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Savannah River Site
Groundwater Protection Program (U)

SRNS-TR-2009-00076

Revision 4

October 2018

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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Printed in the United States of America
Prepared for
U. S. Department of Energy
and
Savannah River Site Nuclear Solutions, LLC
Aiken, South Carolina

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
ALARA	As Low As Reasonably Achievable
BMP	Best Management Practices
CA	Composite Analysis
CAA	Clean Air Act
CAB	Citizens Advisory Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMC	Chemical Management Center
CWA	Clean Water Act
D&D	Deactivation and Decommissioning
DWPF	Defense Waste Processing Facility
EC	Environmental Compliance
EC&ACP	Environmental Compliance and Area Completion Projects
ECA	Environmental Compliance Authority
EEC	Environmental Evaluation Checklist
EMS	Environmental Management System
EPCRA	Emergency Planning and Community Right-to-Know Act
EQMD	Environmental Quality Management Division
ERPP	Environmental Radiological Protection Program
ERO	Emergency Response Organization
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FFA	Federal Facility Agreement
GMCT	Groundwater Modeling Consistency Team
GPP	Groundwater Protection Program
HWMF	Hazardous Waste Management Facility
IC	Institutional Controls
IDW	Investigation Derived Waste
ISD	In Situ Decommissioning
LUC	Land Use Controls
LLWF	Low-Level Waste Facility
LWO	Liquid Waste Operations
M&O	Management and Operations
MCL	Maximum Contaminant Level
MRWJ	Mueser, Rutledge, Wentworth, and Johnston Consulting Engineers
MWMF	Mixed Waste Management Facility
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
ORO	ORPS Reporting Official
ORPS	Occurrence Reporting and Processing System
P2	Pollution Prevention
PA	Performance Assessment

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
PCB	polychlorinated biphenyl
PPA	Pollution Prevention Act
RCRA	Resource Conservation and Recovery Act
RSER	Removal Site Evaluation Report
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SEPC	Site Environmental Protection Coordinator
SEMC	Senior Environmental Managers Council
SIRIM	Site Item Reportability and Issue Management
SPCC	Spill Prevention Control and Countermeasure
SDF	Saltstone Production Disposal Facility
SRIT	SRS Regulatory Integration Team
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SRSOC	SRS Operations Center
SWM	Solid Waste Management
TSCA	Toxic Substances Control Act
TRU	Transuranic
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USDOE-SR	U.S. Department of Energy-Savannah River
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
Waste Min	Waste Minimization
WSRC	Westinghouse Savannah River Company
WSRC	Washington Savannah River Company LLC

1.0 INTRODUCTION

The U.S. Department of Energy (USDOE) Order 436.1, *Department Sustainability*, requires USDOE sites to maintain an Environmental Management System (EMS) that implements sound stewardship practices that are protective of the air, the land, and other natural archaeological, and cultural resources that could be potentially impacted by construction, operations, maintenance, and decommissioning activities. Because groundwater can be affected by any operating facility or activity, implementation of the site's EMS should ensure that all efforts to protect groundwater resources are integrated within a site-wide program. This Groundwater Protection Program (GPP) plan supports the Savannah River Site (SRS) EMS program by providing an overarching document that describes the integrated program for groundwater protection, management, monitoring, and restoration at the SRS. In addition, this plan also addresses specific requirements provided in USDOE Order 458.1, *Radiation Protection of the Public and the Environment*, which establishes requirements to protect the public and the environment against undue risk from radiation associated with USDOE radiological activities (USDOE 2013). Specific USDOE requirements addressed in this GPP document include:

- Demonstrating Compliance with the Public Dose Limit (USDOE O 458.1, 4e).

    (5) Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.

    (9) Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate the dispersal pattern in the environs, characterize the pathway(s) of exposure to members of the public and estimate the doses to individuals and populations in the vicinity of the site or operation commensurate with the nature of the USDOE radiological activities and the risk to the public and the environment. Radiological monitoring must be integrated with the general environmental and effluent monitoring. Environmental monitoring must include, but is not limited to:

        (a) Effluent Monitoring

(b) Environmental Surveillance

- Control and Management of Radionuclides from USDOE Activities in Liquid Discharges (USDOE O 458.1, 4g). Operators of USDOE facilities discharging or releasing liquids containing radionuclides from USDOE activities must:

  (3) Conduct activities to ensure that liquid releases containing radionuclides from USDOE activities are managed in a manner that protects groundwater resources now and, in the future, based on use and value considerations.

  (10) Manage the disposition of non-process water potentially containing radionuclides from USDOE activities to protect soil and groundwater and prevent the creation of future cleanup sites.

- Protection of Drinking Water and Groundwater (USDOE O 458.1, 4i).

  (1) USDOE sites must provide a level of radiation protection for persons consuming water from a drinking water system operated by USDOE, directly or through a USDOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR Part 141, *National Primary Drinking Water Regulations* (that is, not exceed the radionuclide maximum contaminant levels [MCLs]).

  (2) Groundwater must be protected from radiological contamination to ensure compliance with dose limits in the Order and consistent with As Low As Reasonably Achievable (ALARA) process requirements. To this end, USDOE must ensure that:

  (a) Baseline conditions of the groundwater quantity and quality are documented;

  (b) Possible sources of, and potential for, radiological contamination are identified and assessed;

  (c) Strategies to control radiological contamination are documented and implemented;

  (d) Monitoring methodologies are documented and implemented; and

  (e) Groundwater monitoring activities are integrated with other environmental monitoring activities.

2.0 SRS OVERVIEW

2.1 Site Location

SRS is a USDOE complex constructed during the early 1950s to produce nuclear materials for weapons. The site borders the Savannah River and encompasses approximately 310 mi^2 in South Carolina (Figure 1). Savannah River Nuclear Solutions, LLC (SRNS) is responsible for the SRS Management and Operations (M&O) activities. Savannah River Remediation LLC (SRR) is responsible for the Liquid Waste Operations (LWO).

2.2 Geology and Hydrogeology

The Atlantic Coastal Plain sequence beneath the SRS consists mostly of semi-consolidated clastic sediments - layers and various mixtures of sand, silt, clay, and gravel deposited by water in shallow marine, marginal marine, and nearshore fluvial environments (Figure 2). The groundwater system at SRS consists of four major aquifers, which include from deepest to shallowest, the McQueen Branch, the Crouch Branch, the Gordon, and the Upper Three Runs Aquifers. Groundwater normally migrates downward and laterally either discharging into the Savannah River and its tributaries or migrating into the deeper regional aquifer system. The site uses groundwater for process water in facilities and for drinking water. Contaminated groundwater plumes predominately occur with the shallow aquifers (Upper Three Runs and Gordon Aquifers), however drinking water wells generally extract groundwater from the deeper aquifers (Crouch Branch and McQueen Branch Aquifers) (SRNS 2011a).

2.3 Facilities

During the time when SRS produced materials for nuclear weapons, the site encompassed five reactors, a heavy water reprocessing facility, separations areas, waste management facilities, a reactor material area, and administration and research facilities. In recent years, many of these facilities have been shut down. Currently, one of the SRS missions is environmental stewardship, which focuses on groundwater restoration, deactivation and decommissioning (D&D) of excess contaminated facilities, and radioactive waste disposition.

Groundwater restoration programs include both Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) facilities and waste sites. Radioactive waste disposition at SRS includes the closure of high-level radioactive waste tanks and operation of the Saltstone Disposal Facility, the low-level radioactive waste storage and disposal facility, and the radioactive waste glassification plant. Descriptions of these facilities can be found in other site documents as systems plans, closure plans, performance assessments (PAs), and the site composite analysis (CA) (e.g., SRNL 2010, SRR 2011, WSRC 1999, and WSRC 2008)

2.4 Groundwater Use/Conservation

Groundwater is the source of all domestic water at SRS, and therefore, SRS is subject to South Carolina regulations R. 61-58, *State Primary Drinking Water Regulations,* which defines requirements for water systems with groundwater sources. Requirements include periodic sample collection and analysis by SRS and South Carolina Department of Health and Environmental Control (SCDHEC) to ensure groundwater and drinking water meet bacteriological and chemical drinking water quality standards (e.g., MCLs) (SRNS 2011a). Domestic water at SRS is monitored at onsite locations and at water treatment facilities that use the Savannah River for water. A summary of results including exceedances is reported annually in the Annual SRS Environmental Report.

South Carolina regulation R.61-113, *Groundwater Use and Reporting,* is concerned with any groundwater well that will withdraw 3 million gallons or more of groundwater in any month. SRS has wells of this capacity and higher (SRNS 2011a). *[Note: a 150-gallon per minute well pumping only 12 hours a day will exceed 3 million gallons per month]*. Given its location on the Coastal Plain, SRS is required to submit a Notice of Intent 30 days prior to installing a new well or increasing the capacity of an existing well before withdrawing. SRS, as a groundwater withdrawer, is required to submit annually (before January 30), a water use report documenting the quantities of groundwater withdrawn, and the report includes both domestic and process wells.

2.5 Baseline Conditions

SRS has considerable knowledge of the site's subsurface environment. This information includes core field descriptions, cone penetrometer electric logs, borehole geophysical logs, geotechnical data, cross-hole tomography/resistivity, ground penetrating radar, seismic data, borehole flow test data, aquifer pumping test data, slug test data, x-ray fluorescence, geochemical data, and groundwater level data.

Baseline characterization started in the early 1950s prior to construction of the SRS when the U.S. Army Corps of Engineers (USACE) performed an extensive evaluation of the subsurface. Their work included aerial photography, geologic mapping, and geotechnical drilling (USACE 1951 and USACE 1952). Since that time, numerous studies have investigated SRS's groundwater regime and geochemistry. A few of these studies are highlighted below.

