summarize the quality assurance and quality control practices that support the sampling and analysis reported in this chapter. Appendix Table B-1 of this document summarizes the nonradiological surveillance sampling media and frequencies.

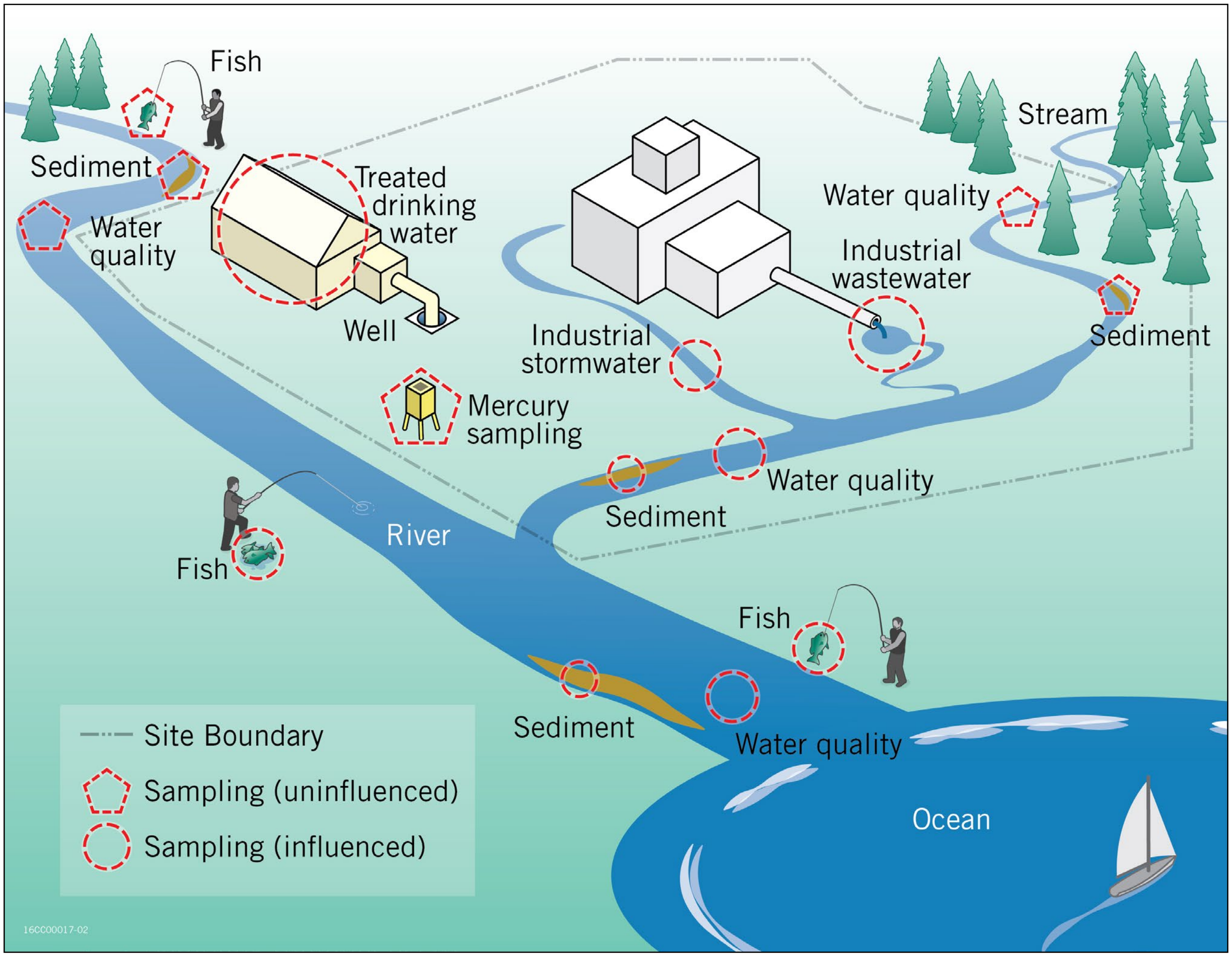


Figure 4-1 Types and Typical Locations of Nonradiological Sampling

4.2 CALCULATED AIR EMISSIONS

Airborne contaminants can present a risk to public health and the environment. Thus, identifying and quantifying these contaminants is essential to a nonradiological monitoring program. SCDHEC regulates nonradioactive air pollutant emissions from SRS sources. The regulations list pollutants, compliance limits, and the analytical methods or test procedures approved to demonstrate compliance.

SRS uses nonradioactive volatile chemicals (for example, gasoline, toluene), fuels, and combustion products that can adversely affect the environment if released into the air in sufficient quantities. However, the Site uses most of these materials in very small quantities, and the environmental impact from their potential release is negligible. Because of the nature and quantity of potential air emissions, regulators do not require SRS to sample or monitor the ambient air for chemical pollutants. Following SCDHEC requirements, SRS uses process data to calculate emissions.

Many of the applicable regulatory standards are source-dependent (that is, applicable to certain types of industries, processes, or equipment). The SCDHEC-issued Title V operating permit provides the source-specific limits for operating facilities, source sampling, testing, monitoring, and reporting frequency. SRS demonstrates it is complying with these regulations by performing air dispersion modeling and submitting to SCDHEC an emissions inventory of air pollutant emissions. SRS uses SCDHEC- and EPA-approved calculations that include source-operating parameters—such as operating hours, process throughput, and EPA-approved emission factors—to determine facility source emissions. SRS then compares the total actual annual emissions for each source to the emission limits contained in applicable permits. Chapter 3, *Compliance Summary*, Section 3.3.6.4, *Air Emissions Inventory,* discusses emissions reporting.

4.3 WATER MONITORING

SRS nonradiological water monitoring includes collecting water, sludge, and sediment samples and performing field measurements on various water sources onsite and from the Savannah River. The sample results enable SRS personnel to evaluate whether there is long-term buildup of pollutants downstream of discharge points and determine whether SRS is complying with permit requirements. SRS also collects and analyzes fish from the Savannah River to evaluate metal uptake in the flesh. SRS monitors groundwater, as Chapter 7, *Groundwater Management Program,* discusses.

4.3.1 Wastewater, Stormwater, and Sludge Monitoring

Nonradiological surface water monitoring primarily consists of sampling water discharges (industrial wastewater and industrial stormwater) associated with SRS NPDES-permitted outfalls. SRS monitors nonradiological 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 and is responsible for permitting, compliance tracking, monitoring, and enforcing the program. The permits SCDHEC issues to SRS provide specific requirements for sampling locations, collection methods, analytes required at an individual outfall, monitoring frequency, permit limits for each analyte, and analytical and reporting methods.

SRS collects NPDES samples in the field according to 40 CFR 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants.* This document lists specific methods for sample collecting and preserving, and acceptable analytical methods for the type of pollutant.

A Refrigerated Sampler Allows for Remote Temperature Verification.

<u>Wastewater</u>

In 2021, SRS monitored 28 industrial wastewater outfalls for physical and chemical properties, including flow, dissolved oxygen, acidity (pH), ammonia, biochemical oxygen demand, fecal coliform, metals, oil and grease, volatile organic compounds, and total suspended solids (TSS). Figure 4-2 shows these locations. The permits specify how often SRS is to monitor the outfalls. Typically, SRS took samples at the locations once

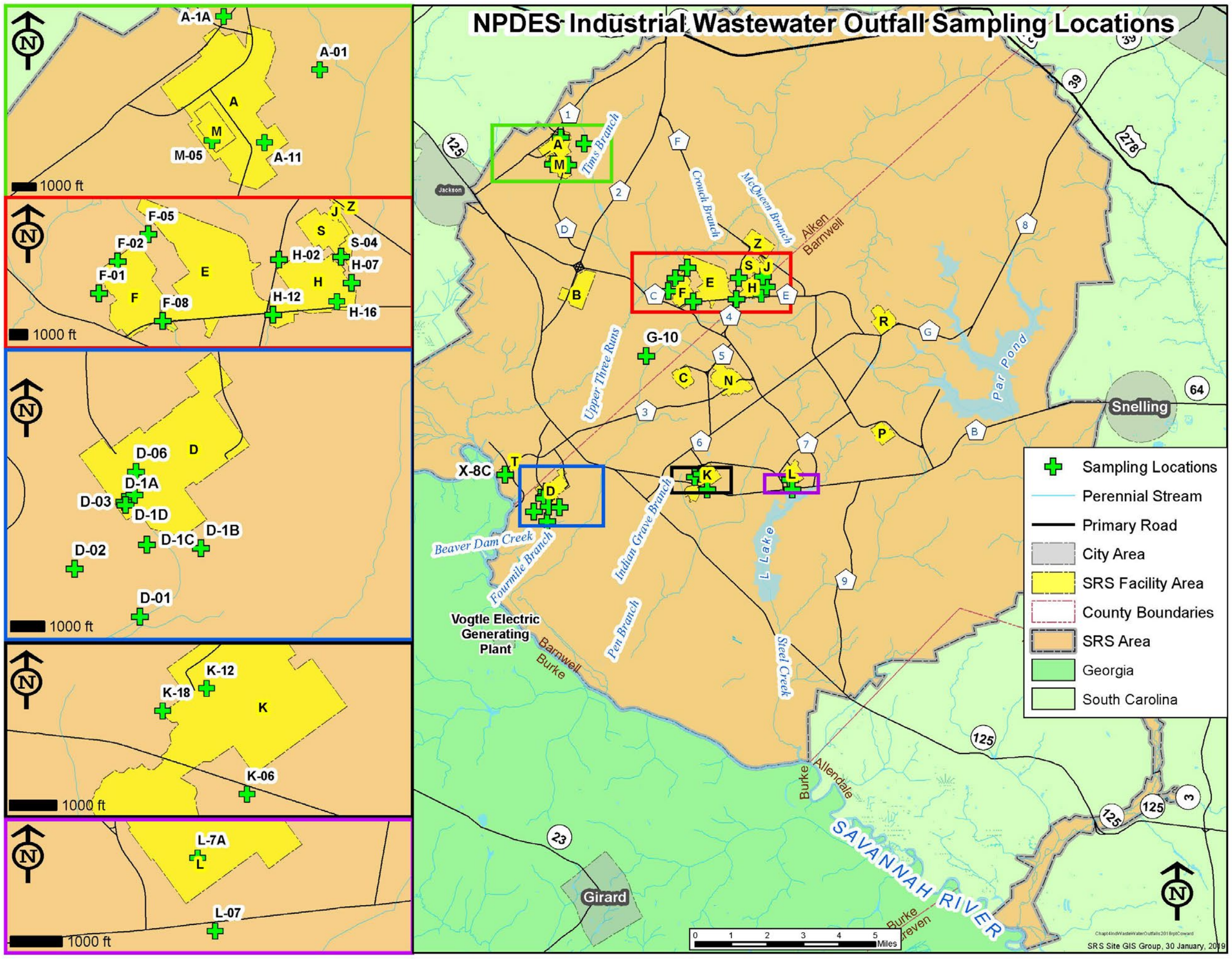


Figure 4-2 NPDES Industrial Wastewater Outfall Sampling Locations

a month, although some locations required monitoring as frequently as once a day and others as infrequently as once a quarter. As specified by permits, SRS collected either grab samples (individual sample collected all at one time) or composite samples (a mixture of grab samples collected over a specific period, typically 24 hours). In 2021, SRS also implemented new technology to more efficiently collect samples and improve quality assurance (QA)/quality control (QC) methods. A refrigerated sampler coupled with a modem allowed the personnel to verify the temperature and communicate with the equipment by remote control. SRS reported results to SCDHEC in required monthly discharge monitoring reports. In addition, SRS collected QC samples as an internal check to ensure representative data. Section 8.5, *Environmental Monitoring Program QC Activities,* summarizes the QC sample results.

SCDHEC assesses the SRS NPDES Industrial Wastewater program during Comprehensive Evaluation Inspections or Comprehensive Sample Inspections. The evaluation includes records and procedures review; personnel interviews; and outfall, treatment facility, and land application site inspections. SCDHEC did not conduct any inspections in 2021.

Stormwater

The five-year SCDHEC-issued general permit covers 36 industrial stormwater outfalls that Figure 4-3 illustrates. Industrial stormwater monitoring consists of four components: effluent limitations guidelines monitoring, impaired waters monitoring, benchmark monitoring, and visual assessment.

Effluent Limitations Guidelines Monitoring—Certain outfall sectors have specific limitations imposed. SRS has one outfall that falls in this category because the runoff is from a coal storage pile area at a decommissioned steam electric-generating facility. The stormwater runoff collects into a basin that was designed for at least a 10-year/24-hour rainfall event. Although the outfall has not discharged since 1991, in the event that it does discharge, SRS will sample for pH. SRS submits an annual report to SCDHEC that indicates the outfall has not discharged in the previous 12 months.

Impaired Waters Monitoring—A waterbody is impaired if it has been identified as not meeting applicable state water quality standards. When a receiving stream is impaired, SRS samples stormwater discharges to that stream to ensure they are not contributing to an existing problem. Under the impaired water monitoring program, SRS does not sample and analyze for *Escherichia coli* (*E. coli*) because SRS processes do not contribute that contaminant to either of the two *E. coli*-impaired streams onsite.

Benchmark Monitoring—SRS must monitor for any benchmark parameter specified for the outfall's assigned industrial sector(s). Not all outfalls have required benchmark monitoring. Under the current permit, benchmark sampling has been completed for all but outfall N-12A, which is not meeting the copper benchmark limit. The Site has implemented corrective measures, and the results are trending in a positive direction.

Visual Assessment—Visual assessment outfalls are divided into groups with substantially identical effluents. Each year, one outfall is selected from each group to be the designated representative outfall for the required quarterly sampling. The representative outfall in each group rotates annually. Trained Site employees collect samples and inspect them for clarity, odor, oil and grease, and other simple parameters. The inspector completes visual assessment forms to document the assessment results.

SRS typically collects stormwater samples during qualifying rain events, characterized by two conditions: 1) at least 72 hours have elapsed since the previous flow event, and 2) the sample collection should occur during the first 30 minutes of the flow event. For certain sampling locations, SRS continued to use wireless technology to send immediate text notifications of rain events and to start automated samplers. SRS also uses sample bottles installed in some outfalls that fill when the flow reaches the bottle inlet. These practices allowed SRS to comply with the SCDHEC permit requirement of sampling within 30 minutes of stormwater flow. SRS collects grab samples in a few locations where automated installations are not possible due to the construction of the outfall.

Sludge

SRS disposes of sludge from the Central Sanitary Wastewater Treatment Facility according to the requirements in the SCDHEC-issued NPDES land application permit. In doing so, the Site must sample the sludge to confirm it has met the permit's standards before applying the sludge to the designated pine forest land.

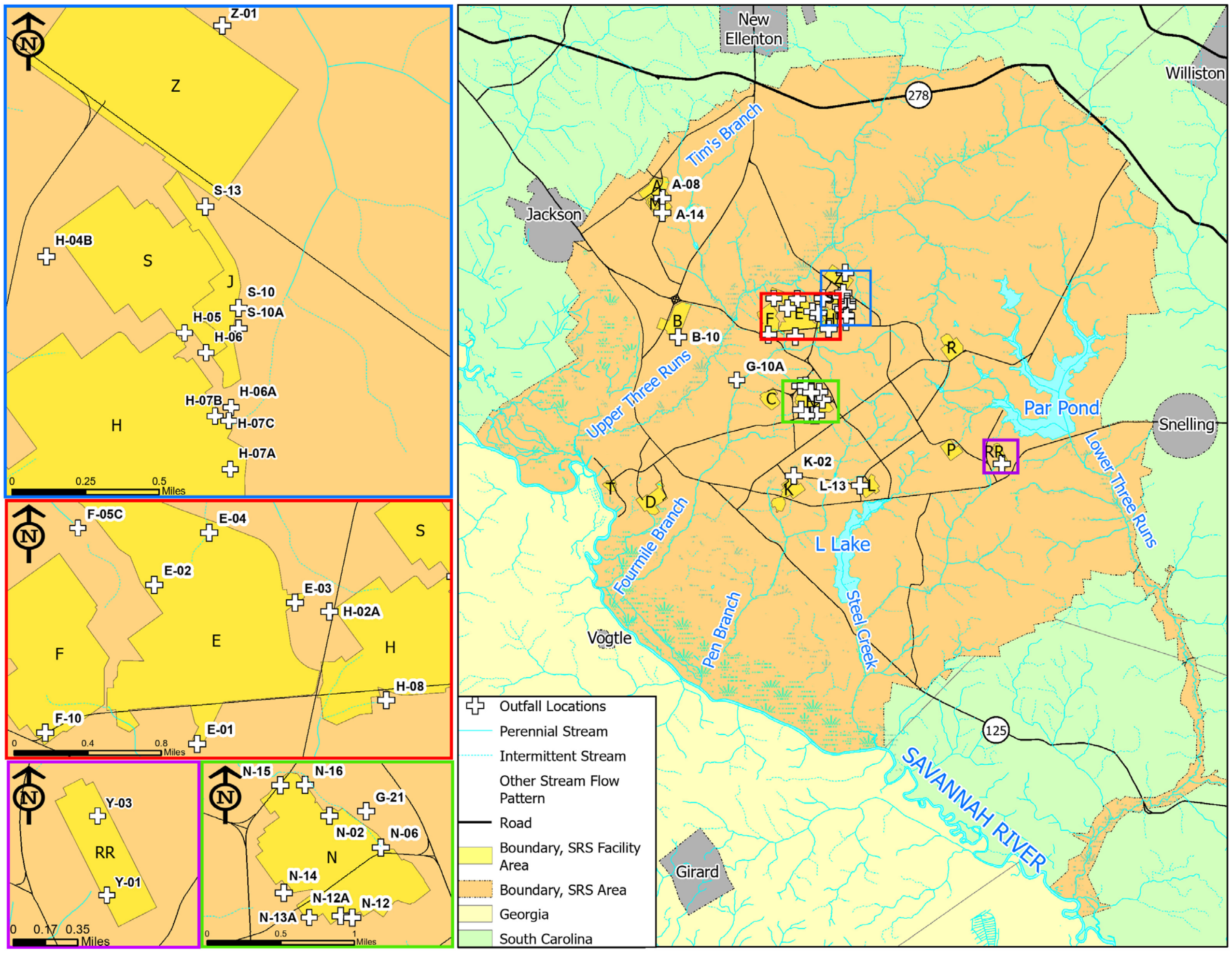


Figure 4-3 NPDES Industrial Stormwater Outfall Sampling Locations

4.3.1.1 Wastewater, Stormwater, and Sludge Results Summary

Wastewater

SRS reports NPDES industrial wastewater analytical results to SCDHEC through monthly Discharge Monitoring Reports. The Site reported only two occurrences where the permit limit was exceeded and one permit exception to the permit requirements for the 2,357 analyses performed during 2021, a 99.9% compliance rate. A permit limit exceedance is when a sample's analyte exceeds the permit amount limits minimum or maximum value. One such exceedance occurred at outfall H-12 for copper, and another at outfall K-12 for a daily maximum flow. A permit exception is a failure to comply with permit conditions other than listed effluent volumes. An example is when a laboratory analysis failure occurs resulting in no reporting, which happened for mercury at outfall H-16 in 2021. SRS received no Notices of Violation in 2021.

Stormwater

SRS monitored all industrial stormwater outfalls according to permit requirements in the following manner:

A Jug is Removed from the ISCO Sampler and Taken to the Lab for Analysis.

- SRS did not collect samples at the one outfall (H-07B) that required effluent sampling because there was no discharge in 2021. SRS reported results to SCDHEC in a required annual discharge monitoring report.
- SRS previously met benchmark sampling requirements at all but two outfalls (G-10A and N-12A) for the remainder of the five-year permit.
  - There was no discharge in 2021, so SRS could not collect samples at outfall G-10A.
  - SRS met benchmark sampling requirements for all analytes except copper at outfall N-12A. The 2021 sample result exceeded the copper benchmark limit; however, corrective measures implemented in 2017 and 2018 remain in place, and results were lower than the highest historical result.
  - Based on evaluations of the current operations in the watersheds, SRS recategorized Z-01 and deactivated S-09A, S-10B, and Y-04 because the discharges do not meet the criteria SCDHEC specified.
- For visual assessment sampling, SRS groups together substantially identical outfalls—30 outfalls in 9 groupings—and designates one outfall to represent a group each year. SRS samples the remaining six outfalls individually and not in groups. In 2021, Site personnel visually assessed the water of these outfalls for color, odor, clarity, solids, foam, and oil sheen. Visual assessments identified no industrial impacts.

Sludge

The Site generally applies treated sludge from the Central Sanitary Wastewater Treatment Facility once every two years. SRS did not perform sludge land application in 2021.

4.3.2 Onsite Drinking Water Monitoring

SRS uses groundwater sources to supply drinking water to onsite facilities. The A-Area treatment plant supplies most of SRS's drinking water. The Site also has 4 smaller drinking water facilities that SCDHEC regulates, each serving fewer than 25 people.

SCDHEC requires SRS to collect 10 bacteriological samples each month from the A-Area Domestic Water Distribution System to ensure that domestic water meets SCDHEC and EPA bacteriological drinking water quality standards. SRS exceeds this requirement by collecting 15 samples each month from various locations throughout the system.

4.3.2.1 Drinking Water Results Summary

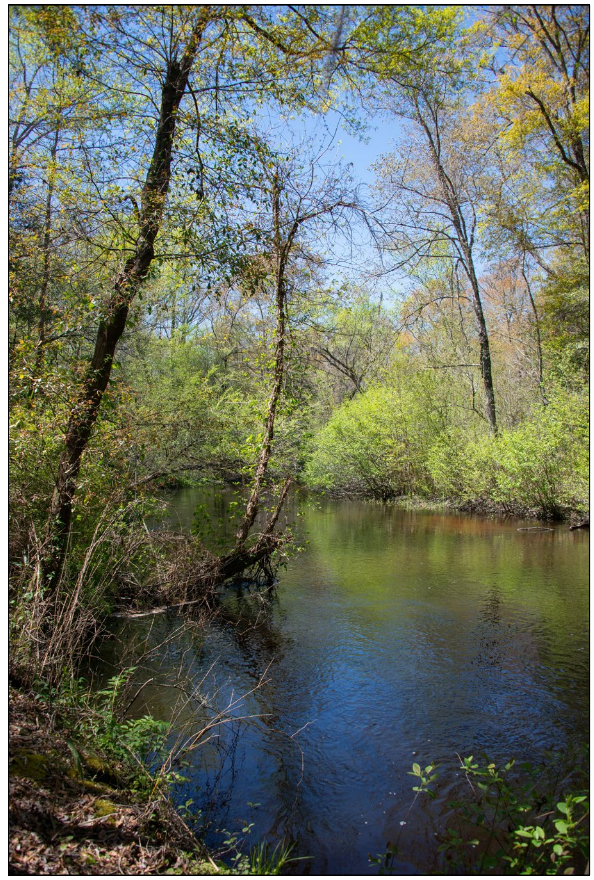
All drinking water bacteriological samples that SRS collected in 2021 met the state and federal drinking water quality standards.

4.3.3 River and Stream Water Quality Surveillance

South Carolina Regulation 61-69, *Classified Waters,* classifies SRS streams and the Savannah River as "freshwaters." Freshwaters, as defined in Regulation 61-68, *Water Classifications and Standards,* (SCDHEC 2014) support the following:

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

SRS surveys river and stream water quality to identify: 1) any degradation that could be attributable to the water discharges Site NPDES permits regulate, and 2) materials coming from inadvertent releases at sources other than routine release points.



SRS Surveys River and Stream Water Quality.

SRS sampled 10 onsite streams and 5 Savannah River locations for various physical and chemical properties, including temperature, hardness, dissolved oxygen, pH, herbicides, metals, nitrate, nitrite, pesticides, phosphorus, polychlorinated biphenyls (PCBs), total organic carbon, and TSS. Figure 4-4 shows the sampling locations. The river and stream sampling locations are upstream from, adjacent to, and downstream from the Site. SRS compares results to background levels of chemicals from natural sources and from contaminants produced by municipal sewage plants, medical facilities, and other upstream industrial facilities to assess the environmental impacts of Site operations on the surrounding area. SRS samples the water quality locations monthly and semiannually by the conventional grab-collection technique. SCDHEC also collects samples at several onsite stream locations as a quality-control check of the SRS program. SRS collects quality control samples throughout the year, as documented in Section 8.5, *Environmental Monitoring Program QC Activities*.

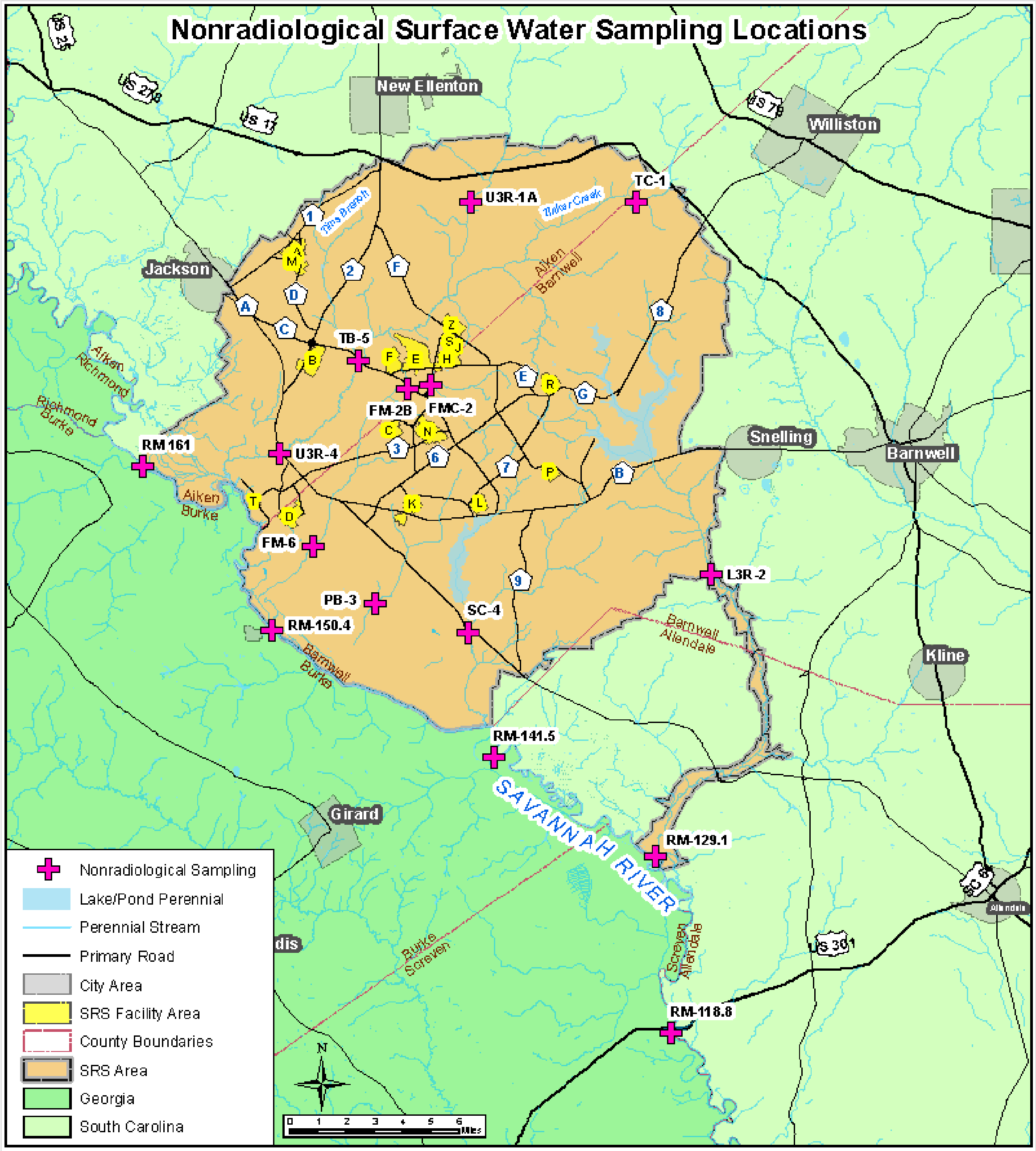


Figure 4-4 Nonradiological Surface Water Sampling Locations

4.3.3.1 River and Stream Water Quality Results Summary

SRS analyzed 4,590 individual samples collected from the 15 stream- and river-water quality locations during 2021, with 3,525 of 3,870 (91.1%) meeting South Carolina Freshwater Quality Standards, as available. (Not all analytes sampled have a standard.) All samples met standards for beryllium, nickel, nitrite, thorium, temperature, pesticides, herbicides, and PCBs. Averages for each river and stream location met standards for cadmium, chromium, copper, lead, mercury, nitrate, zinc, and dissolved oxygen. Additionally, all locations met pH maximum standards. Appendix Table C-1 summarizes the analytical results. These results continue to indicate that SRS discharges are not significantly affecting the water quality of onsite streams or the Savannah River.

4.3.4 Sediment Sampling

SRS's nonradiological sediment surveillance program measures the concentrations of various inorganic contaminants that Site releases deposit in stormwater basins, stream systems, and the Savannah River, where they accumulate or disperse.

The nonradiological sediment program collects sediment samples annually at various Site stream, stormwater basin, and Savannah River locations (Figure 4-5). The locations vary from year-to-year, depending on the rotation schedule agreed upon with SCDHEC. SRS collects duplicate samples to assess quality control, as documented in Section 8.5, *Environmental Monitoring Program QC Activities*.

4.3.4.1 <u>Stream and River Sediment Results Summary</u>

SRS's Sediment Sampling Program Examines Metals Concentrations in Rivers, Streams, and Basins.

SRS collected and analyzed 400 individual sediment samples from 25 locations (14 from streams, 3 from stormwater basins, and 8 from the Savannah River). SRS measured aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, uranium, and zinc. Many of these are trace metals that occur naturally in soils and sediments. Of the 2021 results, 94.8 % (379 of 400 analyses) met the EPA Region 4 Sediment Refinement Screening Values (RSVs). Barium accounted for 14 of the 21 samples that exceeded its RSV (60 mg/kg), while manganese accounted for the remaining 7 exceeding its RSV (1,100 mg/kg). SRS considers the barium exceedances as background, as evidenced by Agency for Toxic Substances and Disease Registry 2007 Toxicological Profile for Barium (mean values ranging between 265 and 835 mg/kg), and because there are similar results in both control locations and in historical trending. Appendix Table C-2 summarizes the analytical results. All results compare to those of the previous five years and demonstrate SRS activities are not significantly affecting the metals concentrations of onsite basins and streams, or the Savannah River.

4.3.5 Fish Monitoring

SRS samples aquatic species to identify and evaluate any effect of Site operations on contaminant levels in fish. The Site collects freshwater fish (bass, catfish, flathead catfish, and panfish) at six locations on the Savannah River from above SRS at Augusta, Georgia to the coast at Savannah, Georgia. SRS collects freshwater fish at the mouth of the streams that flow through the Site and gathers saltwater fish (mullet) at the Savannah River mouth near Savannah. SRS analyzes samples of the edible flesh for metals uptake. SRS performs nonradiological analyses for antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc.

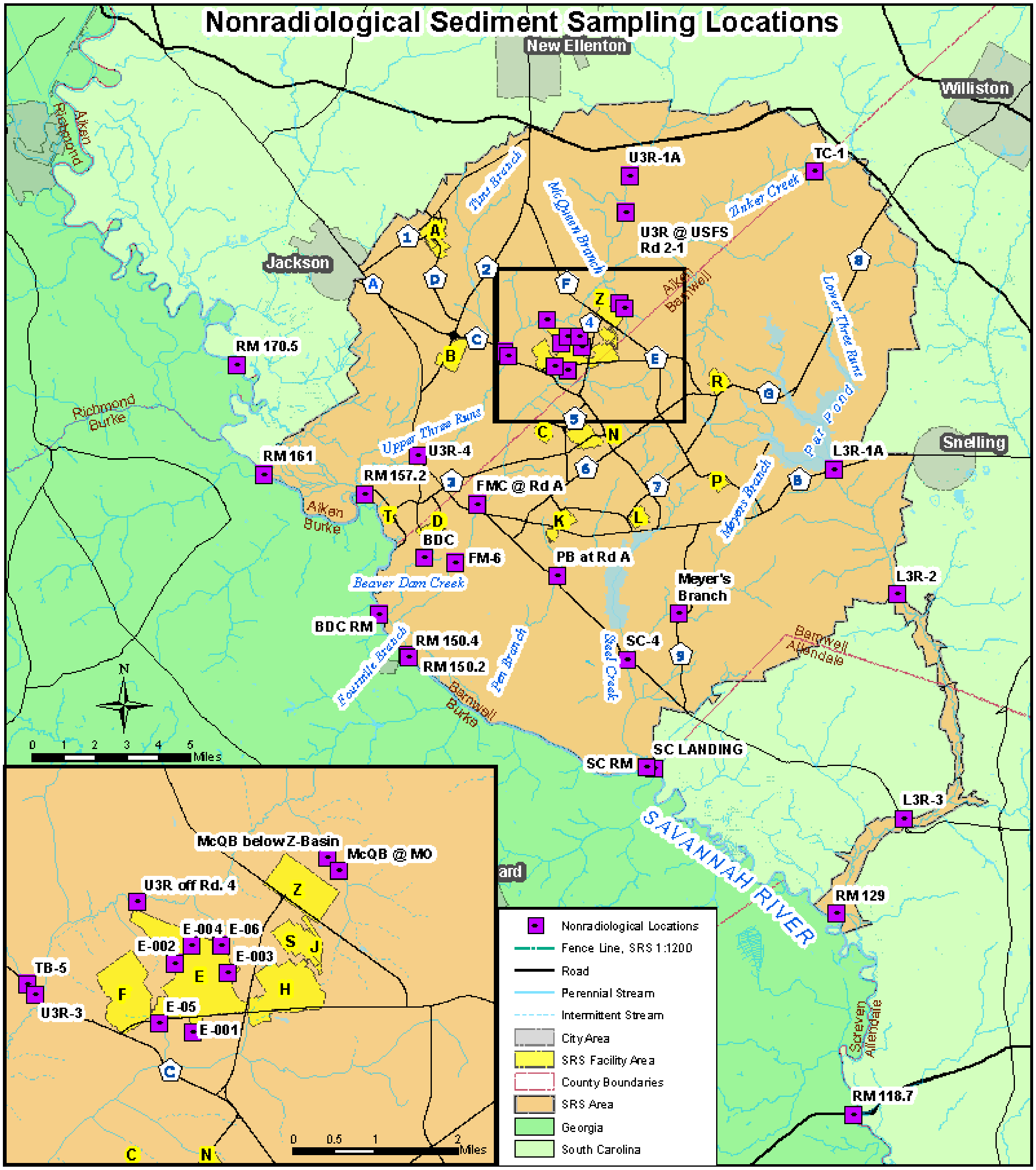


Figure 4-5 Nonradiological Sediment Sampling Locations

4.3.5.1 Fish Results Summary

In 2021, SRS performed 1,764 individual analyses on 176 fish flesh samples. In 2020, SRS added flathead catfish to the freshwater fish surveillance program as the flathead have become established in most waters where they have been introduced, including the Savannah River. Appendix Tables C-3 and C-4 summarize the analytical results. SRS detected and quantified 15%, or 257 results of the 1,764 individual analyses. Most of the detected and quantified results were for mercury and zinc. Sixty-two percent of the results were nondetects (less than the method detection limit), with the remaining 23% being estimated values. This indicates SRS detected the analyte, and the concentration was close to the method detection limit. The 2021 data is comparable to the results for the previous five years. Figure 4-6 shows the average mercury results by fish type for 2016 through 2021.

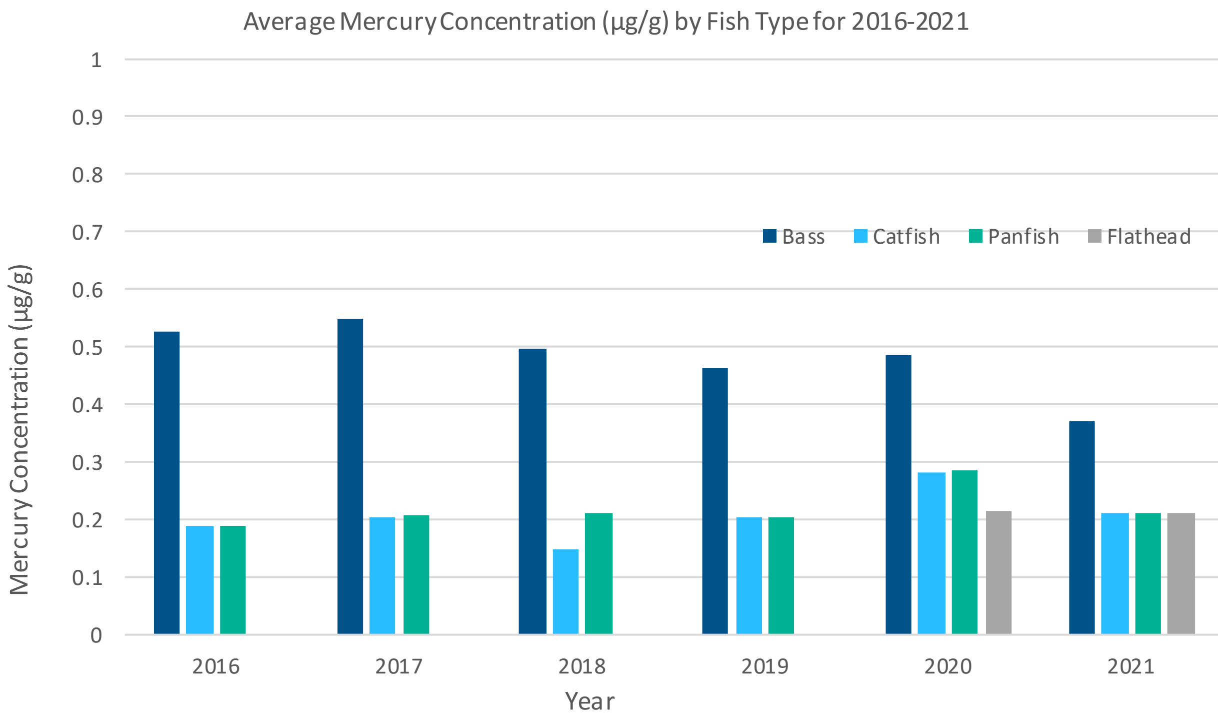


Figure 4-6 Average Mercury Concentration of Fish Species in the Savannah River, Adjacent to the Savannah River Site

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Chapter 5: **Radiological Environmental Monitoring Program**

The purpose of the Savannah River Site (SRS) Radiological Environmental Monitoring Program is twofold: It monitors effects SRS has on the environment, and it demonstrates the Site is complying with applicable U.S. Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Energy (DOE) regulations and standards. Monitoring substantiates that SRS operations pose no risk to the surrounding population. As part of this program, the Site collects thousands of samples throughout the year and analyzes them for radionuclides that could be present from releases due to SRS operations. The Site collects samples both onsite and in the communities surrounding SRS. State and federal regulations drive some of the monitoring SRS conducts. DOE Orders 231.1B, "Environment, Safety and Health Reporting," and 458.1, "Radiation Protection of the Public and the Environment," also address environmental monitoring requirements.

2021 Highlights

Air Pathway—All air contaminants SRS released were below applicable permit and regulatory limits. Radiological results for surveillance media associated with the airborne pathway were within historical levels.

Water Pathway—Water contaminants SRS released were all below applicable standards. Radiological results for surveillance media associated with the liquid pathway were within historical levels.

Wildlife Surveillance—Due to the COVID-19 pandemic, the SRS hunts were cancelled during 2021. Savannah River Nuclear Solutions, LLC (SRNS), the management and operations contractor at SRS, in conjunction with the United States Forest Service-Savannah River, collected flesh samples from 26 feral hogs that had been trapped in various hunt compartments onsite and analyzed for radionuclides released during the course of Site operations. The results were used to calculate dose to the sportsman in the vicinity of the Site. Although the animals were not released for consumption, the sportsman dose was well below the applicable standard in the hypothetical event they were harvested during a hunt.

5.1 INTRODUCTION

Environmental monitoring at SRS examines both radiological and nonradiological constituents that the Site could release to the environment. This chapter discusses radiological monitoring at SRS; Chapter 4, *Nonradiological Environmental Monitoring Program*, presents the nonradiological monitoring.

The SRS Radiological Environmental Monitoring Program monitors radiological contaminants from both air and liquid sources, as well as collects and analyzes environmental samples from numerous locations throughout the Site and the surrounding area. SRS measures tritium in most sample media as it is a significant contributor to the potential dose to the public. The Radiological Environmental Monitoring Program has two focus areas: 1) effluent monitoring, and 2) environmental surveillance. SRS determines sampling frequency and analyses based on permit-mandated monitoring requirements, federal regulations, and DOE Orders.

In accordance with DOE Order 458.1, SRS evaluates the effluent monitoring program by comparing the annual average concentrations to the DOE-derived concentration standards (DCSs). DOE's *Derived Concentration Technical Standard* (DOE 2011) establishes numerical standards for DCSs to implement DOE Order 458.1. DCSs are radiological quantities for certain radionuclides specific to a surface or concentration used in surveying or characterizing radiation to comply with DOE Order 458.1. SRS demonstrates DCS compliance when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. This sum is called the "sum of fractions." The DCSs are applicable at the point of discharge, and SRS uses them to screen existing effluent treatment systems to determine whether they are appropriate and effective. SRS uses the same DCSs as reference concentrations to conduct environmental protection programs. All DOE sites use these DCSs.

