

5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The Savannah River Site (SRS) Radiological Environmental Monitoring Program (REMP) monitors any effects SRS operations have on the environment and demonstrates compliance with applicable U.S. Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and U.S. Department of Energy (DOE) standards. REMP at SRS is designed to detect and identify the effects, if any, of SRS operations on human health and the environment. Thousands of samples are collected throughout the year and analyzed for radionuclides that could be present from SRS operations. Samples are collected both onsite and in the communities surrounding SRS. State and federal regulations drive some of the monitoring conducted at SRS, such as limitations on discharges to air and water. DOE Orders 231.1B, Environment, Safety and Health Reporting, and 458.1, Radiation Protection of the Public and Environment, also address environmental monitoring requirements.

2015 HIGHLIGHTS

Air and Water Pathways

The atmospheric and water contaminants released from SRS were all below permit limits and applicable standards. Radiological results for surveillance media associated with the airborne and liquid pathways were within expected historical levels when compared to background.

Wildlife Surveillance

All animals harvested during the annual hunts on the SRS are monitored to ensure the total dose to any hunter is below the SRS 22 mrem/year limit. Monitoring of the deer, feral hogs, turkeys, and coyotes harvested during annual hunts resulted in the release of 449 animals.

5.1 INTRODUCTION

Environmental monitoring programs at SRS examine both radiological and nonradiological constituents that could be released to the environment as a result of SRS activities. Nonradiological monitoring was discussed previously in Chapter 4, “Nonradiological Environmental Monitoring Program.”

The REMP involves monitoring of radiological contaminants from both atmospheric and liquid point-sources, as well as the collection and analysis of environmental samples from numerous locations throughout SRS and the surrounding area offsite. Monitoring of radiological analytes is required to assess the environmental impact of Site operations on SRS and the surrounding area from routine and non-routine releases from SRS facilities.

Chapter 5 – Key Terms

Derived concentration standard is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in a dose of 0.1 rem (1 mSv).

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

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

Exposure pathway is the way that a person could be impacted from releases of radionuclides into the water and air.

Fallout is 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.

Emission is the release of a gas.

Thermoluminescent Dosimeter (TLD) is a passive device that measures the exposure from ionizing radiation.

The REMP is divided into two focus areas: 1) effluent monitoring, and 2) environmental surveillance. Sampling frequency and analyses conducted are determined by permit-mandated monitoring requirements and/or federal regulations.

SRS gauges the effluent monitoring program against DOE derived concentration standards (DCSs) by comparing the annual average concentrations to the DOE DCSs as documented in DOE Derived Concentration Technical Standard (DOE 2011) and in accordance with DOE Order 458.1, "Radiation Protection of the Public and the Environment." These DCSs are applicable at the point of discharge and the SRS uses them as a screening method to determine if existing effluent treatment systems are appropriate and effective. SRS uses the same DCSs as reference concentrations for conducting environmental protection programs. These DCSs are used by all DOE sites.

SRS designed the radiological surveillance program to sample the types of media that may be impacted by Site Operations. Figure 5-1 shows the liquid and airborne pathways, as well as the types of media sampled through those pathways.

SRS conducts radiological environmental monitoring activities for the following:

- Atmospheric (airborne emissions, airborne filters, airborne moisture, rainwater),
- Vegetation,
- Soil,
- Food Products (milk, meat, fruit, nuts, green vegetables),
- Water (stream, river, drinking water, stormwater basins),
- Stream and River Sediment,
- Aquatic Food Products
- Wildlife

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

Appendix Table C-1 of this document provides a summary of the radiological surveillance sampling media and frequencies.

All raw data associated with the SRS sampling efforts described in this chapter are documented in the *2015 Environmental Monitoring Program Data Report* (SRNS 2016a).

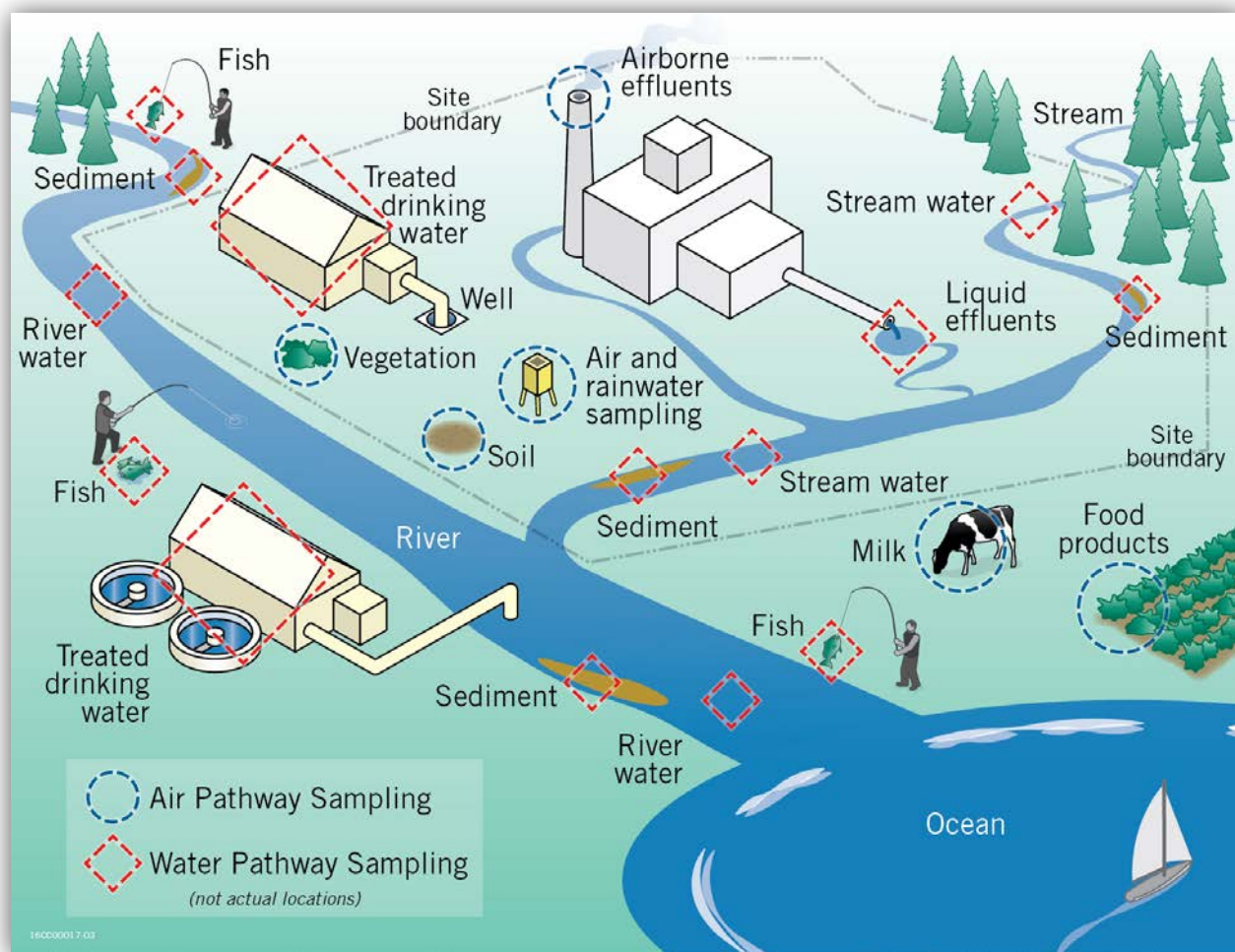


Figure 5-1 Radiological Air and Liquid Pathway Samples

5.2 SRS OFFSITE MONITORING

Offsite monitoring involves collecting and analyzing samples of air, river water, soil, sediment, vegetation, milk, food products, fish, and other media from many locations. SRS analyzes these samples for radioactive contaminants to monitor any effects SRS operations have on the environment and assess long-term trends of the contaminants in the environment. SRS collects samples beyond the SRS perimeter in Georgia (GA) and South Carolina (SC) at 25 and 100 miles from the Site. Additionally, the SRS collects samples at the population centers of Aiken, Allendale, Barnwell, New Ellenton, North Augusta, and Williston in South Carolina and Augusta, Savannah, and Waynesboro in Georgia.