- During the 1980's, the Savannah River National Laboratory (SRNL), formerly known as the Savannah River Laboratory (1951-1992) and the Savannah River Technology Center (1992-2004), installed a series of observation well clusters in remote and background areas (upgradient of operating facilities) at SRS (Bledsoe 1984, Bledsoe 1987, and Bledsoe 1988). These well clusters are referred to as the P Wells and are part of SRNL's current regional water-level monitoring program. Since their installation, SRNL has periodically monitored these wells using the data to determine overall changes and impacts to the regional groundwater systems, to establish horizontal and vertical gradients, to determine geochemistry of the units, and to provide lithologic information for coastal plain sediments down to bedrock. In recent years, P Well data have been utilized in local and regional groundwater flow models performed at SRS in support of various PAs, CAs, remedial action evaluations, facility siting(s), and the Underflow Study conducted by the United States Geological Survey (USGS).
- Marine (1976) provides one of the earliest comprehensive geochemistry studies for SRS. As part of this study, Marine documented and interpreted water rock analyses from the Bedrock Waste Storage Exploration Program and from earlier studies of bedrock exploration. Data collection spanned from 1961 to 1973 and included samples from the bedrock, Coastal Plain aquifers, and surface waters.

- In the 1970's, Mueser, Rutledge, Wentworth and Johnston (MRWJ) Consulting Engineers conducted investigations at the F Area and H Area Tank Farms (MRWJ 1974; MRWJ 1975a, MRWJ 1975b, MRWJ 1975c, MRWJ 1975d, MRWJ 1977a, and MRWJ 1977b). Much of this work focused on geotechnical characterization for engineering purposes (e.g., slope stability, settlement issues) and involved exploratory drilling, soil descriptions and testing, identification of the water table, construction of geologic cross-sections, and mapping of calcareous zones.
- The mineralogy and chemistry of principal hydrogeologic units and the geochemistry of the water in principal aquifers at SRS was evaluated as part of the Baseline Hydrogeologic Investigation (WSRC 1992). Groundwater analyses included major cations, anions, minor and trace elements, gross alpha and nonvolatile bet, tritium, stable isotopes of hydrogen, oxygen and carbon, and carbon-14. Sediments were analyzed for mineralogy in addition to major and minor elements.
- As part of the Underflow Study, the USGS evaluated groundwater levels, predevelopment groundwater flow and stream-aquifer relations in a 5,147-square mile study area that included SRS and adjacent parts of Georgia and South Carolina (Clark and West 1997 and Clark and West 1998).

In addition to these specific studies, other documents are also available that provide comprehensive baseline information regarding the geology and hydrogeology at SRS including Aadland et al. (1995) and Denham (1999). Because of the extensive environmental dataset available for SRS, little baseline subsurface characterization work is currently commissioned. However, in areas where new facilities are planned, and existing baseline data is insufficient, further characterization is performed.

3.0 IDENTIFICATION AND ASSESSMENT OF CONTAMINANT SOURCES

3.1 Legacy Facilities/Waste Sites

Past operations at SRS have resulted in the release of hazardous and radioactive substances to soil and groundwater in some instances with contamination levels exceeding regulatory thresholds. The mission of Environmental Compliance and Area Completion Projects (EC&ACP) personnel

is to D&D contaminated facilities and remediate soils, groundwater, surface water, and sediments to levels that comply with established regulatory standards and that protect human health and the environment.

As documented in the *Federal Facility Agreement for the Savannah River Site* (FFA 1993) (FFA), EC&ACP investigates areas with potential or known release of hazardous substances that have not yet been identified in the FFA agreement. Upon discovery of such a site, USDOE at SRS notifies the United States Environmental Protection Agency (USEPA) and SCDHEC. Once the site assessments are complete, USDOE submits the Removal Site Evaluations Reports (RSERs) to the USEPA and SCDHEC and if necessary, appropriate actions are taken (e.g., removal actions are initiated, or the site is added to the SRS Site Evaluation List, Appendix G in the FFA).

For sites that have already been identified and are listed in the SRS Site Evaluation List of Appendix G in the FFA, EC&ACP conducts a remedial preliminary assessment following federal guidelines. Upon completion of the site assessments, USDOE submits RSERs and recommendations to the USEPA and SCDHEC. Agreement among the three parties (USDOE, USEPA, and SCDHEC) is required for final disposition of RSERs

3.2 Operating Facilities

In addition to legacy sites, releases of hazardous and radioactive substances to the environment can also occur through ongoing site operations. During day-to-day operations, liquid discharges and air emissions have a potential to release contaminants to the environment. SRS uses (ALARA) to manage these releases.

Effluent/waste monitoring and environmental surveillance programs at SRS are used to identify, characterize, trend, and report the effects, if any, of SRS operations on the public and the environment. The monitoring programs also verify compliance with applicable environmental regulations, USDOE orders, and commitments made in environmental documents. Examples of the types of monitoring conducted at SRS are listed in Section 5.0, Monitoring of Hazardous Materials and Radionuclides. Results from these monitoring programs are documented in annual facility monitoring reports as well as the annual Savannah River Site Environmental Report.

3.3 New Facilities

The SRS EMS implements and integrates the environmental requirements mandated by statutes, regulations, and policies. The EMS is executed by multiple contractors using documents, programs, and strategies tailored to organization-specific resources. USDOE at SRS oversees the contractors to ensure a consistent and integrated site program. As new facilities and missions are brought to SRS, the EMS will incorporate the new or updated environmental programs and strategies.

3.4 Evaluation of Dose

At SRS, direct measurements of radiological effluents are made to the extent practical and the results are documented in the site's annual environmental report. In addition, some environmental surveillance data (surface water data) are used to determine the overall radiological source terms for dose analyses. Surface water data are used to quantify the shallow groundwater migration into site streams from the Solid Waste Disposal Facility and from the various closed waste sites and operating facilities.

The annual compliance dose analysis only encompasses radiological releases to the atmosphere and surface water since these are the primary media that can carry radiological contaminants offsite (SRNL 2016). Groundwater is not considered a primary carrier of radiological contaminants offsite because groundwater monitoring data for SRS show that only an estimated 3% of the site has been contaminated by radionuclides and there is no evidence that groundwater contaminated with radionuclides has migrated offsite (SRNS 2018). With the exception of the radiological source terms originating from the shallow groundwater migrating into site streams (e.g., seeplines), onsite groundwater is not considered as a potential exposure pathway to offsite people.

4.0 STRATEGIES TO CONTROL HAZARDOUS MATERIALS AND RADIOLOGICAL CONTAMINATION

4.1 Environmental Policies and Management

Environmental policies and management at SRS are guided and implemented to comply with federal, state, and local environmental laws and regulations, and USDOE orders, notices, and

directives. These regulations, as well as site procedures and controls, ensure that work is performed in a manner that safely manages radionuclides and protects drinking water and groundwater. Training and communication at SRS and within the surrounding community support the environmental management program by disseminating information and providing opportunities for improvements to the site's overall environmental performance.

SRNS is the prime contractor for the M&O activities at the SRS for USDOE. As such, groundwater monitoring is the responsibility of SRNS. SRR is the prime contractor for the liquid waste operations at the site. In addition, several other major contractors to USDOE provide various support services to the Site or are constructing new facilities. These contractors include Ameresco Federal Solutions, CB&I AREVA MOX Services, LLC, Parsons, University of Georgia Savannah River Ecology Laboratory, U.S. Army, U.S. Department of Agriculture Forest Service – Savannah River, and Centerra Group, LLC. These contractors and tenants are required to implement environmental protection and compliance programs as provided in program specific contracts and agreements with USDOE and to support compliance with environmental permits issued directly to their organization or company. Specific requirements to implement site programs described herein can be found in functional service agreements or program-specific compliance and contract requirements.

4.1.1 Federal and South Carolina Regulations

SRS is subject to a host of state and federal regulations that pertain to the protection of groundwater from contaminants. A list of these regulations and a brief description are provided below.

- SC R.61-58, *State Primary Drinking Water Regulations* defines requirements for water systems with groundwater sources. Requirements include periodic sample collection and analysis by SRS and SCDHEC to ensure groundwater and drinking water meet bacteriological and chemical drinking water quality standards
- SC R.61-67, *Standards for Wastewater Facility Construction* covers permitting of groundwater treatment units such as the air strippers at A/M-Area, and (historically) the groundwater treatment systems at F-Area and H-Area Seepage Basins.

- SC R.61-68, *Water Classifications and Standards* is important in the protection and cleanup of groundwater at SRS. This regulation classifies all South Carolina groundwater as Class GB effectively requiring groundwater to be below MCLs set forth in R.61-58, *State Primary Drinking Water Regulations*. It is also the regulation that allows for groundwater mixing zones, which allow groundwater to deviate from these standards under specific conditions. Groundwater mixing zones have been used as part of the groundwater remediation strategy at SRS.

- SC R.61-71, *South Carolina Well Standards* sets the requirements for monitoring wells (temporary and permanent/conventionally drilled and direct push) and environmental borings at SRS. Issues related to driller certification, well construction, identification and abandonment, data generated, and SCDHEC approval prior to installation and abandonment of monitoring wells are covered. Likewise, with environmental borings, attention is paid to the reporting of data from borings, the abandonment of borings, and the documentation thereof.

- SC R.61-82, *Proper Closeout of Wastewater Treatment Facilities* provides activities that should be undertaken upon cessation of a wastewater treatment facility to mitigate current or prevent future impacts to the environment.

- SC R.61-87, *South Carolina Underground Injection Control* gives SCDHEC the authority to regulate the injection of fluids into the subsurface by means of an injection well. This regulation impacts SRS groundwater corrective action projects, which have permitted Class V.A. injection wells for the re-injection of treated water and nutrient addition. EC&ACP maintains a variety of applications for construction permits and permits to operate.