The SRS surveillance program samples the types of media that Site releases, as measured in the effluent monitoring program, may impact. Figure 5-1 shows the liquid and airborne pathways, as well as the types of media sampled through those pathways.

Chapter 5—Key Terms

Actinides *are a group of radioactive metallic elements with an atomic number between 89 and 103. Within this chapter, laboratory analysis of actinides generally refers to the elements uranium, plutonium, americium, and curium.*

Derived Concentration Standard (DCS) *is the concentration of a radionuclide, measured at the discharge point, in air or water effluents that—under conditions of continuous exposure for one year (annual ingestion of water, submersion in air, or inhalation)—would result in a dose of 100 millirem (mrem). This assumption of direct exposure to discharge point effluents is extremely unlikely and ensures that the DCSs are highly conservative.*

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

Effluent monitoring *collects samples or data from the point a facility discharges liquids or releases gases.*

Environmental monitoring *encompasses both effluent monitoring and environmental surveillance.*

Environmental surveillance *collects samples beyond the effluent discharge points and from the surrounding environment.*

Exposure pathway *is the way that releases of radionuclides into the water and air could impact a person.*

SRS conducts environmental monitoring of the following:

- Air (stack emissions and ambient air)
- Rainwater
- Vegetation
- Soil
- Surface water (facility effluents, stream and river water, and stormwater basins)
- Drinking water
- Stream, basin, and river sediment
- Aquatic food products
- Wildlife
- Food products (milk, meat, fruit, nuts, grains, and vegetables)

Sampling results provide the data needed to assess the exposure pathways for the people living near SRS, as documented in Chapter 6, *Radiological Dose Assessment*.

Appendix Table B-2 of this document summarizes the radiological surveillance sampling media and frequencies.

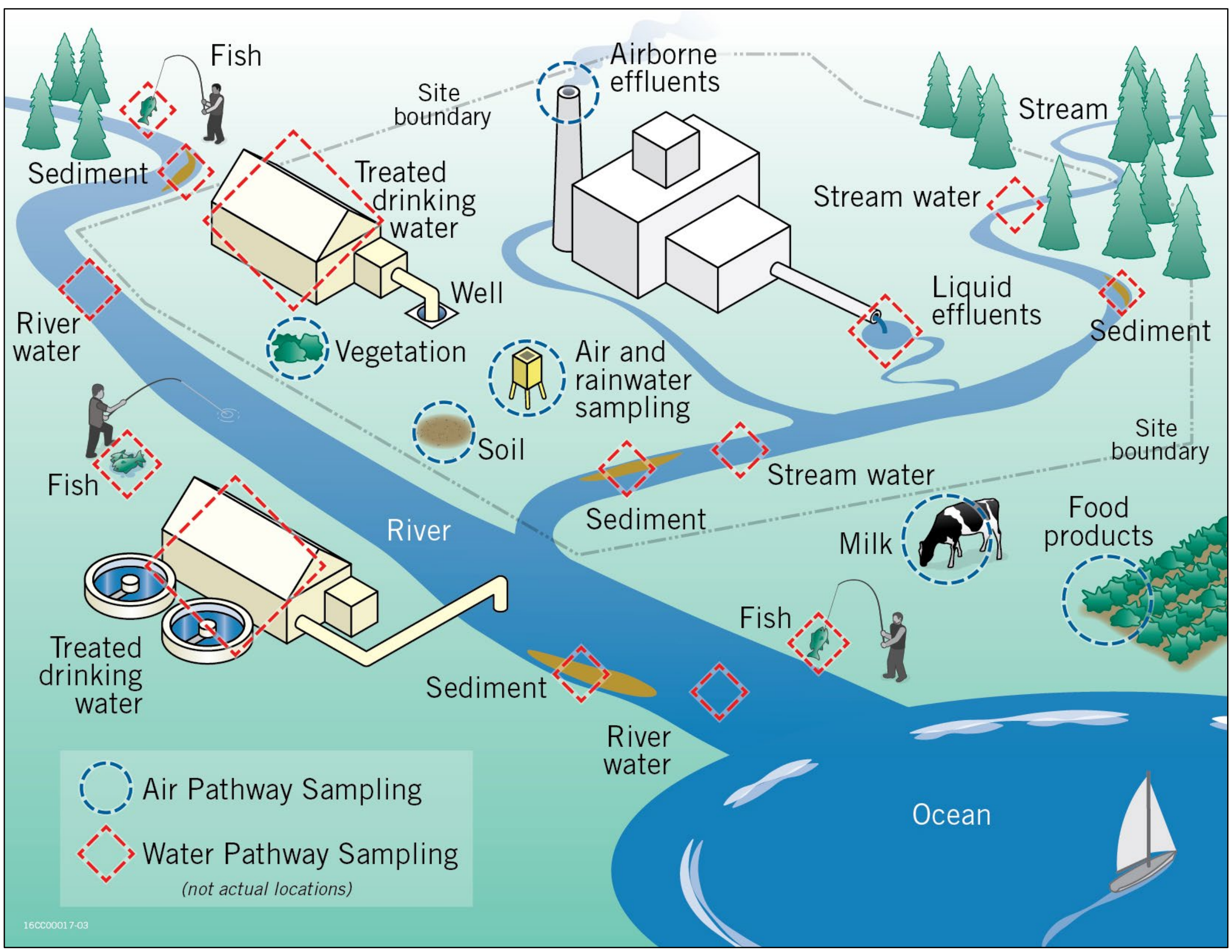


Figure 5-1 Types and Typical Locations of Radiological Sampling

5.2 SRS OFFSITE MONITORING

Offsite monitoring involves collecting and analyzing samples of air, river water, drinking water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations. SRS analyzes these samples for radioactive contaminants to monitor effects the Site has on the environment and to assess long-term trends of the contaminants in the environment. SRS collects samples beyond the Site perimeter in Georgia and in South Carolina at 25- and 100-mile intervals from the Site. Additionally, SRS collects samples at several population centers in Georgia and South Carolina.

SRS monitors the Savannah River at five locations adjacent to and downriver of SRS. A control location is located above the Site at River Mile (RM) 161. Media-specific chapter figures and Environmental Maps show offsite environmental sampling locations. Chapter 7, *Groundwater Management Program,* provides information on SRS groundwater monitoring. Table 5-1 summarizes SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected from the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Sampling Media	Approximate Number of Samples (Number of Locations)	
	South Carolina	Georgia
Air Filters	26 (1)	52 (2)
Silica Gel	26 (1)	52 (2)
Ambient Gamma Radiation Monitoring	56 (7)	32 (4)
Rainwater	12 (1)	25 (2)
Food Products	16 (4)	4 (1)
Milk	16 (4)	12 (3)
Soil	4 (4)	2 (2)
Grassy Vegetation	1 (1)	2 (2)
Drinking Water	24 (2)	0 (0)
Total	**182 (25)**	**182 (18)**

Note:
This table excludes groundwater monitoring locations and samples that Chapter 7, *Groundwater Management Program*, discusses, as well as samples collected from the Savannah River.

5.3 AIR PATHWAY

The media in this section support the air pathway dose assessment Chapter 6, *Radiological Dose Assessment*, discusses.

5.3.1 Air Monitoring

SRS monitors the air to determine whether airborne radionuclides from SRS emissions have reached the environment in measurable quantities and to ensure that radiation exposure to the public remains below regulatory limits. SRS performs effluent monitoring of airborne radionuclides at the point of discharge from operating SRS facilities. This monitoring complies with EPA and DOE requirements and regulations that are in place to protect the public. SRS conducts additional air sampling at surveillance stations onsite, along the SRS perimeter, and within communities surrounding SRS. Radionuclides in and around the SRS environment are both from SRS operations and from sources not related to the Site. The sources not associated with SRS include 1) naturally occurring radioactive material, 2) past atmospheric testing of nuclear weapons, 3) offsite nuclear power plant operations, and 4) offsite medical and industrial activities. Krypton-85 and tritium in the elemental (hydrogen gas) and oxide (water vapor) forms make up most of the radionuclide emissions from SRS to the air. The amount of krypton-85 and tritium released from SRS varies yearly, based on mission activities and on the annual production schedules of the processing facilities.

5.3.2 Airborne Emissions

The EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) program establishes the limits for radionuclide emissions, detailing the methods for estimating and reporting radioactive emissions from DOE-owned or operated sources. SCDHEC issues Clean Air Act Part 70 Air Quality Permits to regulate radioactive airborne pollutant emissions for each major source of airborne emissions on SRS. Each permit has specific limitations and monitoring requirements.

SRS quantifies the total amount of radioactive material released to the environment by the following methods:

- Data obtained from monitored air effluent release points (stacks or vents)
- Calculated releases of unmonitored radioisotopes from spent fuel dissolution
- Estimates for unmonitored sources based on approved EPA calculation methods

SRS monitors the emissions from process-area stacks at facilities that release, or have the potential to release, airborne radioactive materials. SRS typically uses laboratory analyses of samples to determine concentrations of radionuclides in airborne emissions. The Site collects airborne effluent samples on filter papers for particulates, on charcoal sampling media for gaseous iodine, and in a bubbler solution for airborne tritium. Depending on the processes involved, SRS may also use real-time instruments to monitor instantaneous and cumulative releases (of tritium, for example) to the air.

The dissolution of spent nuclear fuel in the H-Canyon facility releases krypton-85, carbon-14, and tritium. SRS calculates these emissions and includes them with the monitored releases.

Each year, SRS calculates radionuclide release estimates (in curies [Ci]) from unmonitored diffuse and point sources. Point sources include stacks or other exhaust points, such as vents. In contrast, emissions from diffuse sources are not actively ventilated or exhausted. Diffuse emissions may originate from a larger area and not from a single location. SRS diffuse sources include research laboratories, disposal sites and storage tanks, and deactivation and decommissioning activities. The emissions calculated from unmonitored releases use the methods contained in Appendix D of the EPA's NESHAP regulations (EPA 2002). Because these methods employ conservative assumptions, they generally overestimate actual emissions. Although SRS does not monitor these releases at their source, it uses onsite and offsite environmental surveillance to assess the impact, if any, of unmonitored releases.

5.3.2.1 Airborne Emissions Results Summary

Appendix Table D-1 presents SRS radioactive release totals from monitored and unmonitored (calculated) sources, while Table 5-2 provides a summary for the calendar year (CY). During the past 10 years, the total annual tritium release has ranged from about 7,030 to 40,000 Ci per year, with an annual average tritium release of 19,000 Ci (Figure 5-2). The 2021 SRS tritium releases totaled 9,110 Ci. SRS tritium releases fluctuate from year to year due to deactivation of legacy process buildings, the amount of tritium released during routine operations, and natural decay of tritium (about 5% per year).

In 2021, tritium and krypton-85 accounted for a majority of the total radiation SRS operations released to the air. Tritium-processing facilities are responsible for most of the SRS tritium releases, and highly enriched uranium reprocessing at H-Area separations facilities is responsible for all krypton-85 releases. Tritium releases from the separations areas are a combination of releases from the tritium-processing facilities and the dissolution in H Canyon. Appendix Table D-1 and Figures 5-2 and 5-3 show the tritium releases from the separations areas, legacy reactor facilities, and unmonitored sources.

Appendix Table D-2 summarizes the 2021 air effluent-derived concentration standards sum of fractions for continuous sources. The table contains calculated concentrations for tritium from the legacy reactor areas and the tritium-processing facilities, and for krypton-85, carbon-14, and tritium from the H-Canyon facility during the dissolving process. SRS calculates these concentrations based on the annual releases in curies and the annual stack release volume.

Most SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. The F-Canyon stack analytical results were elevated in 2021, as they were from 2017 to 2020. The elevated levels continue to result in a DCS exceedance with plutonium-239 as the primary contributing radionuclide. As mentioned earlier in the chapter, compliance with the DCS is when the sum of the ratios

Table 5-2 SRS Radiological Atmospheric Releases for CY 2021

Release Type	Total (curies)
Tritium	9.11E+03
Krypton-85 (^{85}Kr)	1.68E+04
Short-Lived Fission and Activation Products (T1/2 < 3 hr)[a,b]	3.06E-06
Fission and Activation Products (T1/2 > 3 hr)[a,b]	7.04E-02
Total Radio-iodine	5.57E-03
Total Radio-strontium[c]	6.76E-03
Total Uranium	7.38E-05
Plutonium[d]	5.27E-04
Other Actinides	2.40E-04
Other	1.00E-02

[a]International Commission on Radiological Protection (ICRP) 107 half-life data, *Nuclear Decay Data for Dosimetric Calculations (2008)*
[b]International Atomic Energy Agency (IAEA) Common Fission and Activation Products
[c]Includes unidentified beta releases
[d]Includes unidentified alpha releases

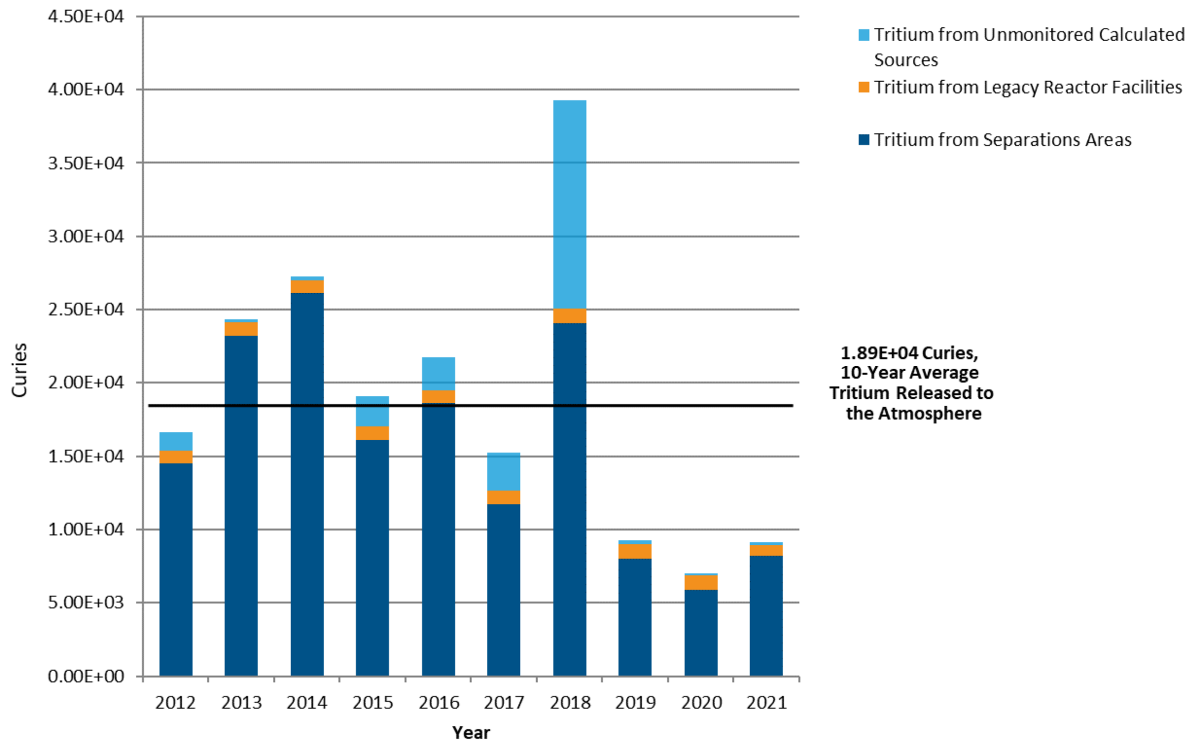


Figure 5-2 10-Year History of SRS Annual Tritium Releases to the Air

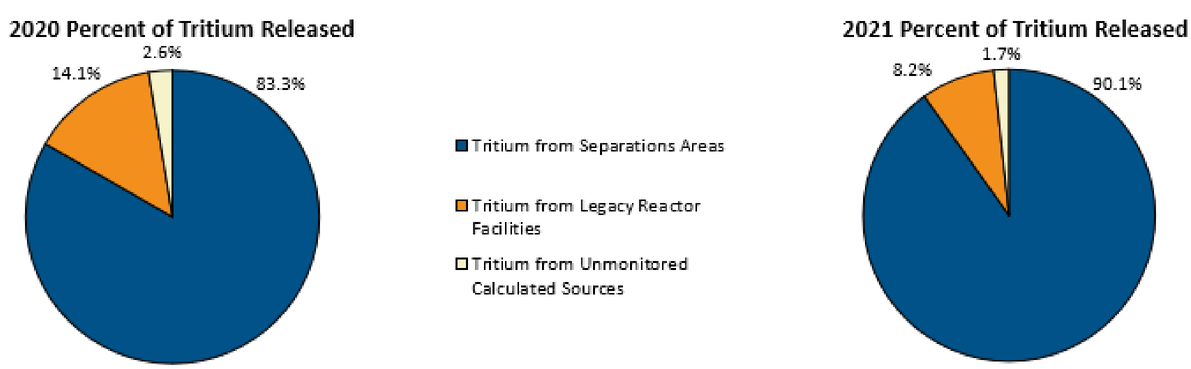


Figure 5-3 Percent of Tritium Released to the Air for 2020 and 2021

of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. The DCS sum of fractions exceedance for 2021 is 2.47, a decrease from the 2020 value of 2.85. SRS continues to monitor and evaluate emissions from the facility and will determine whether the Site needs to take action to further reduce releases.

Because of the nature of several SRS facilities operations, tritium oxide releases exceeded DOE's tritium air DCS. However, DOE recognizes that tritium oxide, which is essentially water vapor, cannot be filtered or removed from the effluent. Therefore, DOE Order 458.1 specifically exempts tritium from Best Available Technology considerations but not from environmental As Low As Reasonably Achievable (ALARA) requirements that Site procedures implement. Thus, the Site maintains tritium releases according to the

ALARA principle to comply with DOE Order 458.1. The ALARA process manages radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable.

5.3.3 Air Surveillance

Beyond the operational facilities, SRS maintains a network of 16 air sampling stations (Figure 5-4 and Environmental Maps, *Radiological Air Surveillance Sampling Locations*) in and around SRS to monitor concentrations of radionuclides in the air and rainwater. The air contains radionuclides in various forms (gaseous, particulate matter, water vapor). Rainwater can redeposit radionuclides from the air onto the ground and vegetation, or soil can eventually absorb the radionuclides.

The sampling stations are at locations on and off the Site. Onsite stations are at the center of the Site and around the perimeter. Offsite sampling stations are 25 miles from the Site in population centers and at a control location, the U.S. Highway 301 Bridge at the Georgia Welcome Center in Screven County. SRS operations are not likely to affect the control location. SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases in the environment. During CY 2021, SRS added a station just south of L Lake (A-14) to improve the network efficiency representative of dose associated with the Site's southern wind quadrant. Each air sampling station collects air and rainwater samples as Table 5-3 lists.

SRS selected the radionuclides Table 5-3 presents based on known SRS airborne emission sources. Background levels in the air consist of naturally occurring radionuclides (for example, uranium, thorium, and radon) and radionuclides from global fallout due to historical nuclear weapons testing related to the Cold War (for example, strontium-89,90, and cesium-137 [a manmade gamma-emitting radionuclide]).

5.3.3.1 Results Summary

For tritium in air (water vapor) and tritium in rainwater, Appendix Tables D-3 and D-4 summarize results and compare them to the background control location at the U.S. Highway 301 Bridge. The 2021 results for tritium in air showed detectable levels in 52 of the 394 samples, or 13%, compared to 2020 results with detectable levels in 14% of the samples.

The 2021 results for tritium in rainwater showed detectable levels in 25 of the 199 rainwater samples, or 13%, as compared to 2020 results with detectable levels in 7% of the samples. All 2021 values were detectable only at Burial Ground North, which is at the center of the Separations Area at SRS.

Charcoal canisters analyzed quarterly for radioiodine in 2021 showed no detections of iodine-129. Charcoal canister results for radioiodine were within the historical trends for the previous 10 years. Glass fiber filter results for gamma-emitting radionuclides showed no detectable levels of cesium-137 and no detectable levels of cobalt-60 at any air surveillance stations during 2021. All offsite location results were near the levels observed at the control location at the U.S. Highway 301 bridge. Appendix Table D-5 summarizes the results.

Table 5-3 Air Sampling Media

Media	Purpose	Radionuclides
Glass-Fiber Filter	Airborne particulate matter	Gamma-emitting radionuclides, gross alpha/beta emitting radionuclides, actinides, strontium-89,90
Charcoal Canister	Gaseous states of radioiodine	Iodine-129
Silica Gel	Tritiated water vapor	Tritium
Rainwater	Tritium in rainwater	Tritium

SRS also selected offsite and plant perimeter glass fiber filter samples for actinide and strontium-89,90 analysis. Sample selection was dependent on dates of elevated concentrations at F-Canyon stack and the wind direction during the corresponding time period. Actinide and strontium-89,90 analysis was also performed on glass fiber filter samples collected biweekly at the Burial Ground North onsite. Appendix Table D-5 summarizes all glass fiber filter results, and all are comparable to historical trends.

5.3.4 Ambient Gamma Surveillance

Since 1965, SRS has been monitoring ambient (surrounding) environmental gamma exposure rates. SRS currently measures ambient gamma exposure using optically stimulated luminescent dosimeters (OSLDs), which are passive devices that measure exposure from ionizing radiation. The Site uses data from OSLDs to determine the impact of Site operations on the gamma exposure to the public and the environment and to evaluate trends in exposure levels. Other uses include supporting routine and emergency response dose calculations.

An extensive OSLD network in and around SRS monitors external ambient gamma exposure rates (Environmental Maps, *SRS Optically Stimulated Luminescent Dosimeter [OSLD] Sampling Locations*). The SRS ambient gamma radiation-monitoring program has four subprograms: 1) Site perimeter stations, 2) population centers, 3) air surveillance stations, and 4) onsite perimeter stations colocated with Georgia Power's Vogtle Electric Generating Plant's stations. SRS conducts most gamma exposure monitoring onsite and at the SRS perimeter.

SRS Measures Environmental Gamma Exposure Rates with OSLDs Placed Across the Site.

SRS monitors population centers near the Site boundary, with limited monitoring beyond at the three 25-mile air surveillance stations.

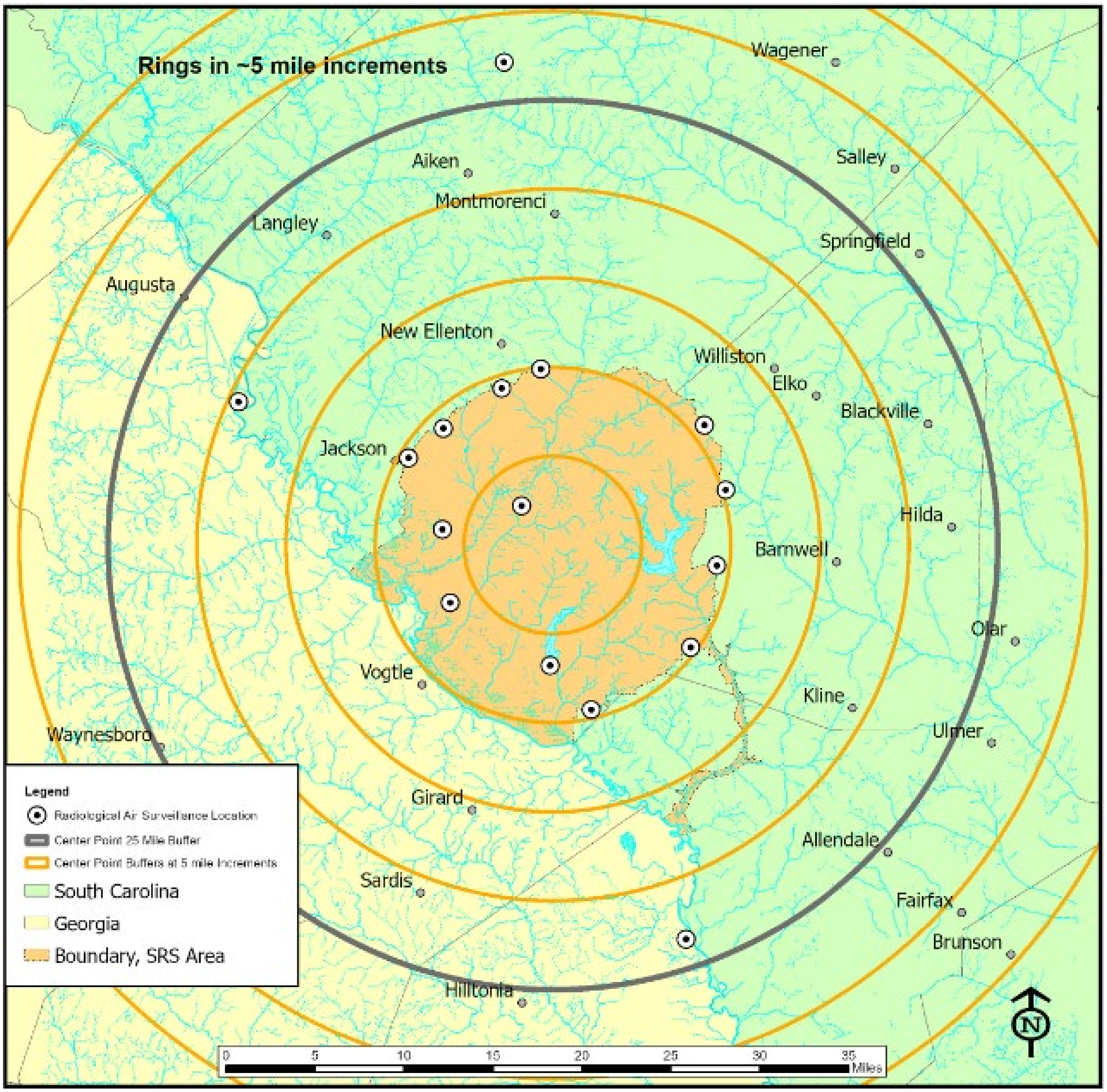


Figure 5-4 Air Sampling Locations Surrounding SRS up to 25 Miles

5.3.4.1 Ambient Gamma Results Summary

Appendix Table D-6 summarizes the gamma results. Ambient gamma exposure rates at all OSLD monitoring locations show some variation based on location and natural levels of background radiation in the environment. In 2021, ambient gamma exposure rates onsite varied between 76 mR/yr at location NRC2 (onsite southwest) and 154 mR/yr at the BGN (onsite, near the center of the Site). Rates at population centers ranged from 100 mR/yr at the Windsor, South Carolina, location to 165 mR/yr at the Beech Island, South Carolina location.

Consistent with the previous five-year trends, ambient gamma results indicate that no significant difference in average annual dose rates exists between monitoring networks. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks, as expected, because materials present in buildings and roadways contribute to the natural background radiation.

5.3.5 Soil Surveillance

SRS conducts soil surveillance to provide the following:

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

In 2021, SRS collected soil samples from 5 onsite locations, 11 Site perimeter locations, and 3 offsite locations (Environmental Maps, *Radiological Soil Sampling Locations*). Radionuclide concentrations in soil vary greatly among locations because of differences in the patterns, retention, and transport of rainfall in different types of soils. Therefore, a direct comparison of year-to-year data could be misleading. However, SRS evaluates the data for long-term trends.

Sampling technicians use hand augers, shovels, or other similar devices to collect soil samples to a depth of 6 inches at each sampling location. The technicians mix the soil samples from each sampling location to ensure they are homogeneous when the laboratory analyzes them for gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and actinides (including neptunium).

5.3.5.1 Soil Results Summary

Collecting a Soil Sample

In 2021, SRS detected radionuclides in soil samples from all 19 sampling locations. Analyses detect uranium isotopes (uranium-234, uranium-235, and uranium-238) in the soil samples each year. Uranium is naturally occurring in soil and is expected to be present in the environment. The concentration range for naturally occurring uranium in soil is typically about 1-5 pCi/g, with an average concentration of 2 pCi/g in soils in the United States. Uranium results both onsite and at the Site perimeter are consistent with naturally occurring uranium levels. Many factors affect the uranium concentration in soil over time. These include the pH of the soil, the type of soil, and deposits from the air transferred through rainfall. Organic matter and clay minerals provide exchange sites in soil, which can increase the uranium sorption.

The concentrations of other radionuclides at these locations are consistent with historical results, with maximum cesium-137 concentrations of 0.34 pCi/g at the Aiken Airport location and of 0.12 pCi/g at the control location (Highway 301). Appendix Table D-7 summarizes the results.

5.3.6 Grassy Vegetation Surveillance

SRS collects and analyzes grassy vegetation samples annually at locations onsite and offsite (Environmental Maps, *Radiological Vegetation Sampling Locations*). This information complements the soil sample results that the Site uses to evaluate radionuclide accumulation in the environment and to validate SRS dose models. Vegetation can receive radioactive contamination either externally, when radioactive particles from the air settle on the plant, or internally, when the plant absorbs contaminants in soil and water through its roots. The Site prefers Bermuda grass for surveillance because of its importance as a pasture grass for dairy herds. SRS collects vegetation samples from the following:

- All air sampling locations
- When applicable, locations where SRS expects soil radionuclide concentrations to be higher than normal background levels
- When applicable, locations receiving potentially contaminated water

Vegetation sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, technetium-99, and actinides (including neptunium).

5.3.6.1 Grassy Vegetation Results Summary

SRS collected all annual samples for 2021. SRS detected various radionuclides in the grassy vegetation samples at all air sampling locations (1 onsite, 11 at the perimeter, and 3 offsite). Appendix Table D-8 summarizes the results. All radionuclides are within the trends of the previous 10 years for all locations.

SRS Analyzes Grassy Vegetation Both Onsite and Offsite.

5.3.7 Terrestrial Food Surveillance

SRS personnel collect terrestrial food products grown and consumed in the communities surrounding the Site, as well as fish and shellfish caught from the Savannah River. They analyze these samples for radionuclides. The results reveal whether radionuclides are present in the environment. Tritium releases from SRS sources are the primary contributors to tritium in food products.

Agricultural products, livestock, and game animals that humans eat may contain radionuclides. Livestock and game animals may be exposed if the radionuclides are in the air. Radionuclides in the air can settle on grass, which animals can eat. If humans consume the meat of these exposed animals, they become exposed to radiation. Dairy cows are also livestock of concern to SRS because they produce milk that humans consume, leading to potential radiation exposure. SRS samples milk, meat, fruit, nuts, grains, and vegetables based on their potential to transport radionuclides to humans through the food chain.

Local gardens, farms, and dairies are the source of terrestrial food products. SRS collects beef, watermelon, and greens annually. Site personnel also collect two specific crops a year, rotating through a variety of vegetables, grains, and nuts. Once a quarter, the Site collects milk samples. Food product samples come from each of the four quadrants surrounding SRS, which extend up to 10 miles from the Site boundary. Additionally, SRS collects a control sample to the southeast at a distance between 10 miles and 25 miles from the Site boundary.

Laboratory analysis of the food samples include those for gamma-emitting radionuclides, tritium, strontium-89,90, technetium-99, gross alpha, gross beta, and actinides (including neptunium). Laboratory analysis of the dairy samples include those for gamma-emitting radionuclides, tritium, and strontium-89,90.

5.3.7.1 Terrestrial Food Results Summary

In 2021, SRS sampled milk and the following terrestrial foodstuffs: greens, watermelons, beef, cabbage, and grains. Based on availability, the collected grains were wheat and rye. SRS collected all food types from all four quadrants and the control area. Appendix Tables D-9 and D-10 summarize the foodstuffs and dairy results. The analytical results of the routine terrestrial foodstuffs and milk are consistent with 10-year trends. Results for most foodstuffs (83% for terrestrial foodstuffs and 92% for dairy) did not detect radionuclides. More than half of the detected terrestrial foodstuff results were associated with natural uranium.

5.4 WATER PATHWAY

The media presented in this section support the water pathway dose assessment discussed in Chapter 6, *Radiological Dose Assessment.* Environmental Maps, *Stream Systems,* identifies SRS stream systems included in the pathway.

5.4.1 Liquid Effluents Monitoring Program

SRS routinely samples, analyzes for radionuclides, and monitors flow at each liquid effluent discharge point that releases, or has potential to release, radioactive materials. Figure 5-5 shows the effluent sampling points near SRS facilities.

5.4.1.1 Liquid Effluent Results Summary

Appendix Table D-11 provides SRS liquid radionuclide releases for 2021. These releases include direct releases plus the shallow groundwater migration (as Section 5.4.3 discusses) of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF). Table 5-4 summarizes the liquid effluent releases of radioactive materials. The direct releases (including migration) of tritium decreased by 7% (from 519 Ci in 2020 to 483 Ci in 2021). Beginning in January 2021, outfall G-010 transitioned to the Radiological Liquid Effluent Program, which requires monthly radioactive release monitoring and reporting.

The total amount of tritium released directly from process areas to SRS streams (not including shallow groundwater migration) during 2021 was 88.4 Ci compared to 65.5 Ci released in 2020. Figure 5-6 presents the tritium released by source area and shows that while oftentimes variable, the total direct releases of tritium in 2021 is consistent with the 10-year historical measurements.

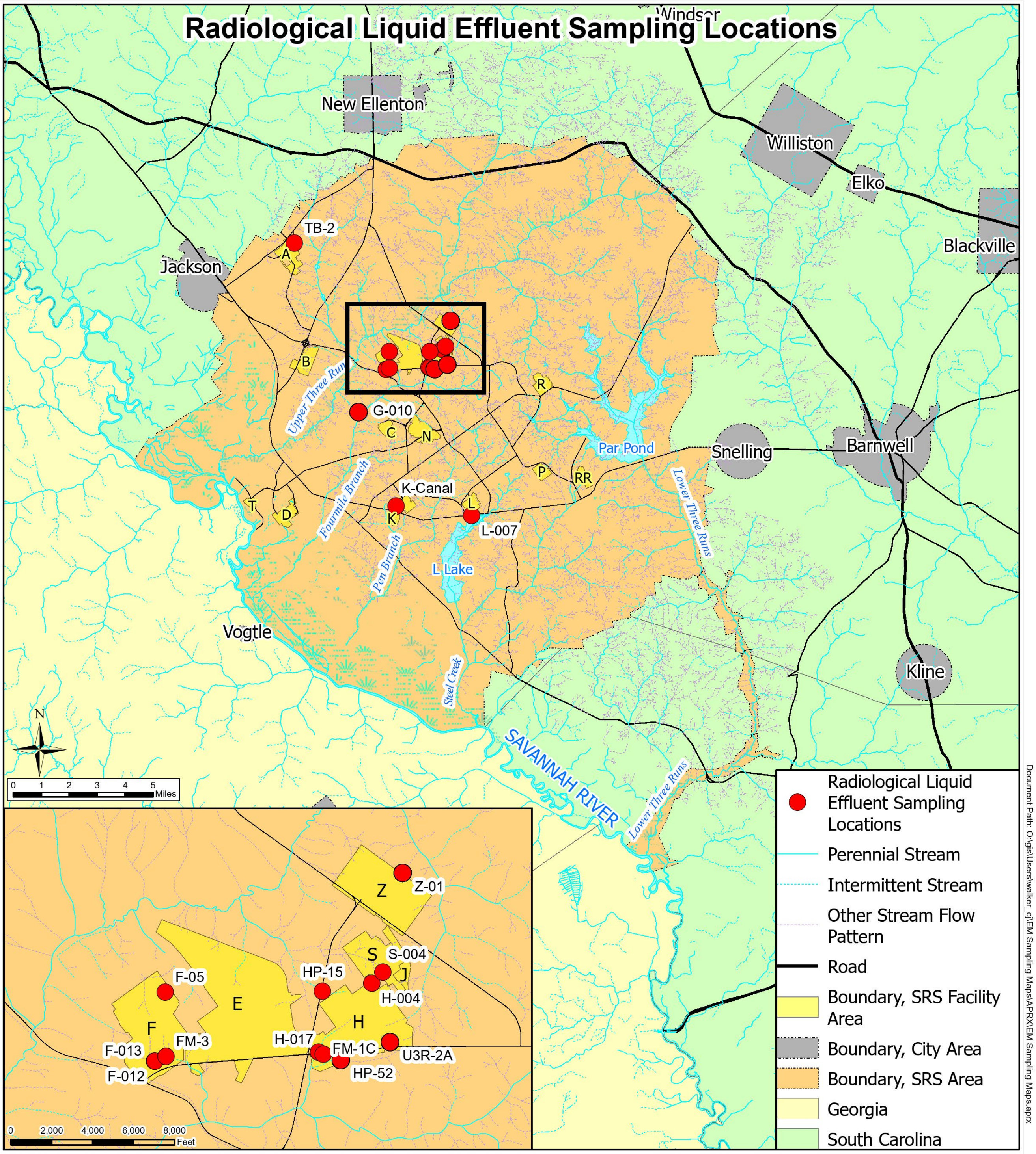
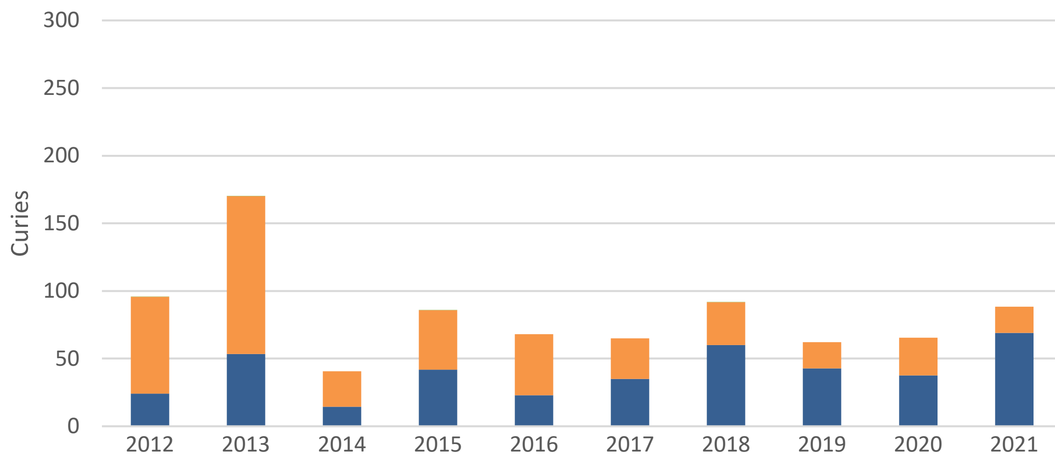


Figure 5-5 Radiological Liquid Effluent Sampling Locations

As the chapter mentions earlier, compliance with the DCS is when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. The DCS sum of fractions for all liquid effluent locations was less than 1.00. Appendix Table D-12 summarizes the 2021 liquid effluent sum of fractions and radionuclides detected at each outfall or facility.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SRNL	0.21	0.12	0	0	0	0.0	0.05	0	0	0
Legacy Reactor Areas	71.6	116.8	26.1	43.8	45.2	29.9	31.7	19.3	27.8	19.5
Separations Areas	24.1	53.3	14.5	41.8	22.9	35	60.1	42.8	37.7	68.9

Figure 5-6 10-Year History of Direct Releases of Tritium to SRS Streams

Table 5-4 SRS Radiological Liquid Effluent Releases[a] of Radioactive Material for CY 2021

Release Type	Totals (curies)
Tritium	4.83+02
Fission and Activation Products (half-life > 3 hr)[b,c]	5.86E-02
Total Radioiodine	2.19E-02
Total Radio-strontium[d]	7.42E-02
Total Uranium	6.65E-02
Plutonium[e]	6.64E-03
Other Actinides	2.95E-04
Other	0

[a] Includes direct releases and shallow groundwater migration from SRS seepage basins and SWDF
[b] International Commission on Radiological Protection (ICRP) 107 half-life data, *Nuclear Decay Data for Dosimetric Calculations (2008)*
[c] International Atomic Energy Agency (IAEA) Common Fission and Activation Products
[d] Includes unidentified beta releases
[e] Includes unidentified alpha releases

5.4.2 Stormwater Basin Surveillance

SRS monitors the accumulated stormwater in the Site's stormwater basins for gross alpha, gross beta, tritium, strontium, technetium, gamma-emitting radionuclides, and carbon. Additional analytes may include actinides (including neptunium). With no active processes discharging to SRS's stormwater basins, the accumulations in these basins are mainly stormwater runoff. SRS selects the specific radionuclides for monitoring based on the operational history of each basin. The E-Area basins receive stormwater from SWDF, the 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 former Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area (Saltstone processing and disposal facilities). Stormwater basins may release to monitored outfalls during heavy rainfall. As part of the surface water surveillance program, Figure 5-7 identifies all of the Site's stormwater basin locations, along with the Site's stream surveillance location, which are discussed later in this chapter.