SRS monitors the Savannah River at River Mile 118.8 (Georgia Welcome Center at Highway 301), locations downriver of each SRS stream entry point, and above the Site at River Mile 160 as a control location. Figure 5-2 displays the SRS offsite environmental sampling locations. Chapter 7, "Groundwater Management Program" provides information on the SRS groundwater monitoring activities. Table 5-1 summarizes the SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected in the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Media	Approximate Number of Samples (Number of Locations)	
	South Carolina	Georgia
Air Filters	28 (1)	56 (2)
Silica Gel	26 (1)	54 (2)
External Ambient Gamma Radiation Monitoring (thermoluminescent dosimeters[TLDs])	160 (7)	80 (4)
Rain Ion Columns	0 (0)	13 (1)
Rainwater	13 (1)	26 (2)
Food Products	19 (20)	4 (5)
Milk	16 (4)	16 (4)
Soil	1 (1)	3 (3)
Vegetation (nonedible)	1 (1)	2 (1)
Drinking Water	24 (2)	0 (0)
Total	288 (38)	254 (24)

Note: This table excludes groundwater monitoring locations/samples which are discussed in Chapter 7, "Groundwater Management Program."

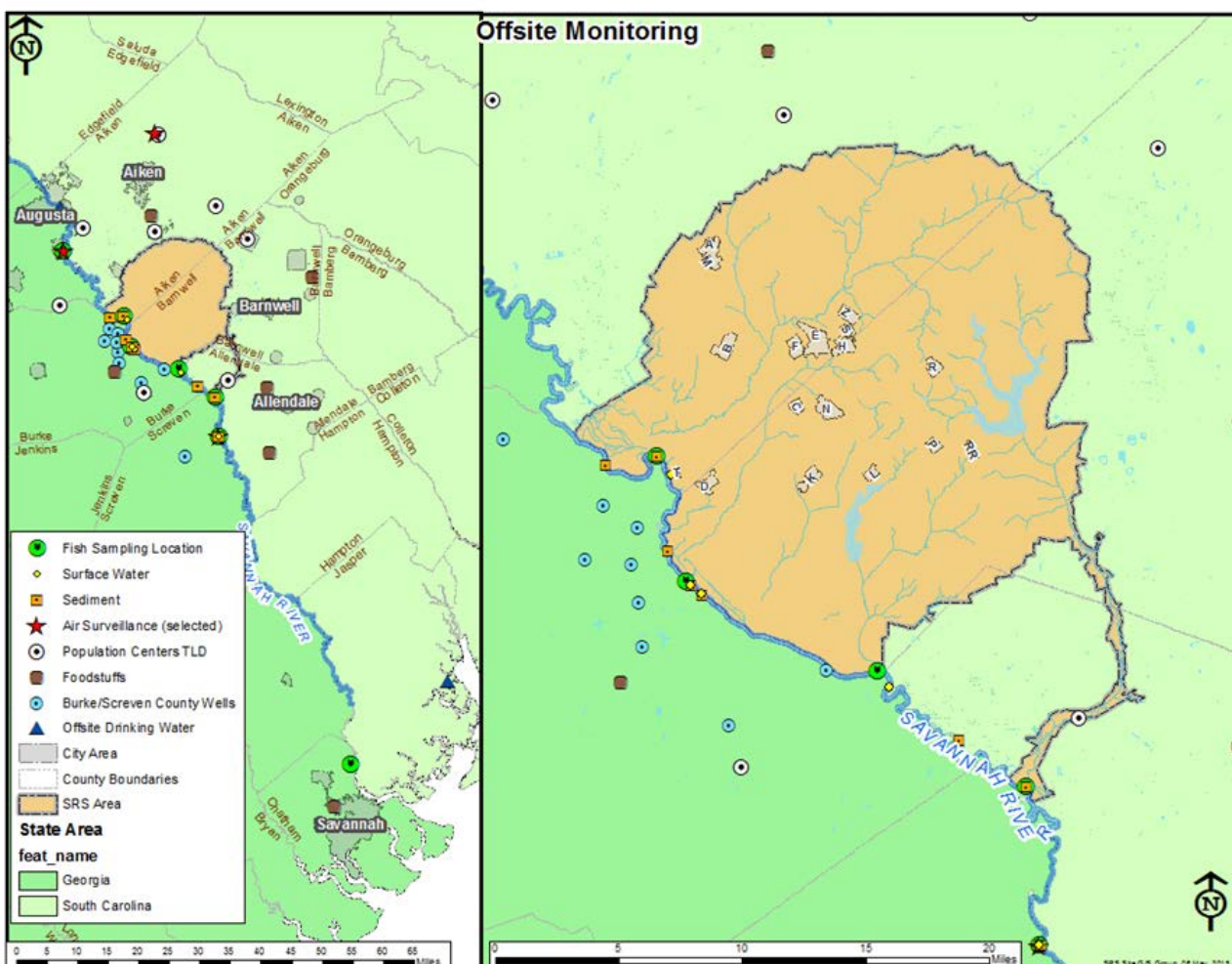


Figure 5-2 SRS Offsite Sampling Media Locations for Georgia and South Carolina

5.3 AIR PATHWAY

The media presented in this section support the air pathway dose assessment discussed in Chapter 6, “Radiological Dose Assessment.”

5.3.1 Atmospheric Monitoring

SRS conducts atmospheric monitoring to determine whether airborne radionuclides from SRS emissions have reached the environment in measurable quantities and to ensure that radiation exposure to employees and the public remain below regulatory limits. In order to demonstrate compliance with radiation dose standards established by the EPA and DOE for public protection, SRS performs radiological atmospheric effluent monitoring at the point of discharge of airborne radionuclides from operating SRS facilities. The SRS conducts additional atmospheric sampling at air monitoring stations along the SRS perimeter and within communities surrounding SRS.

Radionuclides present in and around the SRS environment are from a number of sources, including natural background, fallout from historical atmospheric testing of nuclear weapons, offsite nuclear power plant operations, and SRS operations. Tritium in elemental and oxide forms make up the majority of the radionuclide emissions from SRS to the air. The amount of tritium released from SRS varies yearly, based on mission activities and on the annual production schedules of the tritium processing facilities.

5.3.2 Airborne Emissions

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 regulates radioactive airborne pollutant emissions from SRS sources. SCDHEC issues Clean Air Act Part 70 Air Quality Permits for each major source of airborne emissions on the SRS. Each permit has specific limitations and monitoring requirements.