- SC R.61-92, Part 280: *Underground Storage Tank Control Regulations* Subparts E and F, are concerned with releases from Underground Storage Tank (UST) systems. Subpart E discusses the reporting of releases from a UST system. Groundwater related site characterization and corrective action as a result of UST system releases are discussed in Subpart F.

- SC R.61-107.19, *SWM: Solid Waste Landfills and Structural Fill,* Subpart E of Parts IV and V, is concerned with groundwater monitoring and corrective action for landfills. SRS has five landfills on site that are subject to the requirements of this Subpart and include the Interim Sanitary Landfill, Saltstone Disposal Facility (SDF), 632-G Class 2 Landfill, the 488-4D Ash Landfill, and the 288-F Ash Landfill.

- SC R.61-113, *Groundwater Use and Reporting* is concerned with any groundwater well that will withdraw 3 million gallons or more of groundwater in any month. SRS has wells of this capacity and higher.

- The *1996 Amendments to the Safe Drinking Water Act* requires SCDHEC to provide Source Water Assessments to federally defined public water systems. This assessment provides information on a system's drinking water source and its susceptibility to contamination.

- RCRA and the Hazardous and Solid Waste Amendments apply to RCRA-permitted Treatment, Storage, and Disposal facilities with releases from regulated land-based hazardous waste land disposal units. These facilities must conduct groundwater monitoring to detect, characterize, and respond to releases of hazardous waste or hazardous waste constituents into the uppermost aquifer. These regulations apply to six facilities at SRS: F-Area Hazardous Waste Management Facility (HWMF), H-Area HWMF, M-Area HWMF, Metallurgical Laboratory HWMF, Sanitary Landfill, and the Southwest Plume of the Mixed Waste Management Facility (MWMF).

- CERCLA and the *National Oil and Hazardous Substance Pollution Contingency Plan* (NCP). The NCP is the regulation that implements CERCLA and states that the USEPA expects to return usable groundwater to their beneficial uses wherever practicable within a timeframe that is reasonable given the particular circumstances of the site. CERCLA requires that a federal facility placed on the National Priorities List enter into an interagency agreement with the USEPA to govern the cleanup to be done. This interagency agreement is known as the FFA and is an agreement between SCDHEC, USDOE, and USEPA, which, among other actions, integrates CERCLA response actions and RCRA corrective measures.

- USDOE Order 435.1, *Radioactive Waste Management* (USDOE 1999) is applicable to the operation and closure of the E-Area Low Level Waste Facility (LLWF), SDF, and closure of the F-Area and H-Area Tank Farms. This order requires that a PA be conducted to demonstrate that among other things that facility operations and closure remain protective of the groundwater. The order also requires a site-wide analysis, the CA, to ensure that USDOE low-level waste disposal, high-level waste tank closure, and transuranic waste disposal will provide radiological protection to the public. Facility and site-wide monitoring are performed as required by the Order to verify that facility releases remain within the protective bounds of the PA and CA.
- USDOE Order 458.1, *Radiation Protection of the Public and the Environment* (USDOE 2013) establishes the requirements to protect the public and the environment against any undue risk from radiation associated with radiological activities at the USDOE sites. This order requires an Environmental Radiological Protection Program (ERPP). The SRS ERPP describes the methods used to ensure SRS implements the appropriate actions to comply with the requirements of DOE Order 458.1 (SRNS 2016). DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard to the public is 100 millirem (mrem) (1 milliSievert [mSv]) per year to a person from routine USDOE operations.
- The 1947 *Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)* regulates the application or restricted-use pesticides at SRS through a state-administered certification program.
- The 1969 *National Environmental Policy Act (NEPA)* mandates that federal agencies identify and consider the potential environmental consequences of their proposed actions early in the planning process, so they can make informed and environmentally sound decisions regarding project design and implementation.
- The 1976 *Toxic Substances Control Act (TSCA)* addresses the production, importation, use, and disposal of specific chemicals, including polychlorinated biphenyls (PCBs), asbestos, and lead-based paint.

- The 1977 *Clean Water Act (CWA)* regulates liquid discharges at outfalls (e.g., drains or pipes) that carry effluents to streams (National Pollutant Discharge Elimination System [NPDES], Section 402) in addition to regulating dredge and fill activities.
- The 1986 *Emergency Planning and Community Right-to-Know Act (EPCRA)* requires facilities to notify state and local emergency planning entities about their hazardous chemical inventories and to report releases of hazardous chemicals.
- The 1990 *Pollution Prevention Act (PPA)* established national policy regarding pollution prevention and source reduction whenever feasible and expanded the EPCRA mandated Toxic Chemical Release Inventory. It requires business owners to file a toxic chemical release form that includes a toxic reduction and recycling report to regulators. Several requirements in the PPA are also included in the other federal mandates such as the CWA, the RCRA, and the FIFRA.
- The *1996 Amendments to the Safe Drinking Water Act* requires SCDHEC to provide Source Water Assessment to federally defined public water systems. This assessment provides information on a system's drinking water source and its susceptibility to contamination.

4.1.2 Site Procedures

SRS procedures provide direction concerning environmental work and radiological control ensuring compliance with federal, state, and local environmental laws and regulations, and USDOE orders, notices, and directives. The following procedures provide examples of site controls that protect the environment from the release of hazardous and radioactive materials.

- The 5Q Manual, *Radiological Control*, gives guidance related to radiological standards, conduct of radiological work, control of radioactive materials, radiological health support, radiological training, and radiological control records. The 5Q Manual, along with the Radiation Protection Program, focuses on minimizing the generation of radioactive waste and discharges to the environment and controlling contamination at it source.
- The 3Q1 Manual, Section 200, *Environmental Permitting Requirements Documents*, includes descriptions of permitting processes and delineates responsibilities regarding domestic water wells and treatment systems, industrial wastewater systems, sanitary

wastewater collection systems and treatments, septic tank and tile field systems, stormwater discharges, monitoring wells, and underground injection control (UIC) systems.

- The 3Q1 Manual, Section 9000, *Hydrogeologic Data Collection Procedures and Specifications*, provides guidance related to soil boring investigations, installation of piezometers and wells, sampling of groundwater wells and well abandonments. As documented in these procedures, work is conducted in accordance with SCDHEC regulations and specifies requirements (e.g., use of surface casing, installation of a bentonite seal, and grouting requirements) that prevent contaminants from being carried into uncontaminated aquifers.

- The 3Q Environmental Compliance Manual, Section 1.0, *Groundwater*, Procedure 1.1, "Groundwater Monitoring", outlines the permitting process and individual responsibilities involved in the installation or abandonment of groundwater monitoring wells at the SRS and establishes guidelines for the collection and analysis of groundwater or soil samples from monitoring wells or boreholes at SRS.

- The 3Q Environmental Compliance Manual, Section 2.0, *Spills and Discharges*, includes Procedure 2.3, "Best Management Practices", which ensures compliance with the conditions stipulated in the SRS NPDES Permits to prevent the release of hazardous and toxic substances and prevent their discharge into waters of the State. Other procedures in this section include Procedure 2.4, "Spill Prevention, Control and Countermeasure (SPCC)", which deals with oil pollution prevention, and Procedure 2.20, "Reporting Releases to the Environment".

- The 3Q Environmental Compliance Manual, Section 3.0, *Wells and Drinking Water*, details requirements for the abandonment of production wells and describes the responsibilities for permitting domestic water wells at SRS.

- The 3Q Environmental Compliance Manual, Section 5.0, *Environmental Evaluation* establishes the responsibilities and requirements for preparation and use of the Environmental Evaluation Checklist (EEC). The EEC, which initiates the NEPA process,

is used to identify potential environmental impacts and regulatory requirements (e.g., Federal and State permits) associated with proposed SRS actions.

- The 3Q Environmental Compliance Manual, Section 6.0, *Wastes*, consists of procedures for the following: 1) providing guidance for proper handling, documentation, oversight and disposal of sanitary and special wastes; 2) outlining the process for determining whether a solid waste is hazardous or nonhazardous; 3) summarizing the requirements for proper management of closure of USTs; 4) defining the responsibilities and requirements for implementing a Pollution Prevention (P2) Program; 5) establishing the requirements and responsibilities for identifying, characterizing, and establishing fiduciary responsibility for newly discovered potential waste units; 6) providing the specific instruction for the management of hazardous or mixed wastes in staging areas and satellite accumulation areas in accordance with RCRA and South Carolina Hazardous Waste Management Regulations (SCHWMR); and 7) addressing used oil management and metallic lead management.
- The 3Q Environmental Compliance Manual, Section 8.0, *Insecticides, Fungicides and Rodenticides*, provides general requirements for complying with the FIFRA. It includes requirements for the application, storage, and disposal of pesticides at SRS.
- The 3Q Environmental Compliance Manual, Section 18.0, *Site Coordination*, addresses radiological effluent monitoring, reporting, and the environmental ALARA process. The procedures broadly establish requirements for monitoring and reporting radiological releases to the environment via process effluents and documents the process for establishing and trending Environmental ALARA Release Guides.

4.1.3 Training

Environmental training at SRS is conducted to ensure that personnel whose actions could have environmental consequences are properly trained and made aware of their responsibilities to competently protect the environment, workers, and the public. General environmental awareness training is provided to all SRS employees as part of their initial General Employee Training and subsequent Consolidated Annual Training. Specialized training is developed and offered through a centralized training organization that uses subject matter experts within the environmental

programs. The environmental training program covers topics such Environmental Laws and Regulations, Hazardous Waste Worker Responsibilities, Hazardous and Radiological Waste Characterization, and Environmental Compliance Authorities (ECAs). More than 50 environmental program-related training courses are listed in the site-training database and individual organizations schedule and perform other facility-specific, environmental related training to ensure that personnel have the knowledge and skills to perform work safely and, in a manner, that protects the environment in and around SRS.