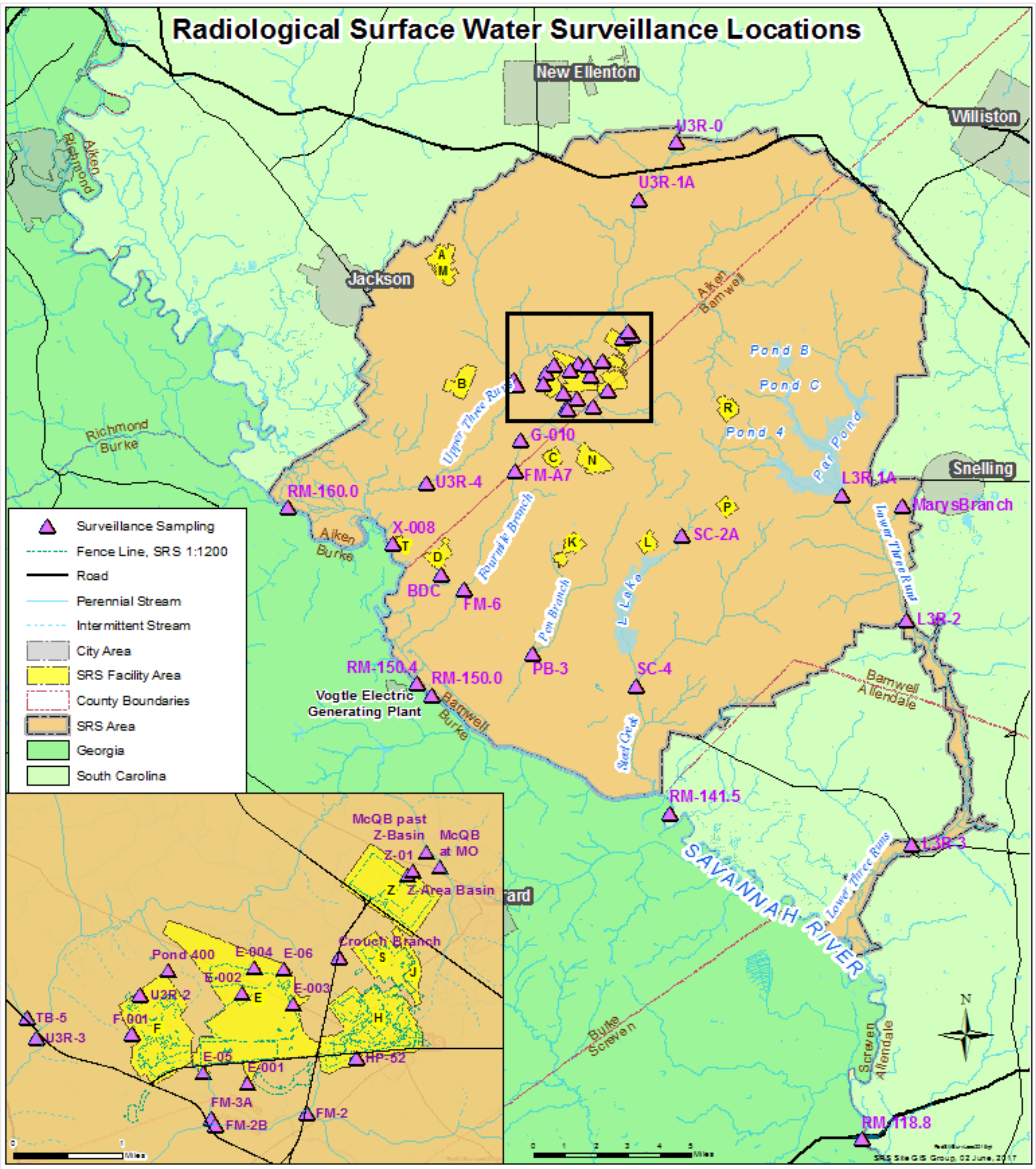


Figure 5-7 Radiological Surface Water Sampling Locations

5.4.2.1 Stormwater Basin Results Summary

In 2021, SRS sampled at five E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. Stormwater basin location E-006 was not sampled during 2021 due to it being dry. Table 5-5 summarizes gross alpha, beta, and tritium results for stormwater basins, which SRS sampled in the following locations: E-001, E-002, E-003, E-004, E-005, Pond 400, and Z Basin. E-002 Basin had the highest tritium concentration (46,800 picocuries/liter [pCi/L]), which is consistent with the results reported for the E-002 Basin in 2020 (31,600 pCi/L). Tritium results for all basin locations are consistent with the 10-year historical measurements.

Table 5-5 Radionuclide Concentrations Summary for Stormwater Basins for CY 2021

Basin Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
E-001	All < DL	2.75	2,830	3,890
E-002	All < DL	2.57	20,000	46,800
E-003	0.763	32.2	6,350	9,970
E-004	0.383	2.50	10,200	14,700
E-005	0.609	2.62	4,520	7,590
Pond 400	0.636	4.87	930	3,540
Z Basin	All < DL	134	869	1,190

Note:

DL = detection limit

5.4.3 SRS Stream Sampling and Monitoring

SRS routinely samples streams down gradient of several process areas to detect and quantify levels of radioactivity that liquid effluents and shallow groundwater transport to the Savannah River (Figure 5-7). The five primary streams that deposit into the Savannah River are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. SRS monitors and quantifies radioactivity migration from SRS seepage basins and SWDF as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and the K-Area Seepage Basin. SRS closed the F-Area and H-Area Seepage Basins in 1991 and the K-Area Seepage Basin in 2002. Radioactivity previously deposited in the seepage basins and SWDF continues to migrate through the groundwater and enter SRS streams. Additionally, Table 5-6 provides information on the stream sampling locations used to determine radioactivity migration in streams and the direct release sample locations associated with the contributing migration source. Figure 5-7 displays the radiological surface water sampling locations. The sampling frequency and types of analyses depend on the upstream discharges and groundwater migration history of radionuclides.

SRS measures gross alpha concentrations in Site streams. If the results for any of the major stream locations, as Table 5-6 shows, are greater than the EPA screening level of 15 pCi/L gross alpha, then SRS measures for alpha-specific isotopes, such as the actinides. In addition to the monthly samples collected for tritium, gross alpha, gross beta, and gamma analyses, SRS collects samples annually for alpha-specific actinide analyses to provide a more comprehensive suite of radionuclides for annual shallow groundwater migration reporting.

Table 5-6 Radionuclide Concentrations in the Primary SRS Streams by Location for CY 2021

	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
Onsite Stream Locations				
Lower Three Runs (L3R-3)	2.55	2.74	429	762
Steel Creek (SC-4)	1.90	2.50	1,350	1,780
Pen Branch (PB-3)	0.788	1.29	8,020	10,400
Fourmile Branch (FM-6)	2.26	7.09	17,100	20,100
Upper Three Runs (U3R-4)	5.45	3.44	739	2,160
Onsite Control Locations (for comparison)				
Upper Three Runs (U3R-1A)	4.90	3.17	147	297

5.4.3.1 SRS Stream Results Summary

Table 5-6 presents the average 2021 concentrations of gross alpha, gross beta, and tritium, along with the maximum concentrations of tritium in SRS streams. These stream locations represent the last monitoring location for the respective tributary before discharging into the Savannah River. SRS found detectable concentrations of tritium at all major stream locations. The 10-year trend for the average tritium levels in the streams shows a decrease, which is due to decreases in Site effluent releases, SRS remediation actions, and the natural decay of tritium. Figure 5-8 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L), although onsite streams are not a direct source of drinking water. The surveillance program uses the EPA standard as a benchmark for comparing stream surface-water results. Tritium levels are higher in Fourmile Branch compared to the other streams due to shallow groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration. Section 7.3.3, *Remediating SRS Groundwater,* presents additional information on the groundwater remediation efforts to reduce tritium to Fourmile Branch.

Figure 5-9 presents a graphical representation of releases of tritium via migration to Site streams from 2012 through 2021. As seen in the figure, migration releases of tritium generally have declined over the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2021, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 395 Ci, compared to 453 Ci in 2020, which represents a 12.8% decrease. Furthermore, the 10-year trend displays an overall decreasing trend in tritium migration.

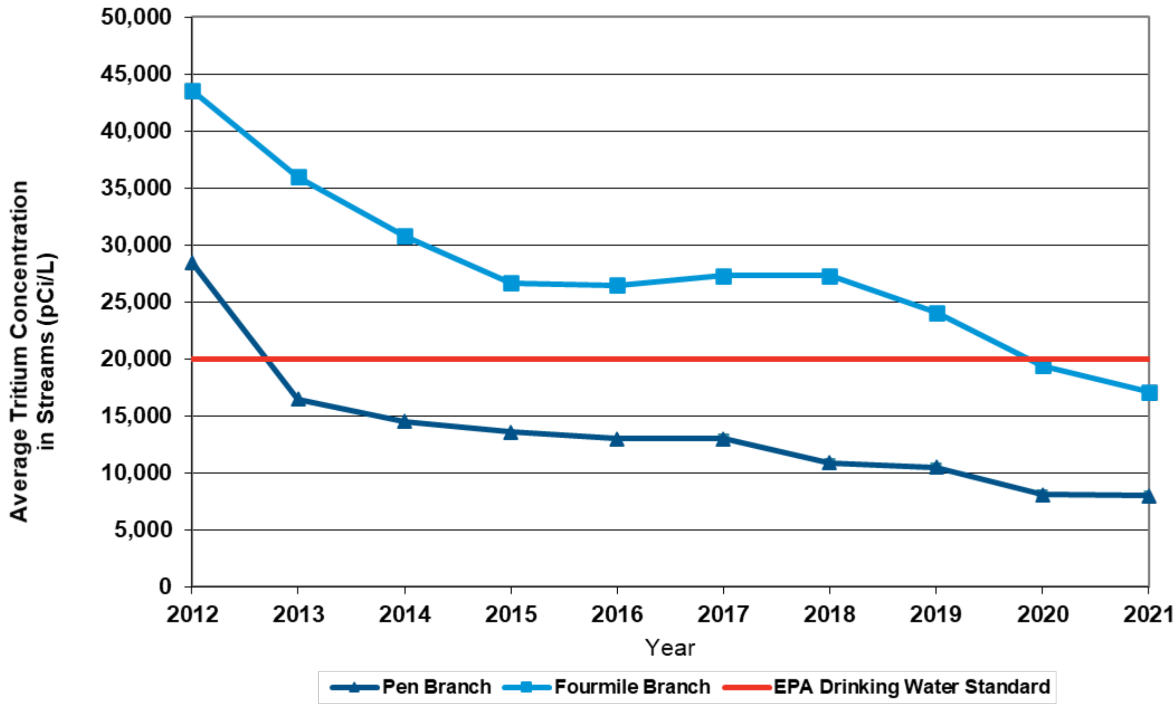


Figure 5-8 10-Year Trend of Tritium in Pen Branch and Fourmile Branch

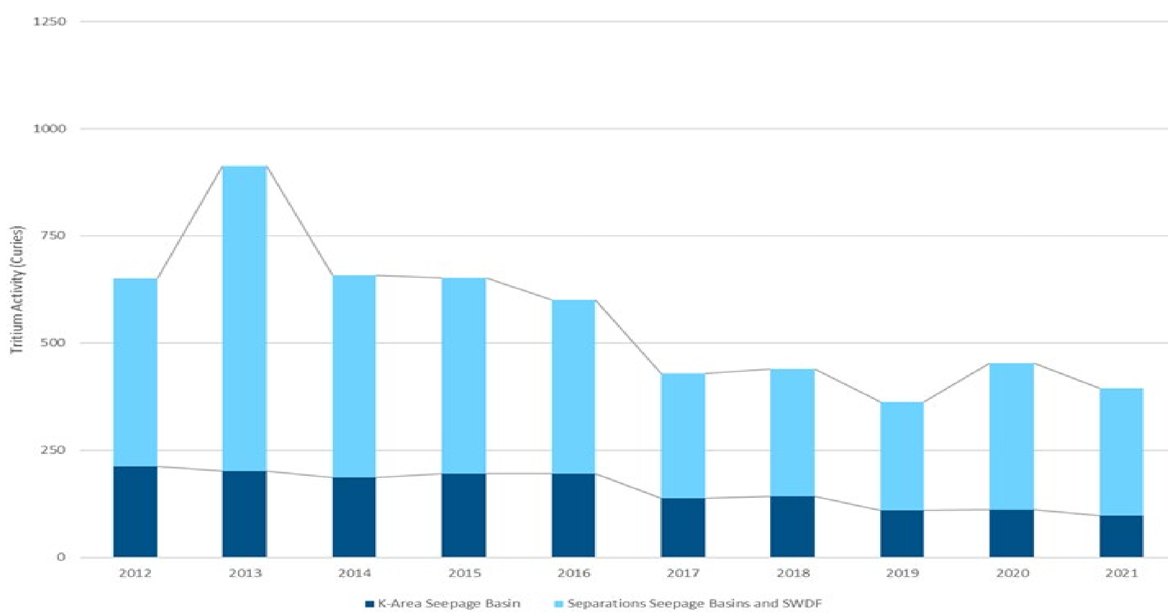


Figure 5-9 10-Year History of Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

SRS measured 242 Ci (61.3%) of the 395 Ci of tritium migrating into SRS streams in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 1 Ci the past 10 years. Sampling in Pen Branch measures the tritium migration from the K-Area Seepage Basin and the percolation field below the K-Area Retention Basin. An estimated 98 Ci migrated in 2021, compared to

111 Ci in 2020. Stream transport includes tritium migration releases from C-Area, L-Area, and P-Area Seepage Basins. (See Section 5.4.5, *Tritium Transport in Streams and Savannah River Surveillance,* in this chapter.)

All radionuclide results for 2021 showed no elevated levels and are consistent with historical measurements.

5.4.4 Savannah River Sampling and Monitoring

SRS routinely samples along the Savannah River at locations up and downstream of SRS tributaries, including at a location where liquid discharges from Vogtle Electric Generating Plant (VEGP) enter the river.

Five locations along the river, as Figure 5-7 shows, continued to serve as environmental surveillance points in 2021. SRS collects samples weekly at these river locations for tritium, gross alpha, gross beta, and gamma analyses. SRS also collects samples annually for strontium, technetium, and actinides to provide a more comprehensive suite of radionuclides.

5.4.4.1 Savannah River Results Summary

Table 5-7 lists the average 2021 concentrations of gross alpha, gross beta, and tritium, and the maximum 2021 concentrations of tritium at river locations. The tritium concentration levels are well below the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L).

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS, VEGP, and Barnwell Low-Level Disposal Facility (BLLDF) tritium estimates based on concentration results at Savannah River RM 141.5 and average flow rates at RM 141.5 were 918 Ci in 2021 compared to 3,029 Ci in 2020. This decrease was due to decreased releases from SRS and VEGP during 2021. Total releases from VEGP were 986 Ci in 2021, compared to 1,830 Ci in 2020. Average radionuclide concentrations for gross alpha, gross beta, tritium, strontium-89,90, technetium-99, actinides, and gamma-emitting radionuclides are consistent with the results from the previous 10 years.

Table 5-7 Radionuclide Concentrations in the Savannah River for CY 2021

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
CONTROL (RM-161)	0.170	1.97	87.3	231
RM-150.4 (VEGP)	0.232	2.07	508	4,350
RM-150	0.216	2.02	165	335
RM-141.5	0.266	2.02	254	981
RM-118.8	0.295	2.02	246	949

5.4.5 Tritium Transport in Streams and Savannah River Surveillance

Due to the mobility of tritium in water and the amount released over the course of more than 60 years of SRS operations, the Site monitors and compares the amount of tritium measured at various onsite stream sampling locations to that found at the Savannah River sampling locations. The comparison uses the following methods of calculation:

- Direct releases measured at the source—Total direct tritium releases, including releases from facility effluent discharges (discussed in Section 5.4.1) and measured shallow groundwater migration (discussed in Section 5.4.3) of tritium from SRS seepage basins and SWDF
- Stream transport, which measures the amount of tritium leaving the Site—Tritium transport in SRS streams, measured at the last sampling point before entry into the Savannah River. This includes shallow groundwater migration contributions from C-Area, L-Area, and P-Area Seepage Basins.
- River transport—Tritium transport in the Savannah River, measured downriver of SRS (near RM 141.5) after subtracting any measured contribution above SRS (RM 161.0)

SRS bases its methods for estimating releases on the environmental data reporting guidance in *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015). General agreement between the three calculation methods of annual tritium transport—measurements at the source plus any measured migration, stream transport, and river transport—validates both that SRS is sampling at the appropriate locations and the accuracy of analytical results.

Within the past 10 years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF, which Energy*Solutions*, LLC operates. The tritium continues to enter the SRS stream system at Marys Branch, which deposits into 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. In 2014, SRS started monitoring at Marys Branch, which is near BLLDF, to account for the tritium BLLDF contributes. SRS estimated the amount of tritium from BLLDF during 2021 to be 29 Ci, which SRS direct release or stream transport totals did not include.

For compliance dose calculations, the Site uses whichever value is higher: SRS direct releases or the stream transport measurements. (See Chapter 6, *Radiological Dose Assessment.*)

5.4.5.1 Tritium Transport in Streams and Savannah River Results Summary

In 2021, tritium levels in stream transport and river transport showed a decrease, specifically as the following describes:

- The total liquid effluent releases (including migration) of tritium decreased by 7% (from 519 Ci in 2020 to 483 Ci).
- The stream transport of tritium decreased by 10.3% (from 477 Ci in 2020 to 428 Ci).
- The river transport of tritium decreased by 36.7% (from 3,029 Ci in 2020 to 1,918 Ci). VEGP, BLLDF, and SRS contributed to these values.

Tritium transport in the Savannah River includes the 29 Ci migration value attributed to BLLDF and the 986 Ci release value attributed to VEGP.

SRS tritium transport data from 1960–2021 (Figure 5-10), shows the history of direct releases plus migration, stream transport, and river transport, while Table 5-8 shows a decrease from 2020 to 2021 for most quantified contributors of these three tritium transport categories. The general downward trend over the past 60 years is attributable to the following:

- Variations in tritium production and processing at SRS
- Implementing effluent controls beginning in the early 1960s
- SRS tritium inventory continuing to deplete and decay

As Chapter 6, *Radiological Dose Assessment*, discusses, the direct plus migration releases value was higher than the tritium stream transport value. Therefore, the compliance dose calculations for 2021 use the direct releases and migration value of 483 Ci.

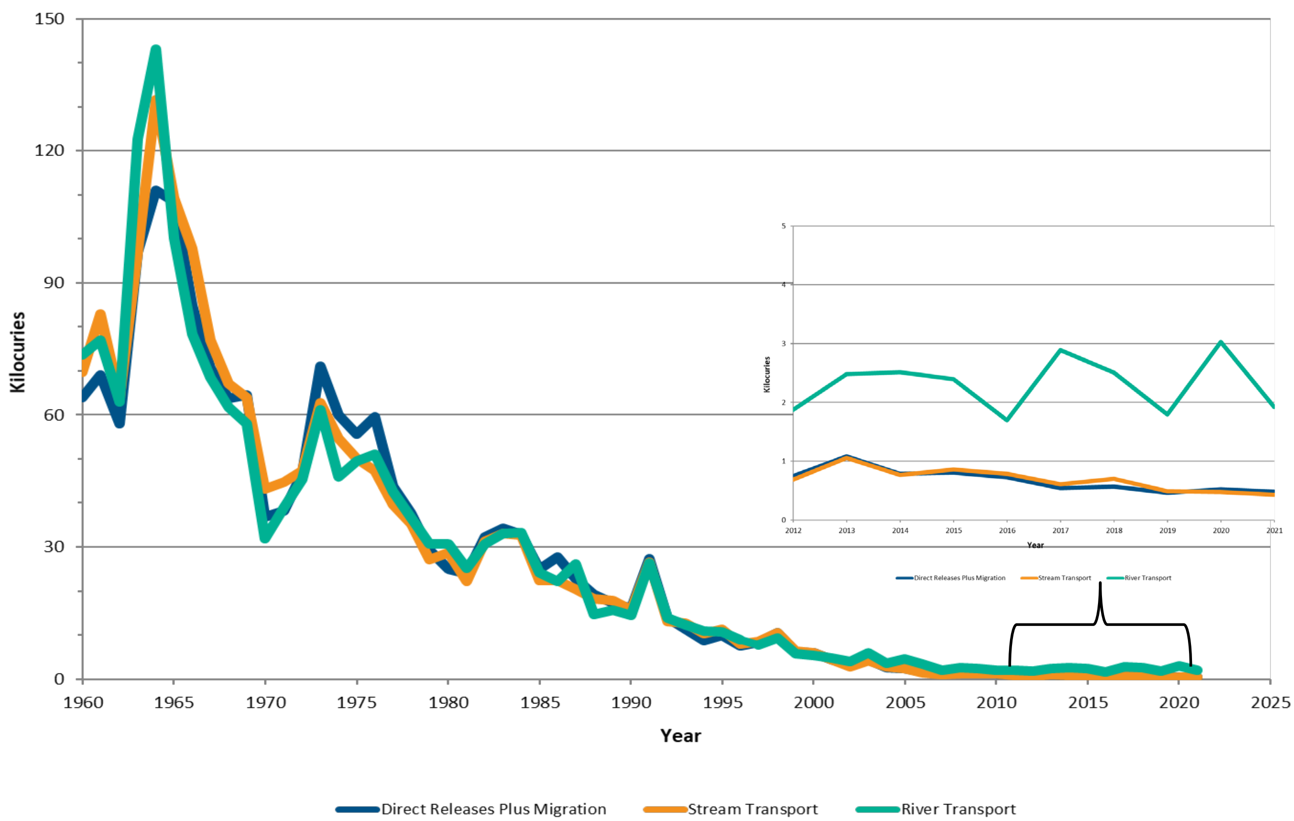


Figure 5-10 History of SRS Tritium Transport (1960 to 2021)

Table 5-8 Liquid Tritium Releases and Transport

Releases/Transport (curies)	CY 2020	CY 2021
Liquid Effluent Releases		
Direct releases	66	88
Shallow groundwater migration from Separations Areas Basins, K-Area Seepage Basins, and Percolation Field below K-Area Retention Basin	453	395
Total Liquid Effluent Releases (direct releases and migration)	519	483
Total Stream Transport		
Stream transport and shallow groundwater migration from C-Area, L-Area, and P-Area Seepage Basins	**477**	**428**
River Transport		
SRS contribution	519	483
VEGP contribution	1,830	986
BLLDF contribution	33	29
Total River Transport (SRS, VEGP, and BLLDF)	3,029	1,918

Note:
For compliance dose calculations, the Site uses whichever value is higher: SRS direct releases and migration or the stream transport measurements. Therefore, in 2021, SRS used direct releases and migration to calculate the dose. See Chapter 6, *Radiological Dose Assessment.*

5.4.5.2 Settleable Solids Surveillance

SRS evaluates settleable solids in water, in conjunction with routine sediment monitoring, to determine whether a long-term buildup of radioactive materials occurs in stream systems. Settleable solids are solids in water that are dense enough to sink to the bottom of the collection container.

DOE limits for the radioactivity levels in settleable solids are 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides. Accurately measuring radioactivity levels in settleable solids is impractical in water samples with low total suspended solids (TSS). In 1995, DOE interpreted the radioactivity levels in settleable solids requirement. The interpretation indicated that TSS levels below 40 parts per million comply with the DOE limits.

To determine compliance with these limits, SRS uses TSS results gathered from radiological liquid effluent locations, National Pollutant Discharge Elimination System outfalls colocated at or near radiological liquid effluent locations, and water quality surveillance locations. If TSS results are regularly greater than 40 parts per million, SRS will investigate the cause and take additional water or sediment samples, or both, if necessary, to ensure compliance.

5.4.5.3 Settleable Solids Results Summary

In 2021, all TSS averages were below the 40 parts per million limit. The TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.6 Sediment Sampling

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the bed of the Savannah River. Year-to-year differences may be evident because sediment continuously moves and deposits at different locations in the stream and riverbeds (or because of slight variations in sampling locations). The Site can use data obtained to observe long-term environmental trends.

In 2021, SRS collected annual sediment samples at 10 Savannah River locations, 8 basin or pond locations, and 23 onsite streams or swamp discharge locations (Environmental Maps, *Radiological Sediment Sampling Locations*). The locations vary from year-to-year, depending on the rotation schedule agreed upon with SCDHEC, which duplicates sampling at several locations as a quality control check of the SRS program. SRS also collects duplicate samples to assess quality control, as Section 8.5, *Environmental Monitoring Program QC Activities,* documents.

5.4.6.1 Sediment Results Summary

Appendix Table D-13 shows the maximum of each radionuclide compared to the applicable SRS control location. The Z-Area Stormwater Basin, a posted soil contamination area, had the maximum cesium-137 concentration of 700 pCi/g. Soil contamination areas at SRS are locations where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. The lowest levels of cesium-137 in river, stream, and basin sediments were below detection. Table 5-9 shows the maximum sediment concentrations.

Radionuclide concentrations in SRS stream, river, and basin sediment are within historical levels. Results indicate radioactive materials from effluent release points are not building up in the sediment at the sampling locations.

Table 5-9 Maximum Cesium-137 Concentration in Sediments Collected in 2021

Location	Maximum Location	Maximum Concentration (pCi/g)
Savannah River Sediment	Steel Creek River Mouth	1.59E+00
SRS Stream Sediment	R Area (Downstream of R-1)	7.90E+01
SRS Basin Sediment	Z Basin	7.00E+02

5.4.7 Drinking Water Monitoring

SRS collects drinking water samples from 10 locations at SRS and at 2 water treatment facilities that use water from the Savannah River as a source of drinking water (Environmental Maps, *Domestic Water Systems*).

Onsite drinking water sampling consists of samples from the large treatment plant in A Area, from five small systems, and from groundwater samples from four wells. However, the pump at 681-3G Domestic Water Faucet, one of the small systems, was inoperable for 2021. Onsite sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and actinides.

SRS monitors potable water at offsite treatment facilities to ensure that SRS operations do not adversely affect the water supply and to assure that drinking water does not exceed EPA drinking water standards for radionuclides. SRS collects samples offsite from the following two South Carolina locations (Figure 5-11):

- Beaufort-Jasper Water and Sewer Authority's Purrysburg Water Treatment Plant
- North Augusta Water Treatment Plant

SRS collects treated water from these two treatment plants, which supply water to the public. Offsite sample analyses consist of tritium, gross alpha, and gross beta.

The North Augusta Water Treatment Plant samples determine concentrations in drinking water upstream of SRS. The Beaufort-Jasper Water and Sewer Authority's Purrysburg Water Treatment Plant is the furthest downriver sampling location. SRS compares these locations to evaluate potential impacts from upstream sources that include SRS.

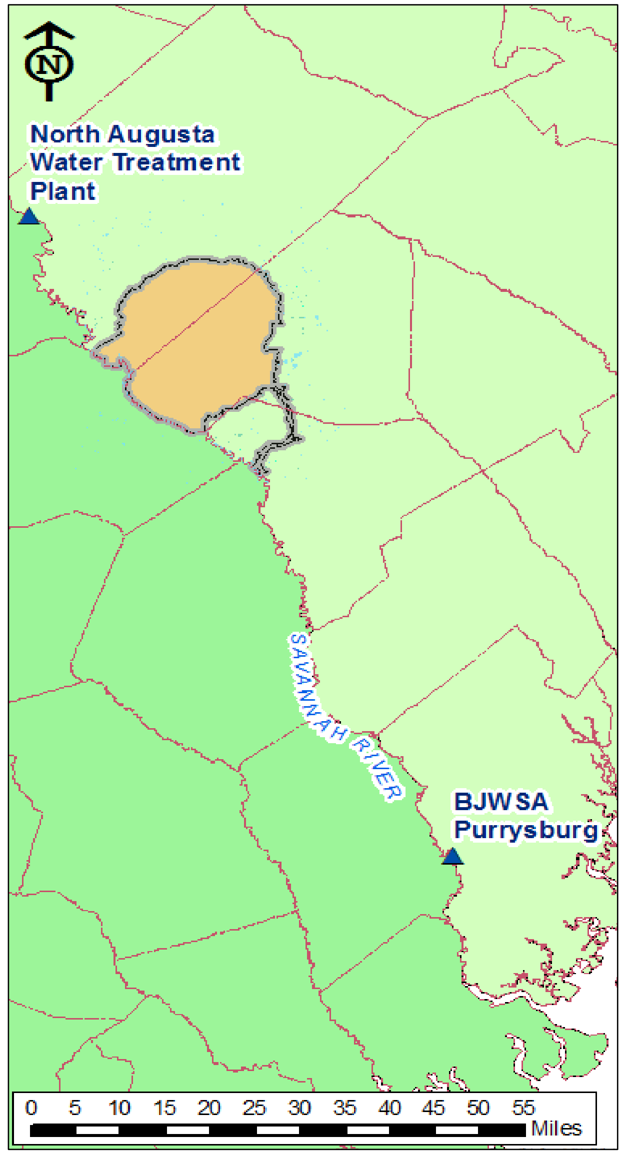


Figure 5-11 Offsite Drinking Water Sampling Locations

5.4.7.1 Drinking Water Results Summary

In 2021, SRS performed gross alpha and gross beta analyses on all onsite and offsite drinking water samples. All results were well below the EPA's 15 pCi/L alpha concentration limit and 50 pCi/L beta concentration limit. In addition, no onsite or offsite drinking water samples exceeded the 20 pCi/mL (20,000 pCi/L) EPA standard for tritium, and no onsite drinking water samples exceeded the 8 pCi/L strontium-89,90 maximum contaminant level.

Figure 5-12 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS compared to the average of weekly river water samples collected at RM 141.5. The average tritium concentration at RM 141.5 is approximately 1.3% of the EPA standard for tritium and decreases slightly at the downstream sampling location.

Sample results did not detect tritium, cobalt-60, cesium-137, strontium-89,90, uranium-235, plutonium-238, plutonium-239, and curium-244 in onsite drinking water test locations. Sample results indicated detectable levels of americium-241 in five onsite samples, uranium-234 in six onsite samples, and uranium-238 in six onsite samples. Appendix Table D-14 summarizes the results. Americium-241 concentrations are near the method detection limit, and the uranium is natural. All analytical results are well below the EPA standard.

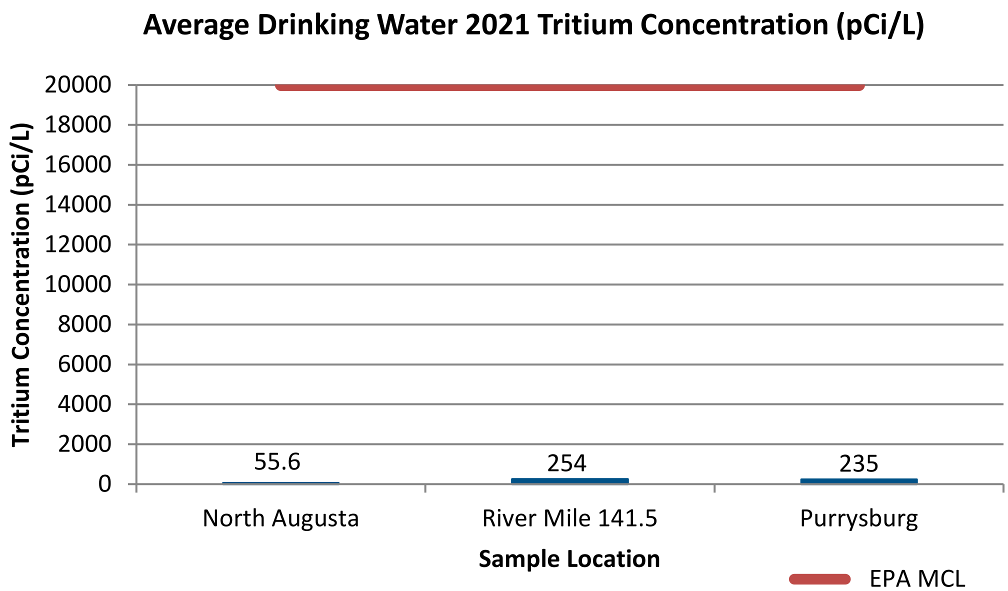


Figure 5-12 Tritium in Offsite Drinking Water and River Mile 141.5

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

SRS collects aquatic food from the Savannah River, including freshwater fish, saltwater fish, and shellfish. During 2020, the flathead fish was added to the routine freshwater fish types collected. Freshwater fish come from six locations on the Savannah River from above SRS at Augusta, Georgia, to the Highway 301 bridge (Environmental Maps*, Fish Sampling Locations*). Onsite, SRS collects freshwater fish at the mouth of the streams that traverse the Site. Saltwater fish come from the Savannah River mouth near Savannah, Georgia. Additionally, shellfish come from the Savannah River mouth near Savannah or SRS purchases them from Savannah-area vendors that harvest from local saltwater that waters of the Savannah River potentially influence. Table 5-10 identifies the aquatic products collected in 2021. SRS analyzes both edible (meat and skin only) and nonedible (bone) samples of freshwater and saltwater fish. SRS analyzes only the edible portion of shellfish. Analyses of edible samples of all aquatic species collected include gross alpha, gross beta, gamma-emitting radionuclides (that is, cesium-137 and cobalt-60), strontium-89,90, technetium-99, and iodine-129. Strontium-89,90 is the only analysis SRS conducts on the nonedible samples.

Table 5-10 Aquatic Products Collected by SRS in 2021 for the Radiological Environmental Monitoring Program

Freshwater Fish		Saltwater Fish	Shellfish
Bass	Catfish	Mullet	Crab
Flathead	Panfish		

5.5.1.1 Fish in Savannah River Results Summary

In 2021, SRS collected freshwater fish from the six locations, saltwater fish from the Savannah River mouth, and obtained crabs in the Savannah area from a supplier that harvests from saltwater potentially influenced by Savannah River water. SRS analyzed 54 freshwater fish composites, 3 saltwater fish composites, and 1 shellfish composite. The freshwater and saltwater composites consisted of three to eight fish each. The shellfish composite consisted of one bushel of crab. The analytical results of the freshwater and saltwater fish, and shellfish collected are consistent with results for the previous 10 years. Most of the results for the specific radionuclides associated with SRS operations were nondetectable (70% for freshwater fish, 95% for saltwater fish, and 80% for shellfish). Table 5-11 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The table also identifies the fish type and the collection location associated with the maximum concentration for each detected radionuclide. SRS did not detect cobalt-60 and iodine-129 in any fish flesh samples. Appendix Tables D-15, D-16, and D-17 for freshwater fish, saltwater fish and shellfish, respectively, summarize results for all fish and shellfish.

Gross alpha results were below the minimum detectable concentration for all freshwater and saltwater fish and shellfish. Gross beta activity was detectable in all freshwater and saltwater fish, as well as shellfish. The concentrations are consistent with results from the previous 10 years and are likely due to the naturally occurring radionuclide potassium-40.

Determining the potential dose and risk to the public, as reported in Chapter 6, *Radiological Dose Assessment*, includes data from the fish monitoring.

Table 5-11 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples Collected in 2021

Radionuclide	Maximum Concentration	Location	Fish Type
Cesium-137	0.762 pCi/g	Steel Creek River Mouth	Bass
Strontium-89,90	0.011 pCi/g	Four Mile Creek River Mouth	Panfish
Technetium-99	0.230 pCi/g	Highway 301 Bridge Area	Catfish

5.6 WILDLIFE SURVEILLANCE

SRS holds annual hunts to reduce animal-vehicle collisions and control Site deer, coyote, and feral hog populations. The wildlife surveillance program monitors wildlife harvested from SRS and subsequently released to the public. Monitoring assesses any impact of Site operations on the wildlife populations and ensures that no individual exceeds the SRS Annual Administrative Game Animal Release Limit of 22 mrem/year. Annual game animal hunts for deer, coyote, and feral hogs are open to the public.

In 2021, SRS cancelled the spring turkey hunts and the annual Site hunt held in the fall due to the COVID-19 pandemic.

The United States Forest Service-Savannah River collected 26 feral hog flesh samples from the Site's feral hog population so that SRS could estimate the offsite sportsman dose. The samples were analyzed for gross alpha, gross beta, and gamma emitting nuclides.

SRS uses the cesium-137 concentration detected in the edible flesh of the animal to calculate dose. SRS assigns a dose to each hunter for every animal harvested if the cesium-137 concentration is above the background concentration of 1.97 pCi/g for hogs (Morrison et al. 2019) and 2.59 pCi/g for the deer and coyote (Aucott et al. 2017). In addition to the field monitoring, SRS collects samples of muscle for laboratory analysis of cesium-137 concentrations in both deer and hogs based on the following: 1) a set frequency, 2) the field measured cesium-137 levels, or 3) exposure limit considerations. These laboratory-analyzed data provide a quality-control check on the field monitoring results.

Cesium-137 is chemically similar to and behaves like potassium in the environment. Cesium-137 has a half-life of about 30 years and tends to persist in soil, where it can readily enter the food chain through plants. Nuclear weapons detonations have distributed it widely throughout the world from 1945 to 1980; it is present at low levels in all environmental media. Flesh sample laboratory analyses also include cobalt-60, strontium-89,90, gross alpha, and gross beta.

5.6.1 Wildlife Results Summary

During the hog sample collection, SRS collected 26 hog flesh samples. The estimated dose from each animal's flesh sample was below the administrative game animal release limit of 22 mrem and would have been cleared for release to the potential hunter.

Appendix Table D-18 summarizes the muscle laboratory sample. As seen in previous years, laboratory analysis detected cesium-137 in muscle tissue. Laboratory analysis detected strontium-89,90, a beta-emitting radionuclide, in some muscle tissue samples.

Table 5-12 summarizes the laboratory measurements of cesium-137. Average cesium-137 concentrations in hog have indicated an overall decreasing trend for the past 50 years, with relatively little change in the last 10 years.

For the hog muscle tissue samples, strontium-89,90 was present at levels greater than the minimum detectable concentration for 3 out of 26 samples, with a maximum concentration of 0.00847 pCi/g. These average results are similar to those of previous years. All cobalt-60 results were not detectable. Gross beta activity, detected in all samples, is consistent with 2008 through 2020 results.

Chapter 6, *Radiological Dose Assessment,* presents the calculation of dose from consuming wildlife harvested on SRS.

Table 5-12 Cesium-137 Results for Laboratory and Field Measurements in Wildlife for CY 2021

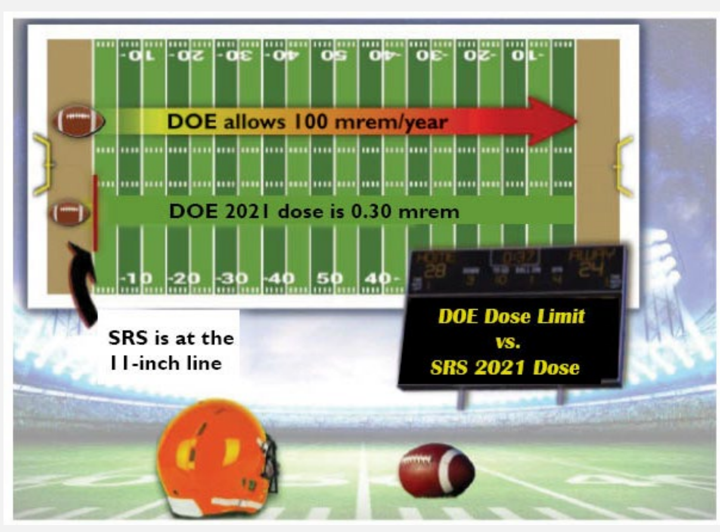
	Number of Animals Field Monitored	Field Gross Average Cs-137 Conc. (pCi/g)	Field Maximum Cs-137 Conc. (pCi/g)	Number of Samples Collected for Laboratory Analysis	Number of Cs-137 Detected Results	Lab Average Cs-137 Conc. (pCi/g)	Lab Maximum Cs-137 Conc. (pCi/g)
Hog	0	N/A	N/A	26	26	1.77	4.60

Chapter 6: **Radiological Dose Assessment**

Department of Energy (DOE) Order 458.1, "Radiation Protection of the Public and the Environment," establishes dose limits for the public and plants and animals that are onsite. DOE establishes these dose limits to protect the public and environment from the potential effects of radiation released during radiological operations. To document that radiation exposure does not exceed the DOE public dose limit of 100 millirem (mrem)/year (yr), the Savannah River Site (SRS) calculates the potential dose to the public from radioactive releases in air and water through all reasonable exposure pathways. SRS also considers and quantifies exposure pathways that are nontypical and not included in the standard dose calculations to the representative person. These apply to conservative and unlikely scenarios, such as a member of the public eating fish caught only from the mouths of SRS streams, or to special scenarios, such as hunters who participate in onsite hunts. In addition, DOE Order 458.1 establishes authorized surface contamination limits, which allow SRS to release personal and real property unconditionally. SRS performs radiological surveys on all equipment considered for release and follows applicable procedures.

2021 Highlights

Dose to the Offsite Representative Person—To comply with the DOE all-pathway dose limit of 100 mrem/yr, SRS conservatively adds the doses to the offsite representative person from both Site liquid and air pathways. In 2021, the dose to the offsite representative person was 0.28 mrem from liquid releases and 0.017 mrem from air releases. The total representative person dose was 0.30 mrem, which is 0.30% of the 100 mrem/yr DOE dose limit.