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

- Data obtained from monitored airborne effluent release points,
- Calculated releases of unmonitored isotopes from the dissolution of spent fuel, and
- 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. Airborne effluent samples are collected on filter papers for particulates, on charcoal sampling media for gaseous iodine, and in a bubbler solution for airborne tritium. For some stacks, SRS uses inline monitoring systems to determine airborne tritium emissions instead of laboratory analyses.

5.3.2.1 Airborne Emissions Summary

SRS uses a variety of methods to estimate atmospheric emissions, including periodic sampling systems or approved calculation methods. Depending on the processes involved, SRS may also use real-time instrumentation to monitor discharge stacks to determine instantaneous and cumulative releases (e.g., of tritium) to the atmosphere.

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 not originate from a single location, but are released over a larger discrete area. SRS diffuse sources include research laboratories, disposal sites and storage tanks, and deactivation and decommissioning activities. Appendix Table E-1 presents these estimates in the SRS radioactive release totals.

SRS calculates emissions from unmonitored releases using the methods contained in Appendix D of EPA's NESHAP regulations (EPA 2002). Because these methods employ conservative assumptions, they generally lead to overestimation of actual emissions. Although SRS does not monitor these releases at their source, SRS uses onsite and offsite environmental surveillance monitoring to assess the impact, if any, of unmonitored releases.

Figure 5-3 depicts the amount of SRS tritium releases. The annual average tritium released during the past 10 years is 29,290 Ci with a range between about 17,000-41,000 Ci per year. The 2015 tritium emissions of 19,100 Ci is significantly below this ten-year average. Compared to the 27,300 Ci of tritium released in 2014, SRS tritium releases decreased by 30% in 2015. Reduced emissions from the five tritium processing facilities account for the decreased tritium releases. One building in the tritium processing facilities was shut down in 2015, causing a significant reduction in tritium releases. Activities which were required to prepare for shutdown caused increases in tritium releases in 2013 and 2014.

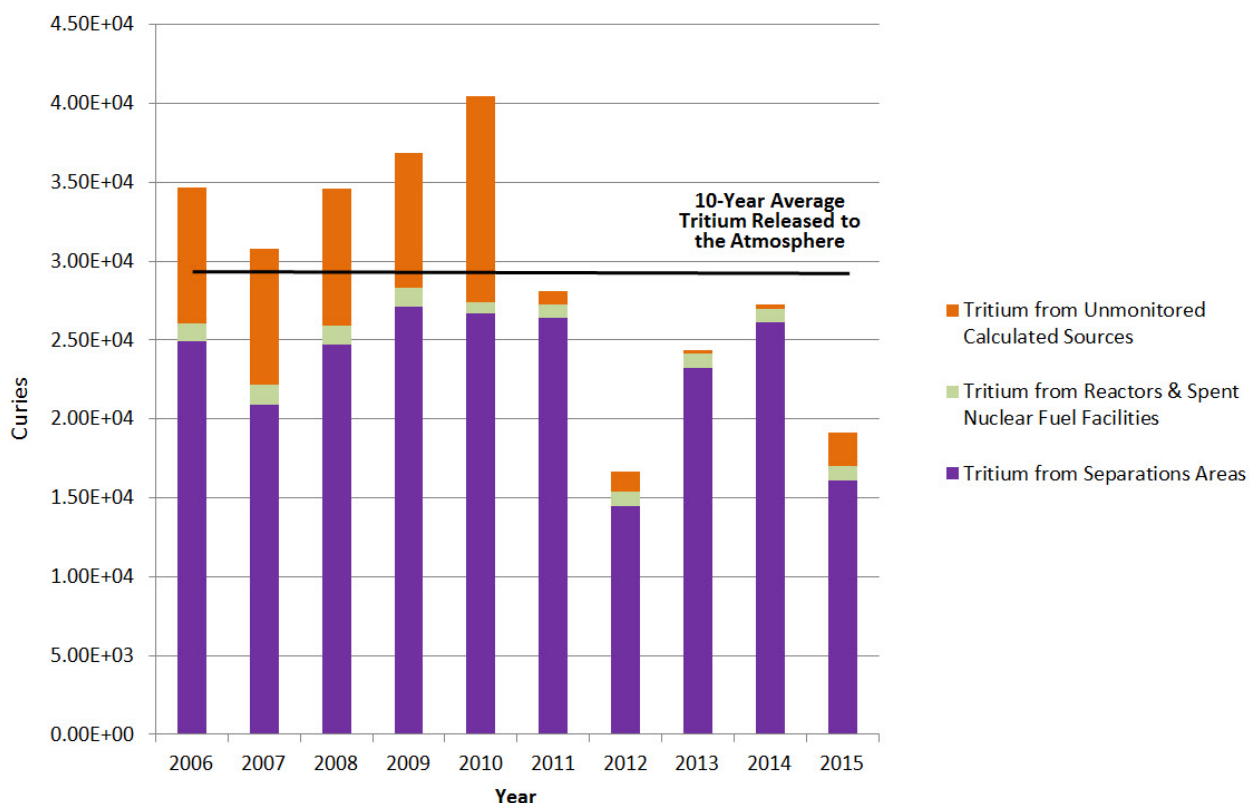


Figure 5-3 Ten-Year History of SRS Annual Tritium Releases to the Atmosphere

In 2015, tritium accounted for more than 87% of the total radioactivity released to the atmosphere from SRS operations. Tritium processing facilities are responsible for 84% of the SRS tritium releases, while the dissolution of spent nuclear fuel in H Canyon resulted in the release of less than 1% of the SRS tritium releases. The combination of releases from the tritium processing facilities and the dissolution in H Canyon comprise the releases from Separations Areas. The Separations Areas, Reactors and Spent Nuclear Fuel Facilities, and Unmonitored Sources are shown in Appendix Table E-1 and Figure 5-3 and Figure 5-4. The estimated tritium releases from unmonitored sources increased in 2015. Based on the review of the unmonitored emission sources for the 2015 reporting period, SRS identified and implemented a more conservative method to calculate tritium emissions from several sources located at the Solid Waste Management Facility.

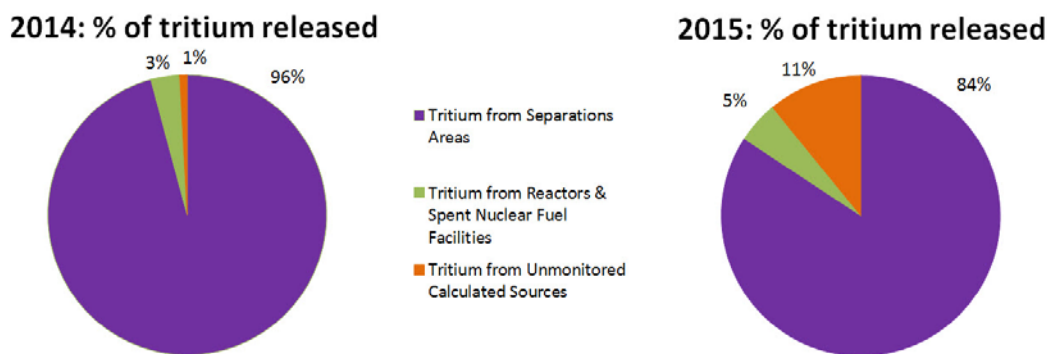


Figure 5-4 Percent of Tritium Released to the Atmosphere for 2014 and 2015

Appendix Table E-2 provides a summary of the 2015 air effluent DCS sum of fractions. The specific radionuclide average concentrations and associated DOE DCS for each monitored discharge point within the facilities are included in the raw data (SRNS 2016a). These concentrations correspond only to isotopic emissions that occur during sampling events. The average concentration is determined only if there is at least one statistically significant result for the isotope. However, concentrations for other periods are represented in the radionuclide dose assessment, including any time between stack samples, gross alpha and gross beta results, and emissions estimated using calculations (i.e., unmonitored diffuse and point) (Jannik and Dixon, 2016). The raw data (SRNS 2016a) contains calculated concentrations for tritium from the reactor areas and from the tritium processing facilities and for krypton-85, carbon-14, and tritium from the H Canyon facility during dissolving operations. These calculated concentrations are based on the annual releases in Curies and the annual stack volume.