4.1.4 Communication

The ultimate goal of environmental communications at SRS is to improve stakeholder understanding, to advance the site's overall environmental performance, and to protect human health and the environment in the surrounding communities. Environmental communications are guided by regulatory policies as well as site procedures and programs. At the core of the communication and community involvement programs are the SRS Environmental Policy and the *Savannah River Site Federal Facility Agreement Community Involvement Plan* (SRNS 2011b). This plan describes the goals and types of community involvement activities implemented by SRS. Community involvement activities include the SRS Citizens Advisory Board (CAB), public meetings and workshops, public tours of SRS, and outreach opportunities. The CAB offers advice and recommendations to USDOE-Savannah River (SR) on environmental compliance, remediation, waste management, facility decommissioning, and related issues. Ex-officio members from USDOE-SR, USEPA, SCDHEC, and the Georgia Department of Natural Resources participate in CAB activities. Public meetings and workshops, outreach opportunities and site tours provide the public with information regarding site operations, cleanup activities, as well as potential health and environmental issues.

Additional forums at SRS for the dissemination of environmental issues include the Senior Environmental Managers Council (SEMC), USDOE-SR's Environmental Quality Management Division (EQMD) and the SRS Regulatory Integration Team (SRIT). SEMC members, who consist of senior-level environmental managers from all SRS contractors, share information on environmental concerns, regulatory matters, SRS operational issues, and improvements to the SRS environmental compliance program. EQMD convenes regular meetings between SRS contractors

and USDOE environmental oversight staff to discuss issues relevant to environmental protection and compliance. The SRIT consists of USDOE-SR, USEPA (Region 4), and SCDHEC representatives and addresses issues that are cross-cutting and require high-level agency collaboration. In addition to these forums, SRS contractors participate in corporate reach back reviews with their respective companies and perform benchmarking assessments of outside organizations, which identify best practices beneficial to operations and environmental compliance at SRS.

CERCLA requires SRS to notify the National Response Center if an unpermitted release to the environment of a reportable quantity of a hazardous substance (including radionuclides) occurs. Reportable quantities are quantities of a hazardous substance greater than or equal to values specified in 40 CFR 302 "Designation, Reportable Quantities and Notification". A summary of reportable releases is provided each year in the Annual SRS Environmental Report.

4.1.5 Environmental Evaluation Checklist (EEC)

Determining elements of activities, products, processes, and services that could have significant impact on the environment is part of the SRS EEC. This checklist is used site-wide to include research and development, environmental cleanup, waste disposal, site operations, and D&D activities. With the checklist, principal investigators, supervisors, and subject matter experts identify and evaluate the significance of potential hazards to the environment. Questions on the checklist focus on gathering information to enable appropriate NEPA reviews (e.g., no review required, categorical exclusion determination, and environmental assessment of an environmental impact statement). In addition, questions specifically address the generation of radioactive emissions, radioactive discharges, and other types of radioactive waste in addition to their potential impacts to surface water and groundwater.

4.1.6 Land Use Control

On April 21, 1998, the USEPA Region 4, Federal Facilities Branch, issued a memorandum entitled *Assuring Land Use Controls at Federal Facilities* (USEPA 1998). By implementing this policy, USEPA Region 4 sought the development of Land Use Control Assurance Plans by federal facilities that utilize land use controls (LUCs) as components of RCRA/CERCLA remedies. SRS

developed the *Land Use Control Assurance Plan for the SRS* (WSRC 1999) for the purpose of cooperating with the USEPA memorandum and protecting human health and the environment.

LUCs, as defined in the USEPA Region 4 Policy and concerning real property on federal facilities, means any restriction or control that limits the use of and/or exposure to any portion of that property, including water resources, arising from the need to protect human health and the environment. The term encompasses "institutional controls" (ICs), such as those involved in real estate interests, governmental permitting, zoning, public advisories, deed notices, and other "legal" restrictions. The term may also include restrictions on access, whether achieved by means of engineered barriers (e.g., fence or concrete pad) or by human means (e.g., the presence of security guards). Additionally, the term may involve both affirmative measures to achieve the desired restrictions (e.g., night lighting of an area) and prohibitive directives (e.g., no drilling of drinking water wells). Considered altogether, the LUCs for a facility will provide a tool for how its property should be used in order to maintain the level of protectiveness that one or more remedial/corrective actions were designed to achieve.

SRS utilizes a comprehensive planning process. This process entails a systematic method for ensuring a site-wide approach to moving the site from the present into the future based on SRS strategic planning. A comprehensive plan is developed that addresses such things as land use, facilities, infrastructure, cultural resources, and natural resources. A site procedure is in place to ensure that proposed land and facility activities are considered for consistency with the comprehensive plan. This process, along with the Site Use/Site Clearance Permit system, ensures that sites selected for an activity are the most appropriate and that any potential conflicts or problems are identified and solved prior to approval.

As part of the FFA, SRS along with USEPA and SCDHEC ensure that environmental impacts associated with past and present activities at SRS are thoroughly investigated, and that appropriate corrective/remedial actions are taken to protect public health and welfare and the environment. The *Land Use Control Assurance Plan for the SRS* (SRNS 2011b) highlights waste units within each watershed that have LUC/ICs as part of the selected remedy. As the three Parties (SRS,

USEPA, and SCDHEC) agree upon remedial decisions, the document is periodically updated to highlight those waste units that require land use controls as part of the remedial decision.

4.1.7 Spills and Releases Prevention and Response

The *SRNS Best Management Practices Plan* (SRNS 2013) along with site procedures (e.g., Manual 3Q, *Environmental Compliance Manual,* Procedure 2.3, "Best Management Practices") guide site operations in the prevention of spills and releases. Similarly, for oil, there is the *SRNS Spill Prevention Control Countermeasure Plan* (SRNS 2011d) along with site procedures (e.g., Manual 3Q, Procedure 2.4, "Spill Prevention Control and Countermeasure [SPCC] Plan"). The *SRNS Best Management Practices Plan* (SRNS 2013) outlines site organizations involved in the development, implementation, oversight, and evaluation of Best Management Practices (BMP), and who are collectively in charge of identifying and preventing the discharge of hazardous and toxic materials into the environment.

As part of the periodic update of the BMP and SPCC plans, walk downs, and coordinated reviews are conducted to verify the current status of equipment and facilities and assess the potential to release hazardous and toxic pollutants and oil. For each area at SRS, detailed descriptions are documented in the BMP plan regarding sources of toxic/hazardous materials, potential pathways for release and methods to control or contain the material in the event of a spill or release. This approach is utilized for oil in the SPCC Plan, as well. Applicable to both chemicals and oil, control and containment methods often include secondary containment and may consist of sloping floors, liners, outer stainless-steel cells, diked areas, and/or sumps for collection/monitoring.

Multiple documents and procedures guide site operations in the response to spills and releases and include:

- Oil Pollution Act of 1990
- 40 CFR 110 – Discharge of Oil;
- 40 CFR 112 – Oil Pollution Prevention;
- 40 CFR 117 – Determination of Reportable Quantity for Hazardous Substances;

- 40 CFR 300 – National Oil and Hazardous Substances Pollution Contingency Plan (or NCP);
- 40 CFR 302 – Designation, Reportable Quantities, and Notification Overview;
- CERCLA and RCRA;
- Oil and Gas Exploration, Drilling, Transportation, and Production (SC Statute);
- ORPS [Occurrence Reporting and Processing System] and non-ORPS Reporting Criteria;
- *SRS Emergency Plan* (SCD-7) (previously known as Manual 6Q – Volume I);
- Manual 3Q – Environmental Compliance Manual
- Manual 9B – *Site Item Reportability and Issue Management (SIRIM)*;Manual 6Q – *Volume II Emergency Plan/Emergency Management Program Procedures Manual* (e.g., Procedures 6Q-008 "Standards for Facility/Area Emergency Response Facilities" and 6Q-009 "Standards for Emergency Response Organization [ERO] Administration");
- SRS Pollution Prevention Plan for Storm Water Outfalls Associated with Industrial Activity (SRNS 2012b); and
- SRS Radiological Response Guide (SRS 2018).

The *SRS Emergency Plan*, SCD-7, consists of an overview of the site emergency management program. It outlines the internal emergency response organization, notification, protective actions, facilities, and equipment.

A system of procedures in place at the SRS specifies the processes, controls, and responsibilities for employees and onsite contractors to concerns that may have environmental implications, including oil discharges. This includes SRS Procedure Manual 9B, *Site Item Reportability and Issue Management (SIRIM)*. As stipulated in this procedure, employees and onsite contractors promptly report to their immediate line manager events such as oil discharges. Line managers, when notified of an event, first implement any necessary immediate corrective actions and then forward the appropriate information of the facility manager and the Occurrence Reporting and Processing System (ORPS) Reporting Official (ORO).

For releases to the environment (e.g., spills, toxic releases), Manual 3Q, *Environmental Compliance*, Procedure 2.20, "Reporting Releases to the Environment", directs facility personnel to contact the Savannah River Site Operations Center (SRSOC) who in turn will contact the Site Environmental Protection Coordinator (SEPC) in Environmental Compliance (EC). The SEPC is responsible for contacting outside regulatory authorities and consulting or following up on any necessary corrective actions and for assisting the ORO with categorizing the event.

The Fire Department is part of the SRS Emergency Services Department and, as the emergency response organization for SRS, is the initial responder for significant oil and other types of spills. Firefighters on each shift are assigned hazardous materials response duties. These emergency response duties are under the direction of a shift Battalion Chief that responds to all types of emergencies including incidents as reported by facility custodians or the SRSOC.