Comparison of DOE's 100 mrem/yr Dose Limit to SRS's 2021 All-Pathway Dose of 0.30 mrem

2021 Highlights (continued)

Sportsman Doses

- **Onsite Hunter**—SRS conducts annual hunts to control onsite deer and wild hog populations. SRS determines the estimated potential dose from eating harvested deer or hog meat for every onsite hunter. Due to pandemic restrictions, the Site did not hold a hunt in 2021. However, SRS collected flesh samples from feral hogs that had been trapped in various hunt compartments onsite and analyzed them for radionuclides. The results were used to calculate dose to sportsman in the vicinity of the Site.
- **Creek Mouth Fisherman**—SRS estimated the maximum potential dose from fish consumption from bass collected at the mouth of Steel Creek at 0.43 mrem. This dose is 0.43% of the 100 mrem/yr DOE dose limit. SRS bases this hypothetical dose on the low probability that, during 2021, a fisherman consumed 53 pounds (lbs) of bass caught exclusively from the mouth of Steel Creek.

Release of Material Containing Residual Radioactivity—SRS did not release any real property (land or buildings) in 2021. SRS unconditionally released 12,158 items of personal property (such as tools) from radiological areas. Most of these items did not leave SRS but were reused elsewhere on the Site. Therefore, these items required no additional radiological controls postsurvey, as they met DOE Order 458.1 release criteria.

Radiation Dose to Aquatic and Terrestrial Biota— SRS evaluates plant and animal doses for water and land systems using the RESidual RADioactivity (RESRAD) Biota model (version 1.8) (SRS EDAM 2017). This model is a graded approach for evaluating radiation doses to aquatic and terrestrial biota to comply with DOE Order 458.1. For 2021, all SRS water, sediment, and soil locations passed the Level 1 (using maximum measured concentrations) screenings and did not require further assessments.

6.1 INTRODUCTION

Routine SRS operations release controlled amounts of radioactive materials to the environment through air and water. These releases could expose people offsite to radiation. 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 weather 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 SRS calculates doses, and presents the estimated doses from SRS activities for 2021.

Radiological Impact of 2021 Operations at the Savannah River Site (Stagich, Dixon, and LaBone 2022) details SRS dose calculation methods and results. SRS used the data from the monitoring programs described in Chapter 5, *Radiological Environmental Monitoring Program,* to calculate the potential doses to the public.

Chapter 6—Key Terms

Exposure pathway *is the way that releases of radionuclides into the water and air could impact a person.*

Maximally exposed individual *is a hypothetical member of the public (typically an adult male) who lives near the SRS boundary and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible equivalent dose.*

Reference person *is a hypothetical person with average physical and physiological characteristics—including factors such as age and gender—used internationally to standardize radiation dose calculations.*

Representative person *is a hypothetical individual receiving a dose that is representative of highly exposed individuals in the population. The calculations incorporate age, gender, food and water consumption, and breathing rate. At SRS, the representative person equates to the 95th percentile of applicable national human-use radiation exposure data.*

6.2 WHAT IS RADIATION DOSE?

Radiation dose to a person is the amount of energy the human body absorbs from a radiation source located either inside or outside of the body. SRS typically reports dose in millirem, which is one-thousandth of a rem. A rem is a standard unit used to measure the amount of radiation deposited in human tissue.

Humans, plants, and animals potentially receive radiation doses from natural and manmade sources. The average annual background dose for all people living in the United States is 625 mrem (NCRP 2009). This includes an average background dose of 311 mrem from naturally occurring radionuclides found in our bodies, in the earth, and from cosmic radiation, such as from the sun. Manmade sources and their doses include medical procedures (300 mrem), consumer products (13 mrem), and industrial and occupational exposures from facilities such as SRS (less than 1 mrem).

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 2013) establishes 100 mrem/yr (1 millisievert [mSv]/yr) as the annual dose limit to a member of the public. Exposure to radiation primarily occurs through the following pathways, which Figure 6-1 illustrates:

- Inhaling air
- Ingesting water and food
- Absorbing through skin
- Direct (external) exposure to radionuclides in soil, air, and water

6.3 CALCULATING DOSE

To comply with DOE Order 458.1, SRS can calculate dose to the maximally exposed individual (MEI) or to a representative person. The MEI is usually assumed to be an adult male, and the representative person is representative of all ages and genders of the highly exposed individuals in the population. Since 2012, SRS has used the representative person concept to determine whether the Site is complying with the DOE public dose limit. SRS calculates the representative person dose using Site-specific reference person parameters. The SRS representative person falls at the 95th percentile of national and regional data. The

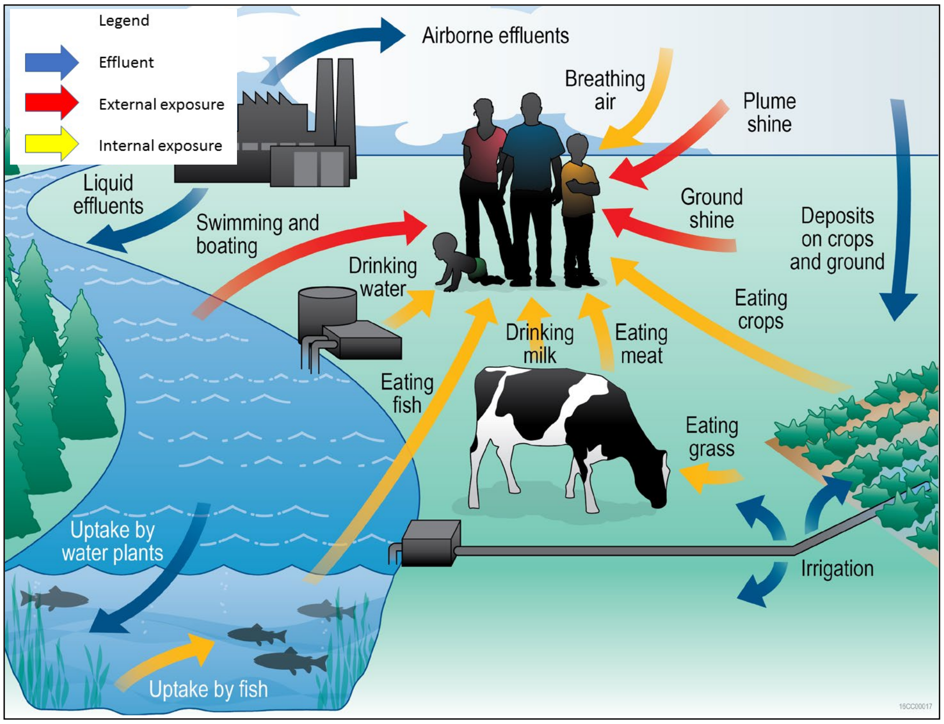


Figure 6-1 Exposure Pathways to Humans from Air and Liquid Effluents

applicable national and regional data used are from the U.S. Environmental Protection Agency's (EPA's) *Exposure Factors Handbook*, 2011 Edition (EPA 2011).

The reference person is weighted based on gender and age. The International Commission on Radiation Protection Publication 89, (ICRP 2002) groups these ages as: Infant (0 years), 1 year, 5 years, 10 years, 15 years, and Adult (17 years and older). The reference person accounts for the fact that younger people are generally more sensitive to radioactivity than older people. SRS also developed human usage parameters at the 50th percentile for calculating dose to a "typical" person when determining population doses. The SRS report *Site-Specific Reference Person Parameters and Derived Concentration Standards for SRS* (Stone and Jannik 2013) documents SRS-specific reference and typical person usage parameters. The SRS report *Land and Water Use Characteristics and Human Health Input Parameters for Use in Environmental Dosimetry and Risk Assessments at the Savannah River Site* (Jannik and Stagich 2017) documents all other applicable land- and water-use parameters in the dose calculations. These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in SRS models to calculate radiation dose exposure.

To determine whether the Site is complying with DOE public dose requirements, SRS calculates the potential doses to members of the public from Site effluent releases of radioactive materials (air and liquid) for the following scenarios:

- Representative person living near the SRS boundary
- Adult person working at the Three Rivers Landfill located on SRS (near B Area)
- Population living within a 50-mile (80-kilometer [km]) radius of SRS's H Area

For all routine environmental dose calculations, SRS uses environmental transport and dose models based on codes the Nuclear Regulatory Commission (NRC) developed (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. To demonstrate compliance with DOE Order 458.1, SRS uses the MAXDOSE-SR and POPDOSE-SR codes for air releases (representative person and population, respectively) and LAPTAP XL© for liquid releases. The SRS *Environmental Dose Assessment Manual* (Jannik 2017) describes these models.

At SRS, the dose to a representative person is based on the following:

1) SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data (Stone and Jannik 2013).
2) Reference person (gender- and age-averaged) ingestion and inhalation dose coefficients from the *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011).
3) External dose coefficients derived from EPA's Federal Guidance Report (FGR) #15 (EPA 2019). FGR #15 is a revision to FGR #12 (EPA 1993), which incorporated age-specific external dose coefficients. SRS used these age-specific values to develop reference-person external dose coefficients in a method similar to what DOE 2011 documents. SRS started using these newly developed reference person external dose coefficients in 2019. The SRS report *Updated External Exposure Dose Coefficients*, SRNL-L3200-2020-00014 (Laird and Jannik 2020) documents the external dose coefficients used.

6.3.1 Weather Database

Complete and accurate weather (meteorological) data are important to determine offsite contamination levels. SRS calculated potential offsite doses from radioactive releases to the air with quality-assured weather data from 2014 to 2018 (Bell 2020).

Figure 6-2 presents the H-Area wind rose plot for 2014-2018 and shows the direction and frequency the wind blows. SRS bases its wind rose plot in H Area because it is where most of SRS's radiological air releases occur. As shown, the wind blows the most towards the East-Northeast sector (about 10% of the time), but there is no strongly prevalent wind direction.

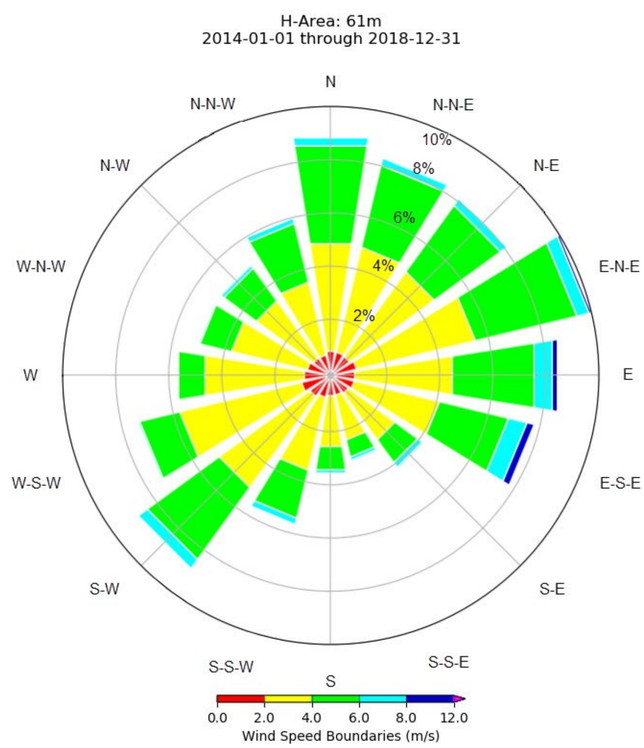


Figure 6-2 2014-2018 Wind Rose Plot for H Area (Showing Direction and Frequency Toward Which the Wind Blows)

6.3.2 Population Database and Distribution

SRS calculates the collective (population) doses from air releases for the population within a 50-mile radius of the H Area. Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of H Area is 803,370 people. This translates to about 107 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area.

Table 6-1 presents the number of people currently served by the three drinking water supply plants that are downriver of SRS.

The total population dose from routine SRS liquid releases is the sum of the following five contributing categories:

1) Consumers of water from Beaufort-Jasper Water and Sewer Authority (BJWSA)
2) Consumers of water from City of Savannah Industrial and Domestic (I&D) Domestic Water Supply Plant
3) Consumers of fish and invertebrates of Savannah River origin
4) Participants of recreational activities on the Savannah River
5) Gardeners and farmers irrigating foodstuffs with river water near River Mile (RM) 141.5

Table 6-1 Regional Water Supply Service

Water Supply Plant	Nearest City	Population Served
City of Savannah I&D	Port Wentworth, Georgia	36,667 people
BJWSA Chelsea Water Treatment Plant	Beaufort, South Carolina	102,000 people
BJWSA Purrysburg Water Treatment Plant	Beaufort, South Carolina	81,000 people

6.3.3 River Flow Rate Data

The annual rate of flow in the Savannah River, which varies greatly from year to year, is an important criterion for determining down-river concentrations of the contaminants SRS releases. The U.S. Geological Survey (USGS) measures Savannah River flow rates downriver of SRS at its RM 118.8 gauging station near the U.S. Hwy 301 Bridge.

Figure 6-3 provides the river flow rates the USGS measured at this location from 1981 to 2021. It also shows that the average river flow rate for these years is about 10,032 cubic feet per second (cfs). However, except for in 2020, there has been a downward trend in these data, with an average measured flow rate of 9,045 cfs.

For 2021, SRS used a calculated "effective" Savannah River flow rate of 8,456 cfs in the dose calculations. The 2021 effective flow rate is about 19% less than the 2020 effective flow rate of 10,501 cfs. This effective flow rate (based on actual measured tritium concentrations in the river) is more conservative than the 2021 USGS measured flow rate of 10,534 cfs (based on daily flow rates). By using a more conservative method, the calculated effective flow rate assumes radioactive material is less diluted and, therefore, increases the estimated potential dose.

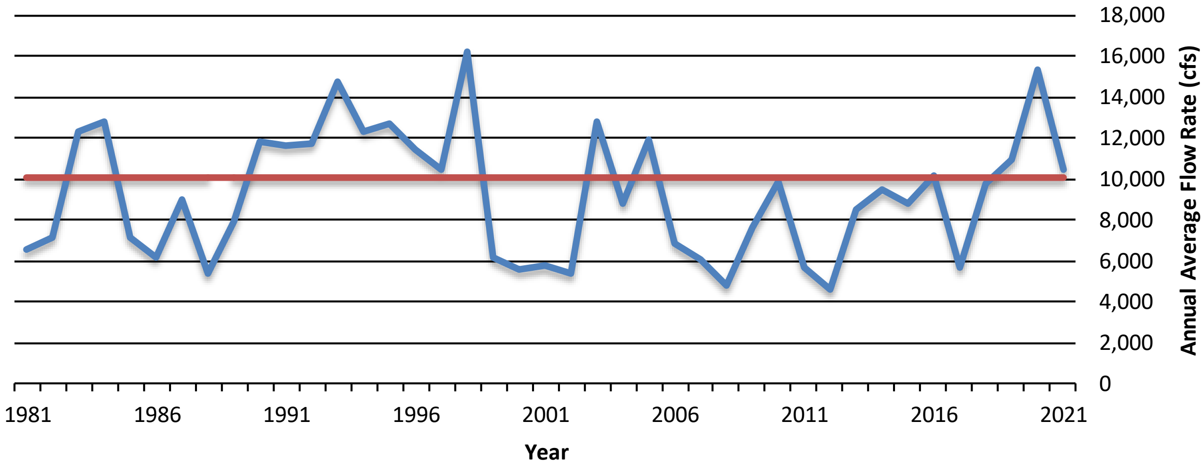


Figure 6-3 Savannah River Annual Average Flow Rates Measured by USGS at River Mile 118.8

6.4 OFFSITE REPRESENTATIVE PERSON DOSE CALCULATION RESULTS

To determine whether the Site is complying with DOE public dose requirements, SRS calculates the potential offsite doses from Site effluent releases of radioactive materials in air and liquid pathways for a representative person living near the SRS boundary. SRS calculates the pathways individually and then adds the two results to obtain the total representative person dose.

6.4.1 Liquid Pathway

6.4.1.1 Liquid Release Source Terms

Table 6-2 shows, by radionuclide, the amount of radioactivity in liquid form that SRS released in 2021. SRS uses these release amounts in the dose calculations. Chapter 5, *Radiological Environmental Monitoring Program,* discusses these sources of data.

Tritium accounts for more than 99% of the total amount of radioactivity released from the Site to the Savannah River. In 2021, SRS released 483 curies (Ci) of tritium to the river, a 7% decrease from the 2020 amount of 519 Ci. For compliance dose calculations, SRS used the measured direct release total (483 Ci), which was higher than the stream transport measurement (428 Ci).

During 2021, in addition to the 483 Ci SRS released, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 986 Ci of tritium to the Savannah River, and about 29 Ci migrated from the Barnwell Low-Level Disposal Facility (BLLDF). In Table 6-2, SRS used the "river transport" total of 1,918 Ci of tritium, which includes SRS, VEGP, and BLLDF contributions. Refer to Chapter 5, *Radiological Environmental Monitoring Program*, Section 5.4.5 for details concerning these measurements.

Radionuclide Concentrations in Savannah River Water, Drinking Water, and Fish—SRS measures concentrations of tritium in the river water and cesium-137 in fish at several locations along the Savannah River. SRS uses these direct measurements to make dose determinations. The amounts of all other radionuclides SRS released are so small that conventional analytical techniques usually cannot detect their concentration in the Savannah River. The Site calculates the concentrations in the river based on the annual release amounts and river flow rates and then compares them to the Safe Drinking Water Act, 40 CFR 141 (EPA 2000) maximum contaminant level (MCL) for each radionuclide.

Table 6-2 2021 Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCLs)

Nuclide	Curies Released	12-Month Average Concentration (pCi/L)		
		Below SRS[a]	BJWSA Purrysburg Plant[b]	EPA MCL[c]
H-3[d]	1.92E+03	2.54E+02	2.35E+02	2.00E+04
C-14	5.80E-04	7.67E-05	7.10E-05	2.00E+03
Mn-54	9.70E-06	1.28E-06	1.19E-06	3.00E+02
Co-58	1.61E-04	2.13E-05	1.97E-05	3.00E+02
Sr-90	2.15E-02	2.85E-03	2.63E-03	8.00E+00
Tc-99	3.42E-02	4.52E-03	4.18E-03	9.00E+02
I-129	2.19E-02	2.90E-03	2.68E-03	1.00E+00
Cs-137[e]	3.90E-01	5.15E-02	4.77E-02	2.00E+02
U-234	3.28E-02	4.34E-03	4.02E-03	1.03E+01
U-235	3.85E-04	5.09E-05	4.71E-05	4.67E-01
U-238	3.34E-02	4.41E-03	4.08E-03	1.00E+01
Np-237	1.17E-04	1.55E-05	1.43E-05	1.50E+01
Pu-238	3.98E-04	5.26E-05	4.87E-05	1.50E+01
Pu-239	2.01E-05	2.66E-06	2.46E-06	1.50E+01
Am-241	3.18E-05	4.21E-06	3.89E-06	1.50E+01
Cm-244	1.46E-04	1.93E-05	1.79E-05	1.50E+01
Alpha	6.22E-03	8.23E-04	7.61E-04	1.50E+01
Beta	5.27E-02	6.97E-03	6.45E-03	8.00E+00

[a] Near Savannah River Mile 141.5, downriver of SRS near the Steel Creek mouth
[b] Beaufort-Jasper Water and Sewer Authority, drinking water at the Purrysburg Water Treatment Plant
[c] MCLs for uranium based on radioisotope-specific activity X 30 µg/L X isotopic abundance
[d] Actual measurements of the Savannah River water at the various locations are the basis for the tritium concentrations and source term. They include contributions from VEGP and the BLLDF. In 2021, SRS used the effective river flow rate of 8,456 cfs (see Section 6.3.3) to calculate all other radionuclide concentrations.
[e] Depending on which value is higher, the Cs-137 release total is based on concentrations measured in Steel Creek fish or on the actual measured effluent + migration release total from the Site. (See section "Radionuclide Concentrations in Fish" below.)

Radionuclide Concentrations in River Water and Treated Drinking Water—Table 6-2 shows the measured concentrations of tritium in the Savannah River near RM 141.5 and at the BJWSA Purrysburg Water Treatment Facility, which is representative of the BJWSA Chelsea and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS, VEGP, and BLLDF. In 2021, the 12-month average tritium concentration measured in Savannah River water near RM 141.5 was 254 picocuries per liter (pCi/L). This concentration is well below EPA's MCL for tritium of 20,000 pCi/L. Table 6-2 also provides the calculated concentrations for the other released radionuclides and a comparison of these concentrations to the EPA's MCLs. As shown, all radionuclide concentrations are well below the MCLs.

SRS Samples Fish from the Savannah River Using Electrofishing Methods. Radionuclide Concentrations in Fish Harvested from the Steel Creek Mouth are Used in the Representative Person Dose Calculations.

Radionuclide Concentrations in Fish—Consuming fish is an important dose pathway for the representative person. Fish exhibit a high degree of bioaccumulation for certain elements. For cesium (including radioactive isotopes of cesium, such as cesium-137), the bioaccumulation factor for Savannah River fish is estimated to be 3,000, meaning the cesium concentration 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, SRS can detect cesium-137 more easily in fish flesh than in river water. Therefore, when conservative to do so, SRS bases the fish pathway dose from cesium-137 directly on analyzing the fish collected from the location of the hypothetical representative person, which is near the mouth of Steel Creek, at RM 141.5. In 2021, SRS used the Steel Creek fish concentrations to determine the Site's overall cesium-137 release value of 0.390 Ci, which is conservatively higher than the measured cesium-137 effluent release value of 0.0237 Ci.

6.4.1.2 Dose to the Representative Person

SRS estimates the 2021 potential dose to the representative person from all liquid pathways (including irrigation) to be 0.28 mrem (0.0028 mSv), which is 20% less than the comparable dose of 0.35 mrem in 2020.

Table 6-3 shows that the total liquid pathway dose is 0.28% of the DOE public dose limit of 100 mrem/yr (1 mSv/yr).

About 30% of the 2021 total dose to the representative person is from consuming vegetables grown and meat and milk from animals raised using Savannah River water from near RM 141.5. The fish consumption pathway accounted for 66%, and the drinking water pathway accounted for 4%. As Figure 6-4 shows, cesium-137 (71%), technetium-99 (13%), nonvolatile beta (4%) and iodine-129 (4%) contributed the most to the liquid pathway dose.

Table 6-3 Potential Dose to the Representative Person from SRS Liquid Releases in 2021

	Dose (mrem)	Applicable Limit (mrem)	Percent of Limit (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.20		
Irrigation Pathways	0.086		
Total Liquid Pathways	0.28	100[a]	0.28%

[a] DOE dose limit: 100 mrem/yr (DOE Order 458.1)

6.4.1.3 Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by drinking water that contains radioactive releases from the Site as well as from VEGP and BLLDF. In 2021, SRS estimated the maximum potential drinking water dose from all sources to be 0.022 mrem (0.00022 mSv). Tritium in downriver drinking water represented the highest percentage of the dose (about 71%) customers of the three downriver water treatment plants received.

SRS-only releases were responsible for a maximum potential drinking water dose of 0.010 mrem (0.00010 mSv). DOE and EPA do not have a specific regulatory drinking water dose limit, but EPA bases its MCLs, as defined in 40 CFR 141 (EPA 2000), on a potential dose of about 4 mrem/yr for beta and gamma emitters. The 2021 maximum drinking water dose of 0.010 mrem is well below this value.

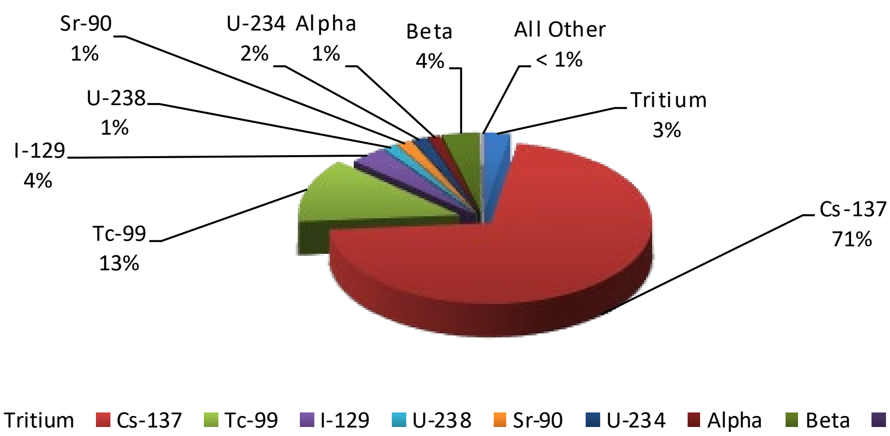


Figure 6-4 Radionuclide Contributions to the 2021 SRS Total Liquid Pathway Dose of 0.28 mrem (0.0028 mSv)

6.4.1.4 Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the separate population groups that are customers of the BJWSA and City of Savannah I&D water treatment plants. Calculations of collective doses from agricultural irrigation assume that major food types (vegetables, milk, and meat) grow or originate from animals kept on 1,000-acre parcels of land in the SRS area, with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels.

SRS calculates the collective dose in person-rem as the average dose per typical person, multiplied by the number of people exposed. DOE Order 458.1 requires that SRS calculate and report a collective dose, but there is not a separate collective dose limit for comparison. In 2021, the collective dose from all liquid pathways was 3.3 person-rem (0.033 person-Sv).

6.4.2 Air Pathway

6.4.2.1 Air Release Source Terms

Chapter 5, *Radiological Environmental Monitoring Program*, documents the 2021 radioactive air release quantities used as the source term in SRS dose calculations. Tritium accounts for most of the dose from SRS air releases.

6.4.2.2 Air Concentrations

SRS uses calculated radionuclide concentrations instead of measured concentrations for dose determinations because conventional analytical methods do not detect most of the radionuclides that SRS released in the air samples collected at the Site perimeter and offsite locations. However, SRS can routinely measure tritium concentrations at locations along the Site perimeter and compare these results with the calculated concentrations to confirm the dose models. In 2021, this comparison showed that the dose models used at SRS were about two times more conservative than the actual measured tritium concentrations.

6.4.2.3 Dose to the Representative Person

The 2021 estimated dose from air releases to the representative person is 0.017 mrem (0.00017 mSv), 0.17% of the EPA air pathway limit of 10 mrem per year. DOE Order 458.1 requires that all DOE sites comply with the EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. Table 6-4 compares the representative person dose with the EPA dose limit of 10 mrem/yr. The 2021 dose is 33% higher than the 2020 dose of 0.012 mrem (0.00012 mSv). SRS attributes most of this increase to the 29% increase in tritium oxide releases during 2021. Refer to Chapter 5, *Radiological Environmental Monitoring Program*, Section 5.3.2 for details concerning these measurements. The air pathway representative person is located at the SRS boundary in the north compass point direction, near New Ellenton, South Carolina.

As Figure 6-5 shows, tritium releases were 72% of the air pathway dose to the representative person. Iodine-129 accounted for 13% of the dose. Krypton-85 (6%), cesium-137 (4%), strontium-90 (2%), and plutonium-239 (1%) were the only other individual radionuclides that contributed 1% or more to the representative person dose.

The predominant ways a representative person received radiation dose from air releases were consuming vegetables (36%), inhalation (34%), and consuming cow milk (21%).

In 2017, the Site began to calculate the potential dose for an adult worker at the Three Rivers Landfill near SRS's B Area. The public has direct access to the landfill from South Carolina Highway 125, which is outside of the Site's security perimeter. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1.

Table 6-4 Potential Doses to the Representative Person and to the MEI from SRS Air Releases in 2021 and Comparison to the Applicable Dose Limit

	DOE Representative Person (MAXDOSE-SR)	EPA NESHAP MEI (CAP88-PC)
Calculated dose (mrem)	0.017	0.020
Applicable Limit (mrem)	10[a]	10[b]
Percent of Limit (%)	0.17	0.20

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

For this assessment, SRS assumed that an adult person worked at Three Rivers Landfill for 2,000 hours during the year (8 hours a day, 5 days a week, 50 weeks a year). SRS also assumed that this worker was exposed only from the inhalation and external-exposure pathways. The Site did not consider any locally grown food consumption at this industrial location.

For 2021, SRS calculated a potential dose of 0.012 mrem (0.00012 mSv) to a Three Rivers Landfill worker. This dose is less than the representative person dose of 0.017 mrem that SRS reported to comply with DOE Order 458.1.

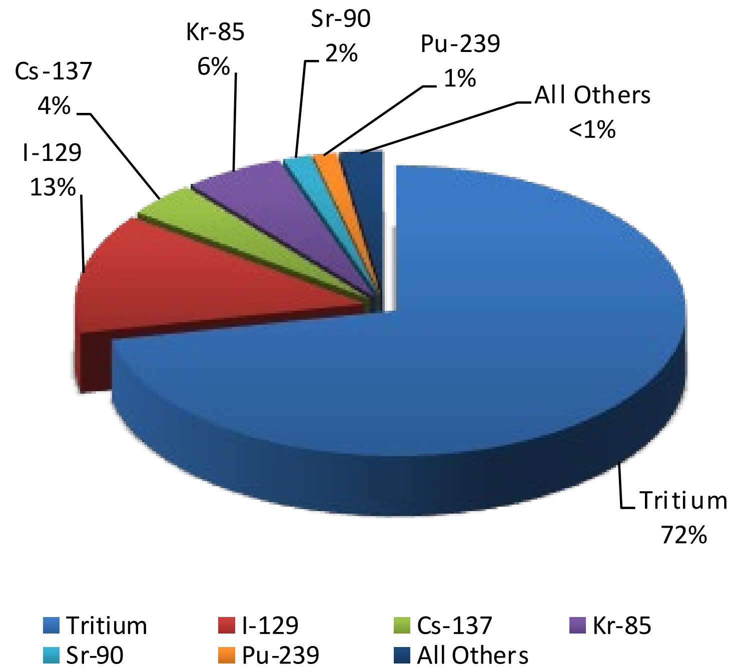


Figure 6-5 Radionuclide Contributions to the 2021 SRS Air Pathway Dose of 0.017 mrem (0.00017 mSv)

6.4.2.4 Collective (Population) Dose

SRS calculates the air-pathway collective dose for all 803,370 members of the population living within 50 miles of the Site's H Area. In 2021, SRS estimated the airborne-pathway collective dose to be 0.73 person-rem (0.0073 person-Sv). DOE Order 458.1 requires that SRS calculate and report a collective dose, but there is not a separate collective dose limit for comparison.

6.4.2.5 National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance

DOE Order 458.1 requires the Site to comply with the EPA's NESHAP regulations (EPA 2002). To demonstrate this compliance, SRS calculated the MEI and collective doses using the following:

1) The CAP88 PC version 4.1.0.2 computer code (released January 2020), which the EPA requires
2) The 2021 airborne-release source term
3) Site-specific input parameters

The EPA requires using the MEI concept and not the representative person concept, and it specifies most of the input parameters in the CAP88 PC program. The EPA requires specific approval for any changes to these parameters.

For 2021, SRS calculated doses to two potential MEIs to demonstrate the Site complied with the EPA's 10 mrem/yr (0.1 mSv/yr) public dose limit for air emissions from DOE sites. One potential MEI was at the usual offsite location, near the Site boundary in the north compass point direction. The second potential MEI was a worker at the Three Rivers Landfill. The EPA requires that the Site consider all exposure pathways (including food consumption) for the potential MEI, even for an industrial worker.

NESHAP dose calculations use H Area as the location for all Site releases because a large majority of SRS's radiological air releases are from the area's Tritium and Separations facilities (Minter et al. 2018).

SRS estimated the MEI dose at the Site boundary to be 0.0192 mrem (0.000192 mSv). SRS estimated the MEI dose for the Three Rivers Landfill worker to be 0.0199 mrem (0.000199 mSv). For 2021, SRS reported the slightly higher Three Rivers Landfill worker dose of 0.0199 mrem for NESHAP compliance. This dose is 0.20% of the 10 mrem/yr EPA limit, as Table 6-4 shows.

The radionuclides that accounted for most of the MEI dose, were tritium oxide (72%), elemental tritium (15%), cesium-137 (6.4%), krypton-85 (2.0%), and strontium-90 (1.6%). No other radionuclide contributed 1% or more to the total MEI dose. The 2021 NESHAP compliance dose (Three Rivers Landfill dose) is 29% more than the 2020 dose of 0.0154 mrem (0.000154 mSv). SRS attributes most of this increase to the 29% increase in tritium oxide releases during 2021. Refer to Chapter 5, *Radiological Environmental Monitoring Program*, Section 5.3.2 for details concerning these measurements.

6.4.3 All-Pathway Doses

6.4.3.1 All-Pathway Representative Person Dose

As stated in DOE Order 458.1, the all-pathway dose limit to a member of the public is 100 mrem/yr. SRS ensures a conservative estimate by combining the representative person airborne all-pathway and liquid all-pathway dose estimates, even though the two estimated doses are for hypothetical individuals living in different geographic locations.

For 2021, the potential representative person all-pathway dose is 0.30 mrem (0.0030 mSv), calculated as 0.28 mrem from liquid pathways plus 0.017 mrem from air pathways. As Table 6-5 shows, the all-pathway representative person dose is 0.30% of the 100 mrem/yr (1 mSv/yr) DOE dose limit. The all-pathway total dose is less than the 2020 total dose of 0.36 mrem (0.0036 mSv). As discussed previously, SRS attributes this decrease in 2021 to the decrease in radioactive liquid releases.

Figure 6-6 shows a 10-year history of SRS's all-pathway (airborne pathways plus liquid pathways) doses to the representative person.

Table 6-5 Potential Dose to the Representative Person from all Standard Pathways in 2021

Pathways	Committed Dose (mrem)	Applicable Limit (mrem)	Percent of Limit
Near Site Boundary (All Pathways)			
Total Liquid Pathways	0.28	100[a]	0.28%
Total Air Pathways	0.017	10[a,b]	0.17%
Total All Pathways	0.30	100[a]	0.30%

[a] DOE: DOE Order 458.1

[b] EPA: (NESHAP) 40 CFR 61, Subpart H

Table 6-6 Potential Collective Dose to the 50-Mile Population Surrounding SRS, Including the People Served by the Downriver Drinking Water Plants (Based on Dose to a Typical Person from all Standard Pathways in 2021)

Pathways	Collective Dose (person-rem)	Natural Background Dose (person-rem)	Percent of Natural Background
50-mile Population Dose (All Pathways)			
Total Liquid Pathways	3.3	Not Applicable	Not Applicable
Total Air Pathways	0.73	Not Applicable	Not Applicable
Total All Pathways	4.0	250,000 [a]	< 0.01%

[a] Calculated as 803,370 people (surrounding SRS population) times 311 mrem (0.311 rem) per person per year, which is the average annual natural background dose for people living in the United States (NCRP 2009).

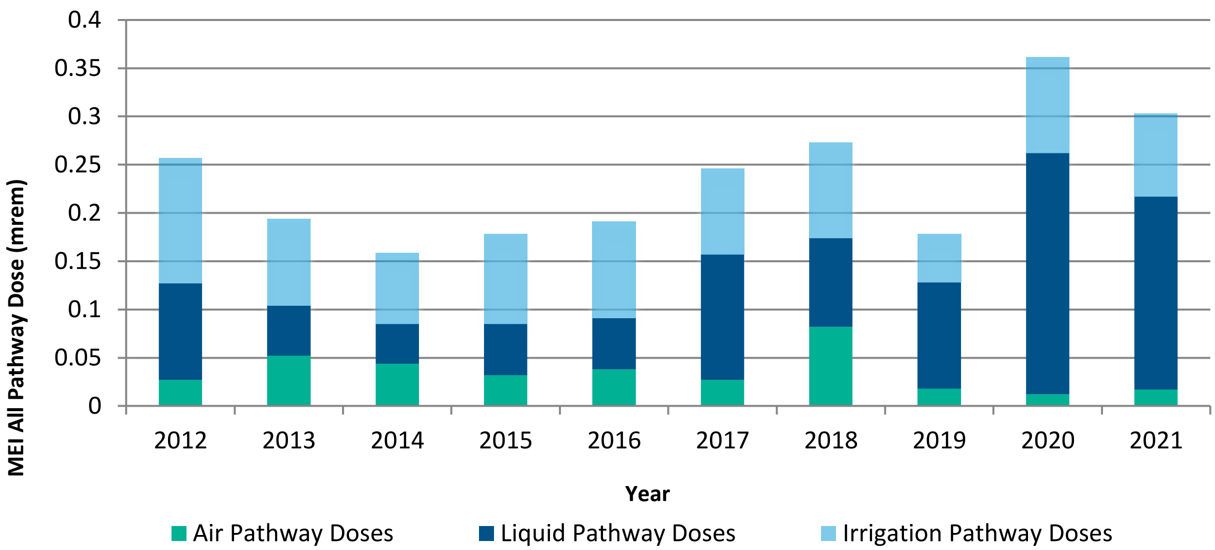


Figure 6-6 10-Year History of SRS Maximum Potential All-Pathway Doses

6.4.3.2 All-Pathway Collective (Population) Dose

DOE Order 458.1 requires that SRS calculate and report a collective dose, but there is not a separate collective dose limit for comparison. For 2021, the total potential collective all-pathway dose is 4.0 person-rem (0.040 person-Sv), calculated as 3.3 person-rem from liquid pathways plus 0.73 person-rem from air pathways. To compare, the annual collective dose from natural sources of radiation that the population within the 50-mile radius surrounding SRS's H Area is about 250,000 person-rem. As Table 6-6 shows, the SRS all-pathway collective dose of 4.0 person-rem is less than 0.01% of the annual collective background dose from natural resources.

6.5 SPORTSMAN DOSE CALCULATION RESULTS

DOE Order 458.1 specifies radiation dose limits for individual members of the public. The dose limit of 100 mrem/yr includes the dose a person receives from routine DOE operations through all exposure pathways. Additionally, SRS considers and quantifies nontypical exposure pathways the standard calculations of the doses to the representative person do not include. This is because they apply to unlikely scenarios such as eating fish caught only from the mouths of SRS streams ("creek-mouth fish") or to special scenarios such as hunters who volunteer to participate in an onsite hunt.

SRS also considered the following exposure pathways for a hypothetical offsite hunter and offsite fisherman on Creek Plantation, a neighboring, privately owned portion of the Savannah River Swamp:

- Ingesting deer meat or fish harvested on Creek Plantation
- Receiving external exposure to contaminated soil
- Incidentally ingesting contaminated soil
- Incidentally inhaling resuspended contaminated soil

6.5.1 Onsite Hunter Dose

Deer and Hog Consumption Pathway—SRS holds annual hunts for the public to control the Site's deer and wild hog populations and to reduce animal-vehicle accidents. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. Due to pandemic restrictions, there were no annual hunts held in 2021. However, SRS collected flesh samples from feral hogs that had been trapped in various hunt compartments onsite and analyzed them for radionuclides. The results were used to calculate dose to sportsman in the vicinity of the Site.

Turkey Consumption Pathway—SRS typically hosts a special turkey hunt in April for hunters with mobility impairments. However, due to pandemic restrictions, there were no turkey hunts in 2021.

6.5.2 Hypothetical 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 [179 lbs]) during the year was either deer or hog meat. SRS assumes that these individuals harvest deer or hogs that had lived on SRS during the year but then moved offsite before hunting season.

Based on these unlikely assumptions and on the measured average concentration of cesium-137 in all deer (1.23 pCi/g) and hogs (1.77 pCi/g) harvested from SRS during 2020 and 2021, respectively, the potential maximum doses from this pathway were estimated to be 2.97 mrem (0.0297 mSv) for the offsite deer hunter and 5.17 mrem (0.0517 mSv) for the offsite hog hunter.

Savannah River Swamp Hunter Soil Exposure Pathway—SRS estimated the potential dose to a recreational hunter exposed to SRS legacy contamination on the privately owned Creek Plantation. SRS used the soil concentration data obtained during the 2017 comprehensive survey of Creek Plantation for this assessment (SRNS 2018). The potential dose assumed that this person hunted for 120 hours during the year (8 hours a day for 15 days) at the location of maximum radionuclide contamination. SRS estimated this offsite-hunter soil exposure dose to be 1.86 mrem.

As Table 6-7 shows, the offsite hog consumption pathway dose (5.17 mrem) and the Savannah River Swamp hunter soil exposure pathway dose (1.86 mrem) were conservatively added together to obtain a total maximum offsite hunter dose of about 7.03 mrem (0.0703 mSv). This potential dose is 7.03% of the DOE 100 mrem/yr dose limit.

Table 6-7 2021 Sportsman Doses Compared to the DOE Dose Limit

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
	Sportsman Dose		
Onsite Hunter	**0.00**	**100**	**0.00**
Creek-Mouth Fisherman[b]	**0.43**	**100**	**0.43**
	Savannah River Swamp Hunter		
Offsite Hog Consumption	**5.17**		
Offsite Deer Consumption	**2.97**		
Soil Exposure[c]	**1.86**		
Maximum Offsite Hunter Dose (Hog + Soil Exposure)	**7.03**	**100**	**7.03**
	Savannah River Swamp Fisherman		
Steel Creek Fish Consumption	**0.43**		
Soil Exposure[d]	**2.08**		
Total Offsite Fisherman Dose (Fish + Soil Exposure)	**2.51**	**100**	**2.51**

[a] DOE dose limit; 100 mrem/yr (DOE Order 458.1)
[b] The 2021 maximum dose to a hypothetical fisherman resulted from consuming bass from the mouth of Steel Creek
[c] Includes the dose from combining external exposure and incidentally ingesting and inhaling the worst-case Savannah River swamp soil
[d] Includes the dose from combining external exposure and incidentally ingesting and inhaling Savannah River swamp soil near the mouth of Steel Creek

6.5.3 Hypothetical Offsite Fisherman Dose

Creek-Mouth Fish Consumption Pathway—For 2021, SRS analyzed four species of fish (panfish, catfish, flathead catfish, and bass), taken from the mouths of four SRS streams, for radionuclides. Using these concentrations, SRS estimated the maximum potential dose from fish consumption to be 0.43 mrem (0.0043 mSv) from bass collected at the mouth of Steel Creek. SRS bases this hypothetical dose on the low probability scenario that during 2021, a fisherman consumed 24 kilograms (53 pounds) of bass caught exclusively from the mouth of Steel Creek. All this potential dose was from cesium-137. As Table 6-6 shows, this dose is 0.43% of the DOE 100 mrem/yr dose limit.