Most of the SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. Because of the nature of the operations and the comparison of DCSs to measured concentrations at the release point, C Area, K Area, L Area, and the tritium facilities exceed the tritium DCS. However, the offsite dose from all airborne releases remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv). Chapter 6, “Radiological Dose Assessments” discusses this further.

5.3.3 Atmospheric Surveillance

Beyond the operational facilities, SRS maintains a network of 14 atmospheric sampling stations (Figure 5-5 and [Environmental Maps “Radiological Air Surveillance Sampling Locations”](#)) in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air and rainwater. The atmosphere contains radionuclides in various forms (gaseous, particulate matter, water vapor). Rainwater can redeposit particulate matter from the air onto the ground and the radionuclides can eventually be absorbed into vegetation or soil.

The sampling stations are located at the center of SRS, around the Site perimeter, in population centers 25 miles from SRS, and at a control location, the Georgia Welcome Center in Screven County nearly 25 miles from SRS (assumed to be un-impacted by SRS operations). SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases

into the environment. Each atmospheric sampling station consists of all or some of the following components listed in Table 5-2. Rain ion exchange columns are placed at six of the 14 locations. Rainfall washes the dry deposition material (particles) through the column.

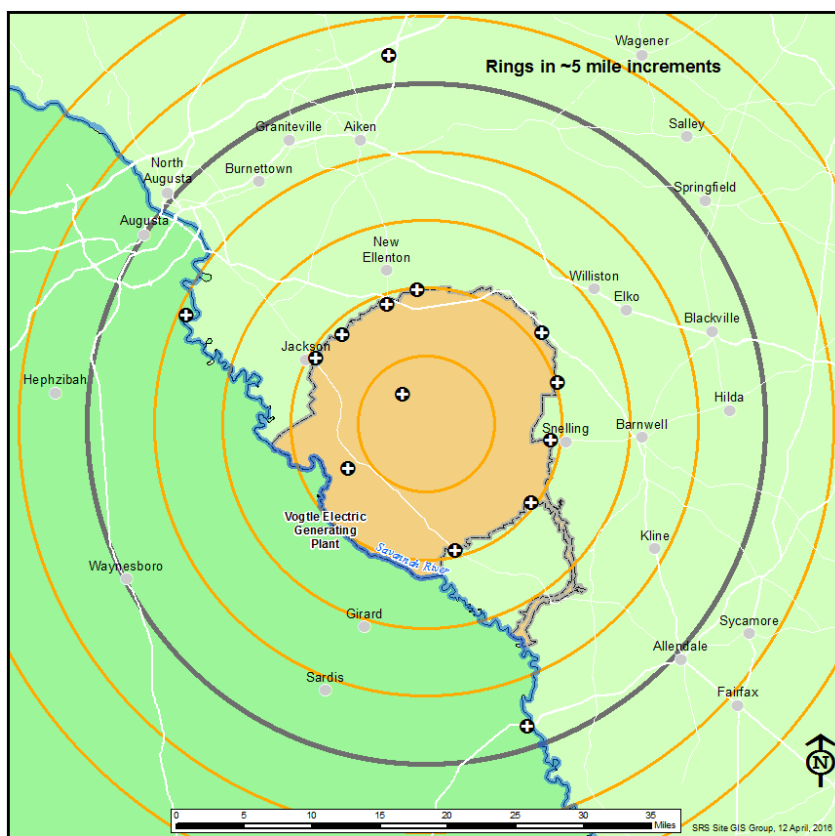


Figure 5-5 Air Sampling Locations Surrounding SRS up to 25 Miles

Table 5-2 Atmospheric Sampling Media

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

SRS selected the radionuclides presented in Table 5-2 based on known SRS airborne emission sources. Background levels in the atmosphere consist of naturally occurring radionuclides (e.g., uranium, thorium, and radon) and radionuclides (e.g., strontium-90, cesium-137) from global fallout due to historical nuclear weapons testing.

5.3.3.1 Results Summary

Appendix Tables E-3, E-4, and E-5 provide summaries of the atmospheric monitoring results for 2015 and comparison to the background control location at Highway 301. SRS detected elevated levels of gross alpha in all environmental filters during December of 2015. SRS analyzed the samples for gross alpha-specific radionuclides to determine the source of the elevations. Alpha specific results indicated positive thorium and uranium that exist naturally in the environment. With the exception of the elevated gross alpha levels in December of 2015, all other radionuclides for surveillance air sampling media (Table 5-2) were within the historical trend levels for the previous ten years. All offsite location results were near the levels observed at the background control location at Highway 301.

Tritium-in-air results for 2015 were comparable or slightly lower than those observed in 2014 and the previous five years. Results showed detectable levels in 75 of 347 (22%) samples for 2015. As shown in previous years, tritium levels decrease to levels at or below background once offsite.

Tritium-in-rainwater results showed detectable levels in 18 of the 182 rainwater samples (10%) for 2015 with levels similar to the previous five to ten years. Concentrations from all locations are below the EPA drinking water standard of 20,000 pCi/L. As in previous years, values were highest near the center of the SRS and decreased with distance from the Site (SRNS 2016a). Appendix Table E-5 provides a summary of the tritium-in-rainwater results.

5.3.4 Ambient Gamma Surveillance

SRS has been monitoring ambient (surrounding) environmental gamma exposure rates with thermoluminescent dosimeters (TLDs) since 1965 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 support of routine and emergency response dose calculations.

An extensive network of TLDs in and around SRS monitors external ambient gamma exposure rates ([Environmental Maps “SRS Thermoluminescent Dosimeter \(TLD\) Sampling Locations”](#)). The SRS ambient



Above: Technician Prepares Rain Ion Exchange Columns

Left: Close-up of Silica Inside Rain Ion Exchange Column

gamma radiation-monitoring program has four subprograms: Site perimeter stations, population centers, air surveillance stations, and Vogtle (stations that monitor exposures from Georgia Power's Vogtle Electric Generating Station). Most gamma exposure monitoring is conducted onsite and at the SRS perimeter.

SRS conducts offsite monitoring in population centers within nine miles of the Site boundary, but only limited monitoring beyond this distance and at the 25-mile air surveillance stations.