If needed, the Sample Data Management Section can dispatch Field Support monitoring teams to collect environmental samples. Environmental monitoring stations and fixed liquid monitoring locations along with other pre-selected sampling sites have been identified for water, vegetation, agricultural products, and milk as part of the regular extensive environmental monitoring and sampling program at SRS. In the event of an unexpected release, applicable samples can also be collected from these pre-selected sampling sites, in addition to the incident area and downwind/downgradient of the incident area. Collected samples are analyzed in certified laboratories as required to confirm release content, verify deposition, and estimate dose commitment. Initial assessments made in the early stages of an emergency release are based primarily on projections. Extended assessments may continue for several days and the post-accident assessments that may continue for several years according to readings and sampling results.

4.1.8 Chemical Management Center

The Chemical Management Center (CMC) provides centralized control for purchasing and excessing chemicals at SRS. The goals of this program include the volume and toxicity of purchased chemicals, reducing chemical inventories and waste, and improving tracking and communication of onsite chemicals. In an effort to reduce the volume of hazardous chemicals and

waste generation, chemicals are reutilized onsite, returned to the vendors, sold through sealed bid sales to approved vendors, or donated to local-area government institutions when possible.

4.1.9 Controlled Use of Pesticides

The 1947 FIFRA regulates the application of restricted-use pesticides at SRS through a state-administered certification program. The site complies with the federal mandate through site procedures, more specifically Manual 3Q, Procedure 8.0, *Insecticides, Fungicides, and Rodenticides*. Site-wide assessments are periodically conducted to improve pesticide management at SRS. All pesticides applied at the site are approved by the SRS Pesticide Use Task Group and the site CMC. Usage is documented in the Pesticide Activity Report database, which allows site environmental personnel to monitor the application practices and report chemical inventories and usage as required by the EPCRA.

4.1.10 Underground Injection Control (UIC)

UIC activities at SRS are guided by the *South Carolina Injection Control* regulation (SC R.61-87) and by the site 3Q1 Manual, Section 200, *Environmental Permitting Requirements Document*, Procedure 221, "Underground Injection Control Systems Guidelines and Permit Information". This site procedure defines the permitting process and delineates responsibility for UIC systems at SRS from the early development phases of a project until receiving final operating approval from SCDHEC. Roles and responsibilities are designated for the permit custodian, the site ECA, and the Site Groundwater Permitting Coordinator. Specific requirements are noted for injection activities associated with RCRA and CERCLA units including reviews by the SCDHEC Bureau of Land and Waste Management as well as the SCDHEC Bureau of Water.

4.1.11 Underground Storage Tank Management

An UST is any storage tank that stores a regulated substance and is at least ten percent of its volume below the surface of the ground. The term regulated substance is extremely broad, encompassing all hazardous substances under the CERCLA, substances listed in Section 112 of Part A of Title I of the federal Clean Air Act (CAA), and petroleum products. Beginning in 1985, SCDHEC has had the responsibility for regulating USTs in South Carolina. The South Carolina *Underground Storage Tank Control Regulations* (SC R.61-92, Part 280) establishes a two-part permitting

process for UST systems. First, a permit to install must be obtained prior to the installation of any system. The USTs at SRS that store petroleum products and hazardous substances, as defined by CERCLA, are regulated under Subtitle I of RCRA. These tanks require a compliance certificate annually from SCDHEC to continue operations. SCDHEC conducts annual compliance inspections and record audits prior to issuing the compliance certificate. At SRS, guidance regarding USTs is provided through Manual 3Q, Procedure 6.0, *Wastes*, Subsection 6.6, "Underground Tank Management and Removal".

4.2 Waste Management

4.2.1 Radioactive Waste Facilities

Part of the SRS's mission is to clean up Cold War legacy by safely storing, stabilizing, and disposing of radioactive wastes. Solid radioactive wastes (low-level waste, mixed low-level waste, and transuranic waste) are managed and stored in E Area facilities for eventual disposal in E Area facilities or shipment to offsite commercial disposal facilities. Liquid radioactive wastes are held in large storage tanks until they are processed on-site through one of several treatment facilities into a safe form for long-term storage and disposal. These treatment facilities include:

- Defense Waste Processing Facility (DWPF), which immobilizes high-level waste in glass and seals it into stainless steel canisters for long-term storage and disposal;
- Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit, which decontaminates the salt waste before sending it to the SDF (until the larger-scale Salt Waste Processing Facility becomes operational); and
- SDF, which processes and disposes of low-activity salt waste in a grout form.

4.2.1.1 USDOE Order 435.1

USDOE Order 435.1, *Radioactive Waste Management* (USDOE 1999), is applicable to the operation and closure of the E-Area LLWF and SDF in addition to the closure of the F-Area and H-Area Tank Farms. This order requires that a PA be conducted to demonstrate that among other things that facility operations and closure remain protective of the groundwater. The order also requires a site-wide analysis, the CA, to ensure that USDOE low-level waste disposal, high-level

waste tank closure, and transuranic waste disposal will provide radiological protection to the public. Facility and site-wide monitoring are performed as required by the Order to verify that facility releases remain within the protective bounds of the PA and CA. Each of the programs listed above have implemented comprehensive programs to ensure compliance with DOE Order 435.1 and that SRS radioactive waste management operations are protective of human health and the environment. Additional information with regard to implementation of these programs can be found in the current revision of the system plan for the specific program (SRNS 2011c and SRR 2011).

4.2.1.2 USDOE Order 458.1

USDOE Order 458.1, *Radiation Protection of the Public and the Environment* (USDOE 2013) establishes the requirements to protect the public and the environment against any undue risk from radiation associated with radiological activities at the USDOE sites. The main objectives of the Order are: (1) to develop and implement an ERPP; (2) to conduct USDOE radiological activities so that exposure is maintained within established dose limits; (3) to control the radiological release and clearance of USDOE real, and personal property; (4) to ensure that potential exposure to the public are ALARA; (5) to ensure that USDOE sites have the capabilities to monitor radiological releases and to assess the dose to members of the public; and (6) to provide protection of the environment from the effects of radiation and radioactive material. Under the ERPP, radiological effluent and surveillance monitoring of the environment is integrated with occupational radiation protection. The ERPP applies to all site areas and encompasses aspects of offsite monitoring to assess exposure to members of the public or the environment due to radiological activities resulting from SRS operations.

This order requires an ERPP. The SRS ERPP describes the methods used to ensure SRS implements the appropriate actions to comply with the requirements of USDOE Order 458.1 (SRNS 2016). DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard to the public is 100 millirem (mrem) (1 mSv) per year to a person from routine USDOE operations.

4.2.1.3 Facility Monitoring and Environmental Surveillance

Facilities that currently store or manage radioactive components (e.g., E-Area LLWF, SDF, high-level radioactive waste tanks) implement monitoring and verification programs to evaluate facility performance and ensure compliance with state and federal regulations. Environmental surveillance at SRS is designed to survey and quantify potential effects that operations could have on the site and surrounding areas. These programs involve monitoring are used to ensure that facilities have adequate radiological control and to protect the groundwater at SRS from radiological contamination.

4.2.2 Investigation-Derived Waste (IDW) Program

The Investigation Derived Waste (IDW) Program at SRS oversees the handling and disposition of environmental media and job-associated waste from site investigations and remedial activities to ensure that the practices are protective of human health and the environment and comply with regulatory requirements for handling hazardous wastes. The *SRS Investigation-Derived Waste Management Plan* (WSRC 2007) describes the methods for handling environmental media and job-associated waste. IDW can be well sampling purge water, soil cuttings, drilling fluids, well pumping test water, fluids from well development (and redevelopment), wash-down fluids from large equipment (e.g., excavators, drill rigs), miscellaneous wash water and cleaning solutions, sampling tool decontamination wash solutions, unused site-characterization samples, disposable equipment, and personal protection equipment.

The plan also describes the process for determining radionuclide levels as part of the IDW characterization. This process may include screening for gross alpha and nonvolatile beta for aqueous and nonaqueous IDW. If the IDW is equal to or exceeds specified screening levels, it may be speciated for individual radionuclide contributors to determine if the radioactivity is from a natural radioactive source. The IDW management plan also provides specific guidance concerning SRS worker exposure to tritium-contaminated groundwater.

The IDW program possesses a multi-disciplined infrastructure that integrates the functions of waste management and ECAs at SRS. For IDW issues not identified in the *SRS Investigation-Derived Management Plan*, the SRS ECA provides interpretation and guidance.

4.2.3 Toxic Substances Control Act (TSCA)

TSCA gives USEPA comprehensive authority to identify and control chemical substances manufactured, imported, processed, used, or distributed in the U.S. Reporting and record keeping are mandated for new chemicals and for any chemical that may present a substantial risk of injury to human health or the environment. Chemicals controlled under this act include PCBs, asbestos, and lead-based paint.

PCBs have been used in various SRS processes. SRS has a well-structured PCB program that complies with the TSCA regulations, with USDOE Orders, and with site policies. Document logs and annual reports regarding onsite PCB disposal activities are completed and submitted to USEPA as required. The disposal and storage of nonradioactive PCBs routinely generated at SRS is conducted at USEPA-approved facilities within the regulatory period. For some forms of radioactive PCB wastes, specifically those contaminated with Transuranic (TRU) radionuclides, disposal capacity is not immediately available. Such wastes remain in long-term storage pending necessary processing and packaging that will allow them to be shipped to the Waste Isolation Pilot Plant for disposal.

4.2.4 Hazardous and Mixed Waste Management

RCRA established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste, such as a flammable or corrosive liquid. USEPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste at SRS. Mixed waste is a mixture of both radioactive and hazardous waste.