Savannah River Swamp Fisherman Soil Exposure Pathway—SRS calculated the potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately owned Creek Plantation using the RESRAD code (Yu et al., 2001). SRS assumes 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 renewed suspension soil to be 2.08 mrem (0.0208 mSv).

As Table 6-6 shows, SRS added the maximum Steel Creek fish consumption dose (0.43 mrem) and the Savannah River Swamp fisherman soil exposure dose (2.08 mrem) to conservatively obtain a total offsite fisherman dose of 2.51 mrem (0.0251 mSv). This potential dose is 2.51% of the DOE 100 mrem/yr dose limit.

6.5.4 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 the EPA, Georgia Department of Natural Resources, and South Carolina Department of Health and Environmental Control. This plan includes assessing radiological risk from consuming Savannah River fish and requires that SRS summarize the results in the annual *SRS Environmental Report*. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA 1999). For 2021, SRS estimated the maximum potential lifetime risk of developing fatal and nonfatal cancer from consuming SRS creek-mouth fish to be 3.2E-07. That is, if 10 million people each received a dose of 0.43 mrem, there is a potential for 3.2 extra cancer incidents.

6.6 RELEASE OF MATERIAL CONTAINING RESIDUAL RADIOACTIVITY

DOE Order 458.1 establishes authorized surface contamination limits for unconditional release of personal and real property. This Order defines personal property as “property of any kind, except for real property” and defines real property 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.” SRS handles the unconditional release of real property on an individual basis that requires DOE approval. SRS did not release any real property in 2021; therefore, the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that the Site must prepare and submit an annual summary of cleared property to the DOE-SR Manager.

6.6.1 Property Release Methodology

SRS uses procedures to govern unconditionally releasing equipment. SRS can release the item after it has a radiological survey if it meets specific documented limits. For items meeting unconditional release criteria, SRS generates a form and attaches it electronically to the applicable radiological survey via the Site’s Visual Survey Data System (VSDS). In some areas, SRS documents equipment and material release directly on the radiological survey form. SRS subsequently compiled these VSDS and survey forms and coordinated a site-wide review to determine the amount of material and equipment SRS released from its facilities in 2021. These measures ensure that radiological material releases from SRS are consistent with DOE Order 458.1 requirements.

SRS unconditionally released 12,158 items of personal property from radiological areas in 2021. Most of these items did not leave the SRS and were reused elsewhere on the Site. Therefore, all items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria. (DOE Order 458.1 allows using DOE Order 5400.5-derived supplemental limits for unconditionally releasing equipment and materials.)

In 2003, DOE approved an SRS request to use supplemental limits to release material from the Site with no further DOE controls. These supplemental release limits, provided in Table 31 of *Radiological Impact of 2021 Operations at the Savannah River Site* (Stagich, Dixon, and LaBone 2022), 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 volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary waste facility. In 2021, an unrestricted release to the onsite Three Rivers Landfill of volumetrically contaminated grit that occurred on October 28, 2020, was identified and found to be below the approved supplemental release limits.

6.7 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

DOE Order 458.1 requires that SRS operate in a manner that protects the local biota from adverse effects of radiation and radioactive material releases. To demonstrate it is complying with this requirement, SRS follows the approved DOE Standard, DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019).

The biota dose rate limits specified in this standard are the following:

- Aquatic animals: 1.0 rad/day
- Riparian animals: 0.1 rad/day
- Terrestrial plants: 1.0 rad/day
- Terrestrial animals: 0.1 rad/day

6.7.1 DOE Biota Concentration Guides

SRS evaluates plant and animal doses for water and land systems using the RESRAD Biota model (version 1.8) (SRS EDAM 2017), which directly implements the DOE (2019) guidance. The RESRAD Biota model uses a graded approach consisting of three increasingly more detailed steps of analysis:

- Level 1 Screening—uses maximum measured concentrations and conservative default model input parameters
- Level 2 Screening—uses average concentrations or site-specific input parameters, as appropriate
- Level 3 Analysis—uses site-specific biota parameters or measured concentrations in the actual biota living at the assessed location

For water systems (animals and plants that live in the water or along riverbanks), the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial (Level 1) screenings in 2021 using radionuclide concentration data from SRS's 14 onsite, colocated stream and sediment sampling locations. A sum of the fractions less than 1.0 indicates the sampling site has passed its initial pathway screening, which means that the sampling site did not exceed its biota dose rate limits, and SRS does not have to assess the location further. All SRS aquatic system locations passed the Level 1 screenings and did not require further assessment.

To evaluate land-based systems, SRS performed Level 1 screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2021, all land-based locations passed their initial Level 1 pathway screenings.

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Chapter 7: Groundwater Management Program

The purpose of the Savannah River Site's (SRS's) groundwater management program is to protect, monitor, remediate, and use groundwater. With this focus, the program accomplishes the following:

- Ensures future groundwater contamination does not occur
- Monitors groundwater to identify areas of contamination
- Remediates groundwater contamination as needed
- Conserves groundwater

2021 Highlights

Drinking Water Standards—The data show no exceedances of drinking water standards (measured by maximum contaminant limit [MCLs] or regional screening levels [RSLs]) in SRS boundary wells near A/M Area.

Groundwater Contaminant Removal—SRS removed 18,544 pounds (lbs) of volatile organic compounds (VOCs) from groundwater and the vadose zone, preventing 51.7 curies (Ci) of tritium from reaching SRS streams.

Offsite Groundwater Monitoring (Georgia)—For the last three years, tritium has not been detected in Georgia groundwater monitoring wells. This data supports the conclusions drawn from a U.S. Geological Survey that indicate there is no mechanism by which groundwater could flow under the Savannah River and contaminate Georgia wells (Cherry 2006).

7.1 INTRODUCTION

Some of SRS's past operations have released chemicals and radionuclides into the soil and contaminated the groundwater around hazardous waste management facilities and waste disposal sites. Because of these past releases, SRS operates extensive groundwater monitoring and groundwater remediation programs.

The SRS groundwater monitoring program requires regular well sampling to monitor for groundwater contaminants. The well monitoring meets sampling requirements in the Federal Facility Agreement (FFA) for the Savannah River Site (FFA 1993) and in Resource Conservation and Recovery Act (RCRA) permits, and ensures the Site is meeting South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (EPA) drinking water quality standards. SRS uses SCDHEC-certified laboratories to analyze groundwater samples.

The monitoring data show that most of the contaminated groundwater is in the central area of SRS, and none extends beyond the SRS boundary. Groundwater contamination at SRS is limited primarily to the Upper Three Runs/Steed Pond Aquifers and the Gordon/Lost Lake Aquifers (Figure 7-1). SRS submits summaries of groundwater data to regulatory agencies and, if necessary, remediates or removes the contamination. *Appendix E: Groundwater Management Program Supplemental Information* lists the documents reporting groundwater monitoring data that SRS submits to the regulatory agencies.

SRS uses several technologies to remediate groundwater that exceeds the MCLs or the RSLs. Remediation includes closing waste units to reduce the potential for contaminants to reach groundwater, actively treating contaminated water, and employing passive and natural (attenuation) remedies.

Groundwater remediation at SRS focuses on VOCs and tritium. VOCs in groundwater, mainly trichloroethylene (TCE) and tetrachloroethylene (PCE), originate from their use as degreasing agents in industrial work at SRS. Tritium in groundwater is a byproduct of nuclear materials production at SRS. Corrective measures at SRS range from active treatment, such as using oxidants to destroy the VOCs in place, to passive measures, such as monitored natural attenuation and phytoremediation (using trees and plants to remove or break down contaminants). These practices are removing VOCs from the groundwater and effectively reducing tritium releases into SRS streams and the Savannah River.

7.2 GROUNDWATER AT SRS

The groundwater flow system at SRS consists of the following four major aquifers separated by confining units:

- Upper Three Runs/Steed Pond
- Gordon/Lost Lake
- Crouch Branch
- McQueen Branch

Chapter 7—Key Terms

Aquifer *is an underground water supply found in porous rock, sand, gravel, and other materials.*

Attenuation *is a reduction of groundwater contaminants over time due to naturally occurring physical, chemical, and biological processes.*

Confining unit *is the opposite of an aquifer. It is a layer of rock or sand that limits groundwater movement in and out of an aquifer.*

Contaminants of concern *are contaminants identified in the risk assessment that are found at a waste unit and pose an unacceptable risk to human health and the environment.*

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

Maximum contaminant level (MCL) *is the highest level of a contaminant allowed in drinking water.*

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

Recharge *occurs when water from the surface travels down into the subsurface, replenishing the groundwater.*

Regional screening level (RSL) *is the risk-based concentration derived from standardized equations, combining exposure assumptions with toxicity data.*

Remediation *cleans up sites contaminated with waste from historical activities.*

Surface water *is water found above ground (for example, streams, lakes, wetlands, reservoirs, and oceans).*

Vadose zone *is the subsurface layer below the land surface and above the water table. The vadose zone has a low water-compared-to-saturated zone; therefore, it is also referred to as being unsaturated.*

Waste unit *is an area that is, or may be, posing a threat to human health or the environment. It ranges in size from a few square feet to tens of acres and includes basins, pits, piles, burial grounds, landfills, tank farms, disposal facilities, process facilities, and contaminated groundwater.*

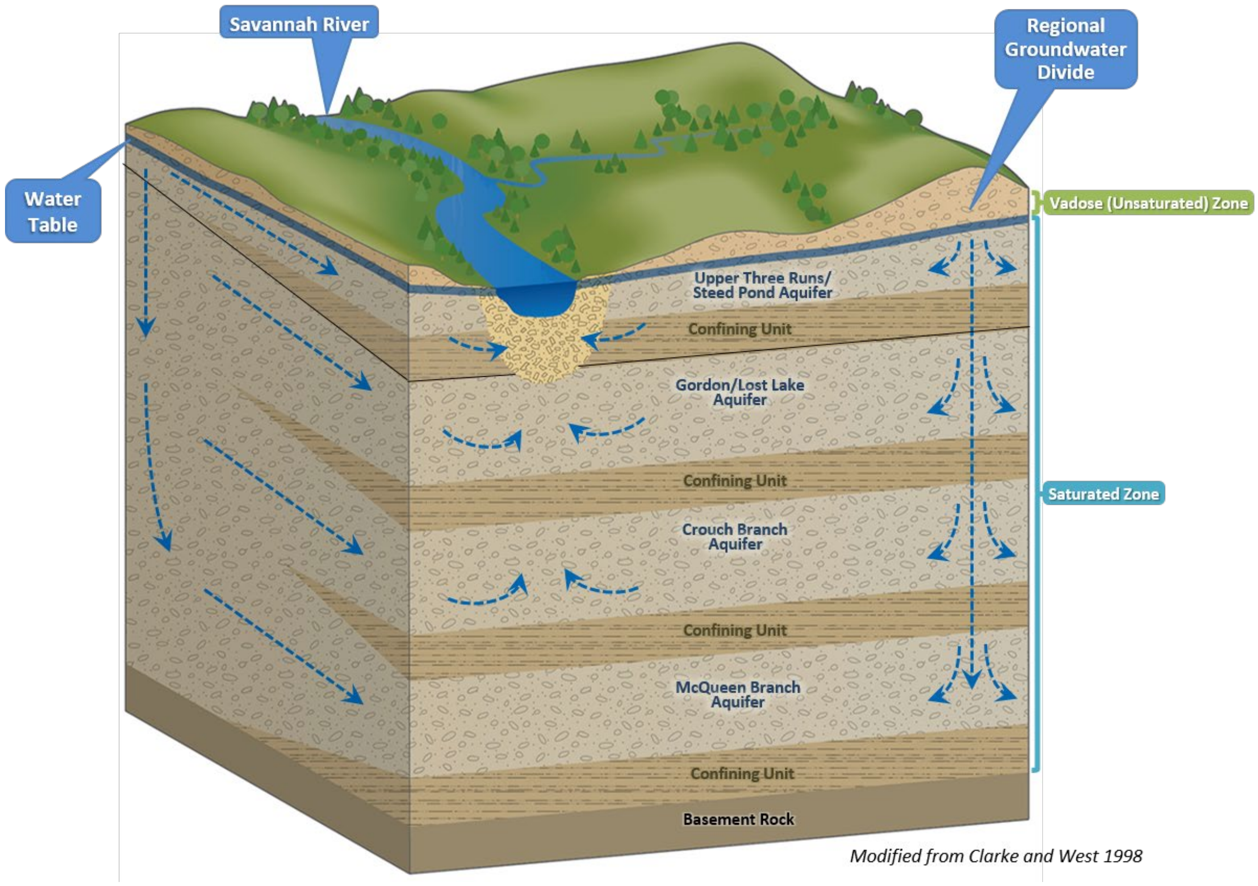


Figure 7-1 Groundwater at SRS

Groundwater flow in recharge areas generally migrates downward and laterally. It eventually flows into the Savannah River and its tributaries or migrates into the deeper regional flow system. Figure 7-1 presents a three-dimensional block diagram of these units at SRS and the generalized groundwater flow patterns within those units. Water moving from the ground's surface into the aquifers can carry contamination along with it, resulting in underground plumes of contaminated water (Figure 7-2).

7.3 GROUNDWATER PROTECTION PROGRAM AT SRS

SRS has designed and implemented a groundwater protection program to prevent new releases to groundwater and to remediate contaminated groundwater to meet federal and state laws and regulations, U.S. Department of Energy (DOE) Orders, and SRS policies and procedures. It accomplishes the following:

- Protects groundwater
- Monitors groundwater
- Remediates groundwater
- Conserves groundwater

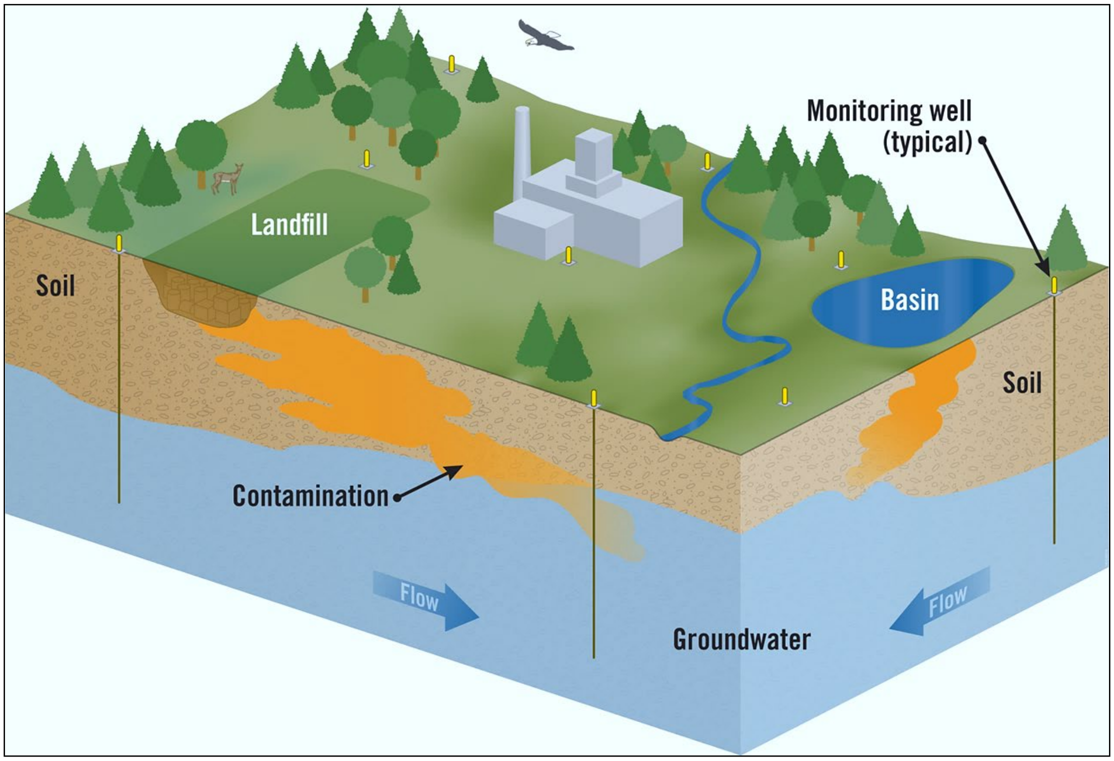


Figure 7-2 How Contamination Gets to Soil and Groundwater

7.3.1 Protecting SRS Groundwater

SRS groundwater management focuses on preventing and monitoring groundwater contamination, protecting the public and environment from contamination, and preserving groundwater quality for future use. SRS protects groundwater by:

- Preventing or controlling groundwater contamination sources from construction sites, hazardous waste management facilities, and waste units
- Monitoring groundwater and surface water to detect contaminants
- Reducing contaminants via a groundwater cleanup program

7.3.2 Monitoring SRS Groundwater

The purpose of monitoring groundwater is to observe and evaluate changes in the groundwater quality over time and to 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: groundwater contaminant source monitoring and groundwater surveillance monitoring. SRS evaluates groundwater-monitoring data frequently to identify whether new groundwater contamination exists or whether it should modify the current monitoring program.

SRS uses groundwater-monitoring data to determine the effects of Site operations on groundwater quality. The program supports the following critical activities:

- Complying with environmental regulations and DOE directives
- Evaluating the status of groundwater plumes

- Evaluating potential impacts from activities planned near or within the groundwater plume footprint
- Enhancing groundwater remediation through basic and applied research projects

Monitoring the groundwater around SRS facilities, waste disposal sites, and associated streams is the best way to detect and track contaminant migration. Through careful monitoring and analysis, SRS implements appropriate remedial or corrective actions. Figure 7-3 shows the groundwater plumes associated with SRS.

Increasing national attention to "emerging contaminants" or contaminants of emerging concern (CEC) can trigger a call for action from federal, state, and local government. Increased monitoring and detections of unregulated substances can lead the EPA to identify solutions to address these substances that may present a risk to human health or the environment. As a result of discussions with the EPA and SCDHEC, SRS adds emerging contaminants to analyte lists when historical or process knowledge indicates that a contaminant could be of concern.

1,4-Dioxane is one of the emerging contaminants that SRS monitors regularly in conjunction with VOC plumes.

SRS Engineers Inspect a Solar-powered MicroBlower™.

Other CECs include per- and polyfluoroalkyls substances (PFAS). PFAS are a family of man-made chemicals that have been manufactured and used worldwide since the 1940s. They are present in various items such as cookware, stain repellants, food packaging, and firefighting foam. In 2019, SRS began assessing the past and present use of PFAS at the Site. Groundwater sampling of PFAS continued in 2021, along with continued assessments of past use. Results from 2021 groundwater sampling range from <10 ng/L up to 1,750 ng/L, which is similar to the 2020 results. These results from D Area indicate that PFAS present are related to historical use of firefighting foams. SRS is committed to understanding the full nature and extent of PFAS contamination at SRS. The SRS groundwater monitoring program ensures that there is no cross-contamination in samples due to the presence of PFAS in many consumer products. The EPA, SCDHEC, and the Interstate Technology Regulatory Council webpages have current information on the state of knowledge and regulatory status of PFAS.

7.3.2.1 Groundwater Surveillance Monitoring

Surveillance monitoring at SRS focuses on collecting and analyzing data to characterize the groundwater flow and determine the presence or absence of contaminants. Characterization at SRS includes the following activities:

- Collecting soil and groundwater samples to determine the extent of contamination
- Obtaining geologic soil cores or seismic profiles to better determine aquifer and confining unit physical and geochemical properties

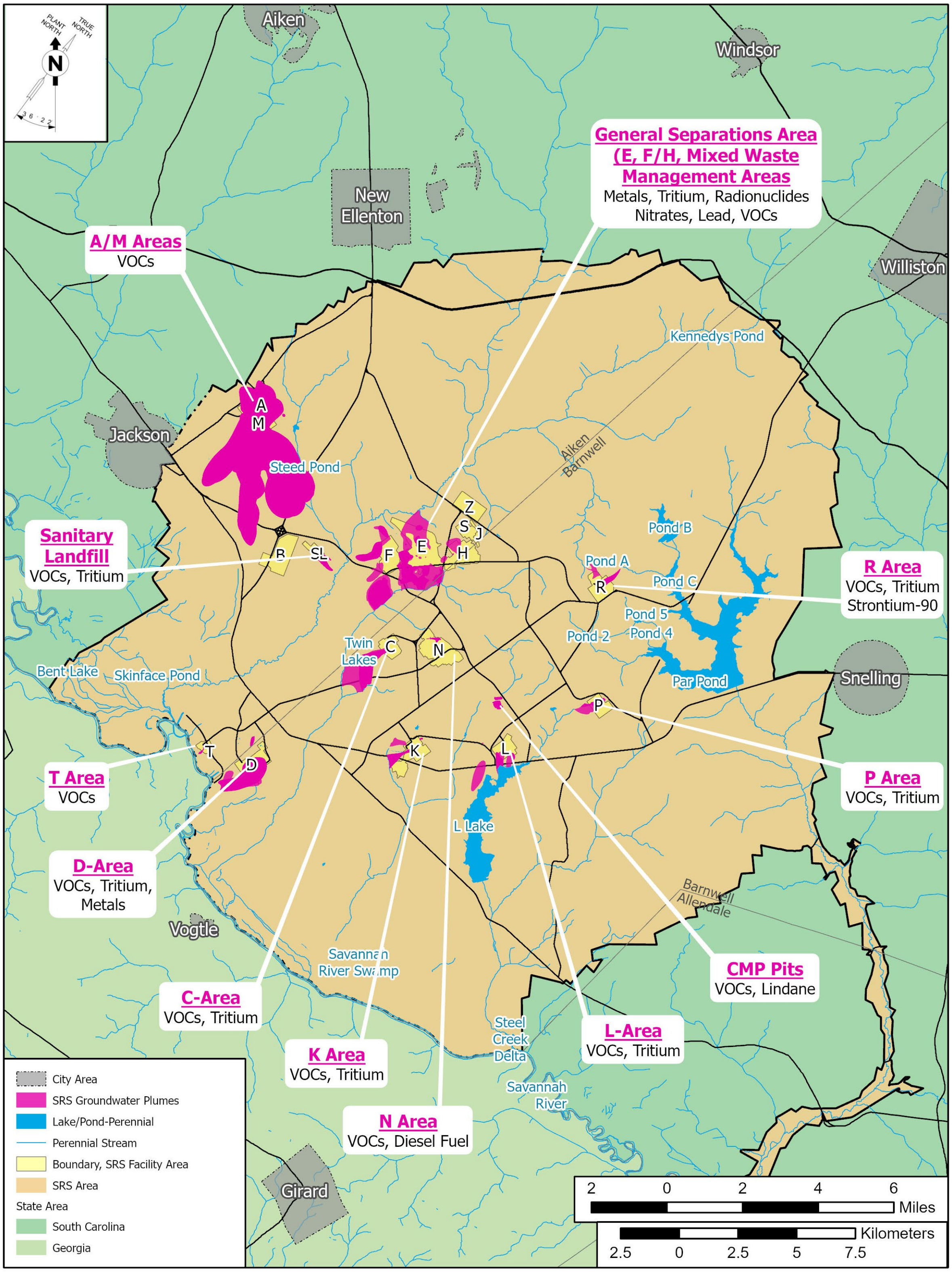


Figure 7-3 Groundwater Plumes at SRS

- Installing wells to periodically collect water-level measurements and groundwater samples
- Developing maps to help define groundwater flow, and visualize the extent of horizontal and vertical contamination
- Performing calculations based on water elevation data to estimate groundwater velocities
- Using groundwater modeling to understand future SRS groundwater movement—and specifically contaminant movement—near facilities, individual waste units, and at the Site boundary
- Characterizing regional surface water flow to assess contaminant risk to perennial streams, which receive groundwater flow

7.3.2.2 2021 Groundwater Data Summary

SRS uses more than 150 wells to monitor a significant plume beneath A/M Area. Some of these monitoring wells lie within a half-mile of the northwestern boundary of SRS. The direction of groundwater flow in the area is parallel to the Site boundary; however, groundwater flow direction can fluctuate. Because of this, SRS concentrates on the groundwater results from the wells along the Site boundary, as well as those between A/M Area and the nearest population center, Jackson, South Carolina (SRNS 2022a). The data show no exceedances of drinking water standards (MCLs or RSLs) in SRS boundary wells near A/M Area. No detectable contamination exists in most of these SRS boundary wells.

Although most SRS-contaminated groundwater plumes do not approach the Site boundary, the potential to affect Site streams exists when contaminated groundwater flows into nearby streams. SRS monitors and evaluates groundwater contamination that flows into Site streams and remediates it as appropriate. In conjunction with stream monitoring, as discussed in Chapter 5, *Radiological Environmental Monitoring Program*, Section 5.4.3, *SRS Stream Sampling and Monitoring*, SRS conducts extensive monitoring near SRS waste units and operating facilities, regardless of their proximity to the boundary. *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2020) details groundwater monitoring and conditions at individual sites.

Table 7-1 identifies the typical contaminants of concern (COCs) found in SRS groundwater and their significance. These COCs are a result of historical SRS operations that released chemicals and radionuclides into the soil and groundwater near hazardous waste management facilities and waste disposal sites. Table 7-2 presents a general summary of the most common contaminants found in groundwater at SRS facility areas, based on 2021 monitoring data, and compares the maximum concentrations to the appropriate drinking water standards. Table 7-2 shows the major COCs in the groundwater beneath SRS, including common degreasers (TCE and PCE) and radionuclides (tritium, gross alpha, and nonvolatile beta emitters).

Since the early 1990s, SRS has directed considerable effort to assessing the likelihood of flow beneath the Savannah River from South Carolina to Georgia. A groundwater model developed by the U.S. Geological Survey 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) by collecting samples annually during the second half of the year. Detections of tritium in groundwater in these Georgia offsite wells have been below 1.5 pCi/mL (1,500 pCi/L) since 1999 (Figure 7-5). The MCL, or drinking water standard, for tritium is 20 pCi/mL (20,000 pCi/L). For the fourth consecutive year, the results had no detectable concentrations of tritium.

Table 7-1 Typical Contaminants of Concern at SRS

Contaminants	Sources	Limits, Exposure Pathways, and Health Effects
Gross Alpha	Alpha radiation emits positively charged particles from radioactive decay of certain elements including uranium, thorium, and radium. Alpha radiation in drinking water can be in the form of dissolved minerals or a gas (radon).	MCL is 15 pCi/L. An alpha particle cannot penetrate a piece of paper or human skin. It causes increased risk of cancer through ingestion or inhalation.
Nonvolatile Beta	Beta decay commonly occurs among neutron-rich fission byproducts produced in nuclear reactors.	MCL is 4 mrem/yr. It causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
Tritium	Radioactive isotope of hydrogen with a half-life of 12.3 years. It emits a very weak beta particle and behaves like water.	MCL is 20 pCi/mL. It primarily enters the body when people swallow tritiated water. It causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
TCE/PCE	VOCs used primarily to remove grease from fabricated metal parts.	MCL is 5 µg/L. It causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
Vinyl Chloride	VOC formed as a degradation product of TCE/PCE.	MCL is 2 µg/L. It causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
1,4-Dioxane[a]	Synthetic industrial chemical used as a stabilizer for VOCs to reduce degradation.	RSL for tap water is 0.46 µg/L. It causes increased risk of cancer through ingestion, inhalation, or dermal exposure.
PFAS[a]	Constituent in firefighting foams, and in consumer products such as cookware, packaging, and stain repellants.	EPA Drinking Water Lifetime Health Advisory Limit (nonenforceable) is 70 ng/L. It causes low birth weights, effects on the immune system, cancer, and thyroid disruption.

[a] Substance identified by EPA as contaminant of emerging concern

Table 7-2 Summary of the Maximum Contaminant Concentrations for Major Areas within SRS

Location	Major Contaminant	Units	2021 Max Concentration	Well	MCL/ RSL	Likely Stream Endpoints
A/M Area	Tetrachloroethylene	µg/L	82,600	MSB002CR	5	Upper Three Runs
	Trichloroethylene	µg/L	64,200	MSB002CR	5	
	1,4-Dioxane	µg/L	500	MCB037C	0.46[a]	
C Area	Tetrachloroethylene	µg/L	8.71	CRP 5C	5	Fourmile Branch
	Trichloroethylene	µg/L	1,940	CRP 20CU	5	
	Tritium	pCi/mL	2,300	CRW024C	20	
	Vinyl Chloride	µg/L	209	CRP 50B	2	
CMP Pits (G Area)	Tetrachloroethylene	µg/L	2,470	CMP 35D	5	Pen Branch
	Trichloroethylene	µg/L	1,390	CMP 35D	5	
	Lindane	µg/L	5.14	CMP 35D	0.2	
	1,4-Dioxane	µg/L	101	CMP 35D	0.46[a]	
D Area	Beryllium	µg/L	112	DCB 26AR	4	Savannah River
	Tetrachloroethylene	µg/L	8.34	DCB 45C	5	
	Trichloroethylene	µg/L	114	DCB 62	5	
	Vinyl Chloride	µg/L	29.5	DOB 15	2	
	Tritium	pCi/mL	206	DCB 26AR	20	
	PFAS	ng/L	1,750	DCB 62	70[b]	

Table 7-2 Summary of the Maximum Contaminant Concentrations for Major Areas within SRS (continued)

Location	Major Contaminant	Units	2021 Max Concentration	Well	MCL/ RSL	Likely Stream Endpoints
E Area (MWMF)	Trichloroethylene	µg/L	414	HSB120C	5	Upper Three Runs/ Fourmile Branch
	1,4-Dioxane	µg/L	550	BSW 6C3	0.46[a]	
	Tritium	pCi/mL	30,900	BGO 15D	20	
	Nonvolatile Beta	pCi/L	36.6	HSP-097A	50[c]	
	Gross Alpha	pCi/L	13.9	BSW 3D2	15	
F Area	Trichlorethylene	µg/L	30.4	FGW003C	5	Fourmile Branch
	Tritium	pCi/mL	109	FGW012C	20	
	Gross Alpha	pCi/L	1,753	FGW005C	15	
	Nonvolatile Beta	pCi/L	7,766	FGW005C	50[c]	
F-Area HWMF	Trichloroethylene	µg/L	13.7	FSB 78C	5	Fourmile Branch
	Tritium	pCi/mL	894	FSB 78C	20	
	Gross Alpha	pCi/L	265	FSB 95DR	15	
	Nonvolatile Beta	pCi/L	552	FSB 94C	50[c]	
F-Area Tank Farm	Tritium	pCi/mL	6.27	FTF012R	20	Fourmile Branch/ Upper Three Runs
	Nonvolatile Beta	pCi/L	171	FTF 28	50[c]	
	Manganese	µg/L	129	FTF030D	28	
H Area	Trichloroethylene	µg/L	3.8	HGW 3D	5	Upper Three Runs/ Fourmile Branch
	Gross Alpha	pCi/L	34.3	HR3 16DU	15	
	Nonvolatile Beta	pCi/L	8.73	HAA 9AR	50[c]	
	Tritium	pCi/mL	18.3	HGW 2D	20	
H-Area HWMF	Trichloroethylene	µg/L	228	HSB120C	5	Fourmile Branch
	Tritium	pCi/mL	1,670	HSB120C	20	
	Gross Alpha	pCi/L	34.3	HSB101D	15	
	Nonvolatile Beta	pCi/L	481	HSB103D	50[c]	
H-Area Tank Farm	Tritium	pCi/mL	34.9	HAA 12C	20	Fourmile Branch/ Upper Three Runs
	Nonvolatile Beta	pCi/L	33.8	HAA 12B	50[c]	
	Manganese	µg/L	395	HAA 10D	28	
K Area	Tetrachloroethylene	µg/L	6.13	KDB 1	5	Indian Grave Branch
	Trichloroethylene	µg/L	2.15	KRP 9	5	
	Tritium	pCi/mL	1,360	KRB 19D	20	
L Area	Tetrachloroethylene	µg/L	65.8	LSW 25DL	5	Steel Creek
	Trichloroethylene	µg/L	2.94	LSW025DL	5	
	Tritium	pCi/mL	405	LSW 25DL	20	
P Area	Trichloroethylene	µg/L	7,530	PGW026DL	5	Steel Creek/Lower Three Runs
	Tritium	pCi/mL	12,000	PSB002B	20	
R Area	Trichloroethylene	µg/L	20	RAG008B	5	Lower Three Runs
	Tritium	pCi/mL	353	RDB 3D	20	
	Carbon-14	pCi/L	95	RDB 3D	2,000	
	Strontium-90[d]	pCi/L	14.4	RSE029D	8	
Sanitary Landfill	1,4-Dioxane	µg/L	150	LFW 62C	0.46[a]	Upper Three Runs
	Trichloroethylene	µg/L	6.15	LFW 32	5	
	Vinyl Chloride	µg/L	18.5	LFW 21	2	
TNX	Trichloroethylene	µg/L	32.6	TRW 2	5	Savannah River

Table 7-2 Summary of the Maximum Contaminant Concentrations for Major Areas within SRS (continued)

Location	Major Contaminant	Units	2021 Max Concentration	Well	MCL/ RSL	Likely Stream Endpoints
Z Area	Technetium-99	pCi/L	117	ZBG002D	900	Upper Three Runs
	Nitrate-Nitrate as Nitrogen	mg/L	8.77	ZBG002D	10	
	Nonvolatile Beta	pCi/L	47.5	ZBG002D	50[c]	

Notes:
MWMF is the Mixed Waste Management Facility; HWMF is the Hazardous Waste Management Facility; TNX is the 678-T facilities; CMP is the Chemicals, Metals, and Pesticides Pits.
µg = micrograms

[a] The 1,4-dioxane standard is a RCRA-permitted Groundwater Protection Standard.
[b] The PFAS standard is an EPA Drinking Water Lifetime Health Advisory Limit (ng/L)
[c] The MCL for nonvolatile beta activity (pCi/L or pCi/mL) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample. At SRS, this value equates to 50 pCi/L.
[d] At R Area, strontium-90 is sampled every two years. It was last sampled in 2020.

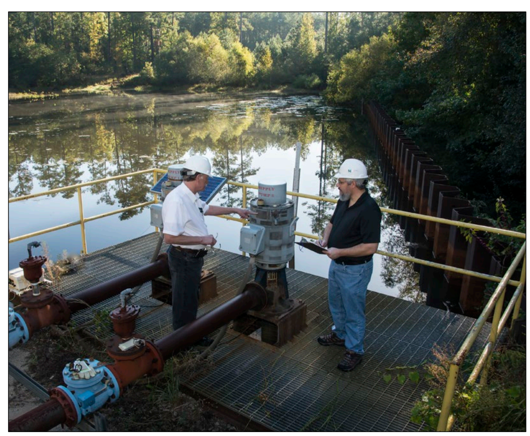
7.3.3 Remediating SRS Groundwater

SRS's environmental remediation program has been in place for more than 20 years. The Federal Facility Agreement (FFA) for the Savannah River Site (FFA 1993) specifies that RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act regulate the processes of remediating and monitoring contaminated groundwater. Remediation focuses on removing mass, reducing contaminant levels, and reducing the exposure of humans and the environment to contaminants that exceed either the MCLs or RSLs. Table 7-2 identifies the MCLs and RSLs for the primary contaminants of concern in SRS groundwater.

For each remediation project, SRS determines the degree of contamination in the groundwater. After this evaluation, SRS and the regulatory agencies decide upon a strategy for remediating the groundwater.

SRS often applies remedial actions to the groundwater contamination source. For instance, SRS widely uses soil vapor extraction, a technology that extracts contaminated soil vapor from the vadose (unsaturated) zone to remove VOCs. This technology minimizes the VOCs that will reach the water table. Recently, SRS has emphasized converting soil vapor extraction systems requiring permanent electrical power to passive systems using solar power or barometric pumping.

SRS implements several groundwater remedial technologies. These technologies manage the rate the contaminants move and reduce the risk of contaminant exposure to human health and ecological receptors. Thirty-nine remediation systems are currently operating. In 2021, SRS removed 18,544 lbs of VOCs from the groundwater and the vadose zone, preventing 51.7 Ci of tritium from reaching SRS streams (SRNS 2022b). SRS has worked for more than 20 years to reduce the tritium flux to Fourmile Branch. Since 2000, SRS has reduced the tritium flux to Fourmile Branch by almost 70% using groundwater remedial technologies (subsurface barriers and water capture with phytoirrigation). The Mixed Waste Management Facility (MWMF) Phytoremediation Project has the largest tritium reductions of the technologies currently in use on the Site.



Phytoremediation Uses Trees and Plants to Remove or Break Down Contaminants.

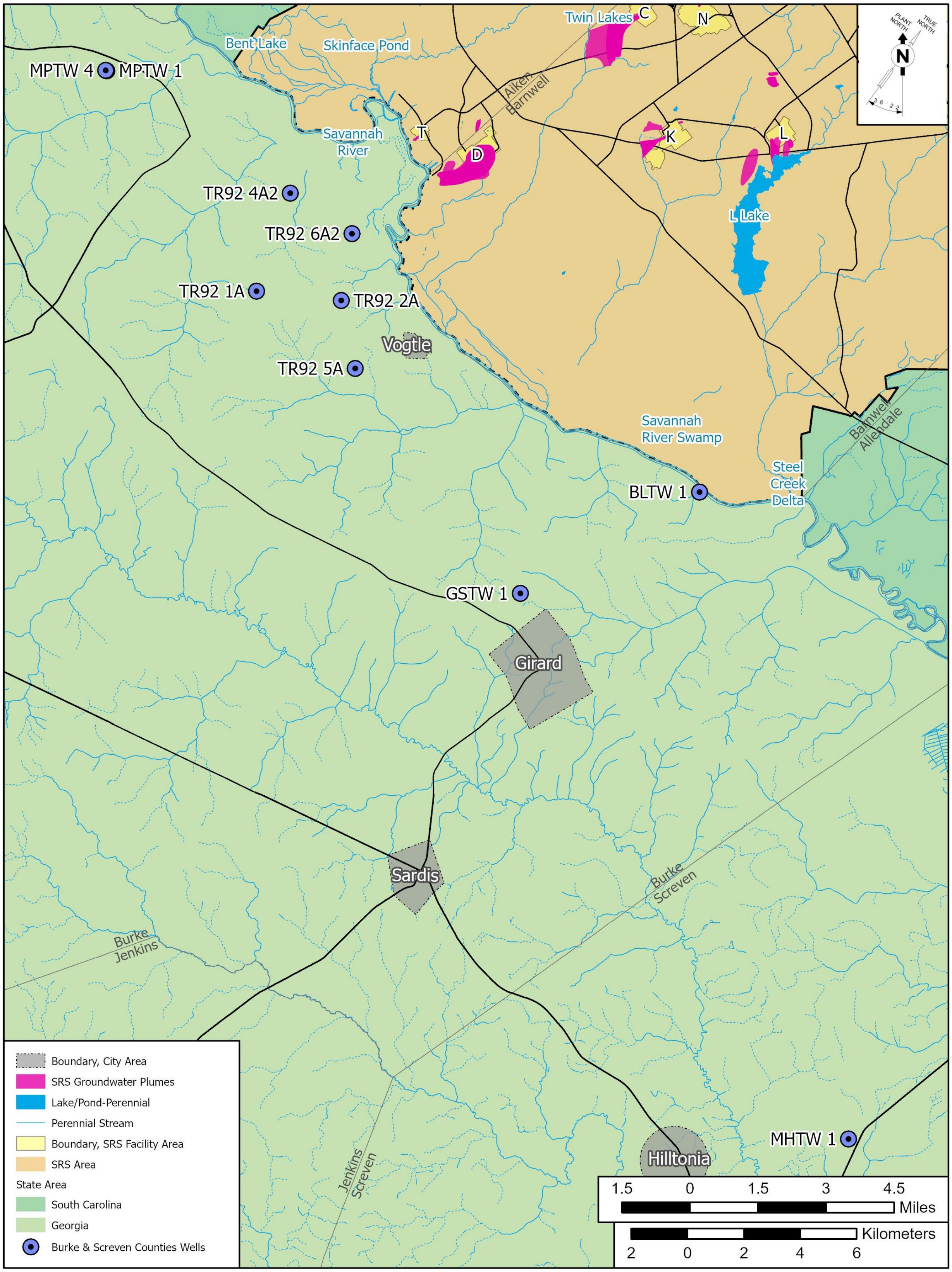


Figure 7-4 Locations of Tritium Monitoring Wells in Burke and Screven Counties, Georgia

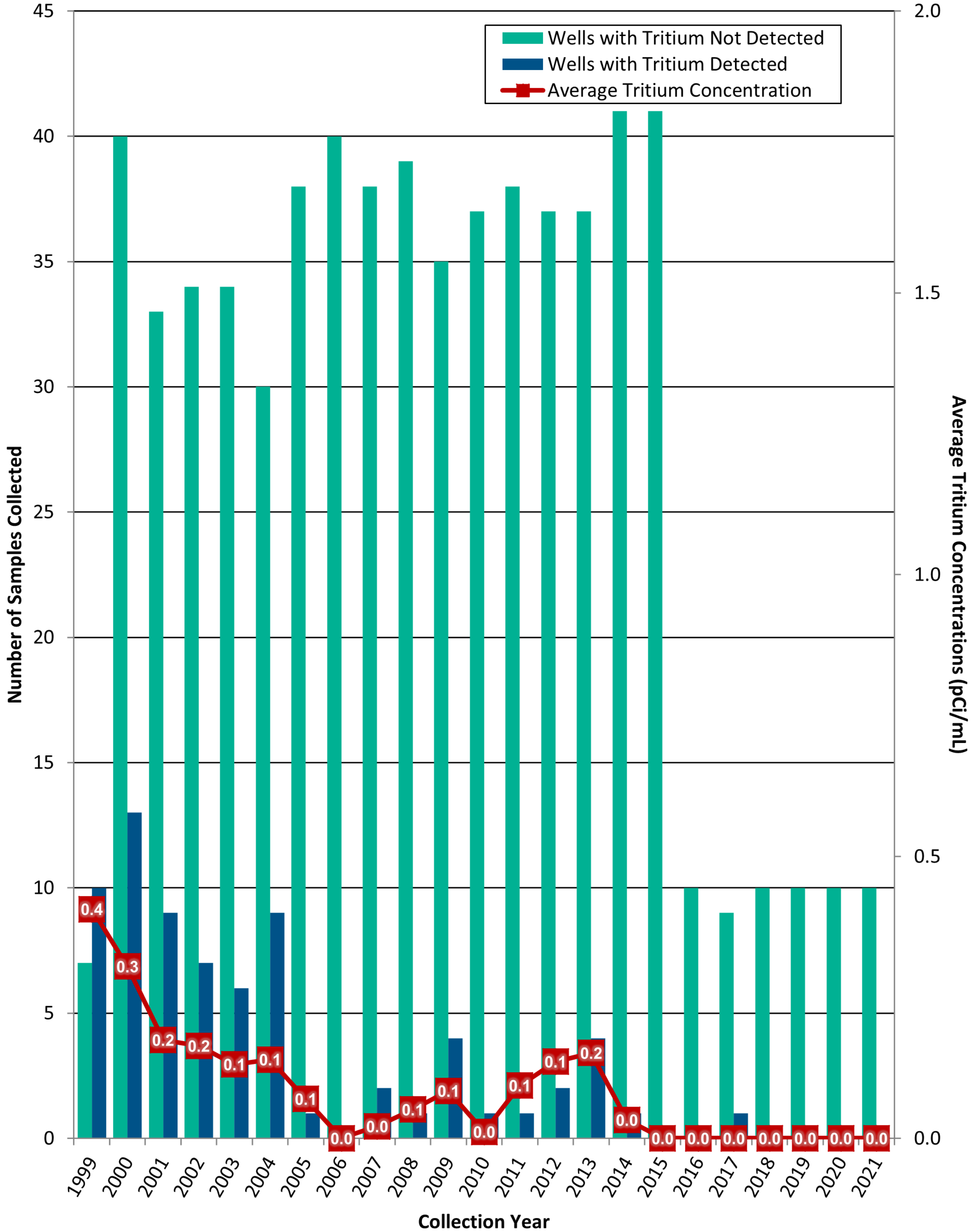


Figure 7-5 Tritium Concentration in Wells Sampled in Burke and Screven Counties, Georgia

A/M Area is SRS's largest groundwater plume, as Figure 7-3 shows. The earliest identified contamination in the A/M Area plume is associated with the M-Area and Metallurgical Laboratory Hazardous Waste Management Facility (HWMF), located in the general proximity of the "M" shown in Figure 7-3. Remediation at these two facilities began in 1983, when SRS pumped groundwater from wells to an above-ground treatment system, followed by soil vapor extraction, and then by thermal treatment. Figure 7-6 shows that as of 2021, these technologies have removed 1.60 million lbs of solvent, consisting of TCE and PCE.