5.3.4.1 Ambient Gamma Surveillance Results Summary

Ambient gamma exposure rates at all TLD monitoring locations show some variation based on normal site-to-site and year-to-year differences in the components of natural ambient gamma radiation exposure levels. In 2015, ambient gamma exposure rates varied between 73 mR/yr at location NRC2 (onsite southwest) and 137 mR/yr at location Burial Ground North (center of the site) (SRNS 2016a). Population centers ranged from 98 mR/yr at the Windsor location to 129 mR/yr at the Williston 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, except in the case of population centers. Ambient dose rates in population centers are slightly elevated compared to the other monitoring networks, as expected, because of higher natural background radiation levels emitted from materials present in buildings and roadways.

5.3.5 **Soil Surveillance**

SRS conducts soil surveillance to provide:

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

SRS collected soil samples in 2015 from five onsite locations, ten Site perimeter locations, and three offsite locations ([Environmental Maps "Radiological Soil Sampling Locations"](#)). Concentrations of radionuclides in soil vary greatly among locations because of differences in rainfall patterns and retention and transport in different types of soils. Therefore, a direct comparison of data from year-to-year could be misleading. However, SRS evaluated the data for long-term trend analysis.

Soil sampling involves the use of hand augers, shovels, or other similar devices for collection to a depth of 3 inches. SRS analyzes these samples for gamma-emitting radionuclides, strontium-89,90, and the actinides.

5.3.5.1 Soil Results Summary

In 2015, SRS detected radionuclides in soil samples from all 18 sampling locations (five onsite, ten at the perimeter, and three offsite). Increasing uranium-234, uranium-235, and uranium-238 trends were observed at many of the locations with the maximum level of 3.73 (uranium-234) pCi/g observed near the center of the site and the control location (Highway 301) at 1.79 pCi/g (uranium-234). Uranium is naturally occurring in soil and expected to be present in the environment. Naturally occurring uranium in soil typically ranges from about 1 to 5 pCi/g with the average U.S. soils about 2 pCi/g. There are many factors that affect the uranium concentration in soil that over time could have caused the increasing trend. These include the pH of the soil, the type of soil, and deposits from the air caused from rainfall. Organic matter

and clay minerals provide exchange sites in soil which can increase the uranium sorption. This increasing trend will continue to be evaluated in the surveillance program but at this point no action levels have been exceeded; all levels were below the EPA's Soil Screening Levels for ingestion of home produce (5.9 pCi/g for uranium-234, 5.77 pCi/g uranium-235, and 4.65 pCi/g uranium-238).

The concentrations of other radionuclides at these locations are consistent with historical results, with the maximum cesium-137 concentration found at onsite perimeter air station Darkhorse (northeast perimeter) at 0.37 pCi/g and the control location (Highway 301) at 0.15 pCi/g. Appendix Table E-6 provides a summary of the results.

5.3.6 Grassy Vegetation Surveillance

SRS conducts the radiological program for grassy vegetation from onsite and offsite locations ([Environmental Maps "Radiological Vegetation Sampling Locations"](#)) to complement soil and sediment samples for evaluation of the environmental accumulation of radionuclides and to help validate SRS dose models. Vegetation can be contaminated externally by airborne radioactive contaminants and by uptake from soil or water by the roots. Bermuda grass is preferred for surveillance because of its importance as a pasture grass for dairy herds. Vegetation sample locations include:

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

Vegetation sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and the actinides.

5.3.6.1 Grassy Vegetation Results Summary

SRS detected various radionuclides in the grassy vegetation samples collected during 2015 at all locations (one onsite, ten at the perimeter, and three offsite). Appendix Table E-7 provides a summary of the results. Results for all radionuclides are within the trends of the previous ten years.

5.3.7 Terrestrial Food Surveillance

SRS personnel collect terrestrial food products grown and consumed in the communities surrounding the Site, as well as aquatic food products harvested from the Savannah River. Samples are analyzed for radionuclides. The results provide information on whether radionuclides are present in the environment and, if present, where the radionuclides are located. Tritium releases from SRS and non-SRS sources are the primary contributors to tritium in food products.

Agricultural products, livestock, and game animals for human consumption may contain radionuclides. Livestock and game animals may be exposed to radionuclides if the radionuclides are in the air. These radionuclides in the air can deposit on grass, which can then be eaten by the animals. If humans consume the meat of these exposed animals, humans become exposed to radiation. In the case of dairy cows, they produce milk that we consume, leading to a potential radiation exposure. SRS samples milk, meat, fruit, nuts, and green vegetables based on the potential to transport radionuclides to people via the food chain.

Local gardens, farms, and dairies are the source of the terrestrial food products. Annually, beef, watermelon, and greens are collected. A variety of vegetables, grains, and nuts are collected on a rotational schedule resulting in two specific crops being collected each year from the four quadrants. Once a quarter, milk samples are collected. Food product samples are collected in each of four quadrants surrounding the SRS and extending 10 miles from the Site boundary. Additionally, the SRS collects a control sample in the southeast quadrant at a distance between 10 miles and 25 miles from the Site boundary.

5.3.7.1 Terrestrial Results Summary

In 2015, the terrestrial foodstuffs sampled were greens, watermelons, beef, pecans and corn. Beef samples from livestock butchered in 2015 were obtained in two of the four quadrants and the control location. No beef samples were identified in the southeast-10 miles and southwest-10 miles quadrants. Laboratory analysis of the food samples includes gamma-emitting radionuclides, tritium, strontium-89,90, uranium-234, uranium-235, uranium-238, neptunium-237, plutonium-238, plutonium-239, americium-241, curium-244, technetium-99, gross alpha, and gross beta. The analytical results of the terrestrial foodstuffs and dairy are consistent with historical trends. A majority of results for the radionuclides associated with foodstuffs is non-detectable (92% for terrestrial foodstuffs and 97% for dairy).

Appendix Tables E-8 and E-9 provide a summary of the foodstuffs and dairy results. The detectable results are near the laboratory instrumentation method detection limits.

5.4 WATER PATHWAY

The media presented in this section support the water pathway dose assessment discussed in Chapter 6, "Radiological Dose Assessment."

5.4.1 Liquid Effluents Monitoring Program

SRS routinely samples, analyzes for radioactivity, and monitors flow at each liquid effluent discharge point that releases, or has potential to release, radioactive materials.

Figure 5-6 shows the effluent sampling points near SRS facilities.

Appendix Table E-10 provides SRS liquid radioactive releases for 2015. The total amount of tritium released directly from process areas to SRS streams during 2015 was 85.6 Ci. This is an increase from the 42.3 Ci released in 2014. As seen in Figure 5-7, Separations Areas experienced a 25.6 Ci increase; this is due to higher tritium concentrations in the waste handled by the Effluent Treatment Plant. Reactor areas saw a 17.7 Ci increase due to normal fluctuations in the amount of water released annually by PAR pond and L-Lake. Although the tritium released in 2015 was higher than 2014, Figure 5-7 shows that the total direct release of tritium has a general decreasing trend over the last ten years.