At SRS, hazardous waste must be managed (i.e., treated, stored, transported, or disposed of) as defined by SCHWMR or RCRA. SCDHEC has issued a RCRA hazardous waste permit to SRS. SRS procedures for management hazardous and mixed waste are found in SRS 3Q Manual, Section 6.0, *Wastes*.

4.2.5 Waste Minimization Program

The P2/Waste Minimization (Waste Min) Program at SRS was established in recognition of controls directed by federal, state, and local regulations including the PPA, the CWA, the CAA,

RCRA and others. The P2/Waste Min Program is implemented through site procedures and is another strategy in protecting groundwater from radiological contamination.

The recognized P2/Waste Min hierarchy includes: 1) "source reduction", which is the preferred method, whereby the generation of waste is reduced and/or eliminated at the point of origin; 2) "recycling" in which byproducts from a process are evaluated and segregated for reuse opportunities; 3) "treatment" of unavoidable waste material to reduce or eliminate the hazards present; and 4) "disposal" in such a way as to minimize the environmental hazards which may still exist in the waste material. Source reduction and recycling are part of pollution prevention while treatment and disposal are pollution management functions.

The program approaches pollution prevention and management through a variety of methods. These methods include:

- Contamination Area Reduction: Reduced square footage of contamination areas due to improved techniques, strategies, and/or prioritization of areas to be recovered based on return on investment analysis.
- Green is Clean Reduction: Program for segregating potentially contaminated waste from radiological buffer areas for unconditional release after second verification through Solid Waste Program.
- Recyclable Anti-Contamination Materials: Single-use disposable items such as paper and plastic sheets, gloves, shoe covers that are successfully replaced with washable, reusable substitutes.
- Wastewater Recycling during Tank Closure: Recycling wastewater and chemical used in cleaning high-level radioactive waste tanks preventing the need for adding new water and chemicals into the system. Less radioactive wastewater is generated, storage space of this wastewater is minimized, and cost of chemicals is less.
- Chemical Management Center: Program for distributing unused chemicals for reuse thus reducing costs and generation of potentially hazardous waste.

- Used Oil Management: Program for collecting and offsite disposal of used oil guided by the SRS 3Q Manual, Environmental Compliance Manual, Procedure 6.0, *Wastes.*

4.3 Closure and Remediation

The EC&ACP is responsible for the remediation of waste units and the D&D of excess facilities at SRS. Groundwater management at SRS is guided by federal and South Carolina regulations, primarily the RCRA, the Safe Drinking Water Act, and CERCLA. As a result of historical operations, soils, surface water, and groundwater have been contaminated by releases of hazardous substances. These areas of contamination are identified as waste units warranting investigation and possibly remediation. Groundwater contamination areas may be addressed as separate units or as part of larger units.

EC&ACP's *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2017b) includes specific objectives that address the protection of groundwater from radiological contamination. The plan's objectives are to:

- Mitigate potential human and ecological exposure to contaminated groundwater and surface water;
- Minimize contaminated groundwater from impacting surface water above regulatory standards;
- Control contaminated groundwater growth and contaminant migration;
- Take actions to return aquifers to their intended beneficial use;
- Meet regulatory requirements;
- Reduce long-term costs of groundwater remediation and land use controls (including monitoring); and
- Minimize carbon emissions and waste generation.

The strategies of EC&ACP's groundwater program focus on protection, monitoring, and remediation.

4.3.1 EC&ACP Groundwater Protection

In addition to the SCDHEC and USEPA programs that are designed to protect groundwater (e.g., UST program, UIC program, wellhead protection program, and waste disposal program), prevention of future groundwater contamination and the disposition of contamination sources are the primary ways by which SRS groundwater is protected. Key activities include removing or immobilizing contaminant sources before contamination can reach groundwater, reducing natural and artificial recharge in contaminated areas, and eliminating the opportunity for contaminants to reach groundwater along unsealed well casings or through wells that are no longer needed. Considerable progress has been made at numerous SRS operable units in this respect through capping, *in situ* stabilization, and volatile organic compound (VOC) treatment technologies.

Reducing natural and artificial recharge in contaminated areas protects groundwater by reducing the transport of contaminants through the vadose zone into the unconfined aquifer. Water run-on/runoff control measures have been implemented in and around SRS waste units.

Wells that no longer serve a useful purpose at SRS potentially provide a pathway for contamination migration to the vadose zone, the unconfined aquifer, or deeper zones. These wells fall into three broad categories:

- Older wells that are noncompliant with the current SRS well specifications,
- Wells that no longer serve an investigative, assessment, or regulatory purpose, and
- Wells with open screens across confining zones.

To aid in protecting the aquifer from mobile contamination, wells must be evaluated to ensure that they still serve a useful purpose. Wells that are not necessary or cannot be used will be abandoned. Wells are prioritized for abandonment based on the threat they pose to groundwater resources. The factors examined in characterizing the threat include proximity to contamination, depth, well construction method, casing material, and installation age.

4.3.2 EC&ACP Groundwater Monitoring

Extensive groundwater monitoring is conducted at SRS waste units and operating facilities. Wells are monitored regularly to meet sampling requirements in FFA-related approved monitoring plans and RCRA permits. In areas with groundwater contamination, the major contaminants are VOCs and tritium however, metals and other radionuclides are also sometimes present. SRS personnel plan and mobilize sampling events, collect and ship the samples, and provide data management. SCDHEC certified off-site commercial laboratories and on-site laboratories perform the sample analyses. Groundwater monitoring plans are typically developed to satisfy a specific regulatory requirement or to address technical data needs at a specific time in the regulatory process. Further description of the groundwater monitoring program is provided in EC&ACP's *Savannah River Site Groundwater Management Strategy and Implementation Plan* (SRNS 2017b).

4.3.3 EC&ACP Groundwater Remediation

The goal of groundwater remediation is to take actions to restore contaminated groundwater to its intended beneficial use and to protect human health and the environment. Groundwater remediation is underway at SRS on a variety of plumes and groundwater contamination areas. The status of these plumes is compiled and tracked in the USDOE groundwater database maintained by USDOE - Head Quarters.

4.3.3.1 Graded Approach in Groundwater Remediation

SRS uses a graded approach to remediation. The selection of groundwater remediation technologies for a specific contamination area is based on the size, contaminant type, contaminant concentration, and configuration of the plume. These attributes are the result of the nature and mass of the source of contamination and the subsurface characteristics in the area of the plume. Aggressive active groundwater remediation technologies remove or immobilize sources and lower contaminant concentrations in plumes. As remediation projects mature and the bulk of contaminants are removed, it is most efficient to transition from robust active systems to passive, low-energy-consumption, low-carbon-emission technologies. The active systems are terminated and replaced with passive and enhanced-passive technologies. Ultimately, when final remedial

goals have been met, the groundwater remediation systems can be permanently terminated. SRS has groundwater remediation projects in all phases of remediation.

4.3.3.2 Modeling in Support of Groundwater Remediation

Groundwater modeling is used to support groundwater corrective action/remediation selection. Groundwater flow and transport modeling is used to predict how groundwater contamination will change with time. Future contaminant concentrations in groundwater and at stream discharge locations can be predicted. This is helpful in determining whether monitored natural attenuation is an appropriate alternative for a plume, or whether technologies that are more active are needed. When active groundwater corrective action/remediation is called for, the effectiveness of various remedial strategies can be compared using predictive models. The mass of contaminants removed, future concentrations of contaminants in groundwater, and the time to reach remedial goals can be predicted for remedial alternatives. This information provides a technical basis for the selection of the optimal corrective action/remedial strategy for each plume.

SRS uses a suite of groundwater modeling codes that are peer reviewed, widely used in the environmental professional community, utilized by other USDOE sites, and accepted by both USEPA and SCDHEC. The SRS Groundwater Modeling Consistency Team (GMCT) is a technical committee with members from various organizations at SRS, including the SRNL. The GMCT reviews modeling efforts to ensure that modeling codes, assumptions, and conceptual models used by various organizations are consistent and technically sound. Major groundwater modeling efforts have focused on A/M Area, F Area, H Area, the Burial Ground Complex, and several of the reactor areas where the most extensive subsurface contamination is known to exist.

4.3.3.3 Remediation Examples Protecting Groundwater from Radionuclides

A range of active and passive (or enhanced-passive) remedial activities have been used at SRS. Several recent activities have focused on protecting soil, surface water, and groundwater from further radiological contamination.

- Tritiated Debris Remediation Project: Legacy heavy-water moderator operations at SRS resulted in the contamination of equipment pads, slabs, and surrounding soil with tritium. Characterization activities showed that tritium had already impacted the shallow

groundwater at the facility while a significant source remained in the abandoned concrete slabs at the surface and within the associated vadose zone soils. To prevent long-term impacts to the shallow groundwater a non-time critical removal action consisting of a thermal detritiation process for these source materials was conducted. During this process concrete rubble is heated to a temperature of 815°C (1500°F), resulting in the dehydration and removal of tritium from the matrix. During heating contaminated soil is used to provide thermal insulation during which the soil temperature readily reaches 100°C (212°F), causing drying, and removal of tritium. The purpose of the removal action was to reduce the potential leaching of tritium in vadose zone soils and concrete slabs thereby protecting the groundwater from further tritium contamination.