Overall, the size, shape, and volume of most SRS groundwater plumes are shrinking because most of the contaminant sources have remediation systems in place. The *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2020) contains details concerning groundwater monitoring and conditions at individual sites.

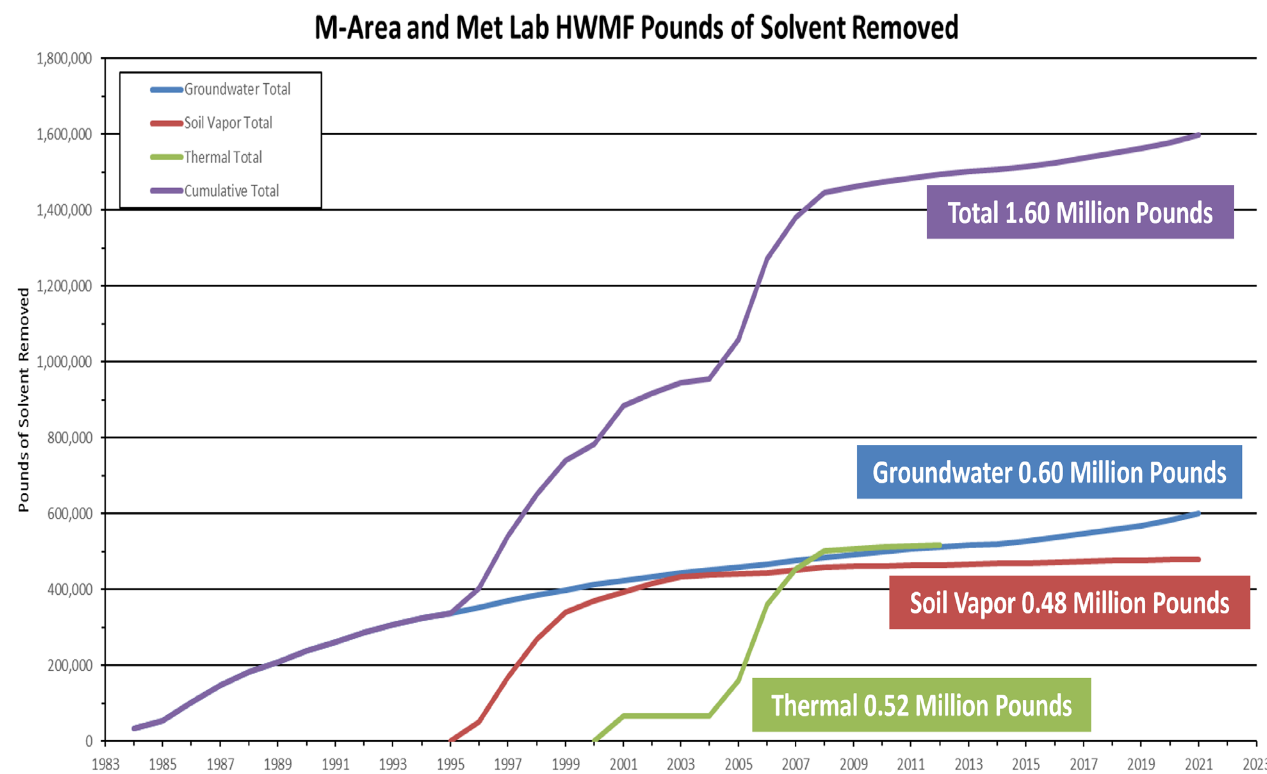


Figure 7-6 Solvent Removed from A/M-Area Groundwater Plume

7.3.4 Conserving SRS Groundwater

As in the past, SRS continues to report its drinking and process water use to SCDHEC. In 2021, SRS used 2.51 million gallons of water per day. Information on SRS water conservation is in Chapter 2, *Environmental Management System*.

SRS manages its own drinking and process water supply from groundwater beneath the Site. Approximately 40 production wells in widely scattered locations across the Site supply SRS domestic and process water systems. Eight of these wells are domestic water systems that supply drinking water. The other 32 wells provide water for all SRS facility operations. The 2021 *SRS Environmental Report* webpage contains a map of SRS domestic water systems under the *Environmental Maps* heading.

The A-Area domestic water system now supplies treated water to most Site areas. The system consists 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, use small drinking water systems and bottled water. SRS domestic water systems meet state and federal drinking water quality standards. SCDHEC samples the systems quarterly for chemical analyses. Monitoring the A-Area water system for bacteria occurs monthly. SCDHEC performs sanitary surveys every two years on the A-Area system and inspects the smaller systems every three years. All 2021 water samples complied with SCDHEC and EPA water quality standards. Information on compliance activities associated with the SRS drinking water system is in Chapter 3, *Compliance Summary*, Section 3.3.7.2, *Safe Drinking Water Act (SDWA).*

A, F, H, and S Areas have process water systems to meet SRS demands for boiler feedwater, equipment cooling water, facility washdown water, and makeup water. SRS uses the 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 Area, the domestic water system supplies the process water system. At some locations, the process water wells pump to ground-level storage tanks, where SRS implements corrosion control measures. At other locations, the wells directly pressurize the process water distribution piping system without supplemental treatment.

Chapter 8: **Quality Assurance**

The Savannah River Site (SRS) Quality Assurance (QA)/Quality Control (QC) program objectives verify that SRS products and services meet or exceed customers' requirements and expectations. The Environmental Monitoring Program has multiple QA requirements for collecting samples, analyzing and reporting data, and managing records. It is important to confirm the accuracy of sample results so SRS can confidently assess the impacts Site activities may have on human health and the environment.

2021 Highlights

Analytical Laboratory Quality Assurance—SRS continued to use South Carolina Department of Health and Environmental Control (SCDHEC)-certified laboratories to analyze the environmental monitoring samples it reports to SCDHEC.

The U.S. Department of Energy (DOE) Consolidated Audit Program (DOECAP) requires the analytical laboratories providing service to DOE have accreditation through the program. In 2021, three SRS subcontract laboratories that analyzed the environmental samples reported in this document continued to maintain their accreditation, as required to provide analytical services to SRS.

DOECAP audits facilities that provide service to DOE. In 2021, DOECAP conducted four virtual audits of four treatment, storage, and disposal facilities (TSDFs). The audits determined that the facilities were in good standing and eligible to continue to provide services to DOE.

Quality Control Activities—QC samples identified no defects affecting the analytical results of the surveillance and monitoring programs. Onsite and subcontracted laboratories reported acceptable proficiency and maintained SCDHEC certification for all analyses.

8.1 INTRODUCTION

SRS implements and conducts its QA program to comply with the following regulations: 1) DOE Order 414.1D, *Quality Assurance*, 2) American Society of Mechanical Engineers Nuclear Quality Assurance (NQA) standards NQA-1-2008 with the NQA-1a-2009 Addenda, *QA Requirements for Nuclear Facility Applications*, and 3) the Code of Federal Regulations (CFR) in 10 CFR 830, *Nuclear Safety Management*. In addition, specific programs may have other QA requirements from outside organizations. For example, under the Tank Closure Program and Area Completion Projects, the U.S. Environmental Protection Agency (EPA) and SCDHEC require DOE to develop and follow a project-specific sampling and analysis plan and a QA program plan. DOE has QA programs to verify the integrity of analyses from both onsite and subcontracted offsite laboratories, and to ensure it is complying with the quality-control program requirements.

The SRS Environmental Monitoring Program uses and disseminates high-quality data to promote environmental stewardship and support other Site missions. The Environmental Monitoring QA/QC Program improves the methods and techniques used to both collect and analyze the environmental data and to prevent errors in generating the data. The QA/QC program includes continuous assessments, precision checks, and accuracy checks, as Figure 8-1 shows. Through an ongoing process, the results of activities in one area provide input into assessments or checks conducted in the other two areas. The result is high-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 accurately represent conditions at SRS. Appendix F, *Glossary*, contains definitions for each term Figure 8-1 presents.

Chapter 8—Key Terms

Quality assurance *is an integrated system of management activities involving planning, implementing, documenting, assessing, reporting, and improving quality to ensure quality in the processes through 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 that ensure 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.*

In summary, quality assurance makes sure an entity is doing the right things, the right way; quality control makes sure these results are what the entity expected.

Some elements of the QA/QC program are inherent within environmental monitoring standard procedures and practices. SRS personnel evaluate these elements as part of the continuous assessment process. DOECAP focuses on assessing specific QA/QC program elements.

8.2 BACKGROUND

DOE Order 414.1D, *Quality Assurance*, requires an integrated management system ensuring 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 collecting samples, analyzing samples, evaluating data, and reporting results. SRS uses an integrated testing system to ensure the integrity of analyses SRS and offsite laboratories perform. This testing includes internal laboratory QA and QC tests and testing associated with state and national testing programs, such as the Mixed Analyte Performance Evaluation Program (MAPEP). In addition, SRS uses QA and QC procedures to verify and control environmental monitoring. Together, these quality measures ensure that the resulting data representatively reflects SRS operational impacts on the health and safety of the public, workers, and the environment.

8.3 QUALITY ASSURANCE PROGRAM SUMMARY

The SRS 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 identifies an ongoing problem with the quality of the product and alerts QA personnel that there is a problem in the process. QA determines the root cause and extent of the problem and changes the process to eliminate the problem, prevent reoccurrences, and improve product quality.

QA focuses on the processes implemented to produce the data presented in this report. SRS continuously evaluates the Environmental Monitoring Program to identify and implement improvements. The Environmental Monitoring Program QA efforts that lead to program improvements include the following:

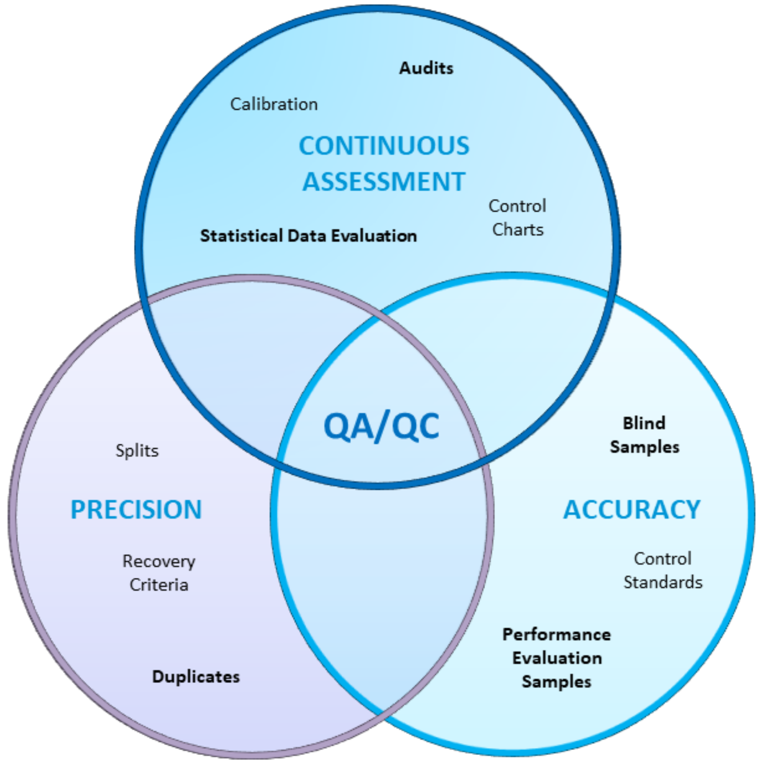


Figure 8-1 Interrelationship between QA/QC Activities

- Implementing Environmental Monitoring Program enhancements
- Improving data quality in the laboratory and field
- Performing DOECAP audits of commercial TSDFs that SRS waste generators use
- Ensuring commercial analytical laboratories maintain DOECAP accreditation

QC activities are the tests and checks that ensure SRS is complying with defined standards. The ongoing QC associated with the Environmental Monitoring Program includes the following:

- Participating in MAPEP by laboratories that perform analytical measurements on SRS samples
- Participating in proficiency testing by laboratories performing National Pollutant Discharge Elimination System (NPDES) and drinking water analyses
- Collecting and analyzing QC samples (duplicates and blind samples) associated with field sampling
- Analyzing QC samples (blanks, laboratory control samples, duplicates, spikes, and others) associated with laboratory analyses

8.4 ENVIRONMENTAL MONITORING PROGRAM QA ACTIVITIES

SRS continuously assesses the Environmental Monitoring Program to identify and implement continuous improvements and minimize the potential for errors. During 2021, SRS implemented the following quality improvements:

The Portable Refrigerated Sampler Allows for Remote Automation and Calibration Checks.

- Air Surveillance—SRS added an air surveillance station to the network to improve efficiency.
- Radiological Liquid and Air Effluent Programs—SRS incorporated updated dose factors into the monthly radioactive release reports.
- Comprehensive Environmental Data Management System—SRS continued transitioning into a new comprehensive environmental database system. The new system will replace a suite of existing applications, systems, and databases. The application programming interface will enable SRS to load and extract data from a consolidated data storage system.
- NPDES Industrial Wastewater Program—SRS evaluated using a portable refrigerated sampler, flowmeter with modem communication, and camera technology for automation and calibration checks that can be controlled remotely from a desktop computer or a cellphone. SRS also installed audio/visual sensors and a modem to measure real-time flows at an NPDES outfall.
- Wildlife Hunts—SRS improved the programming code for the Hunter Dose Tracking System. Also, because the Site cancelled the 2021 deer hunts due to COVID-19 concerns, SRS estimated the sportsman dose by collecting flesh samples and other relevant data from hogs that the U.S. Forest Service trapped onsite.

8.4.1 Department of Energy Consolidated Audit Program (DOECAP)

DOECAP is a comprehensive program that audits contract and subcontracted laboratories, providing analytical services to DOE Operations and Field Offices. DOECAP performs consolidated audits to reduce the number of audits DOE field sites conduct independently and to standardize audit methodologies, processes, and procedures. DOECAP audits commercial environmental analytical laboratories and commercial TSDFs that DOE facilities use.

8.4.1.1 DOECAP Laboratory Audits

The DOECAP laboratory audit program is a formal accreditation program that DOE requires of commercial laboratories that perform analyses for the DOE Complex. A DOECAP-approved third-party accreditation body must assess a laboratory for it to receive and maintain DOECAP accreditation. The DOECAP-approved accreditation bodies evaluate laboratories based on technical capability and competence, along with their proficiency in complying with DOE QA requirements. The accreditation bodies assess how well the laboratories document incoming samples, calibrate instruments, adhere to analytical procedures, verify data, issue data reports, manage records, perform nonconformance and corrective actions, perform preventative maintenance, and dispose of samples. Within these topics, auditors evaluate how the laboratories use control charts, control standards, chemical recoveries, performance evaluation samples, and laboratory procedures.

In 2021, the three subcontracted laboratories that analyze the environmental samples documented in this annual report maintained their accreditation and continued to provide service to DOE and SRS.

8.4.1.2 DOECAP TSDF Audits

DOECAP performs annual audits of the commercial TSDFs SRS uses to treat and dispose of mixed and hazardous waste. These reviews ensure that TSDFs are meeting contract requirements and are complying with applicable local, state, and federal regulations. DOECAP uses functional area checklists to conduct the following audits: QA, analytical data quality, environmental compliance, radiological controls, waste operations, safety and industrial hygiene, and transportation.

In 2021, SRS provided five auditors who participated in four virtual DOECAP audits of commercial TSDFs. A review of the final audit reports of each TSDF indicated that there were no significant findings that would cause SRS waste generators to discontinue using the commercial TSDFs.

8.5 ENVIRONMENTAL MONITORING PROGRAM QC ACTIVITIES

An important part of SRS Environmental Monitoring Program QC activities is to ensure that personnel collect and analyze samples to the highest standard and without errors. The Site collects quality control samples and analyzes them to identify any collection and analysis errors. All laboratories analyzing samples for the SRS Environmental Monitoring Program must participate in QC programs that either SCDHEC or DOE directs.

8.5.1 QC Sampling

SRS personnel collect and transport several types of QC samples—including blinds, field duplicates, trip blanks, and field blanks—throughout the year to determine the source of any measurement error.

To assess the quality and reliability of field data measurements, SRS personnel routinely analyze blind samples to measure hydrogen ion activity (pH). A blind sample contains a composition known to the submitter but not known to the analyst. Analysis of blind samples also tests the analyst's proficiency in performing the specified analysis. Twenty-four blind sample results were within the acceptable limit of less than 0.4 standard unit difference between the original and blind samples.

During intralaboratory checks performed for the NPDES industrial wastewater program, SRS personnel collect blind and duplicate field samples for at least 10% of each outfall's required frequency. For example, if an outfall has a monthly sampling requirement, then SRS collects two blinds and two duplicate samples during the year. SRS onsite and subcontracted laboratories also analyze duplicate samples for the water quality (nonradiological) program. Each month, SRS collects duplicate samples at one river and one stream location to verify analytical results. SRS also collects duplicate samples for both the radiological and nonradiological sediment samples.

The relative percent difference (RPD) between each sample result and the result of the corresponding blind or duplicate sample (when both values are at least five times above the detection limit) should be less than or equal to 20%. Table 8-1 summarizes 1) the blind and duplicate sample analyses associated with the NPDES industrial wastewater program, 2) the duplicate sample analyses associated with the river and stream water quality program, 3) both the nonradiological and radiological duplicate sample analyses for river, stream, and basin sediment programs, and 4) the number of impacted analytes per program and sample type. Table 8-1 addresses both SRS and offsite subcontracted laboratory analyses. Processing duplicate samples evaluates the accuracy of the analytical and measurement methods the laboratories use. Ninety-nine percent of the blind samples, 98% of the NPDES duplicate samples, 98% of the water-quality duplicate samples, 100% of the nonradiological sediment duplicate samples, and 90% of the radiological sediment duplicate samples met the acceptable difference limit. Reasons for results differing between the programs include sampling uncertainties and analytical uncertainties associated with the measurements, such as the precision of the analytical instruments and detection limits of the analytical instruments.

Although results indicate there were some differences between the quality control samples and their corresponding compliance samples, they did not impact conclusions made with the data. The results indicate that in 2021 there were no consistent problems with either sample collection or laboratory analysis techniques.

Table 8-2 summarizes the results of field and trip blank analyses associated with the NPDES program. Field blanks determine whether the field sampling and sample processing environments have contaminated the sample. A trip blank documents contamination associated with shipping and field-handling procedures. The analytical results indicate neither sampling nor shipping techniques contributed to contaminants in the actual samples as discussed in Chapter 4, *Nonradiological Environmental Monitoring Program.*

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

Program and Sample Type	Number of Analyses	Number of Analyses within Acceptable Limits (RPD between results < 20%)	Number of Analyses Outside Acceptable Limits (RPD between results ≥ 20%)	Number of Impacted Analytes
NPDES Blind	168	166	2	1
NPDES Duplicate	214	210	4	3
Water Quality River/Stream Duplicate	1,080	1,053	27	7
Nonradiological River/Stream/Basin Sediment Duplicate	96	96	0	0
Radiological River/Stream/Basin Sediment Duplicate	60	54	6	3

Table 8-2 Summary of Trip and Field Blank Sample Analyses

Program and Sample Type	Number of Samples Analyzed	Number of Samples with Results Below Detection Limits
NPDES Trip Blank	38	38
NPDES Field Blank	12	12

8.5.2 Laboratory Proficiency Testing

8.5.2.1 Nonradiological Methods Proficiency Testing

SCDHEC Regulation 61-81, *State Environmental Laboratory Certification Program,* requires laboratory proficiency testing to assure the validity and quality of the data being generated. Proficiency testing validates a particular measurement process. It is used to evaluate a laboratory's performance against pre-established criteria by testing the same samples at other laboratories and comparing the results. SRS laboratories performing NPDES and drinking water analyses maintained state certification for all analyses after achieving acceptable results in SCDHEC-required proficiency testing.

During 2021, onsite and subcontracted laboratories participated in water pollution and water supply performance evaluation studies. Onsite laboratories reported proficiency of 100%, and subcontracted laboratories reported proficiency greater than 95% for the parameters tested for NPDES and drinking water laboratories. Both onsite and subcontracted laboratories maintained SCDHEC certification for all analyses at SRS.

Laboratories develop corrective actions for failed analyses. The corrective actions are submitted to SCDHEC, along with subsequent passing proficiency testing results for those analyses. The objective of the corrective actions is to prevent a reoccurrence of failed analyses. Corrective actions may include modifying sample preparation or analysis procedures. The unacceptable measurements did not affect the analyses provided to SRS in support of the NPDES and drinking water monitoring programs.

8.5.2.2 Radiological Methods Proficiency Testing

All laboratories with licenses to handle and analyze radioactive materials must participate in MAPEP to support DOE's Environmental Management activities. MAPEP is a laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE. MAPEP standards are distributed twice a year. The standards include air filter, soil, vegetation, and water matrices for stable inorganic, organic, and radioactive elements representative of those at DOE sites. The MAPEP studies conducted during 2021 were MAPEP Series 44 and MAPEP Series 45. Three SRS laboratories and two SRS-contracted laboratories continue to participate in MAPEP. The SRS Environmental Laboratory participated in the two MAPEP studies, receiving acceptable results of 99% on MAPEP Series 44 and 100% on MAPEP Series 45.

Two SRS subcontracted laboratories participated in MAPEP Series 44 and had acceptable results in 99% of the water and soil matrices. One subcontracted laboratory participated in MAPEP Series 45 and received 95% acceptable results for both water and soil matrices. SRS sent all applicable environmental samples to the subcontracted laboratories, which continued to successfully participate in the MAPEP program.

When a laboratory fails an analysis, it will develop corrective actions for that failed analysis to prevent a reoccurrence. These corrective actions may include modifying procedures for preparing and analyzing samples.

8.6 RECORDS MANAGEMENT

Environmental Monitoring Program documentation is an important part of the SRS environmental program. The annual *SRS Environmental Report* is the public record of the SRS Environmental Monitoring Program's performance. SRS compiles it every year following guidelines in DOE Order 231.1B, *Environment, Safety, and Health Reporting*.

The *SRS Environmental Report* communicates results of the Environmental Monitoring Program, and groundwater management and compliance programs to government agencies and the public. In addition to the *SRS Environmental Report*, SRS generates various records and reports to document SRS nonradiological and radiological environmental programs, groundwater management, and Site compliance with applicable regulations. SRS maintains these documents and the records generated as part of the SRS Environmental Monitoring Program, in accordance with SRS records management procedures.

Appendix A: **Environmental Management System**

FY 2021 EMS Goals and Objectives

Requirement	**Leadership in sound environmental stewardship at SRS through innovative programs and projects**
Strategy	**Continuous improvement in reducing the environmental impacts of SRS operations**

Category	Goal	Significant Environmental Aspect	Strategy	Implementation	FY 2021 Status
Clean Energy Initiatives	Goal #1 Energy Management	• Air Pollutants • Renewable Energy	Operate four biomass plants	Site Sustainability Plan	**Goal Met.** SRS has reduced GHG emissions by operating 4 biomass plants and implementing 30 ECMs (LED, HVAC, right-sizing).
			Implement Environmental Conservation Methods		
	Goal #2 Renewable Energy	• Air Pollutants • Renewable Energy	Operate Biomass Cogeneration Facility	Site Sustainability Plan	**Goal Met.** BCF Facility helps exceed Renewable Energy Goal (>7.5%) with performance of 34.4%. Steam is generated onsite primarily by biomass (with tires and fuel oil as secondary fuel).
	Goal #3 Waste Management	• Discharge to Wastewater Systems • Water Use	Reduce water use through low-flow device installation	Site Sustainability Plan	**Goal Met.** SRS installs low-flow devices during maintenance repairs and major renovations.
			Continue to seek new ILA reductions	Site Sustainability Plan	**Goal Met.** Biomass plant provides significant reduction in ILA water (relative to coal power plant).
	Goal #4 Performance Contracting	• Air Pollutants • Renewable Energy	Continue to look for new opportunities for ESPCs in addition to the existing one	Site Sustainability Plan	**Goal Met.** SRS is pursuing new ESPCs in addition to the existing ESPCs.
	Goal #5 Sustainable Buildings	• Building Performance and Sustainable Design	Preventive maintenance and energy efficient repairs	Site Sustainability Plan	Progressing towards goal
Sustainability Goals	Goal #6 Waste Management	• Solid Waste • Pollution Prevention • Use, Reuse, and Recycling Resources	Continue to divert at least 50% of sanitary waste to recycle	Site Sustainability Plan	**Goal Met.** Of 475 metric tons generated in FY 2021, SRS diverted 51% (242 metric tons) of nonhazardous solid waste for recycling.
			Continue to recycle excess- and construction-related waste		**Goal Not Met.** Total C&D diverted waste is 3%. No road repaving to generate asphalt and concrete for reuse (for example, road improvement, daily cover).
	Goal #7 Energy Management, Building Evaluations, Benchmarking	• Energy Efficiency and Greenhouse Gas	Continue EISA audits (25% of applicable buildings/year)	Site Sustainability Plan	**Goal Met.** EISA audits were performed on 16 applicable buildings (~25% of the 63 covered buildings.
	Goal #8 Fleet Management	• Alternative Fuel Use • Transportation	Continue to replace gasoline vehicles with E-85 vehicles when possible	Site Sustainability Plan	**Goal Met.** 111 of 119 new vehicles ordered were E-85. 87% of current fleet (828 of 950 vehicles) is either E-85, hybrid, or electric.
			Continue focus on alternate fuel use for light-duty fleet		
	Goal #9 Acquisition and Procurement	• Procurement of EPP Goods	Include statutory Requirements for Sustainable Acquisition in applicable contract actions	Site Sustainability Plan	**Goal Met.** All new applicable solicitations included EPP clause and other sustainable acquisition statutory requirements.
			Evaluate actions to ensure Sustainable Acquisitions		
Environmental Protection	Goal #10 Electronic Stewardship	• Electronics Management • Renewable Energy	95% eligible acquisitions are EPEAT-registered products; recycle/reuse used electronics	Site Sustainability Plan	Progressing towards goal
	Goal #11 Data Center Management	• Electronics Management	Continue collecting data to support energy-efficient management of data centers	Site Sustainability Plan	**Goal Met.** SRS continued to collect data to support energy-efficient management of data centers.
	Goal #12 Greenhouse Management and Reporting	• Energy Efficiency and Greenhouse Gases • Transportation	Operate four biomass plants	Site Sustainability Plan	**Goal Met.** SRS has reduced greenhouse gas emissions due to its operating four biomass plants and continuing to purchase alternative fuel (E-85) vehicles.
			Continue E-85 usage and alternate fuel vehicle leases		
	Goal #13 Resilience	• All aspects	Continue to develop Resilience guidance for outdoor workers, Site Operations, and buildings	Site Sustainability Plan	**Goal Met.** SRS used the Active Risk Manager tool to manage and prioritize risks and opportunities in response to COVID-19.
	Goal #14 Environmental Awareness	• All Aspects	Continue to increase Environmental Awareness across multiple outlets	Procedure 3Q13.5	**Goal Met.** SRS enhanced EMS and Environmental Awareness in employee annual training, safety slides, and focus sessions.
	Goal #15 Environmental Compliance	• All Aspects	Zero NOVs in CY 2021	Procedure 3Q13.5	**Goal Met.** No NOVs in CY 2021
			Met 100% of regulatory commitments		**Goal Met.** Met 100% of regulatory commitments in CY 2021.
			Continuous improvement and development of compliance methodology		**Goal Met.** Initiatives include deployment of Gensuite to SRR, EECs, Blanket and Work Planners Screening, ERDMS replacement.

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Appendix B: Environmental Surveillance Media and Sampling Frequencies

Appendix Table B-1 SRS Nonradiological Media and Sampling Frequencies

Media	Environmental Surveillance	Sampling Frequency		
		Monthly	Semiannually	Annually
Surface Water[a]	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			✓

[a] All water quality parameters for surface water are sampled monthly except pesticides, herbicides, and PCBs, which are sampled semiannually.

Appendix Table B-2 SRS Radiological Media and Sampling Frequencies

Media	Environmental Surveillance	Sampling Frequency				
		Weekly	Bi-Weekly	Monthly	Quarterly	Annually
Air	Airborne particulate matter		✓			
	Gaseous state of radioiodine		✓			
	Tritiated water vapor		✓			
	Tritium in rainwater			✓		
Soil	Radionuclide deposition into soils					✓
Food Products	Radionuclide uptake in the food chain					✓
Vegetation	Radionuclide uptake in plants					✓
OSLDs	Ambient gamma radiation monitoring				✓	
Water	Onsite drinking water				✓	✓
	Offsite drinking water			✓		
	Onsite surface water (Streams and basins)	✓		✓		✓
	Savannah River	✓				✓
Sediment	Radionuclides in streambeds, the Savannah Riverbed, and SRS basin beds					✓
Fish and Shellfish	Radionuclides in freshwater fish, saltwater fish, and shellfish					✓
Wildlife	Radionuclides in onsite deer, feral hogs, turkey, and coyotes during SRS-sponsored hunts					✓

Appendix C: **Nonradiological Environmental Monitoring Program Supplemental Information**

Appendix Table C-1 River and Stream Water Quality Results Summary

SRS collected monthly water quality samples at 5 Savannah River and 10 stream locations in 2021, totaling 180 samples per analyte or 3,780 records. Locations sampled are as follows: Savannah River locations (RM-118.8, RM-129.1, RM-141.5 and RM 150.4 [Vogtle discharge]), and SRS Stream locations (FM-2B, FM-6, FMC-2, L3R-2, PB-3, SC-4, TB-5, and U3R-4). The control location for the river samples is RM-161.0. The control locations for the stream samples are TC-1 and U3R-1A.

The table compares all results to South Carolina Freshwater Quality Standards (unless otherwise noted) and shows the average and maximum values of each analyte for the river and stream samples. Locations exceeding standards are shown in **red** text. Field duplicates are not included in the generation of these tables.

DL-Detection Limit
DO-Dissolved Oxygen
TOC-Total Organic Carbon
TSS-Total Suspended Solids

Notes:

1. The DO value in the maximum column is a minimum value because the South Carolina Freshwater Quality Standard is based on a minimum value.
2. The pH value in the average column is a minimum value because the South Carolina Freshwater Quality Standard includes minimum and maximum limits.

Four River Locations Plus One Control

Analyte	SC Freshwater Quality Std.	Unit	No. of Results Outside Std.	No. of Results > DL	Control RM 161.0 Avg.[a]	Control RM 161.0 Max.[b]	Highest River Location	Avg.[a]	Highest River Location	Max.[b]	Comments
DO [c]	min. 4.0	mg/L	0 of 60		9.3	8.1	RM-129.1	8.6	RM-129.1	7.6	All samples met std.
pH [d]	6.0-8.5	SU	8 of 60		**5.6**	6.8	RM-150.4	**5.5**	RM-129.1	8.0	All maximums met std.
Temperature	< 5° F (2.8° C) above nat. cond. and not > 90° F (32.2° C)	° C	0 of 60		16.8	23.1	RM-118.8	19.2	RM-118.8	29.5	All samples met std.
Aluminum	87 [e]	µg/L	59 of 60	60 of 60	**216**	**557**	RM-118.8	**297**	RM-150.4	**630**	
Beryllium	4 [f]	µg/L	0 of 60	0 of 60	< DL	< DL	< DL	< DL	< DL	< DL	All samples met std.
Cadmium	0.25	µg/L	0 of 60	3 of 60	0.05	0.05	RM-118.8	0.06	RM-118.8	0.13	All samples met std.
Chromium	11	µg/L	1 of 60	34 of 60	1	4	RM-150.4	2	RM-150.4	**15**	All averages met std.
Copper	2.9	µg/L	0 of 60	60 of 60	1.2	1.5	RM-118.8	1.2	RM-129.1	1.7	All samples met std.
Hardness (total)	none	mg/L	no std.	60 of 60	17	26	RM-129.1	20	RM-118.8	32	
Iron	1,000 [g]	µg/L	1 of 60	60 of 60	389	776	RM-118.8	600	RM-118.8	**1,010**	All averages met std.
Lead	0.54	µg/L	0 of 60	60 of 60	0.24	0.47	RM-118.8	0.28	RM-150.4	0.49	All samples met std.
Manganese	none	µg/L	no std.	60 of 60	79	204	RM-118.8	77	RM-150.4	169	
Mercury	0.91	µg/L	1 of 60	7 of 60	0.02	0.06	RM-118.8	0.33	RM-118.8	**3.74**	All averages met std.
Nickel	16	µg/L	0 of 60	15 of 60	1	2	RM-150.4	1	RM-150.4	2	All samples met std.
Nitrate-Nitrogen	1 [h]	mg/L	1 of 60	60 of 60	0.2	0.3	RM-141.5	0.3	RM-141.5	**1.5**	All averages met std.
Nitrite-Nitrogen	1 [h]	mg/L	0 of 60	54 of 60	0.01	0.02	RM-141.5	0.01	RM-118.8	0.02	All samples met std.
Thallium	0.24 [f]	µg/L	0 of 60	1 of 60	< DL	< DL	RM-118.	0.05	RM-118.8	0.051	All samples met std.
TOC	none	mg/L	no std.	60 of 60	2.8	3.4	RM-129.1	3.7	RM-129.1	8.0	
Phosphorus	0.06	mg/L	48 of 60	51 of 60	**0.10**	**0.20**	RM-150.4	**0.11**	RM-150.4	**0.26**	
TSS	none	mg/L	no std.	59 of 60	5	10	RM-118.8	8	RM-118.8 & RM-129.1	12	
Zinc	37	µg/L	0 of 60	50 of 60	3	5	RM-150.4	4	RM-141.5	17	All samples met std.

Eight Stream Locations Plus Two Controls

Analyte	SC Freshwater Quality Std.	Unit	No. of Results Outside Std.	Number of Results > DL	Control TC-1 Avg.[a]	Control TC-1 Max.[b]	Control U3R-1A Avg.[a]	Control U3R-1A Max.[b]	Highest Stream Location	Avg.[a]	Highest Stream Location	Max.[b]	Comments
DO [c]	min. 4.0	mg/L	4 of 120		9.2	7.0	8.8	7.3	FMC-2	6.0	FMC-2	**1.1**	All averages met std.
pH [d]	6.0-8.5	SU	31 of 120		**5.7**	7.4	**4.8**	7.4	TB-5	**5.2**	TB-5	7.5	All maximums met std.
Temperature	< 5° F (2.8° C) above nat. cond. and not > 90° F (32.2° C)	° C	0 of 120		17	24	18	22	SC-4	20	L3R-2	28	All samples met std.
Aluminum	87 [e]	µg/L	89 of 120	119 of 120	**212**	**915**	**206**	**830**	PB-3	**233**	FM-2B	**736**	
Beryllium	4 [f]	µg/L	0 of 120	2 of 120	< DL	< DL	< DL	< DL	U3R-4	0.1	U3R-4	0.1	All samples met std.
Cadmium	0.25	µg/L	1 of 120	3 of 120	< DL	< DL	< DL	< DL	TB-5	0.08	TB-5	**0.45**	All averages met std.
Chromium	11	µg/L	0 of 120	47 of 120	1.0	3.2	1.0	3.2	FM-6	1.3	L3R-2	5.1	All samples met std.
Copper	2.9	µg/L	2 of 120	51 of 120	0.6	0.6	0.7	1.8	FMC-2	1.8	FMC-2	**10.5**	All averages met std.
Hardness (total)	none	mg/L	no std.	79 of 120	10	18	< DL	< DL	L3R-2	35	L3R-2	44	
Iron	1,000 [g]	µg/L	31 of 120	120 of 120	420	821	432	692	FMC-2	**4,153**	FMC-2	**19,400**	
Lead	0.54	µg/L	10 of 120	119 of 120	0.26	**0.85**	0.29	**0.75**	FM-2B	0.42	FM-2B	**2.93**	All averages met std.
Manganese	none	µg/L	no std.	120 of 120	18	55	11	19	FMC-2	170	FMC-2	522	
Mercury	0.91	µg/L	0 of 120	10 of 120	< DL	< DL	0.02	0.03	SC-4	0.02	SC-4	0.05	All samples met std.
Nickel	16	µg/L	0 of 120	71 of 120	1	1	1	2	TB-5	5	TB-5	10	All samples met std.
Nitrate-Nitrogen	1 [h]	mg/L	0 of 120	119 of 120	0.1	0.1	0.4	0.4	FM-6	0.6	FM-6	0.9	All samples met std.
Nitrite-Nitrogen	1 [h]	mg/L	0 of 120	19 of 120	0.003	0.009	0.003	0.012	FMC-2	0.004	FMC-2	0.014	All samples met std.
Thallium	0.24 [f]	µg/L	0 of 120	2 of 120	< DL	< DL	< DL	< DL	FMC-2	0.06	FMC-2	0.1	All samples met std.
TOC	none	mg/L	no std.	118 of 120	3	4	2	4	FMC-2	7	FMC-2	15	

					Control TC-1		Control U3R-1A		Highest Stream Location				
Analyte	**SC Freshwater Quality Std.**	**Unit**	**No. of Results Outside Std.**	**Number of Results > DL**	**Avg.[a]**	**Max.[b]**	**Avg.[a]**	**Max.[b]**		**Avg.[a]**		**Max.[b]**	**Comments**
Phosphorus	0.06	mg/L	50 of 120	57 of 120	0.04	**0.14**	0.02	**0.07**	FM-6	**0.14**	FM-6	**0.43**	
TSS	none	mg/L	no std.	116 of 120	6	13	6	14	FMC-2	13	FMC-2	68	
Zinc	37	µg/L	1 of 120	101 of 120	2	4	5	16	FMC-2	7	FM-6	**41**	All averages met std.