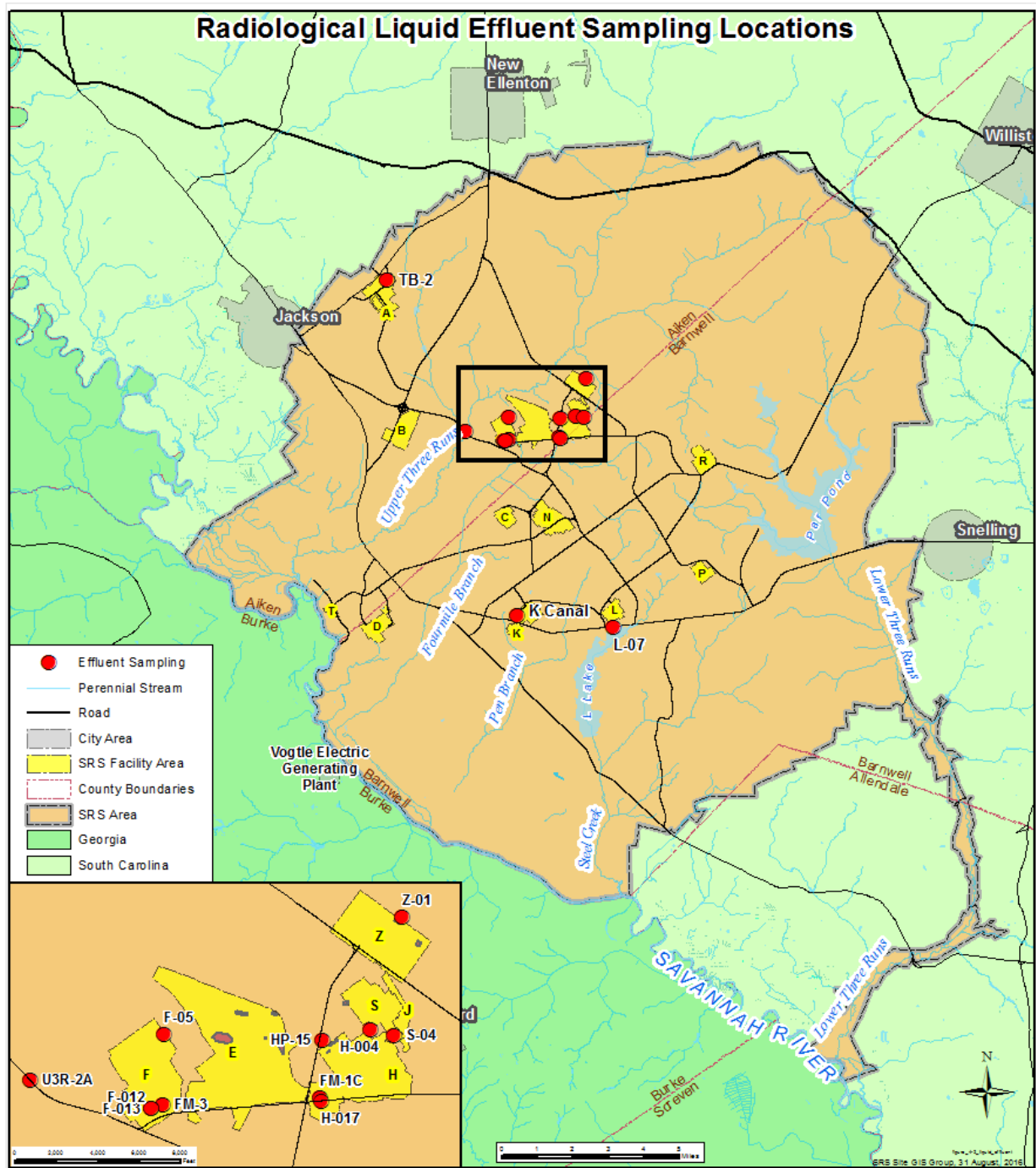


Figure 5-6 Radiological Liquid Effluent Sampling Locations

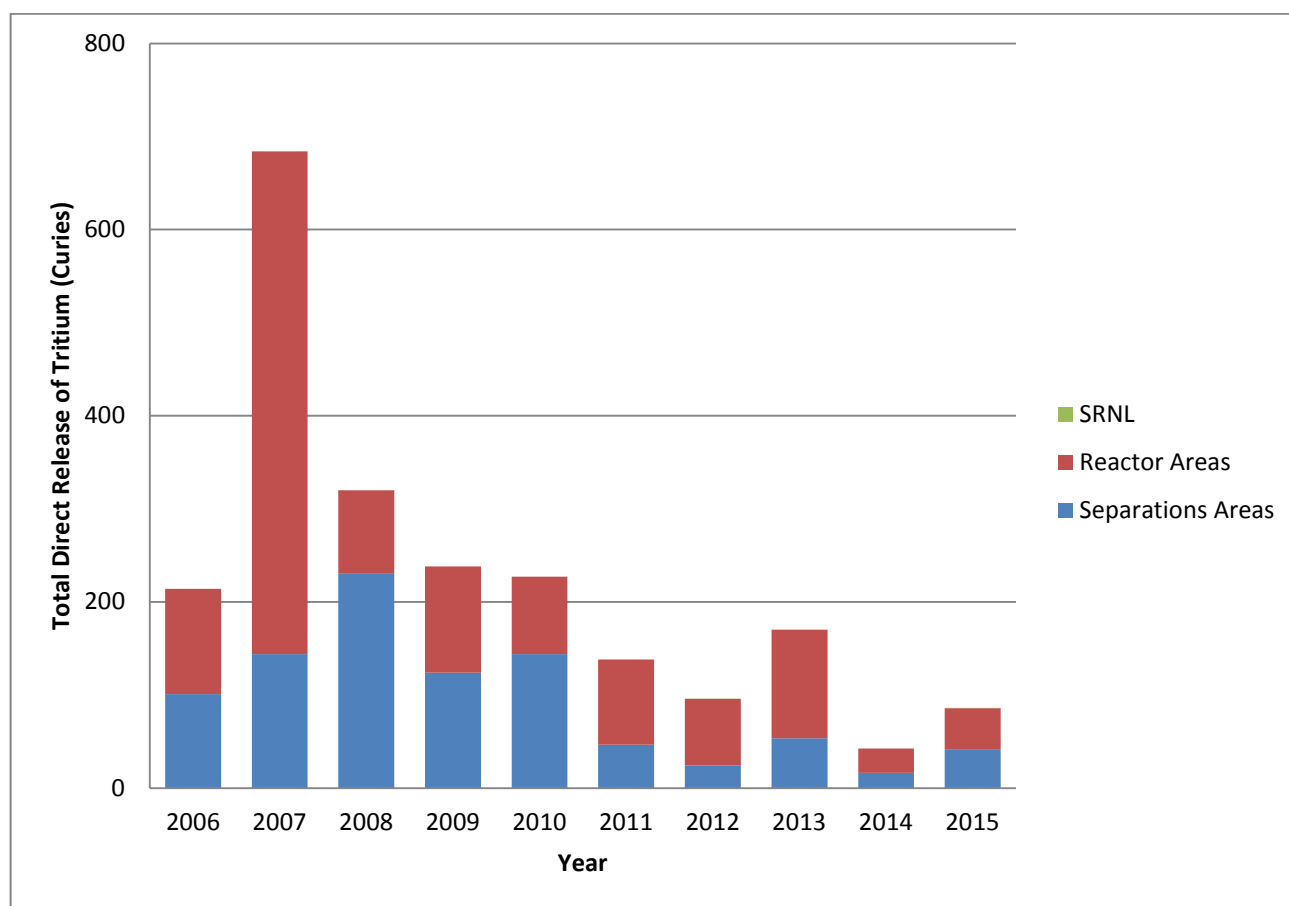


Figure 5-7 Ten-Year History of Direct Releases of Tritium to SRS Streams

NOTE: SRNL contribution to Direct Releases is minimal; thus, not visible on this figure.