- Barrier Wall and Base Injection System: A passive remediation approach being used at SRS addresses metal and radionuclide contamination in the groundwater near F and H Areas. These plumes containing tritium and metals were outcropping into a surface stream within the SRS boundary. The system consists of underground barrier walls coupled with injection of a base solution. The barrier walls effectively minimize the migration of the tritium into the surface streams. The injected base solution adjusts the pH so that metals adhere to the soil particles thereby retarding contaminant migration and decreasing contaminant concentrations in the groundwater.
- Silver Chloride Injection: The base injection system at F and H Areas targets cationic contaminants but does not reduce the concentration of anionic contaminants. To address iodine-129 contamination in the groundwater, silver chloride is injected into the aquifer to stimulate geochemical reactions that will bind and immobilize iodine-129. The solubility of silver iodide is several orders of magnitude lower than the solubility of silver chloride. Thus, when iodine-129 comes in contact with silver chloride it forms silver iodide, which is very stable and essentially insoluble in water.
- Tritium Phytoremediation Project: At the MWMF, tritium-contaminated groundwater was seeping into a surface stream creating an unacceptable risk. A two-acre retention pond with sheet pile at the seepline was constructed to collect the tritium-contaminated water. Water from the pond is used to irrigate naturally occurring pine forest. The trees take up the tritium-contaminated water through their roots and release very low concentrations of

tritium vapor into the atmosphere where it is safely diluted. This semi-passive system makes use of natural processes of hydrology and evapotranspiration to reduce tritium-contaminated water entering site streams and the Savannah River.

- In Situ Decommissioning of P and R Reactors: In situ decommissioning (ISD) was used to close P- and R-Area Reactors as part of the cleanup area closure under CERCLA. Groundwater modeling indicated that groundwater could be adequately protected from migration of radiological contamination associated with the reactor vessels, disassembly basins, and the reactor buildings by grouting the below grade portions of the building in place.
- Edible Oil Treatment: Edible oil treatment is an enhanced attenuation technology that alters site conditions such that the contaminant plume will passively decrease. The edible oil treatment technology consisted of: 1) deployment of neat (pure) vegetable oil at the top of the water table in the residual source area (vicinity of the smear zone); and 2) deployment of emulsified oil substrate (EOS®) in the core of the groundwater VOC plume.

5.0 MONITORING OF HAZARDOUS MATERIALS AND RADIONUCLIDES

Monitoring practices at SRS are conducted to ensure that soil and groundwater are not adversely impacted from liquid releases containing radionuclides. Monitoring entails both effluent/waste monitoring and environmental surveillance. Effluent/waste monitoring at SRS is conducted to demonstrate compliance with applicable environmental standards and regulations and to determine if a facility is performing as expected. It includes the collection and analysis of liquid discharges at the point where materials are released from site facilities in addition to the monitoring of waste matrices, structures (e.g., vaults), covers, vadose zone, surface water, and groundwater. Environmental surveillance at SRS is designed to survey and quantify potential effects that operations could have on the site and surrounding areas. This program covers more than 31,000 square miles and extends up to 100 miles from the site (SRNL 2011). Environmental surveillance includes the routine sampling and analysis of surface water (site streams and the Savannah River), drinking water, soil, sediment, and groundwater. With results of this surveillance, scientists collect data to assess baseline conditions and the extent of migration and impact of contaminants that have entered the environment.

Figure 3 shows the programmatic documents associated with monitoring requirements at the SRS. DOE Orders 458.1 and 435.1 provide the basis of the monitoring requirements. From these Orders, policies and implementation documents (e.g., manuals, lower-tier procedures) are utilized to ensure monitoring requirements are met.

6.0 INTEGRATION OF ENVIRONMENTAL MONITORING ACTIVITIES

The SRNS Environmental Compliance (EC) Department is responsible for coordinating and providing environmental support and compliance-based oversight of SRS operations to ensure that site activities are conducted in accordance with all applicable state and federal environmental regulations, USDOE directives and Orders, and in a manner that will have minimal impact on workers, the public, and the environment.

The SRS EMS implements and integrates the environmental requirements mandated by statutes, regulations, and policies. The EMS is executed by multiple contractors using documents, programs, and strategies tailored to organization-specific resources. USDOE at SRS oversees the contractors to ensure a consistent and integrated site program. The implementation strategy for SRNS, as the M&O contractor and SRR, as the LWO contractor, is documented in the *Environmental Management System Description Manual* (SRNS 2017a). Other SRS contractors, such as Centerra Group, LLC, Parson, and CB&I AREVA MOX Services, LLC have their own procedures or programs that address environmental management.

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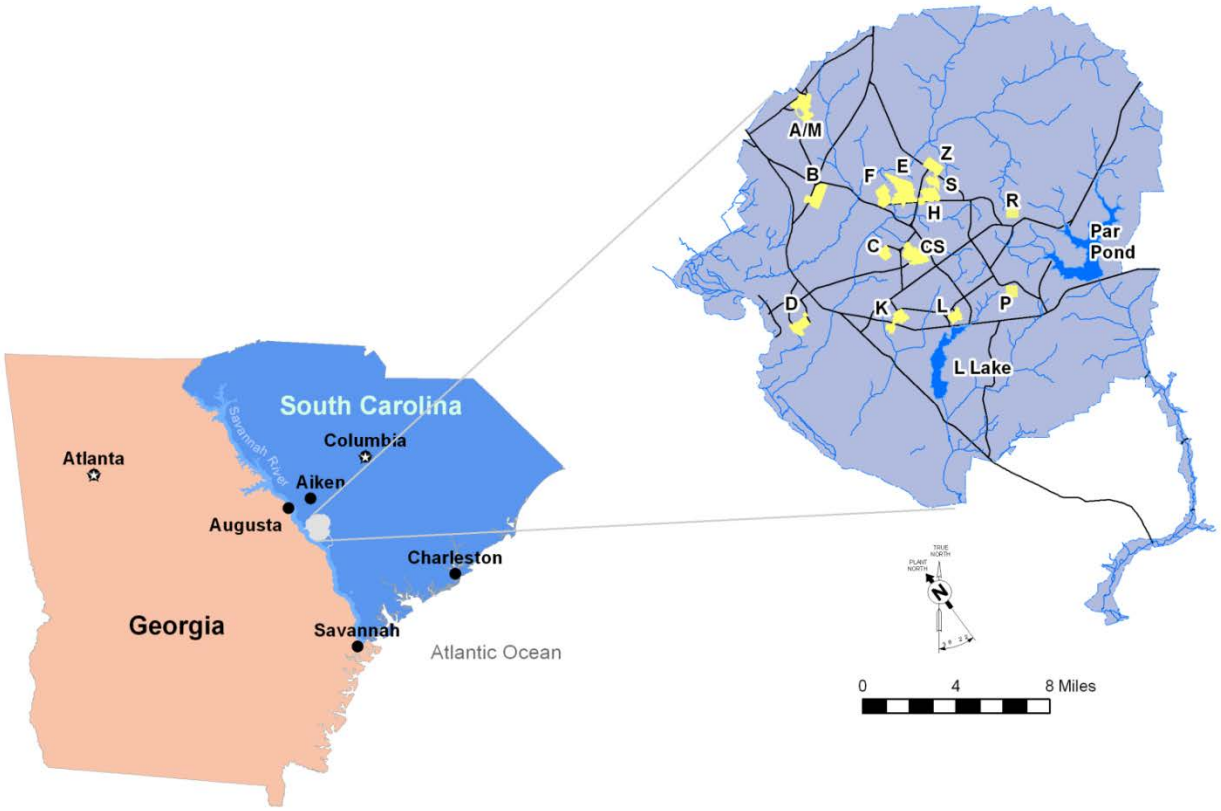