Note:
The following pesticides, herbicides, and PCBs were sampled semiannually in 2021: Aldrin, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (Lindane), Chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Dieldrin, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin aldehyde, Heptachlor, Heptachlor epoxide, Toxaphene, 2,4-D and 2,4,5-TP (Silvex). 810 analytical records were reviewed. All results were < DL.

[a] When results fell below the detection limit, the detection limit value was used to determine average.
[b] Maximum detected value
[c] Min. (versus Max.) value reported
[d] Min. (versus Avg.) value reported
[e] EPA Region 4 Ecological Risk Assessment Supplemental Guidance, March 2018 Update
[f] Standard from Human Health vs. Freshwater Aquatic Life (which has no standard)
[g] EPA National Recommended Water Quality Criteria - Aquatic Life
[h] Per SCDHEC Environmental Surveillance and Oversight Program 2020 Data Report (CR-004111 11/21)

Appendix Table C-2 Summary of Nonradiological Results for Sediments Collected from the Savannah River, SRS Streams, and Stormwater Basins

SRS collected annual sediment samples at 25 locations in 2021: 8 Savannah River, 14 stream, and 3 stormwater basins, totaling 400 analytes. Locations sampled are as follows: Savannah River locations (BDC RM, RM 118.7, RM 129, RM 150.2, RM 150.4 [Vogtle discharge], RM 157.2, and SC RM), SRS stream locations (BDC, FMC @ Rd A, L3R-2, McQB at MO, McQB below Z Basin, Meyers Branch, PB @ Rd A, SC-4, U3R @ USFS Rd 2-1, U3R off Rd 4, U3R-3, and U3R-4), and SRS stormwater sasin locations (E-004, E-05, and E-06). The control location for the river samples is RM 161.0. The control locations for the stream and stormwater basin sediment samples are TC-1 and U3R-1A.

The table compares all results to EPA Region 4 Refinement Screening Values (RSVs) for sediment and shows the maximum value of each analyte for the river, stream, and stormwater basin samples. Locations exceeding RSVs are shown in **red** text.

River Sediment Results

Seven River Locations Plus One Control

Analyte	No. of Detected Results	Control RM 161.0 (mg/kg)	Location of Maximum Result	Maximum Conc. (mg/kg)	EPA Region 4 RSV for Sediment (mg/kg)	No. of Results > RSV	Comments
Aluminum	8 of 8	13,000	RM 118.7	30,000	58,000	0	All samples met std.
Antimony	0 of 8	< DL	All < DL	All < DL	25	0	All samples met std.
Arsenic	8 of 8	2	RM 157.2	4	33	0	All samples met std.
Barium	8 of 8	**84**	RM 157.2	**240**	60	8	
Cadmium	0 of 8	< DL	All < DL	All < DL	5	0	All samples met std.
Chromium	8 of 8	17	RM 118.7 & RM 157.2	32	111	0	All samples met std.
Copper	8 of 8	10	RM 118.7	17	149	0	All samples met std.
Iron	8 of 8	14,000	RM 118.7	28,000	40,000	0	All samples met std.
Lead	8 of 8	9	RM 157.2	21	128	0	All samples met std.
Manganese	8 of 8	**1,300**	RM 118.7	**1,900**	1,100	7	
Mercury	0 of 8	< DL	All < DL	All < DL	1.1	0	All samples met std.
Nickel	8 of 8	7.2	RM 157.2	21.0	48.6	0	All samples met std.
Selenium	0 of 8	< DL	All < DL	All < DL	2.9	0	All samples met std.
Silver	0 of 8	< DL	All < DL	All < DL	2.2	0	All samples met std.
Uranium	0 of 8	< DL	All < DL	All < DL	1,000	0	All samples met std.
Zinc	8 of 8	32	RM 157.2	110	459	0	All samples met std.

Stream Sediment Results

12 Stream Locations Plus 2 Controls

Analyte	No. of Detected Results	Control TC-1 (mg/kg)	Control U3R-1A (mg/kg)	Location of Maximum Result	Maximum Conc. (mg/kg)	EPA Region 4 RSV for Sediment (mg/kg)	No. of Results > RSV	Comments
Aluminum	14 of 14	2,900	22,000	BDC	27,000	58,000	0	All samples met std.
Antimony	0 of 14	< DL	< DL	All < DL	All < DL	25	0	All samples met std.
Arsenic	8 of 14	< DL	4	U3R-3	3	33	0	All samples met std.
Barium	14 of 14	42	**210**	U3R-3	**110**	60	6	
Cadmium	3 of 14	< DL	< DL	PB @ Rd A	0.4	5	0	All samples met std.
Chromium	14 of 14	5	34	BDC	27	111	0	All samples met std.
Copper	14 of 14	2	16	BDC	11	149	0	All samples met std.
Iron	14 of 14	2,200	15,000	BDC	13,000	40,000	0	All samples met std.
Lead	14 of 14	5	34	BDC	13	128	0	All samples met std.
Manganese	14 of 14	100	82	PB @ Rd A	514	1,100	0	All samples met std.
Mercury	4 of 14	< DL	< DL	PB @ Rd A	0.6	1.1	0	All samples met std.
Nickel	11 of 14	< DL	16.0	U3R-3	11.0	48.6	0	All samples met std.
Selenium	1 of 14	< DL	< DL	SC-4	0.7	2.9	0	All samples met std.
Silver	0 of 14	< DL	< DL	All < DL	All < DL	2.2	0	All samples met std.
Uranium	2 of 14	< DL	< DL	L3R-2	4.0	1,000	0	All samples met std.
Zinc	14 of 14	11	45	U3R-3	35	459	0	All samples met std.

Stormwater Basin Sediment Results

Three Basin Locations Plus Two Controls

Analyte	Number of Detected Results	Control TC-1 (mg/kg)	Control U3R-1A (mg/kg)	Location of Maximum Result	Maximum Conc. (mg/kg)	EPA Region 4 RSV for Sediment (mg/kg)	Number of Results > RSV	Comments
Aluminum	5 of 5	2,900	22,000	E-004	39,000	58,000	0	All samples met std.
Antimony	0 of 5	< DL	< DL	All < DL	All < DL	25	0	All samples met std.
Arsenic	4 of 5	< DL	4	E-004	9	33	0	All samples met std.
Barium	5 of 5	42	**210**	E-004	45	60	1	
Cadmium	0 of 5	< DL	< DL	All < DL	All < DL	5	0	All samples met std.
Chromium	5 of 5	5	34	E-004	49	111	0	All samples met std.
Copper	5 of 5	2	16	E-004	16	149	0	All samples met std.
Iron	5 of 5	2,200	15,000	E-004	40,000	40,000	0	All samples met std.
Lead	5 of 5	5	34	E-06	23	128	0	All samples met std.
Manganese	5 of 5	100	82	E-06	140	1,100	0	All samples met std.
Mercury	0 of 5	< DL	< DL	All < DL	All < DL	1.1	0	All samples met std.
Nickel	4 of 5	< DL	16.0	E-05	12.0	48.6	0	All samples met std.
Selenium	0 of 5	< DL	< DL	All < DL	All < DL	2.9	0	All samples met std.
Silver	0 of 5	< DL	< DL	All < DL	All < DL	2.2	0	All samples met std.
Uranium	0 of 5	< DL	< DL	All < DL	All < DL	1,000	0	All samples met std.
Zinc	5 of 5	11	45	E-004	64	459	0	All samples met std.

Appendix Table C-3 Summary of Detected Metal Results for Freshwater Fish Tissue Collected from the Savannah River

All antimony, arsenic, copper, manganese, and nickel results were not detected; therefore, they were not reported in this table.

Analyte	Number of Detected Values (above the MDC)	Number of Estimated Values (above the MDC, below the SQL)	Maximum Detected Concentration (µg/g)	SQL (µg/g)	MDC (µg/g)	Fish Type with Maximum Concentration	Location of Maximum Concentration
Cadmium	1	3	1.04	0.547	0.055	Panfish	Steel Creek Mouth
Chromium	1	81	1.95	0.771	0.077	Catfish	Lower Three Runs Creek Mouth
Mercury	80	89	0.795	0.2	0.02	Catfish	Upper Three Runs Creek Mouth
Zinc	168	1	20.2	1.2	0.12	Catfish	Augusta Lock and Dam

Note:

169 freshwater tissue samples were collected and analyzed for metals and mercury.

Appendix Table C-4 Summary of Detected Metal Results for Saltwater Fish Tissue Collected from the Savannah River between River Miles 0–8, Near Savannah, Georgia

Antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, and nickel results were not detected; therefore, they were not reported in this table.

All results are for mullet.

Analyte	Number of Detected Values (above the MDC)	Number of Estimated Values (above the MDC, below the SQL)	Maximum Detected Concentration (µg/g)	SQL (µg/g)	MDC (µg/g)
Zinc	7	0	4.67	1.41	0.141

Note:
Seven saltwater tissue samples were collected and analyzed for metals and mercury.

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Appendix D: **Radiological Environmental Monitoring Program Supplemental Information**

Negative values are reported in tables in this appendix. Background counts are subtracted from the sample counts. Negative values occur when the background count is greater than the sample count. Background counts reflect naturally occurring radionuclides and cosmic radiation that is detected by laboratory instrumentation.

Appendix Table D-1 Summary of Radioactive Atmospheric Releases by Source

All values under the "Calculated" column through "Totals" column are reported in curies.[a]

In the Calculated column, blanks indicate the radionuclide is not present. In the facility (Reactors, Separations, SRNL) columns, a blank indicates the radionuclide was not analyzed. A 0.00E+00 in the facility columns indicates the result was not significant.

Radioactive Atmospheric Releases by Source (Curies[a])

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Gases and Vapors							
H-3 (oxide)	12.3	y	1.54E+02	7.43E+02	6.61E+03		7.51E+03
H-3 (elemental)	12.3	y			1.60E+03		1.60E+03
H-3 Total	12.3	y	1.54E+02	7.43E+02	8.21E+03		9.11E+03
C-14	5700	y	1.04E-05		6.20E-02		6.20E-02
Hg-203	46.6	d	5.26E-10				5.26E-10
Kr-85	10.8	y			1.68E+04		1.68E+04
I-129	1.57E+07	y	1.58E-05		5.56E-03	6.19E-07	5.57E-03
I-131	8.02	r	7.10E-10				7.10E-10
Particles							
Ag-110m	250	d	1.48E-11				1.48E-11
Am-241	432	y	1.67E-05	0.00E+00	7.00E-06		2.37E-05
Am-243	7370	y	3.61E-07				3.61E-07
Ba-133	10.5	y	6.55E-07				6.55E-07
Cd-109	461	d	1.36E-08				1.36E-08
Ce-139	138	d	5.18E-10				5.18E-10
Ce-141	32.5	d	4.94E-11				4.94E-11
Ce-144	285	d	2.00E-08				2.00E-08
Cm-243	29.1	y	2.98E-07	0.00E+00	1.90E-08		3.17E-07
Cm-244	18.1	y	4.95E-10				4.95E-10
Co-57	272	d	3.39E-06	0.00E+00	0.00E+00	0.00E+00	3.39E-06
Co-60	5.27	y	4.31E-07				4.31E-07
Cs-134	2.06	y	3.51E-03	0.00E+00	4.72E-03	0.00E+00	8.23E-03
Cs-137	30.2	y	9.21E-09				9.21E-09
Eu-152	13.5	y	7.11E-07				7.11E-07
Eu-154	8.59	y	1.18E-07				1.18E-07
Eu-155	4.76	y	1.00E-02				1.00E-02
Fe-55	2.74	y	3.76E-08				3.76E-08
Mn-54	312	d	4.55E-10				4.55E-10
Nb-94	2.03E+04	y	2.42E-07				2.42E-07
Nb-95	35.0	d	3.63E-07				3.63E-07
Ni-59	1.01E+05	y	3.67E-07				3.67E-07

Radioactive Atmospheric Releases by Source (Curies) [a] *(continued)*

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Ni-63	100	y	4.55E-05				4.55E-05
Np-237	2.14E+06	y	1.54E-06	0.00E+00	1.30E-07		1.68E-06
Pa-233	27.0	d	1.42E-06				1.42E-06
Pb-212	10.6	h	8.43E-07				8.43E-07
Pm-147	2.62	y	2.89E-06				2.89E-06
Pm-148m	41.3	d	1.90E-12				1.90E-12
Pr-144	17.3	m	2.00E-08				2.00E-08
Pu-236	2.86	y	4.56E-10				4.56E-10
Pu-238	87.7	y	3.19E-05	0.00E+00	3.65E-06		3.56E-05
Pu-239	2.41E+04	y	8.20E-05	0.00E+00	8.10E-05		1.63E-04
Pu-240	6560	y	2.54E-05				2.54E-05
Pu-241	14.4	y	2.37E-04				2.37E-04
Pu-242	3.75E+05	y	2.68E-05				2.68E-05
Ra-226	1600	y	4.04E-07				4.04E-07
Ra-228	5.75	y	4.07E-07				4.07E-07
Rh-106[(e)]	29.8	s	3.04E-06				3.04E-06
Ru-103	39.3	d	5.11E-10				5.11E-10
Ru-106	374	d	3.04E-06				3.04E-06
Sb-125	2.76	y	1.18E-06				1.18E-06
Sb-126[(e)]	12.4	d	1.70E-07				1.70E-07
Se-79	2.95E+05	y	4.90E-09				4.90E-09
Sm-151	90	y	2.89E-06				2.89E-06
Sn-113	115	d	6.30E-10				6.30E-10
Sn-123	129	d	6.66E-12				6.66E-12
Sn-126	2.30E+05	y	1.70E-07				1.70E-07
Sr-85	64.8	d	5.82E-10				5.82E-10
Sr-89	50.5	d	5.40E-10				5.40E-10
Sr-90	28.8	y	2.85E-03	0.00E+00	1.51E-05		2.87E-03
Tc-99	2.11E+05	y	5.08E-05				5.08E-05
Te-127	9.35	h	1.04E-11				1.04E-11
Te-129	69.6	m	1.05E-12				1.05E-12
Th-228	1.91	y	1.17E-08	3.35E-09			1.51E-08
Th-229	7340	y	1.23E-09				1.23E-09
Th-230	7.54E+04	y	7.87E-11	4.99E-09			5.06E-09
Th-231	25.5	h	2.12E-04				2.12E-04
Th-232	1.41E+10	y	4.29E-12	2.68E-09			2.69E-09

Radioactive Atmospheric Releases by Source (Curies)[a] (continued)

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Tl-208	3.05	m	1.41E-06				1.41E-06
U-232	68.9	y	5.35E-09				5.35E-09
U-233	1.59E+05	y	2.89E-08				2.89E-08
U-234	2.46E+05	y	5.02E-07	3.68E-09	3.12E-05		3.17E-05
U-235	7.04E+08	y	2.73E-08	0.00E+00	1.81E-06		1.83E-06
U-236	2.34E+07	y	3.01E-08				3.01E-08
U-238	4.47E+09	y	4.48E-07	3.41E-09	3.98E-05		4.03E-05
Y-88	107	d	5.18E-10				5.18E-10
Y-90[e]	64.1	h	2.85E-03	0.00E+00	1.51E-05		2.87E-03
Y-91	58.5	d	7.98E-10				7.98E-10
Zn-65	244	d	9.41E-10				9.41E-10
Zr-95	64.0	d	1.22E-07				1.22E-07
Unidentified alpha	N/A		3.00E-05	4.34E-06	1.90E-06	2.55E-06	3.88E-05
Unidentified beta	N/A		8.56E-04	4.13E-05	1.16E-04	4.91E-06	1.02E-03
TOTAL	**N/A**		**1.54E+02**	**7.43E+02**	**2.50E+04**	**8.08E-06**	**2.59E+04**

[a] One curie equals 3.7E+10 Becquerels

[b] ICRP 107, *Nuclear Decay Data for Dosimetric Calculations (2008);* Half-life time intervals are given in seconds (s), hours (h), days (d), months (m), and years (y).

[c] Estimated releases from unmonitored sources. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table; therefore, they were not used in the dose calculations.

[d] Includes separations, waste management, and tritium facilities

[e] Daughter products (Sb-126, Rh-106 & Y-90) in secular equilibrium with source terms (Sn-126, Ru-106 & Sr-90, respectively). In MAXDOSE/POPDOSE, they are included in the source term and their ingrowth is included in their parents' source term.

Appendix Table D-2 Summary of Air Effluent DOE DCS Sum of Fractions

As discussed in Chapter 5, SRS evaluates the effluent monitoring program by comparing the annual average concentrations to the U.S. Department of Energy (DOE)-derived concentration standards (DCSs). DOE's *Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011), establishes numerical standards for DCSs to support implementing DOE Order 458.1. This table presents the air effluent DCS sum of fractions for continuously monitored sources. Discussion regarding the 291-F sum of fractions exceedance can be found in Section 5.3.2.1.

Facility (Sampling Location)	Radionuclides Included in the DCS Sum of Fractions	DCS Sum of Fractions	DCS Sum of Fractions Excluding Tritium
A Area (791-A Sandfilter Discharge)	I-129	1.06E-04	1.06E-04
C Area (C-Area Main Stack)	H-3 (oxide)	1.31E-01	0.00E+00
F Area (235-F Sandfilter Discharge)	U-234, U-238, Am-241	1.99E-03	1.99E-03
F Area (291-F Stack Isokinetic)	I-129, Cs-137, U-234, U-235, Np-237, U-238, Pu-238, Pu-239, Am-241, Cm-244	2.47E+00	2.47E+00
F Area (772-4F Stack)	U-234, U-238, Pu-239, Am-241	7.72E-04	7.72E-04
H Area (291-H Stack Isokinetic)	H-3 (oxide), C-14, Kr-85, I-129, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Am-241, Cm-244	6.66E-02	6.66E-02
K Area (K-Area Main Stack)	H-3 (oxide)	1.31E+00	0.00E+00
L Area (L-Area Disassembly)	H-3 (oxide)	1.35E+00	0.00E+00
L Area (L-Area Main Stack)	H-3 (oxide)	1.32E+00	0.00E+00
Tritium (232-H)	H-3 (elemental), H-3 (oxide)	1.91E+01	0.00E+00
Tritium (233-H)	H-3 (elemental), H-3 (oxide)	3.90E+00	0.00E+00
Tritium (234-H)	H-3 (oxide)	4.00E+00	0.00E+00
Tritium (238-H)	H-3 (oxide)	1.16E-01	0.00E+00
Tritium (264-H)	H-3 (elemental), H-3 (oxide)	1.37E+01	0.00E+00

Appendix Table D-3 Summary of Tritium in Environmental Air

Samples were collected approximately every 2 weeks at each of the 15 locations, with site A-14 being added in October and totaling 16 sites. One sample was invalidated at site Burial Ground North in April due to unexpected power loss. Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. The results at the following locations were all not detected: Site Perimeter (A-14 and Barnwell Gate) and 25-Mile Radius (Augusta Lock & Dam and Aiken Airport). The Highway 301 @ State Line location is the control location.

Location	Number of Detected Results	Mean Concentration (pCi/m^3)	Minimum Concentration (pCi/m^3)	Maximum Concentration (pCi/m^3)
Onsite				
Burial Ground North	25 of 25	3.53E+02	**9.00E+01**	**7.62E+02**
Site Perimeter				
Allendale Gate	1 of 26	4.15E+00	-7.95E+00	2.67E+01
Barricade 8	4 of 26	5.31E+00	-2.52E+00	**1.98E+01**
D Area	5 of 26	6.49E+00	-3.46E+00	**2.12E+01**
Darkhorse @ Williston Gate	3 of 26	3.93E+00	-2.17E+00	**1.43E+01**
East Talatha	1 of 26	3.36E+00	-6.24E+00	1.08E+01
Green Pond	1 of 26	4.67E+00	-2.42E+00	1.26E+01
Highway 21/167	2 of 26	3.65E+00	-3.68E+00	**1.24E+01**
Jackson	3 of 26	4.96E+00	-2.24E+00	**2.36E+01**
Patterson Mill Road	1 of 26	3.02E+00	-3.95E+00	1.47E+01
Talatha Gate	5 of 26	6.44E+00	-1.87E+00	**2.48E+01**
25-Mile Radius				
Highway 301	1 of 26	2.05E+00	-6.92E+00	**1.88E+01**

Appendix Table D-4 Summary of Tritium in Rainwater

Samples were collected approximately every 4 weeks at each of the 15 air surveillance locations, with site A-14 being added in October and totaling 16 sites. Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. The results at the following locations were all not detected: Site Perimeter (A-14, Allendale Gate, Darkhorse @ Williston Gate, East Talatha, Green Pond, Patterson Mill Road, and Talatha Gate) and 25-Mile Radius (Augusta Lock & Dam, Aiken Airport, and Highway 301 @ State Line). The Highway 301 @ State Line location is the control location. Burial Ground North, Barricade 8, and D Area had special samples pulled in November as a precaution due to open glovebox work at the Tritium Facility.

Location	Number of Detected Results	Mean Concentration (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)
Onsite				
Burial Ground North	14 of 14	4.88E+03	**6.41E+02**	**2.86E+04**
Barnwell Gate	1 of 13	3.19E+01	-1.52E+02	**4.35E+02**
Barricade 8	4 of 14	2.09E+02	-1.13E+02	**6.38E+02**
D Area	3 of 14	2.35E+02	-1.61E+02	**1.22E+03**
Hwy 21/167	1 of 13	6.39E+01	-1.11E+02	**3.81E+02**
Jackson	2 of 13	1.50E+02	-1.17E+02	**7.03E+02**

Appendix Table D-5 Summary of Radionuclides in Environmental Air

Glass fiber filter samples were collected approximately every 2 weeks at each of the 15 locations, with site A-14 being added in October and totaling 16 sites. Samples from all locations were analyzed biweekly for gamma emitting radionuclides, gross alpha, and gross beta. The onsite location Burial Ground North is the only location where samples were analyzed for actinides and strontium-89,90 biweekly. Due to lab prep and analysis errors, the sample collected January 27 to February 10 is missing results for strontium-89,90, the sample collected February 24 to March 10 is missing all analytes, samples collected from April 21 to May 5 were invalidated due to a pump failure, and samples collected March 24 to April 21 are missing strontium-89,90 and plutonium-238/239 at Burial Ground North.

One sample from every perimeter location and 25-mile radius location was chosen for actinide and strontium-89,90 (Sr-89,90) analysis based on elevated releases at F-Area stacks during 2021. Highway 301 @ State Line used three samples since it was the control location and the three different sampling time periods were utilized.

Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or that the uncertainty is large.

Cobalt-60 and cesium-137 results were not detected for any samples collected biweekly.

Biweekly Samples: All Locations

Radionuclide	Number of Detected Results	Location of Minimum Concentration	Minimum Concentration (pCi/m^3)	Location of Maximum Concentration	Maximum Concentration (pCi/m^3)
Gross Alpha	393 of 394	Highway 21/167	7.08E-05	D-Area	**5.76E-03**
Gross Beta	394 of 394	Highway 21/167	**1.23E-03**	Talatha Gate	**3.03E-02**

Cm-244 and U-235 results were not detected for site Burial Ground North; therefore, they were not reported in the table Biweekly Actinide and Strontium-89,90 Samples.

Biweekly Actinide and Strontium-89,90 Samples

Location: Burial Ground North				
Radionuclide	**Number of Detected Results**	**Mean Concentration (pCi/m^3)**	**Minimum Concentration (pCi/m^3)**	**Maximum Concentration (pCi/m^3)**
Sr-89,90	1 of 21	1.55E-04	-9.08E-05	**5.35E-04**
U-234	24 of 24	2.54E-05	**1.32E-05**	**4.97E-05**
U-238	24 of 24	2.09E-05	**1.04E-05**	**3.05E-05**
Pu-238	1 of 22	1.07E-06	-1.33E-06	**1.05E-05**
Pu-239	1 of 22	1.03E-06	-2.43E-06	4.81E-06
Am-241	4 of 23	4.61E-06	1.87E-07	**1.33E-05**

U-235, Pu-238, Sr-89,90, and Cm-244 results were not detected for the annual sites; therefore, they were not reported in the table Annual Actinide and Strontium-89,90 Samples.

Appendix Table D-5 Summary of Radionuclides in Environmental Air (continued)

Annual Actinide and Strontium-89,90 Samples

		U-234	U-238	Am-241	Pu-239
Location	**Number of Samples**	**Concentration (pCi/m^3)**	**Concentration (pCi/m^3)**	**Concentration (pCi/m^3)**	**Concentration (pCi/m^3)**
A-14	1	**1.55E-05**	**1.90E-05**	2.44E-06	-1.72E-06
Allendale Gate	1	**4.38E-05**	**1.87E-05**	1.29E-05	-2.06E-06
Barnwell Gate	1	**2.76E-05**	**1.59E-05**	3.30E-06	-8.54E-08
Barricade 8	1	**1.45E-05**	**1.21E-05**	**5.59E-06**	-1.26E-06
D Area	1	**2.76E-05**	**1.80E-05**	3.59E-06	**2.09E-05**
Darkhorse @ Williston Gate	1	**3.51E-05**	**2.66E-05**	**8.78E-06**	1.25E-06
East Talatha	1	**3.22E-05**	**2.41E-05**	8.16E-07	3.00E-07
Green Pond	1	**1.93E-05**	**2.84E-05**	**7.14E-06**	0.00E+00
Highway 21/167	1	**1.48E-05**	**9.73E-06**	**8.11E-06**	-3.57E-07
Jackson	1	**1.86E-05**	**2.34E-05**	3.27E-06	-6.30E-07
Patterson Mill Road	1	**2.23E-05**	**2.23E-05**	7.57E-06	-9.89E-08
Talatha Gate	1	**2.18E-05**	**2.44E-05**	4.89E-06	-1.04E-07
Aiken Airport	1	**1.96E-05**	**1.79E-05**	1.64E-06	-9.62E-07
Augusta Lock and Dam 614	1	**1.94E-05**	**2.20E-05**	2.68E-06	0.00E+00
Highway 301 @ State Line (Control Location)	3	**3.14E-05**	**2.11E-05**	**5.65E-06**	-1.90E-06
		1.47E-05	**1.97E-05**	**8.86E-06**	0.00E+00
		1.41E-05	**1.58E-05**	**7.16E-06**	6.41E-07

Appendix Table D-6 Summary of Gamma Surveillance

Samples were collected approximately every quarter (12 weeks) at each of the 51 locations. Typically, two samples are collected from each location. This was the case in 2021 except for Site Perimeter location PP-65, which was missing one sample for the fourth-quarter, and Population Center locations Girard and McBean, where Girard was missing one sample during the retrieval of the first-quarter samples and McBean was missing one third-quarter sample. Also, SRS was not able to retrieve any OSLDs for Plant Vogtle Vicinity locations GAP_4H and GAP_4L during the first quarter and NRC_5 during the fourth quarter. Please reference Environmental Maps, SRS Optically Stimulated Luminescent Dosimeter [OSLD] Sampling Locations.

Station Location Type	Number of Stations	Quarter 1 Average mR/day	Quarter 2 Average mR/day	Quarter 3 Average mR/day	Quarter 4 Average mR/day	Annual Total Average mR/year	Annual Minimum mR/year	Annual Maximum mR/year
Population Centers	9	0.39	0.37	0.38	0.44	141	100	165
Site Perimeter	9	0.34	0.30	0.29	0.38	119	101	135
Air Surveillance Stations	15	0.33	0.31	0.31	0.40	123	93	154
Plant Vogtle Vicinity	18	0.31	0.29	0.30	0.37	112	76	136

Appendix D-7 Summary of Radionuclides in Soil

Soil samples were collected from 19 locations in 2021. Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit, or the uncertainty is large.

The following locations were sampled: F Area (2,000 feet West), H Area (2,000 feet East), Z Area (#3), Burial Ground Locations (643-26E-2 and Burial Ground North), Plant Perimeter Locations (Allendale Gate, Barnwell Gate, Barricade 8, D Area, Darkhorse @ Williston Gate, East Talatha, Green Pond, Highway 21/167, Jackson, Patterson Mill Road, and Talatha Gate), and 25-Mile Radius Locations (Aiken Airport, Augusta Lock and Dam 614, and Highway 301 @ State Line). The Highway 301 @ State Line is the control location.

All Co-60, Sr 89,90, and Np-237 results were not detected; therefore, they were not reported in this table.

Radionuclide	Number of Detected Results	Control Hwy 301 Concentration (pCi/g)	Location of Minimum Concentration	Minimum Concentration (pCi/g)	Location of Maximum Concentration	Maximum Concentration (pCi/g)
Cs-137	17 of 19	**1.15E-01**	Burial Ground (643-26E-2)	-1.43E-02	Aiken Airport	**3.38E-01**
U-234	19 of 19	**1.50E+00**	Barricade 8	**2.86E-01**	Augusta Lock and Dam 614	**1.32E+00**
U-235	19 of 19	**7.19E-02**	Highway 21/167	**1.20E-02**	Augusta Lock and Dam 614	**7.14E-02**
U-238	19 of 19	**1.49E+00**	Barricade 8	**2.35E-01**	Augusta Lock and Dam 614	**1.41E+00**
Pu-238	5 of 19	-3.22E-04	Burial Ground North	-1.82E-04	F Area (2000 feet west)	**5.11E-02**
Pu-239	17 of 19	**7.35E-03**	Burial Ground North	**1.09E-03**	F Area (2000 feet west)	**1.43E-01**
Am-241	15 of 19	**4.27E-03**	Green Pond	8.11E-04	F Area (2000 feet west)	**1.41E-02**
Cm-244	2 of 19	4.32E-04	Barricade 8	-1.99E-04	Jackson	**4.57E-03**
Gross Beta	17 of 19	**1.21E+01**	Patterson Mill Road	1.49E+00	Augusta Lock and Dam 614	**1.27E+01**
Gross Alpha	18 of 19	**1.06E+01**	Barricade 8	7.24E-01	Augusta Lock and Dam 614	**1.44E+01**

Appendix Table D-8 Summary of Radionuclides in Grassy Vegetation

Samples are collected annually from 15 locations. Bolded values are detected results. Values not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All results for Co-60, Pu-238, Cm-244, and Tc-99 were not detected; therefore, they were not reported in this table.

The following locations are sampled: Onsite location (Burial Ground North), Site Perimeter locations (Allendale Gate, Barnwell Gate, Barricade 8, D Area, Darkhorse @ Williston Gate, East Talatha, Green Pond, Highway 21/167, Jackson, Patterson Mill Road, Talatha Gate), and 25-Mile Radius Locations (Aiken Airport, Augusta Lock and Dam 614, and Highway 301 @ State Line). Highway 301 @ State Line is the control location.

Radionuclide	Number of Detected Results	Control (Highway 301) Concentration (pCi/g)	Location of Minimum Concentration	Minimum Concentration (pCi/g)	Location of Maximum Concentration	Maximum Concentration (pCi/g)
H-3	6 of 15	2.57E-02	Darkhorse @ Williston Gate	2.97E-03	Burial Ground North	**1.03E+00**
Cs-137	11 of 17	**2.67E-01**	Darkhorse @ Williston Gate	-1.82E-03	Allendale Gate	**6.16E-01**
Sr-89,90	11 of 15	**6.89E-02**	Darkhorse @ Williston Gate	3.32E-02	Patterson Mill Road	**3.92E-01**
U-234	14 of 15	**1.38E-03**	Darkhorse @ Williston Gate	1.22E-03	Highway 21/167	**2.04E-02**
U-235	1 of 15	2.81E-04	Allendale Gate	-2.42E-04	Talatha Gate	**8.35E-04**
U-238	14 of 15	**1.21E-03**	Darkhorse @ Williston Gate	1.60E-03	Highway 21/167	**1.90E-02**
Np-237	3 of 15	1.13E-04	Highway 21/167	-1.00E-04	Green Pond	**9.38E-04**
Pu-239	1 of 15	3.11E-05	Jackson	-1.94E-04	Barricade 8	**1.12E-03**
Am-241	1 of 15	6.40E-04	Highway 21/167	-1.40E-04	Augusta Lock & Dam 614	6.41E-04
Gross Beta	15 of 15	**5.08E+00**	Green Pond	**2.70E+00**	Barricade 8	**1.42E+01**
Gross Alpha	1 of 15	-1.13E-01	Barnwell Gate	-1.26E-01	East Talatha	**1.02E+00**

Appendix Table D-9 Summary of Radionuclides in Foodstuffs

Samples of five foodstuffs are collected annually from five regions surrounding SRS. Beef, greens, and fruit are collected each year. Six foodstuffs are collected on a rotating three-year cycle. Pecans and corn were the rotational crop samples for 2021. However, no pecans were collected due to poor crop production. Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit, or the uncertainty is large.

Food Type	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Concentration (pCi/g)	Minimum Sample Concentration (pCi/g)	Maximum Sample Concentration (pCi/g)
Beef	Gross Beta	5	5	2.75E+00	**2.26E+00**	**3.97E+00**
	H-3	5	1	3.24E-02	-2.42E-03	**9.08E-02**
	Pu-239	5	1	5.82E-06	-1.35E-05	5.57E-05
	U-234	5	1	3.03E-05	2.20E-06	**6.62E-05**
Am-241, Cm-244, Co-60, Cs-137, Gross Alpha, Np-237, Pu-238, Sr-89,90, Tc-99, U-235 and U-238 were not detected in beef.						
Greens	Cs-137	5	4	2.55E-02	1.52E-02	**3.35E-02**
	Gross Beta	5	5	2.12E+01	**1.64E+01**	**2.84E+01**
	Pu-239	5	1	3.21E-04	7.43E-05	**5.59E-04**
	Sr-89,90	5	4	1.18E-01	3.16E-02	**3.57E-01**
	Tc-99	5	5	5.54E-01	**2.15E-01**	**8.78E-01**
	U-234	5	4	1.38E-02	8.81E-04	**2.57E-02**
	U-235	5	2	5.61E-04	0.00E+00	**9.73E-04**
	U-238	5	5	1.44E-02	**2.48E-03**	**2.73E-02**
Am-241, Cm-244, Co-60, Gross Alpha, H-3, Np-237, and Pu-238 were not detected in greens.						
Fruit (watermelon)	Gross Beta	5	4	1.30E-01	4.16E-02	**2.19E-01**
	U-234	5	1	6.77E-05	3.11E-05	**9.68E-05**
Am-241, Cm-244, Co-60, Cs-137, Gross Alpha, H-3, Np-237, Pu-238, Pu-239, Sr-89,90, Tc-99, U-234, U-235, and U-238 were not detected in fruit.						
Corn	Cs-137	5	2	9.98E-03	2.43E-03	**2.50E-02**
	Gross Beta	5	5	9.60E+00	**8.38E+00**	**1.23E+01**
Am-241, Cm-244, Co-60, Gross Alpha, H-3, Np-237, Pu-238, Pu-239, Sr-89,90, Tc-99, U-234, U-235, and U-238 were not detected in peanuts.						

Appendix Table D-10 Summary of Radionuclides in Dairy

SRS collects cow and goat milk samples from dairies in communities surrounding the Site. The number listed in parentheses in the "location" column indicates the number of dairies in the named state that provide samples to SRS.

Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All Co-60 and H-3 results were not detected; therefore, they were not reported in this table.

Location	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Concentration (pCi/L)	Minimum Sample Concentration (pCi/L)	Maximum Sample Concentration (pCi/L)
SC–Dairies (4) Cow Milk	Cs-137	16	5	2.62E+00	-4.27E-01	**1.08E+01**
SC–Dairies (4) Cow Milk	Sr-90	16	4	6.43E-01	-4.57E-01	**3.03E+00**

Appendix Table D-11 Radiation in Liquid Source Releases

All values under the "Reactors," "Separations," "SRNL," and the "Totals" column are reported in curies.[a]

Tritium is the main contributing radionuclide in liquid source releases. Although the remaining radionuclides are contributors, their contributions in liquid source releases are minimal.

In the facility (Reactor, Separations, and SRNL) columns, a blank indicates the radionuclide was not analyzed. A 0.00E+00 in the facility columns indicates the result was not significant.

All Co-60 results were not detected; therefore, they were not reported in this table.

Radionuclide	Half-Life Time Interval[b]		Reactors (Ci)	Separations[c] (Ci)	SRNL (Ci)	Totals (Ci)
H-3[d]	12.3	y	1.17E+02	3.65E+02	0.00E+00	4.83E+02
C-14	5,700	y		5.80E-04	0.00E+00	5.80E-04
Mn-54	8.56E-01	y		9.70E-06		9.70E-06
Co-58	1.94E-01	y		1.61E-04		1.61E-04
Sr-90	28.8	y	0.00E+00	2.15E-02		2.15E-02
Tc-99	2.11E+05	y		3.42E-02	0.00E+00	3.42E-02
I-129	1.57E+07	y		2.19E-02	0.00E+00	2.19E-02
Cs-137[e]	30.2	y	0.00E+00	2.37E-02	0.00E+00	2.37E-02
U-234	2.46E+05	y		3.27E-02	1.32E-04	3.28E-02
U-235	7.04E+08	y		3.72E-04	1.31E-05	3.85E-04
U-238	4.47E+09	y		3.32E-02	1.33E-04	3.34E-02
Np-237	2.14E+06	y		1.17E-04		1.17E-04
Pu-238	87.7	y		3.97E-04	8.43E-07	3.98E-04
Pu-239	2.41E+04	y		2.01E-05	0.00E+00	2.01E-05
Am-241	432	y		3.18E-05		3.18E-05
Cm-244	18.1	y		1.46E-04		1.46E-04
Alpha[f]	N/A		3.88E-03	1.74E-03	5.97E-04	6.22E-03
Beta-Gamma[g]	N/A		4.53E-02	6.36E-03	9.99E-04	5.27E-02
					Sum	**4.83E+02**

[a] One curie equals 3.7E+10 becquerels

[b] ICRP 107, *Nuclear Decay Data for Dosimetric Calculations* (2008). Half-life time intervals are given in years (y).

[c] Includes separations, waste management, and tritium processing facilities

[d] The tritium release total, which includes direct + migration releases, is used in the dose calculations for SRS impacts.

[e] Depending on which value is higher, the Cs-137 release total is based on concentrations measured in Steel Creek mouth fish near RM 141.5 or on the actual measured effluent release total from the Site. Refer to Chapter 6, *Radiological Dose Assessment*, for more information.

[f,g] For dose calculations, unidentified alpha and beta/gamma releases are assumed to be Pu-239 and Sr-90, respectively.

Appendix Table D-12 Summary of Liquid Effluent DOE DCS Sum of Fractions by Facility

Facility (Sampling Location)	Radionuclides Included in The Sum of Fractions	DCS Sum of Fractions	DCS Sum of Fractions Excluding Tritium
A Area (TB-2 Outfall at Road 1A)	H-3, Tc-99, C-14, Co-60, I-129, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239	1.56E-03	1.52E-03
F Area (F-013 200-F Cooling Basin)	H-3, Tc-99, Co-60, I-129, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	4.90E-03	4.52E-03
F Area (F-05)	H-3, Tc-99, C-14, Co-60, I-129, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	6.14E-03	5.84E-03
F Area (FM-3 F-Area Effluent)	H-3, Tc-99, C-14, Co-60, I-129, Cs-137, U-234, U-235 U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	1.93E-03	1.54E-03
F-Tank Farm (F-012 281-8F Retention Basin)	H-3, Tc-99, Co-60, I-129, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	1.08E-02	1.03E-02
G-010 (Central Sanitary Wastewater Treatment Facility)	H-3, Tc-99, Co-60, I-129, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	1.15E-02	1.10E-02
H Area (FM-1C H-Area Effluent)	H-3, C-14, Co-60, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	3.48E-03	2.56E-03
H Area (H-004)	H-3, Co-60, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Sr-89,90	7.77E-03	3.57E-03
H-ETP (U3R-2A ETP Outfall)	H-3, C-14, Co-60, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	1.24E+00	1.25E-01
H-Tank Farm (H-017 281-8H Retention Basin)	H-3, Tc-99, Co-60, I-129, Cs-137, U-234, U-235, U-238, Np-237, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	1.00E-02	9.43E-03
H-Tank Farm (HP-52 H-Area Tank Farm)	H-3, Co-60, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Am-241, Cm-244, Sr-89,90	2.24E-03	1.50E-03
K Area (K Canal)	H-3, Co-60, Cs-137, Sr-89,90	1.22E-03	1.01E-03
L Area	H-3, Co-60, Cs-137, Sr-89,90	4.11E-04	3.10E-04
S Area (S-004)	H-3, Co-60, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Sr-89,90	2.72E-03	8.76E-04
Tritium (HP-15 Tritium Facility Outfall)	H-3, Co-60, Cs-137, Sr-89,90	8.61E-03	6.32E-05

Appendix Table D-13 Summary of Radionuclides in Sediments

SRS collected annual sediment samples at 41 locations in 2021—10 Savannah River, 23 stream, and 8 stormwater basins—totaling 461 analytes. Locations sampled are as follows: Savannah River locations (mouths of Beaver Dam Creek [BDC] and Steel Creek [SC], River Miles [RM] 118.7, 129, 134, 150.2, 150.4, 151, and 157.2), SRS Stream locations (downstream of R-1, FM-2, FM-3A, FM-A7, FM-A7A, FMC @ Rd A, FMC Swamp, L3R-1A , L3R-2, McQB @ MO, McQB below Z Basin, Meyers Branch, PB @ Rd A, PB Swamp, SC-2A, SC-4, TB-5, U3R-3, U3R-4, U3R of Rd. 4, and U3R @ USFS Rd 2-1), and SRS Stormwater Basin locations (E-001, E-002, E-003, E-004, E-05, E-06, Pond 400, and Z-Basin). The control location for the river samples is RM 161.0. The control locations for the stream and stormwater basin sediment samples are TC-1 and U3R-1A.