5.4.1.1 Liquid Effluent Results Summary

All discharges in 2015 were well below the standards and the DCS sum of the fractions for all locations was less than 1.00. Appendix Table E-11 provides a summary of the 2015 liquid effluent sum of fractions and radionuclides monitored for each outfall or facility. The specific radionuclide average concentrations and associated DOE DCS for each monitored facility and outfall are included in the raw data (SRNS 2016a).

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

5.4.2 Stormwater Basin Surveillance

SRS performs sampling of stormwater accumulating in the Site's stormwater basins (Figure 5-8) for gross alpha, gross beta, tritium, strontium, gamma-emitting radionuclides, and actinides. With no active processes discharging to stormwater basins onsite, the accumulations in the stormwater basins are primarily stormwater runoff. Monitoring for specific radionuclides occurs where previous operational history indicates the possible presence of certain radionuclides. The E-Area basins receive stormwater from the Solid Waste Disposal Facility (SWDF), E-Area Vault, and stormwater from the controlled clean-soil pit on the east side of E Area. F-Area Pond 400 receives stormwater from F Area and the Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area (Saltstone processing and disposal facilities).

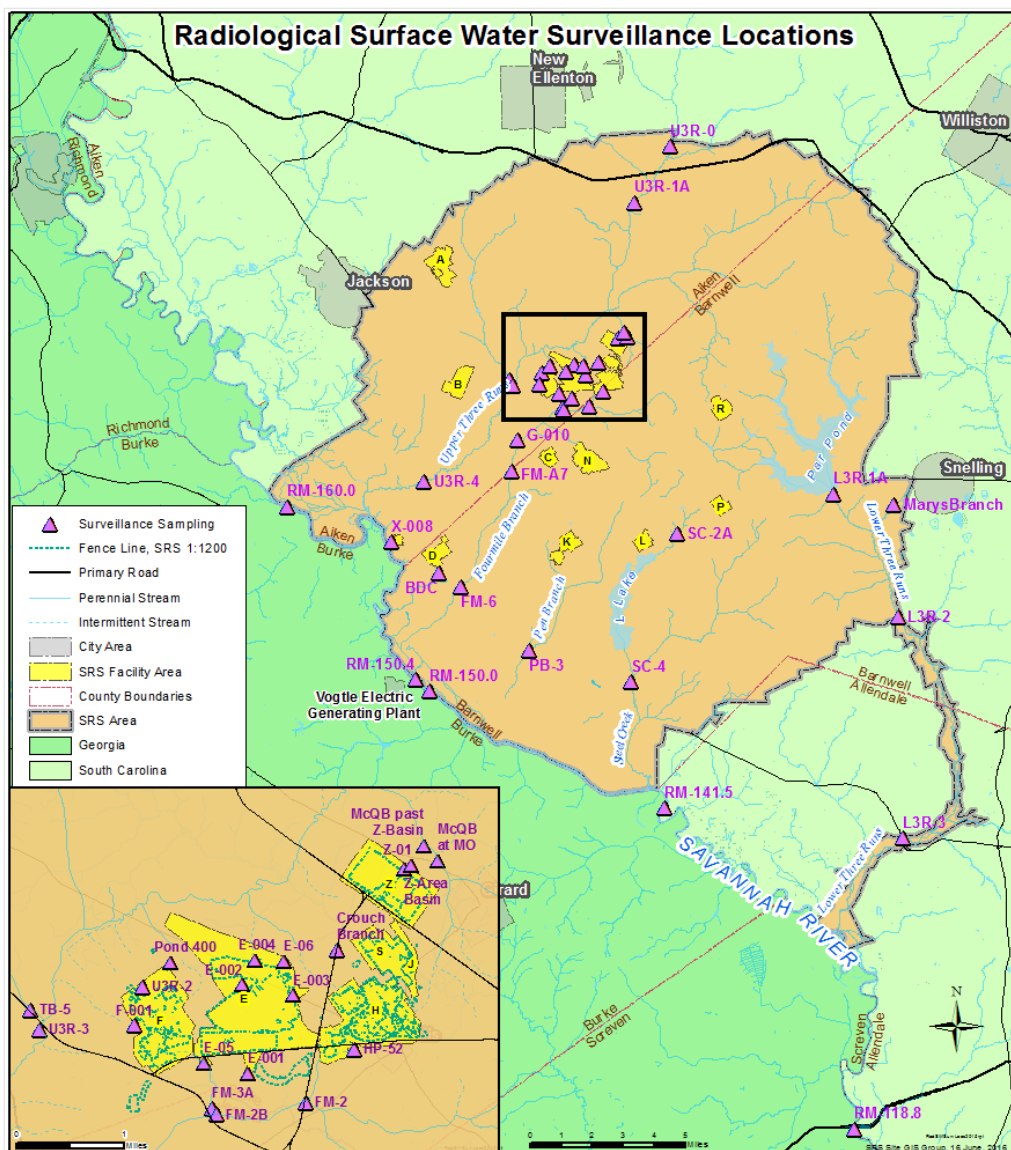


Figure 5-8 Radiological Surface Water Sampling Locations

5.4.2.1 Stormwater Basin Results Summary

In 2015, SRS conducted sampling at five E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. One E-Area basin was not sampled due to dry conditions. Table 5-3 provides a summary of gross alpha, beta, and tritium results for the SRS stormwater basins. The highest tritium concentration was observed at the E-005 Basin, at 32,200 pCi/L, consistent with the previous five years of historical results. The stormwater basins do not actively discharge to the environment.

Table 5-3 Radionuclide Concentrations Summary for Stormwater Basins (pCi/L)

Basin Location	Average Gross Alpha	Average Gross Beta	Average Tritium	Maximum Tritium
E-001	0.457	3.33	5,530	8,650
E-002	0.319	4.62	13,300	24,200
E-003	1.06	2.42	6,560	16,700
E-004	0.297	2.30	7,420	10,200
E-005	0.823	3.05	15,800	32,200
Pond 400	0.433	4.98	577	1,310
Z-Basin	0.411	202	1,170	2,230

5.4.3 Settleable Solids Surveillance

Settleable solids are solids in water that are heavy enough to sink to the bottom of the collection container. SRS evaluates settleable solids in water to determine, in conjunction with routine sediment monitoring, whether a long-term buildup of radioactive materials occurs in stream systems. DOE has set limits for the radioactivity levels in settleable solids to 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides. Accurate measurement of radioactivity levels in settleable solids is impractical in small amounts with low Total Suspended Solids (TSS). The TSS limit set by DOE is 40 parts per million. If TSS results are below this limit, no samples are analyzed for alpha-emitting and beta/gamma-emitting radionuclides. SRS monitors for TSS as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near radiological effluent points. If TSS results are greater than or equal to 40 parts per million, samples are analyzed for radionuclides.