Figure 1. Map of SRS

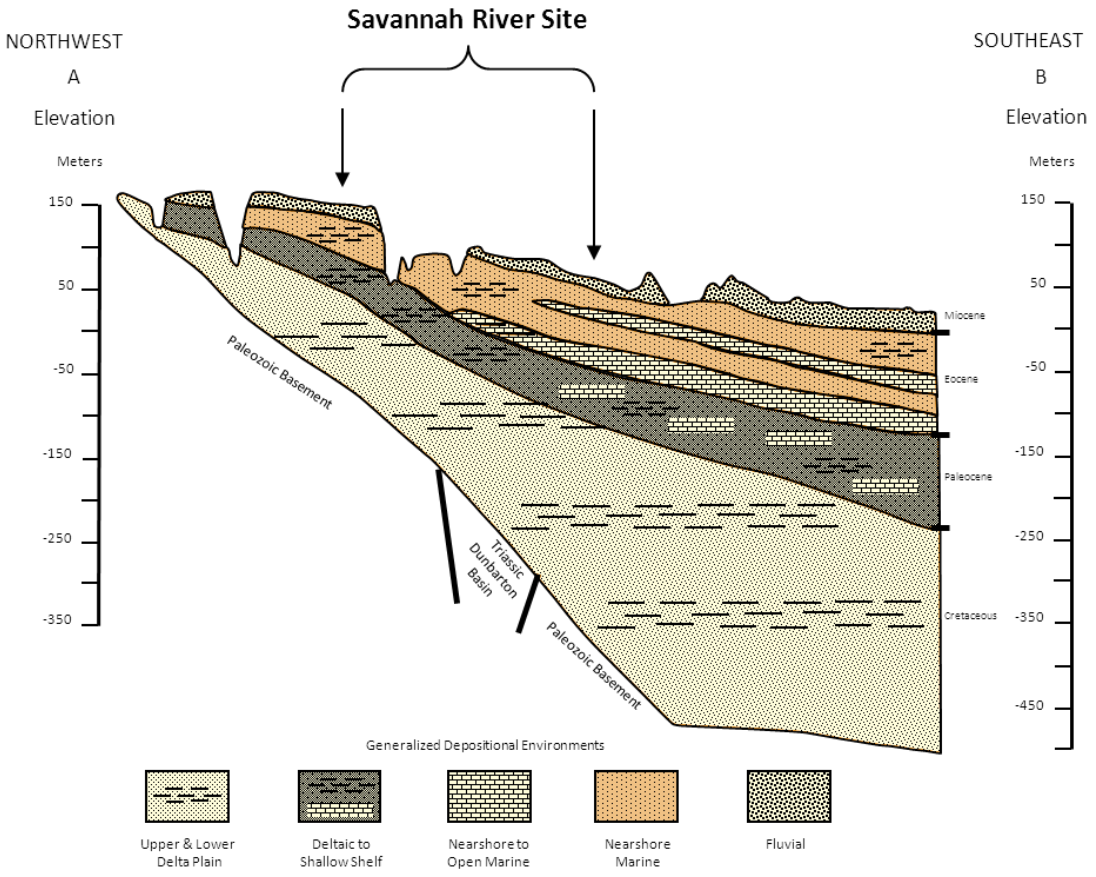

Figure 2. Generalized Geology of Southeastern Coastal Plain and SRS

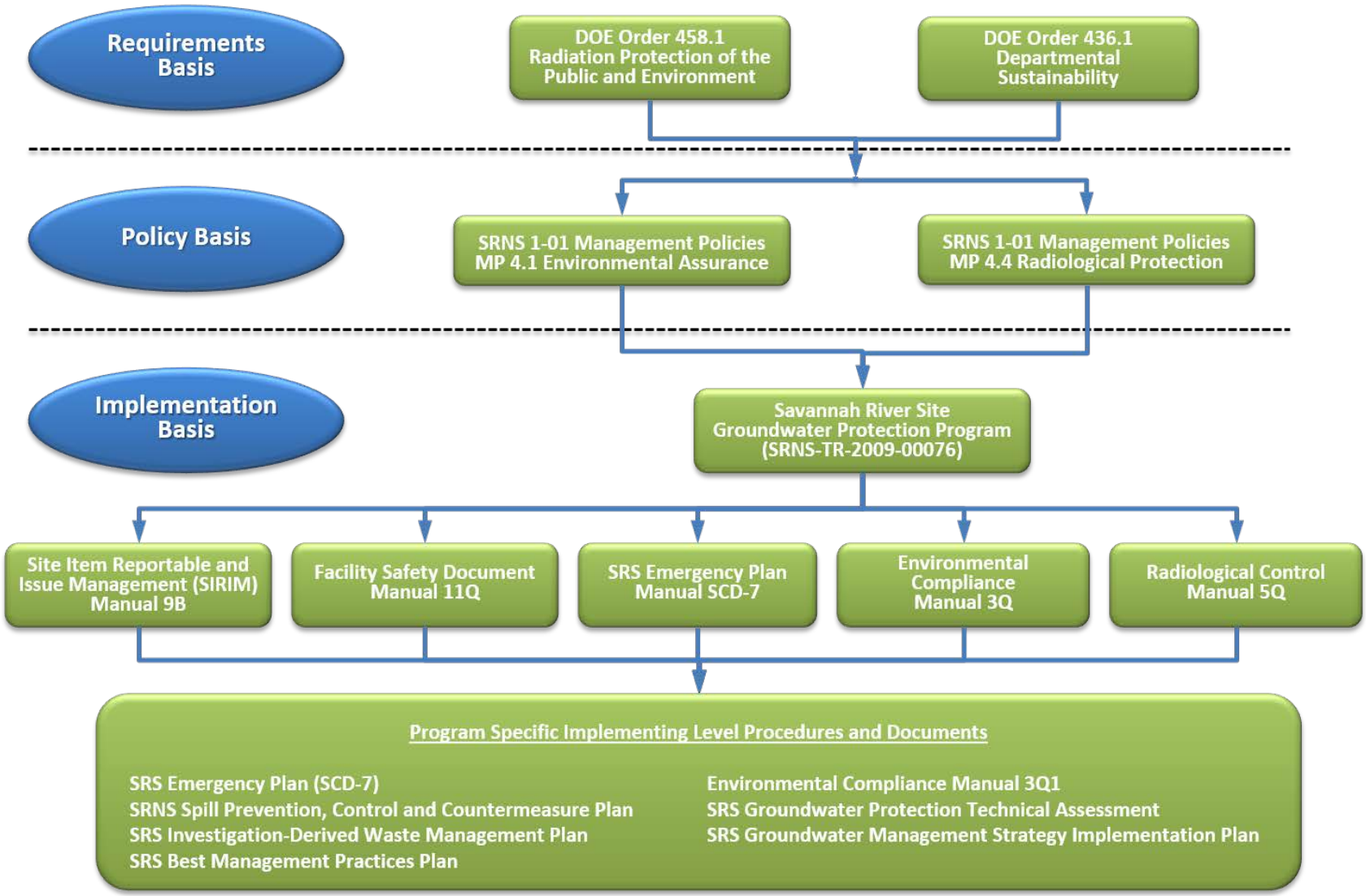

Figure 3. Programmatic Documents Associated with Monitoring Requirements

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Table 1. USDOE Order 458.1 Requirements Table for Groundwater Protection

Summarized Requirement	USDOE O 458.1 Source Citation	Section Discussed in this GPP Document	Other Sources
Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.	Demonstrating Compliance with the Public Dose Limit (4e) (5)	3.4 – Evaluation of Dose	*Critical Radionuclide and Pathway Analysis for the Savannah River Site* (SRNL 2016)
Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate dispersal pattern in the environs, characterize pathway(s) of exposure to members of the public and estimate the doses to individuals and populations in the vicinity of the site or operation commensurate with the nature of the USDOE radiological activities and the risk to the public and the environment. Radiological monitoring must be integrated with the general environmental and effluent monitoring. include, but is not limited to: (a) Effluent Monitoring; (b) Environmental Surveillance	Demonstrating Compliance with the Public Dose Limit (4e) (9a and b)	3.4 – Evaluation of Dose	*Critical Radionuclide and Pathway Analysis for the Savannah River Site* (SRNL 2016); Annual SRS Environmental Report (document number varies for each year)
Conduct activities to ensure that liquid releases containing radionuclides from USDOE activities are managed in a manner that protects groundwater resources now and, in the future, based on use and value considerations	Control and Management of Radionuclides from USDOE Activities in Liquid Discharges (4g) (3)	4.0 – Strategies to Control Hazardous Materials and Radiological Contamination 5.0 – Monitoring of Hazardous Materials and Radionuclides	SRS 3Q, 3Q1, and 5Q Manuals; *SRS Groundwater Management Strategy and Implementation Plan (U)* (SRNS 2017b)
Manage the disposition of non-process water potentially containing radionuclides form USDOE activities to protect soil and groundwater and prevent the creation of future cleanup sites.	Control and Management of Radionuclides from USDOE Activities in Liquid Discharges (4g) (10)	4.0 – Strategies to Control Hazardous Materials and Radiological Contamination 5.0 – Monitoring of Hazardous Materials and Radionuclides	SRS 3Q, 3Q1, and 5Q Manuals; *SRS Groundwater Management Strategy and Implementation Plan (U)* (SRNS 2017b)

Table 1. USDOE Order 458.1 Requirements Table for Groundwater Protection (*continued)*

Summarized Requirement	USDOE O 458.1 Source Citation	Section Discussed in this GPP Document	Other Sources
USDOE sites must provide a level of radiation protection for persons consuming water from a drinking water system operated by USDOE, directly or through a USDOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR Part 141, *National Primary Drinking Water Regulations* (that is, not exceed the radionuclide MCLs)	Protection of Drinking Water and Groundwater (4i) (1)	2.4 – Groundwater Use/ Conservation 4.0 – Strategies to Control Hazardous Materials and Radiological Contamination 5.0 – Monitoring of Hazardous Materials and Radionuclides	*Savannah River Site Groundwater Protection Technical Assessment* (SRNS 2011a) Annual SRS Environmental Report (document number varies for each year)
USDOE must ensure that: Baseline conditions of the groundwater quantity and quality are documented	Protection of Drinking Water and Groundwater (4i) (2a)	2.5 – Baseline Conditions 5.0 – Monitoring of Hazardous Materials and Radionuclides	Annual SRS Environmental Report (document number varies for each year)
USDOE must ensure that: Possible sources of, and potential for, radiological contamination are identified and assessed;	Protection of Drinking Water and Groundwater (4i) (2b)	3.0 – Identification and Assessment of Contaminant Sources 5.0 – Monitoring of Hazardous Materials and Radionuclides	*Federal Facility Agreement for the Savannah River Site* (FFA 1993)
USDOE must ensure that: Strategies to control radiological contamination are documented and implemented;	Protection of Drinking Water and Groundwater (4i) (2c)	4.0 – Strategies to Control Hazardous Materials and Radiological Contamination	SRS 3Q, 3Q1, and 5Q Manuals Annual SRS Environmental Report (document number varies for each year)

Table 1. USDOE Order 458.1 Requirements Table for Groundwater Protection (*continued)*

Summarized Requirement	USDOE O 458.1 Source Citation	Section Discussed in this GPP Document	Other Sources
USDOE must ensure that: Monitoring methodologies are documented and implemented;	Protection of Drinking Water and Groundwater (4i) (2d)	5.0 – Monitoring of Hazardous Materials and Radionuclides	SRS 3Q and 3Q1 Manuals; *PA Monitoring Plan for the E-Area Low Level Waste Facility* (SRNL 2012); *SRS DOE 435.1 CA Monitoring Plan* (SRNL 2011); *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program* (SRR 2011); *Performance Assessment Monitoring Plan for the Z-Area Saltstone Disposal Facility* (SRR 2015)
USDOE must ensure that: Groundwater monitoring activities are integrated with other environmental monitoring activities.	Protection of Drinking Water and Groundwater (4i) (2e)	6.0 – Integration of Environmental Monitoring Activities	Annual SRS Environmental Report (document number varies for each year)

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