Bolded concentration results were reported as detected. Concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

River Sediment Results

Nine River Locations Plus One Control

(Some locations only sampled for Cs-137, Co-60, gross alpha, and nonvolatile beta)

Analyte	Number > DL	Control RM 161.0 (pCi/g)	Location of Maximum Result	Maximum Result (pCi/g)
Americium-241	4 of 9	**3.53E-03**	RM-157.2	**4.07E-03**
Cesium-137	7 of 10	**7.38E-02**	SC RM	**1.59E+00**
Cobalt-60	1 of 10	6.48E-02	RM-134	**9.83E-02**
Curium-243/244	1 of 9	**1.05E-03**	All < MDA	All < MDA
Gross Alpha	10 of 10	**9.29E+00**	RM-157.2	**3.15E+01**
Neptunium-237	0 of 9	2.59E-03	All < MDA	All < MDA
Nonvolatile Beta	10 of 10	**2.04E+01**	RM-157.2	**3.20E+01**
Plutonium-238	0 of 9	2.03E-03	All < MDA	All < MDA
Plutonium-239/240	1 of 9	1.95E-03	RM-157.2	**1.60E-02**
Strontium-90	0 of 9	1.22E-01	All < MDA	All < MDA
Uranium-233/234	8 of 9	**1.47E+00**	RM-157.2	**2.14E+00**
Uranium-235	9 of 9	**8.27E-02**	RM-157.2	**1.07E-01**
Uranium-238	9 of 9	**1.43E+00**	RM-157.2	**2.34E+00**

Appendix Table D-13 Summary of Radionuclides in Sediments (continued)

Stream Sediment Results

21 Stream Locations Plus 2 Controls
(Some locations only sampled for Cs-137, Co-60, gross alpha and nonvolatile beta)

Analyte	Number >DL	Control TC-1 (pCi/g)	Control U3R-1A (pCi/g)	Location of Maximum Result	Maximum Result (pCi/g)
Americium-241	12 of 16	1.23E-03	**2.94E-03**	FM-A-7A	**1.13E-01**
Cesium-137	17 of 23	5.08E-02	9.83E-02	DS of R-1	**7.90E+01**
Cobalt-60	0 of 23	3.97E-02	8.10E-02	All < MDA	All < MDA
Curium-243/244	7 of 16	9.94E-04	1.00E-03	FM-A-7A	**7.26E-02**
Gross Alpha	23 of 23	**5.54E+00**	**4.42E+01**	TB-5	**7.90E+01**
Neptunium-237	3 of 16	2.35E-03	1.48E-03	FM-2	**1.35E-02**
Nonvolatile Beta	23 of 23	**3.79E+00**	**2.86E+01**	DS of R-1	**1.11E+02**
Plutonium-238	9 of 16	2.16E-03	1.59E-03	FM-2	**2.76E-01**
Plutonium-239/240	13 of 16	**4.07E-03**	**6.98E-03**	FM-A-7A	**9.36E-02**
Strontium-90	4 of 16	1.26E-01	1.25E-01	SC-4	**5.07E-01**
Uranium-233/234	15 of 16	**5.70E-01**	**1.40E+00**	TB-5	**7.52E+00**
Uranium-235	15 of 16	**4.01E-02**	**6.30E-02**	TB-5	**3.82E-01**
Uranium-238	16 of 16	**5.32E-01**	**1.63E+00**	TB-5	**7.55E+00**

Stormwater Basin Sediment Results

Eight Basin Locations Plus Two Controls

Analyte	Number >DL	Control TC-1 (pCi/g)	Control U3R-1A (pCi/g)	Location of Maximum Result	Maximum Result (pCi/g)
Americium-241	4 of 10	1.23E-03	**2.94E-03**	E-003	**2.07E-02**
Cesium-137	3 of 10	5.08E-02	9.83E-02	Z Basin	**7.00E+02**
Cobalt-60	0 of 10	3.97E-02	8.10E-02	All < MDA	All < MDA
Curium-243/244	1 of 10	9.94E-04	1.00E-03	Pond 400	**9.86E-04**
Gross Alpha	10 of 10	**5.54E+00**	**4.42E+01**	E-004	**2.29E+01**
Neptunium-237	0 of 10	2.35E-03	1.48E-03	All < MDA	All < MDA
Nonvolatile Beta	10 of 10	**3.79E+00**	**2.86E+01**	Z Basin	**5.08E+02**
Plutonium-238	4 of 10	2.16E-03	1.59E-03	E-001	**1.48E-02**
Plutonium-239/240	7 of 10	**4.07E-03**	**6.98E-03**	Pond 400	**3.11E-02**
Strontium-90	1 of 10	1.26E-01	1.25E-01	E-003	**1.26E+00**
Uranium-233/234	10 of 10	**5.70E-01**	**1.40E+00**	E-004	**2.05E+00**
Uranium-235	9 of 10	**4.01E-02**	**6.30E-02**	E-004	**1.28E-01**
Uranium-238	10 of 10	**5.32E-01**	**1.63E+00**	E-004	**2.07E+00**

Appendix Table D-14 Summary of Radionuclides in Drinking Water

Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large.

Samples at the treatment plants are collected monthly. These samples are analyzed for tritium, Co-60, Cs-137, gross alpha, and gross beta. For the treatment plants samples, all results for Co-60, Cs-137, and gross alpha were below detection limits; therefore, they were not reported in the table below. Samples are collected at one onsite (782-3A) location quarterly for tritium, Co-60, Cs-137, gross beta and gross alpha analyses, and collected annually for Sr-90 and actinides analyses. Unfortunately, SRS was unable to collect the third quarter sample for 2021 for this location. All other onsite locations are collected annually. For the quarterly onsite samples, all results for tritium, Co-60, and Cs-137 were below detection limits; therefore, they were not reported in the table below. For the onsite annual samples, all results for tritium, Co-60, Cs-137, Sr-89,90, U-235, Pu-238, Pu-239, and Cm-244 were below detection limits; therefore, they were not reported in this table.

Treatment Plants—Finished Water Summary

			Tritium		
Locations	**Number of Samples**	**Number of Detects**	**Mean Concentration (pCi/L)**	**Minimum Concentration (pCi/L)**	**Maximum Concentration (pCi/L)**
BJWSA Purrysburg WTP	12	12	2.35E+02	**1.30E+02**	**6.62E+02**
North Augusta Public Water Works	12	1	5.56E+01	-2.06E+01	**1.41E+02**

			Gross Beta		
Locations	**Number of Samples**	**Number of Detects**	**Mean Concentration (pCi/L)**	**Minimum Concentration (pCi/L)**	**Maximum Concentration (pCi/L)**
BJWSA Purrysburg WTP	12	12	1.74E+00	**1.25E+00**	**2.17E+00**
North Augusta Public Water Works	12	12	1.71E+00	**1.34E+00**	**2.16E+00**

Appendix Table D-14 Summary of Radionuclides in Drinking Water (continued)

Onsite Location Summary—Quarterly Samples

Gross Beta					
Location	Number of Samples	Number of Detects	Mean Concentration (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)
782-3A quarterly	3	3	1.50E+00	**1.30E+00**	**1.66E+00**

Gross Alpha					
Location	Number of Samples	Number of Detects	Mean Concentration (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)
782-3A quarterly	3	3	9.61E-01	**7.70E-01**	**1.18E+00**

Onsite Location Summary—Annual Samples

		U-234	U-238	Am-241
Location	Number of Samples	Concentration (pCi/L)	Concentration (pCi/L)	Concentration (pCi/L)
617-8G	1	**8.78E-03**	**8.78E-03**	**1.66E-02**
704-16G	1	6.11E-04	5.51E-03	**1.16E-02**
709-1G	1	5.19E-03	-3.78E-06	7.46E-03
737-G	1	5.57E-04	5.11E-03	**1.35E-02**
782-3A (annual)	1	**1.27E-02**	**2.66E-02**	**1.24E-02**
905-112G Well	1	**2.38E-02**	**3.11E-02**	6.73E-03
905-113G Well	1	**2.55E-02**	**2.76E-02**	**1.04E-02**
905-125B	1	**1.16E-02**	**1.21E-02**	6.73E-03
905-67B	1	**2.76E-02**	**6.27E-02**	5.84E-03

Appendix Table D-14 Summary of Radionuclides in Drinking Water (continued)

Onsite Location Summary—Annual Samples (continued)

		Gross Beta	Gross Alpha
Location	**Number of Samples**	**Concentration (pCi/L)**	**Concentration (pCi/L)**
617-8G	1	**9.68E-01**	3.95E-02
704-16G	1	**1.29E+00**	**1.17E+00**
709-1G	1	**1.34E+00**	3.49E-01
737-G	1	**8.00E-01**	**5.68E-01**
782-3A (annual)	1	**1.66E+00**	**9.32E-01**
905-112G Well	1	**9.89E-01**	**7.84E-01**
905-113G Well	1	**8.92E-01**	**5.43E-01**
905-125B	1	**8.38E-01**	**3.11E-01**
905-67B	1	3.57E-01	3.00E-01

Appendix Table D-15 Summary of Radionuclides in Freshwater Fish

Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. Sr-89,90 is the only analysis performed in both flesh (edible) and bone (nonedible) samples. All Co-60, I-129, and gross alpha results were nonsignificant; therefore, they were not reported in this table.

The analyte mean is set to zero if all composite values per fish species at a single location are less than the MDL or the uncertainty is large. Three composite samples were analyzed for each fish type from each location, except flathead catfish.

	Cs-137 (Edible)											
	Bass			Catfish			Flathead			Panfish		
Location	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**
Augusta L&D	0.00E+00	1.15E+01	1.59E+01	3.59E+01	**2.46E+01**	**4.22E+01**	**5.32E+01**	**3.22E+01**	**7.43E+01**	0.00E+00	-8.57E+00	1.32E+01
Four Mile Creek River Mouth	**3.84E+01**	**3.03E+01**	**4.84E+01**	**6.41E+01**	**3.68E+01**	**7.97E+01**	**4.58E+01**	**2.25E+01**	**9.89E+01**	**5.09E+01**	**2.42E+01**	**7.41E+01**
Hwy 301 Bridge Area	**2.23E+01**	**1.74E+01**	**3.19E+01**	**2.46E+01**	**1.85E+01**	**3.30E+01**	**2.78E+01**	**2.61E+01**	**3.00E+01**	**2.17E+01**	**2.05E+01**	**2.29E+01**
Lower Three Runs Creek River Mouth	**3.92E+01**	**3.16E+01**	**4.46E+01**	**1.04E+02**	**3.24E+01**	**2.23E+02**	**1.60E+02**	**2.32E+01**	**4.00E+02**	2.79E+01	1.55E+01	**4.22E+01**
Steel Creek River Mouth	**3.61E+02**	**2.02E+02**	**5.03E+02**	**1.06E+02**	**8.38E+01**	**1.25E+02**	**3.35E+01**	**2.14E+01**	**6.24E+01**	**1.59E+02**	**8.24E+01**	**2.68E+02**
Upper Three Runs Creek River Mouth	**4.43E+01**	**1.98E+01**	**6.27E+01**	1.33E+01	5.95E+00	**2.10E+01**	**3.25E+01**	**1.52E+01**	**4.86E+01**	**5.56E+01**	**3.43E+01**	**8.46E+01**

Appendix Table D-15 Summary of Radionuclides in Freshwater Fish (continued)

	Sr-89,90 (Edible)											
	Bass			Catfish			Flathead			Panfish		
Location	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**
Augusta L&D	2.87E+00	4.41E-01	**6.78E+00**	0.00E+00	8.32E-01	2.44E+00	0.00E+00	1.11E+00	1.39E+00	0.00E+00	-1.46E-01	2.02E+00
Four Mile Creek River Mouth	2.09E+00	1.28E+00	**2.70E+00**	2.39E+00	1.21E+00	**4.30E+00**	**2.85E+00**	**2.38E+00**	**3.27E+00**	**3.06E+00**	**2.61E+00**	**3.84E+00**
Hwy 301 Bridge Area	0.00E+00	9.78E-01	2.56E+00	3.98E+00	1.04E-01	**6.05E+00**	0.00E+00	2.01E-01	2.89E+00	0.00E+00	1.15E+00	1.58E+00
Lower Three Runs Creek River Mouth	4.60E+00	2.92E+00	**6.16E+00**	1.48E+00	7.57E-01	**2.64E+00**	0.00E+00	1.35E+00	1.99E+00	0.00E+00	1.47E+00	4.62E+00
Steel Creek River Mouth	0.00E+00	1.49E+00	2.29E+00	0.00E+00	1.66E-01	2.37E+00	0.00E+00	-7.76E-01	2.10E+00	4.93E+00	3.51E+00	**5.68E+00**
Upper Three Runs Creek River Mouth	4.34E+00	3.84E+00	**5.32E+00**	0.00E+00	1.85E+00	3.95E+00	0.00E+00	-1.41E-01	3.38E+00	0.00E+00	7.59E-01	3.41E+00

	Sr-89,90 (Nonedible)											
	Bass			Catfish			Flathead			Panfish		
Location	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**
Augusta L&D	4.91E+02	2.45E+02	**7.27E+02**	**8.07E+02**	**7.22E+02**	**9.46E+02**	**4.74E+02**	**3.95E+02**	**5.54E+02**	**6.66E+02**	**4.62E+02**	**8.49E+02**
Four Mile Creek River Mouth	**1.21E+02**	**7.11E+01**	**1.99E+02**	**1.42E+02**	**1.11E+02**	**1.91E+02**	1.03E+02	7.22E+01	**1.14E+02**	**3.14E+02**	**1.31E+02**	**4.35E+02**
Hwy 301 Bridge Area	**5.64E+02**	**4.41E+02**	**6.97E+02**	**5.75E+02**	**5.03E+02**	**6.49E+02**	**4.59E+02**	**4.00E+02**	**6.05E+02**	**6.84E+02**	**5.57E+02**	**8.14E+02**
Lower Three Runs Creek River Mouth	5.05E+02	3.84E+02	**5.81E+02**	**5.80E+02**	**4.70E+02**	**7.51E+02**	5.14E+02	3.30E+02	**7.51E+02**	**5.84E+02**	**3.35E+02**	**8.05E+02**
Steel Creek River Mouth	**6.95E+02**	**5.35E+02**	**7.89E+02**	**7.16E+02**	**5.22E+02**	**8.27E+02**	6.07E+02	3.14E-02	**8.81E+02**	6.14E+02	3.76E+02	**8.05E+02**
Upper Three Runs Creek River Mouth	5.51E+02	1.88E+02	**1.09E+03**	**5.26E+02**	**4.08E+02**	**6.78E+02**	2.79E+02	8.76E+01	**3.62E+02**	**6.28E+02**	**5.62E+02**	**7.49E+02**

Appendix Table D-15 Summary of Radionuclides in Freshwater Fish (continued)

Tc-99 (Edible)

Location	Bass			Catfish			Flathead			Panfish		
	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)
Augusta L&D	0.00E+00	-3.92E+01	4.03E+00	0.00E+00	-2.76E+01	-9.19E+00	0.00E+00	-2.64E+01	**-5.51E+00**	0.00E+00	-1.47E+01	2.49E+01
Four Mile Creek River Mouth	0.00E+00	-7.30E+00	5.24E+01	0.00E+00	1.02E+01	3.57E+01	0.00E+00	-7.30E-01	9.14E+01	0.00E+00	2.19E+01	3.43E+01
Hwy 301 Bridge Area	0.00E+00	-3.08E+01	-2.46E+00	0.00E+00	-4.43E+01	-2.70E+01	0.00E+00	-3.49E+01	-2.50E+01	0.00E+00	-4.03E+01	-2.67E+01
Lower Three Runs Creek River Mouth	0.00E+00	-2.15E+01	9.76E+00	0.00E+00	1.42E-04	2.30E+01	0.00E+00	-3.89E+00	2.23E+01	0.00E+00	-7.03E+00	9.73E+00
Steel Creek River Mouth	0.00E+00	6.43E+00	2.48E+01	0.00E+00	-2.03E+00	4.19E+01	0.00E+00	4.05E+00	4.49E+01	0.00E+00	1.87E+01	4.97E+01
Upper Three Runs Creek River Mouth	0.00E+00	2.05E+00	7.30E+01	0.00E+00	-8.27E+00	7.62E+01	6.48E+01	-1.86E+01	1.09E+02	0.00E+00	-3.38E+00	3.65E+01

Gross Beta (Edible)

Location	Bass			Catfish			Flathead			Panfish		
	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)	Mean (pCi/kg)	Minimum (pCi/kg)	Maximum (pCi/kg)
Augusta L&D	2.64E+03	2.40E+03	2.84E+03	2.83E+03	2.12E+03	3.38E+03	2.76E+03	2.64E+03	2.89E+03	1.94E+03	1.39E+03	2.38E+03
Four Mile Creek River Mouth	1.82E+03	1.51E+03	2.18E+03	2.35E+03	2.06E+03	2.52E+03	1.97E+03	1.76E+03	2.22E+03	1.61E+03	1.41E+03	1.74E+03
Hwy 301 Bridge Area	1.19E+03	1.01E+03	1.30E+03	1.70E+03	1.29E+03	2.09E+03	1.90E+03	1.73E+03	2.12E+03	1.44E+03	1.28E+03	1.59E+03
Lower Three Runs Creek River Mouth	1.51E+03	1.21E+03	1.75E+03	1.65E+03	1.56E+03	1.74E+03	1.79E+03	1.43E+03	2.15E+03	8.10E+02	5.54E+02	1.15E+03
Steel Creek River Mouth	2.83E+03	2.17E+03	3.27E+03	3.03E+03	2.76E+03	3.43E+03	2.36E+03	1.95E+03	2.73E+03	2.06E+03	1.49E+03	2.84E+03
Upper Three Runs Creek River Mouth	2.15E+03	1.78E+03	2.33E+03	1.93E+03	1.75E+03	2.18E+03	2.12E+03	1.95E+03	2.39E+03	1.77E+03	1.72E+03	1.84E+03

Appendix Table D-16 Summary of Radionuclides in Saltwater Fish

Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. Sr-89,90 is the only analysis performed in both flesh (edible) and bone (nonedible) samples. Results of all samples for Co-60, gross alpha, I-129, Sr-89,90 (in flesh), and Tc-99 were below method detection limits.

All saltwater fish are collected at the location designated as RM 0–8 (mouth of Savannah River).

Marine Mullet					
Analyte	**Number of Samples**	**Number of Results > Detection Limit**	**Mean (pCi/kg)**	**Minimum (pCi/kg)**	**Maximum (pCi/kg)**
Cs-137	3	1	0.00E+00	--2.25E+00	6.03E+00
Gross Beta	3	3	**1.60E+03**	**1.44E+03**	**1.82E+03**
Sr-89,90 (Nonedible)	3	1	2.41E+02	1.37E+02	**4.41E+02**

Appendix Table D-17 Summary of Radionuclides in Shellfish

Bolded minimum and maximum concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All Cs-137, Co-60, I-129, Sr-89,90, and Tc-99 results were not detected; therefore, they were not reported in this table.

All shellfish are collected at the location designated as RM 0-8 (at the mouth of Savannah River).

The specie of shellfish collected in 2021 was crab.

Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Concentration (pCi/kg)	Minimum Concentration (pCi/kg)	Maximum Concentration (pCi/kg)
Gross Alpha	1	0	1.88E+02	1.88E+02	1.88E+02
Gross Beta	1	2	**8.51E+02**	**8.51E+02**	**8.51E+02**

Appendix Table D-18 Summary of Radionuclides in Wildlife

Bolded concentration results were reported as detected. Minimum and maximum concentrations not bolded indicate the result was less than the analytical method detection limit or the uncertainty is large. All Co-60 results were below detection limits; therefore, they are not reported in this table.

Sample Type	Nuclide	Number of Samples	Number of Results > Detection Limit	Mean Sample Concentration (pCi/g)	Minimum Sample Concentration (pCi/g)	Maximum Sample Concentration (pCi/g)
Hog Flesh	Cs-137	26	26	1.77E+00	**1.86E-01**	**4.60E+00**
Hog Flesh	Sr-89,90	26	3	2.23E-03	-6.82E-04	**8.47E-03**

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Appendix E: Groundwater Management Program Supplemental Information

Appendix Table E-1 Summary of Documents that Report Groundwater Monitoring Data

Document Title	Submittal Frequency
Data Report for the C-Area Groundwater (CAGW) Operable Unit	Annual
K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) (KBRP), L-Area Burning/Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L) and L-Area Rubble Pile (131-3L) (LBRP), and P-Area Burning/Rubble Pit (131-P) (PBRP) Operable Units Combined Groundwater Monitoring Report Sampling Summary	Annual
Annual Comprehensive TNX Area Groundwater Monitoring and Remedial Action Effectiveness Interim Report	Annual
R-Area Groundwater Effectiveness Monitoring Report in Support of R-Area Operable Unit	Biennial
Effectiveness Monitoring Report (EMR) for Monitored Natural Attenuation (MNA) at the L-Area Southern Groundwater (LASG) Operable Unit	Biennial
Five-Year Remedy Review Report for Savannah River Site Operable Units	Phased—Annual
D-Area Groundwater Operable Unit	Annual
Groundwater Mixing Zone Report for the D-Area Oil Seepage Basin	Annual
Groundwater Mixing Zone Sampling Summary Report for the R-Reactor Seepage Basin, 108-4R Overflow Basin Operable Unit	Biennial
632-G C&D Class Two Landfill Groundwater Monitoring Report	Biannual
N-Area Heating Oil (NHO) Plume Groundwater Monitoring Report	Annual
Z-Area Saltstone Disposal Facility Groundwater Monitoring Report	Biannual
288-F Class Two Landfill Annual Groundwater Monitoring Report	Biannual
Interim Sanitary Landfill (Class Three) Annual Groundwater Monitoring Report	Biannual
Annual M Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action Report	Annual
Annual Corrective Action Report for the F-Area Hazardous Waste Management Facility, the H-Area Hazardous Waste Management Facility, and the Mixed Waste Management Facility	Annual
Performance Evaluation Report for the M-Area Inactive Process Sewer Lines (MIPSL) (081-M) Operable Unit	Annual
Performance Evaluation Report for the A-Area Burning/Rubble Pit (731-A, 731-1A) and Rubble Pit (731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A, 731-5A) Operable Unit	Annual

Appendix Table E-1 Summary of Documents that Report Groundwater Monitoring Data (continued)

Document Title	Submittal Frequency
Effectiveness Monitoring Report (EMR) for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit	Annual
Biennial Effectiveness Monitoring Report (EMR) for Monitored Natural Attenuation (MNA) at the C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit	Biennial
Scoping Summary for the General Separations Area Eastern Groundwater Operable Unit	Annual
Scoping Summary for the General Separations Area Western Groundwater Operable Unit	Annual
Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit	Annual
Sanitary Landfill Groundwater Monitoring and Corrective Action Report	Annual
Annual Groundwater Monitoring Report for the F- and H-Area Radioactive Liquid Waste Tank Farms	Annual
SRS Environmental Report	Not applicable[a]

[a] The *SRS Environmental Report* is not submitted to the regulatory agencies as a regulatory requirement. The annual report is a publicly available document. The *SRS Environmental Report* summarizes information on offsite wells and onsite wells that are not included in regulatory submittals.

Appendix F: **Glossary**

A

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

actinide—Group of radioactive metallic 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.

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—Existing in the surrounding area. Completely enveloping.

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

analyte—Constituent or parameter that is being analyzed.

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

Area Completion Project—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 Agency—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 control location—A sampling point that is not impacted by SRS operations.

background radiation—Naturally occurring radiation, fallout, medical, consumer products, and cosmic radiation. Generally, the lowest level of radiation obtainable within the scope of an analytical measurement, that is, a blank sample.

benchmark — A standard or point of reference against which things may be compared or assessed.

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.

Biopreferred® —A program the U.S. Department of Agriculture (USDA) manages to increase the purchase and use of biobased products. The program's purpose is to spur economic development, create new jobs, and provide new markets for farm commodities. For more information, please see the USDA website.

biota—Plant and animal life.

blind sample—A subsample for analysis with a composition known to the submitter. The analyst or laboratory may know the identity of the sample, but not its composition. It tests 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.

canyon—Two facilities located at SRS where nuclear materials are chemically recovered and purified. They are called “canyons” because of their similarity to how a canyon looks, open space with high wall-like mountains on either side of a valley.

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.

categorical exclusion—Categories of actions that do not individually or cumulatively have a significant effect on the human environment and for which, therefore, neither an environmental assessment nor an environmental impact statement is required.

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").

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

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 (for example, 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 line 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.

cool roof—A thick white rubber-type roof that lowers the temperature of standard roofs from about 150 degrees Fahrenheit to 100 degrees or less.

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 Clean Air Act requires the Environmental Protection Agency to set National Ambient Air Quality Standards for these six pollutants.

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

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

D

DCS sum of fractions—The sum of the ratios of the average concentration of each radionuclide to its corresponding DCS value. (See definition of derived concentration standard [DCS].)

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

deactivation—The process of placing a facility in a stable and known condition, including removing 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 dismantlement.

derived concentration standard (DCS)—Concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (that is, ingestion of water, submersion in air, or inhalation), would result in 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) (DOE 2011).

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

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.

DOE Consolidated Audit Program (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) (1 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 equivalent dose received by all organs or tissues of the body after each one has been multiplied by an appropriate tissue weighting factor.
- **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.

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

duplicates or duplicate results—Results derived by taking a portion of a primary sample and performing the same analysis on that portion that is performed on the primary sample.

E

effluent—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.

effluent monitoring—Collection and analysis of samples or measurements of liquid and gaseous effluents to characterize and quantify the release of contaminants, assess radiation exposures to members of the public, and demonstrate compliance with applicable standards.

emission—A release of a gas.

ENERGY STAR®—A U.S. Environmental Protection Agency program that helps businesses and individuals save money and protect the climate through energy efficiency. For more information, please visit the ENERGY STAR website.

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—Vital role in determining health and safety issues for the purpose of public health or environmental health. Environmental monitoring at Savannah River Site includes effluent monitoring and environmental surveillance with the dual purpose of 1) showing compliance with federal, state, and local regulations, as well as with U.S. Department of Energy orders, and 2) monitoring any effects of Site operations on onsite and offsite natural resources and on human health.

environmental occurrence—Any sudden or sustained deviation from a regulated or planned performance at a DOE operation that has environmental protection and compliance significance.

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 to demonstrate compliance with applicable standards, assess radiation exposures to members of the public, and assess effects, if any, on the local environment.

EPEAT—A product database that registers products based on the devices' ability to meet various criteria developed and agreed upon by diverse stakeholders to address the full lifecycle of an electronic product.

This system ensures all products listed in the EPEAT database truly represent environmental leadership. For more information, please visit the EPEAT website.

exception (formerly "exceedance")—Term used by the Environmental Protection Agency and the South Carolina Department of Health and Environmental Control that denotes a reported 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.

exclusion or exclusion device—Material or equipment used for wildlife control. These devices may be used to deter animal use of an area, to provide a method of collecting animals, or to provide a means of exit for an animal.

exposure (radiation)—Incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation or man-made radiation that is not specific to a person's occupation. 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—The way that a person could be impacted from releases of radionuclides into the water and air.

F

fallout—The settling to the ground of airborne particles ejected into the atmosphere from the earth by explosions, eruptions, forest fires, etc. or from human production activities such as found at nuclear facilities.

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 duplicate—An independent sample collected as closely as possible to the same point in space and time as the original sample. The duplicate and original are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

fiscal year (FY)—An established period of time when an organization's annual financial records start and end. In the federal government, this period is from October 1 to September 30.

G

global fallout—Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

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).

graded approach (to sampling)—A decision process in which the requirements on the system vary with the risk of exposure to radionuclides.

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 that is a toxic, corrosive, reactive, or ignitable material that could affect human health or the environment.

I

impaired water— Water for which technology-based regulations and other required controls are not stringent enough to meet the water quality standards set by states.

International Organization for Standardization (ISO)—Creates documents that provide requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes, and services are compatible with their purpose. For more information, please visit the ISO website.

intralaboratory checks—Compare performance within a laboratory by analyzing duplicate and blind samples throughout the year.

isotope—Each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei and, hence, differ in relative atomic mass but not in chemical properties; in particular, a radioactive form of an element.

L

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.

M

Mixed Analyte Performance Evaluation Program (MAPEP)—A laboratory comparison program that tracks performance accuracy and tests the quality of environmental data reported to DOE.

maximally exposed individual (MEI)—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 equivalent dose.

maximum contaminant level (MCL)—The maximum allowable concentration of a drinking water contaminant as legislated through the Safe Drinking Water Act.

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 (radionuclides)—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.

minimum detectable concentration (chemicals)—Smallest amount or concentration of a chemical that can be distinguished in a sample by a given measurement system 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 or human health are measured periodically to regulate and control potential impacts.

N

nuclide—Atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

O

organic—Of, relating to, or derived from living organisms (plant or animal).

optically stimulated luminescence dosimeter (OSLD)— A reusable passive device that measures the exposure from ionizing radiation. In 2019, SRS transitioned from TLDs to OSLDs to obtain a higher and more accurate absorption rate to radiation exposure.

outfall—Place where treated or untreated water flows out of a pipe to mix with water from a water body, such as a stream or lake.

P

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

passive device—A device that does not require a source of energy for its operation.

person-rem—Collective dose to a population group. For example, a dose of 1 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).

plume—Volume of contaminated water originating at a waste source for example, 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 under dose definition.

potable water—Water that is safe to drink.

precision—An 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.

proficiency testing—An evaluation of a laboratory's performance against preestablished criteria by means of interlaboratory 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 age and gender averaged individual that is a combination of human (male and female) physical and physiological characteristics arrived at by international consensus to standardize radiation dose calculations.

RCRA/CERCLA Units—Units subject to the remedial action process established in the Federal Facilities Agreement.

regional screening level (RSL)—The risk-based concentration derived from standardized equations combining exposure assumptions with toxicity data.

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 equivalent dose (absorbed dose in rads times the radiation weighting factor). Equivalent dose 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.

representative person—A hypothetical 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.

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.

SEER—Seasonal Energy Efficiency Ratio—This is a measure of equipment energy efficiency over the cooling season. It represents the total cooling of a central air conditioner or heat pump during the normal cooling season as compared to the total electric energy input consumed during the same period.

sievert—The International System of Units (SI) derived unit of equivalent dose. 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.

source—Point or object from which radiation or contamination emanates.

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.

SRS Community Reuse Organization (SRSCRO)—A nonprofit organization charged with developing and implementing strategy to diversify the economy in the five South Carolina and Georgia counties surrounding the Site. For more information, please see the SRSCRO website.

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.

stormwater runoff—Surface streams that appear after precipitation.

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

surface water—Water that has not penetrated below the surface of the ground.

T

tank farm—Interconnected underground tanks used 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 on or growing from the land.

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.

translocation—The deliberate movement of organisms from one site for release in another. It must be intended to yield a measurable conservation benefit at the levels of a population, species or ecosystem, and not only provide benefit to translocated individuals.

transuranic (TRU) 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.

tritium—Elemental form of the radioactive isotope of hydrogen and occurs as a gas.

tritium oxide—Water in which the tritium isotope has replaced a hydrogen atom. Stack releases of tritium oxide typically occur as water vapor.

U

unidentified alpha and beta releases—The unspecified alpha and beta releases that are conservatively determined at each effluent location by subtracting the sum of the individually measured alpha-emitting (for example, plutonium-239 and uranium-235) and beta-emitting (for example, cesium-137 and strontium-90) radionuclides from the measured gross alpha and beta values, respectively. Unidentified alpha and beta releases also include naturally occurring radionuclides, such as uranium, thorium, radon progeny, and potassium-40.

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

V

volatile organic compounds (VOC)—Broad range of organic compounds, commonly halogenated, that vaporize at ambient, or relatively low, temperatures (for example, 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 DOE facilities.

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.

waste stream—Waste material generated from a single process or from an activity that is similar in material, physical form, isotopic makeup, and hazardous constituents.

WaterSense®—A U.S. Environmental Protection Agency partnership that offers ways to increase water efficiency through products and services. For more information, please visit the U.S. EPA website.

water table—Planar, underground surface beneath which earth materials, such as soil or rock, are saturated with water.

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.

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Appendix G: **References**

Aucott et al. 2017. Aucott, T.J., A.D. Brand, D.P. DiPrete, T.S. Whiteside. "Improvements to the Hunter Dose Tracking System," SRNL-STI-2017-00091, Savannah River National Laboratory, Savannah River Site, Aiken, SC

Bell 2020. Bell, E.S. "Creation of CAP88 and MAXDOSE Meteorological Datasets (2014-2018) for Regulatory Dose Assessment," SRNL-STI-2020-00259, July 2020, Savannah River National Laboratory, Savannah River Site, Aiken, SC

Carlton et al. 1994. Carlton, W.H., C.E. Murphy, Jr., and A.G. Evans. "Radiocesium in the Savannah River Site Environment," *Health Physics*, Volume 67, Number 3, Williams & Wilkins, Baltimore, MD

Cherry 2006. Cherry, G.S. "Simulation and Particle Tracking Analysis of Ground-Water Flow near the Savannah River Site, Georgia and South Carolina, 2002, and for Selected Ground-Water Management Scenarios, 2002 and 2020," *Scientific Investigations Report*, 2006-5195, U.S. Geological Survey, Reston, VA

Denham 1995. Denham, M.E. "SRS Geology/Hydrogeology Environmental Information Document," WSRC-TR-95-0046, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

DOE 2006. U.S. Department of Energy. "Section 3116 Determination for Salt Waste Disposal at the Savannah River Site," DOE-WD-2005-001, January 2006. Savannah River Site, Aiken, SC

DOE 2011. U.S. Department of Energy. "DOE Derived Concentration Technical Standard," DOE-STD-1196-2011, Washington, DC

DOE 2012. U.S. Department of Energy. "Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site," DOE-WD-2012-001, March 2012. Savannah River Site, Aiken, SC

DOE 2013. U.S. Department of Energy. "Radiation Protection of the Public and the Environment," DOE Order 458.1, Change 3; 2013, Washington, DC

DOE 2014. U.S. Department of Energy. "Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site," DOE-WD-2014-001, December 2014, Savannah River Site, Aiken, SC

DOE 2015. U.S. Department of Energy. "Environmental Radiological Effluent Monitoring and Environmental Surveillance," DOE Handbook, DOE-HDBK-1216-2015, Washington, DC

DOE 2019. U.S. Department of Energy. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," DOE-STD-1153-2019, Washington, DC

EPA 1993. U.S. Environmental Protection Agency. "External Exposure to Radionuclides in Air, Water, and Soil," Federal Guidance Report No. 12, USEPA 402-R-93-081, Sept. 1993, Washington, DC

EPA 1999. U.S. Environmental Protection Agency. "Cancer Risk Coefficients for Environmental Exposure to Radionuclides," Federal Guidance Report No.13, USEPA 402-R-99-001, Sept. 1999, Washington, DC

EPA 2000. U.S. Environmental Protection Agency. "National Primary Drinking Water Regulations," Title 40 Code of Federal Regulations, Part 141, December 2000, Washington, DC

EPA 2002. U.S. Environmental Protection Agency. "National Emission Standards for Hazardous Air Pollutants," Title 40 Code of Federal Regulations, Part 61, Subpart H, July 2002, Washington, DC

EPA 2011. U.S. Environmental Protection Agency. "Exposure Factor Handbook," National Center for Environmental Assessment, Office of Research and Development, Sept. 2011, Washington, DC

EPA 2019. U.S. Environmental Protection Agency. "External Exposure to Radionuclides in Air, Water and Soil," Federal Guidance Report No. 15, USEPA402/R19/002 Aug. 2019, Washington, DC

FFA 1993. "Federal Facility Agreement for the Savannah River Site," Administrative Docket Number 89-05-FF, WSRC-OS-94-42, Effective Date: August 16, 1993, Savannah River Site, Aiken, SC

ICRP 2002. International Commission on Radiation Protection, "Basic Anatomical and Physiological Data for Use in Radiological Protection Reference Values," Annals of the ICRP 32, Publication 89, Elmsford, NY

ICRP 2008. International Commission on Radiation Protection, "Nuclear Decay Data for Dosimetric Calculation," Annals of the ICRP 38(3), Publication 107, Elmsford, NY

Jannik 2017. Jannik, G.T. "Environmental Dose Assessment Manual," SRNL-TR-2010-00274, Revision 2, October 25, 2017, Savannah River National Laboratory, Savannah River Site, Aiken SC

Jannik and Stagich 2017. Jannik, G.T., B. Stagich. "Land and Water Use Characteristics and Human Health Input Parameters for Use in Environmental Dosimetry and Risk Assessments at the Savannah River Site—2017 Update," SRNL-STI-2016-00456, Revision 1, May 2017, Savannah River National Laboratory, Savannah River Site, Aiken, SC

Laird and Jannik 2020. Laird, M.G., G.T. Jannik. "Updated External Exposure Dose Coefficients," SRNL-L3200-2020-00014, May 2020, Savannah River National Laboratory, Savannah River Site, Aiken, SC

Minter et al 2018. Minter, K.M., G.T. Jannik, B.H. Stagich, K.L. Dixon, and J.R. Newton. "Comparison of the Current Center of the Site Annual NESHAP Dose Modeling at the Savannah River Site with Other Assessment Methods," Health Physics Society, Health-Physics.com, 408-413

Morrison et al 2019. Morrison, C., S. Hitchens, T. Edwards, J. Mayer, and K. Minter. "Determining CS-137 Background Bodyburdens for Wild Pigs at Savannah River Site," SRNL-TR-2019-00193, Savannah River National Laboratory, Savannah River Site, Aiken, SC

NCRP 2009. National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States." NCRP Report 160, Bethesda, MD check

NRC 1977. U.S. Nuclear Regulatory Commission. "Regulatory Guide 1.109 - Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, Washington, DC

SCDHEC 2014. South Carolina Department of Health and Environmental Control. "Water Classifications and Standards," South Carolina Code of Regulations, R.61-68, Columbia, SC

SRNS 2018. Savannah River Nuclear Solutions, LLC. "Environmental Report for 2017," SRNS-RP-2018-00470, Savannah River Site, Aiken, SC

SRNS 2020. Savannah River Nuclear Solutions, LLC. "Groundwater Management Strategy and Implementation Plan (U)," WSRC-RP-2006-4074, Updated October 2020, Savannah River Site, Aiken, SC

SRNS 2022a. Savannah River Nuclear Solutions, LLC. "Annual 2021 M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action Report (U)," SRNS-RP-2022-05328, Savannah River Site, Aiken, SC

SRNS 2022b. Savannah River Nuclear Solutions, LLC. "Annual Corrective Action Report for the F-Area Hazardous Waste Management Facility, the H-Area Hazardous Waste Management Facility, and the Mixed Waste Management Facility (U)," SRNS-RP-2022-00276, Savannah River Site, Aiken, SC

SRS EDAM 2017. Savannah River National Laboratory. "Environmental Dose Assessment Manual," SRNL-TR-2010-00274, Revision 2, October 2017, Savannah River National Laboratory, Aiken, SC

Stagich, Dixon, and LaBone 2022. Stagich, B.H., K.L. Dixon, and E.D. LaBone. "Radiological Impact of 2021 Operations at the Savannah River Site," SRNL-STI-2022-00323, Rev. 0, July 2022, Savannah River National Laboratory, Savannah River Site, Aiken, SC

Stone and Jannik 2013. Stone, D.K. and G.T. Jannik. "Site Specific Reference Person Parameters and Derived Concentration Standards for the Savannah River Site," SRNL-STI-2013-00115, Savannah River National Laboratory, Aiken, SC

Yu et al. 2001. C. Yu, A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, Amish, A. Wallo III, W.A. Williams, and H. Peterson. "User's Manual for RESRAD," Version 6, Environmental Assessment Division, Argonne National Laboratory, Argonne, IL, July 2001

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Appendix H: **Units of Measure**

Symbol	Name	Symbol	Name
Temperature		***Concentration***	
°C	degrees Celsius	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	Ci/mL	curie per millilter
km	kilometer	cpm	counts per minute
m	meter	mCi	millicurie
mm	millimeter	µCi	microcurie
µm	micrometer	pCi	picocurie
Mass		pCi/L	picocurie per liter
g	gram	Bq	becquerel
kg	kilogram	***Radiation Dose***	
mg	milligram	mrad	millirad
µg	microgram	mrem	millirem
Area		Sv	sievert
mi^2	square mile	mSv	millisievert
ft^2	square foot	µSv	microsievert
Volume		R	roentgen
gal	gallon	mR	milliroentgen
L	liter	µR	microroentgen
mL	milliliter	Gy	gray

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

Conversion Table (Units of Radiation Measure)		
Current System	***Systeme International***	**Conversion**
curie (Ci)	becquerel (Bq)	1 Ci = $3.7\text{x}10^{10}$ 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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