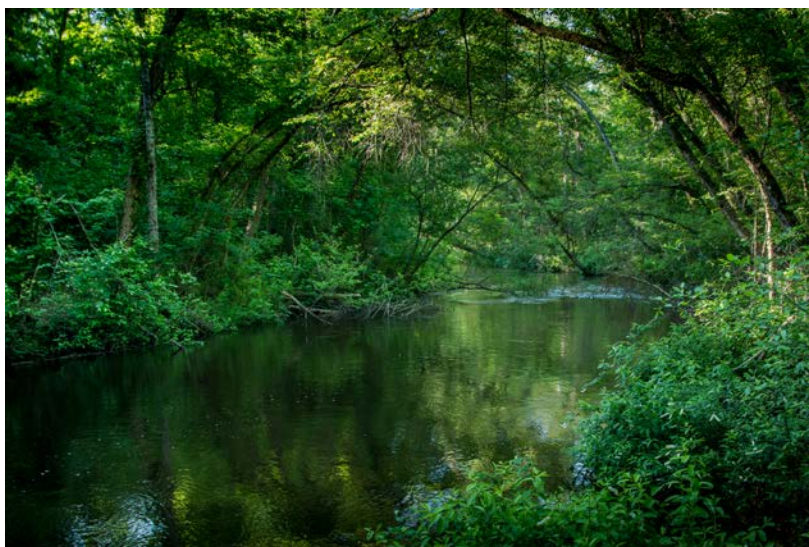
5.4.3.1 Settleable Solids Results Summary

In 2015, all NPDES TSS sample results were well below 40 parts per million. The 2015 NPDES TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.4 SRS Stream Sampling and Monitoring

SRS conducts continuous sampling of SRS streams downstream of several process areas to detect and quantify levels of radioactivity transported to the Savannah River by effluents and shallow groundwater

migration. The five primary streams that deposit into the Savannah River are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs. SRS monitors and quantifies the migration of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF) as part of its stream surveillance program. Seepage basins include the General Separations Area (F and H Area) Seepage Basins and K-Area Seepage Basin, which have been closed. SRS closed the F-Area and H-Area Seepage Basins in 1991 and the K-Area Seepage Basin during 2002.



Onsite Stream - McQueens Branch

Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF continues to migrate through the groundwater and enter Fourmile Branch and Upper Three Runs. Groundwater migration from the F-Area Seepage Basins enters Fourmile Branch at three monitoring locations, FM-3A, FM-2B, and FM-A7, located along the stream. Groundwater contamination from K-Area Seepage Basin migrates into Pen Branch.

Figure 5-8 displays the radiological surface water sampling locations. The sampling frequency and types of analyses are dependent on the upstream discharges and groundwater migration history of radionuclides.

5.4.4.1 SRS Stream Results Summary

Table 5-4 presents the average 2015 concentrations of gross alpha, gross beta, and tritium in SRS streams. SRS found detectable concentrations of tritium at least once at all stream locations in 2015. The ten-year trend for the average tritium levels in the streams shows a decreasing trend, which is due to a combination of decreases in Site releases and the natural decay of tritium. Figure 5-9 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA standard of 20,000 pCi/L, though onsite streams are not a direct source of drinking water. In the surveillance program, the EPA standard is used as a benchmark for comparing stream surface water results. Tritium levels are higher in Fourmile Branch compared to the other streams due to surface groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration.

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

Table 5-4 Radionuclide Concentrations in SRS Streams by Location

Location	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
<i>Onsite Stream Locations</i>				
Tims Branch (TB-5)	2.32	1.82	223	497
Lower Three Runs (L3R-3)	5.41	5.18	769	1,490
Steel Creek (SC-4)	0.787	1.53	1,950	2,970
Pen Branch (PB-3)	0.913	1.18	13,600	22,000
Fourmile Branch (FM-6)	1.25	4.77	26,700	31,400
Upper Three Runs (U3R-4)	5.86	3.32	678	1,100
<i>Onsite Control Locations (for comparison purposes)</i>				
Upper Three Runs (U3R-1A)	4.67	2.76	47.5	207

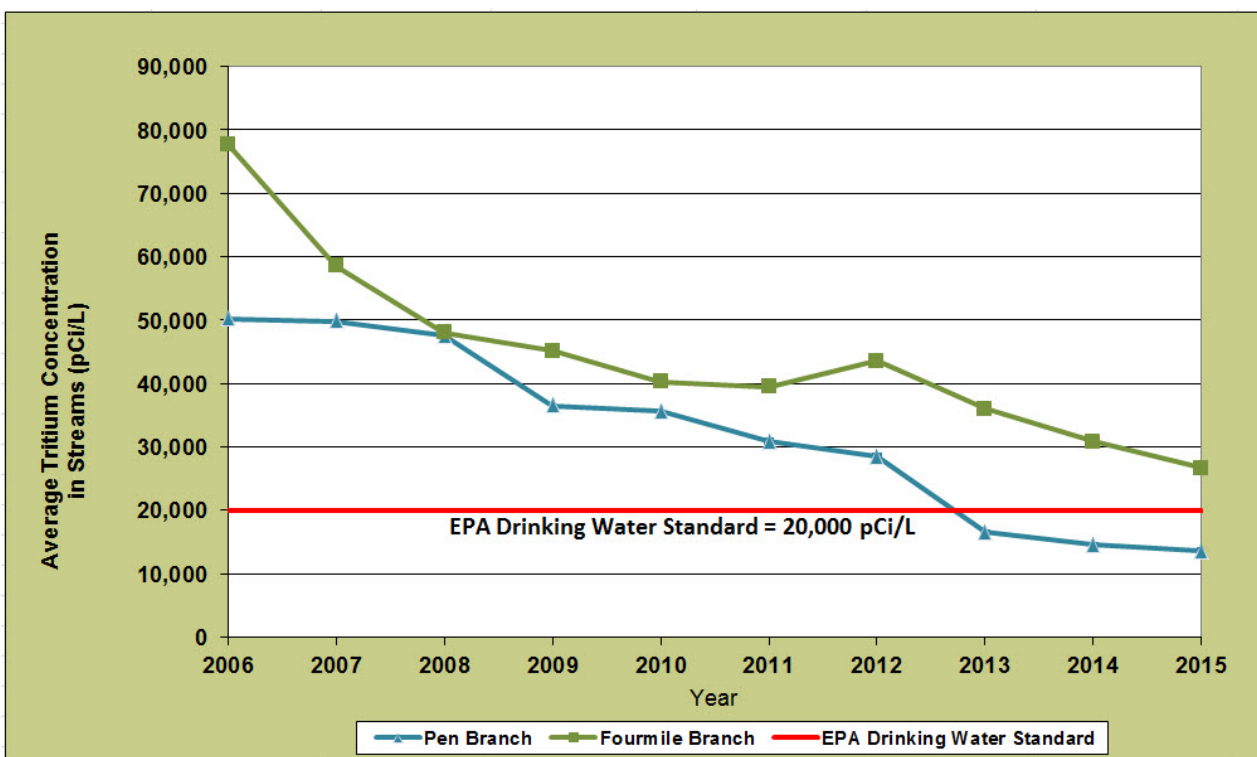


Figure 5-9 Ten-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

Figure 5-10 presents a graphical representation of releases of tritium via migration to Site streams from 2006 through 2015. As seen in the figure, migration releases of tritium generally have declined the past ten years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2015, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 652 Ci compared to 657 Ci in 2014, which represents a <1% decrease. The ten-year trend displays a decrease in tritium migration.

Of the 652 Ci of tritium migrating into SRS streams, 457 Ci (70%) were measured in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 0.1 Ci the past ten years. Sampling in Pen Branch measures the tritium migration from the seepage basin and the percolation field below the K-Area Retention Basin. It is estimated that 195 Ci migrated in 2015, which is comparable to the 186 Ci recorded in 2014.

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

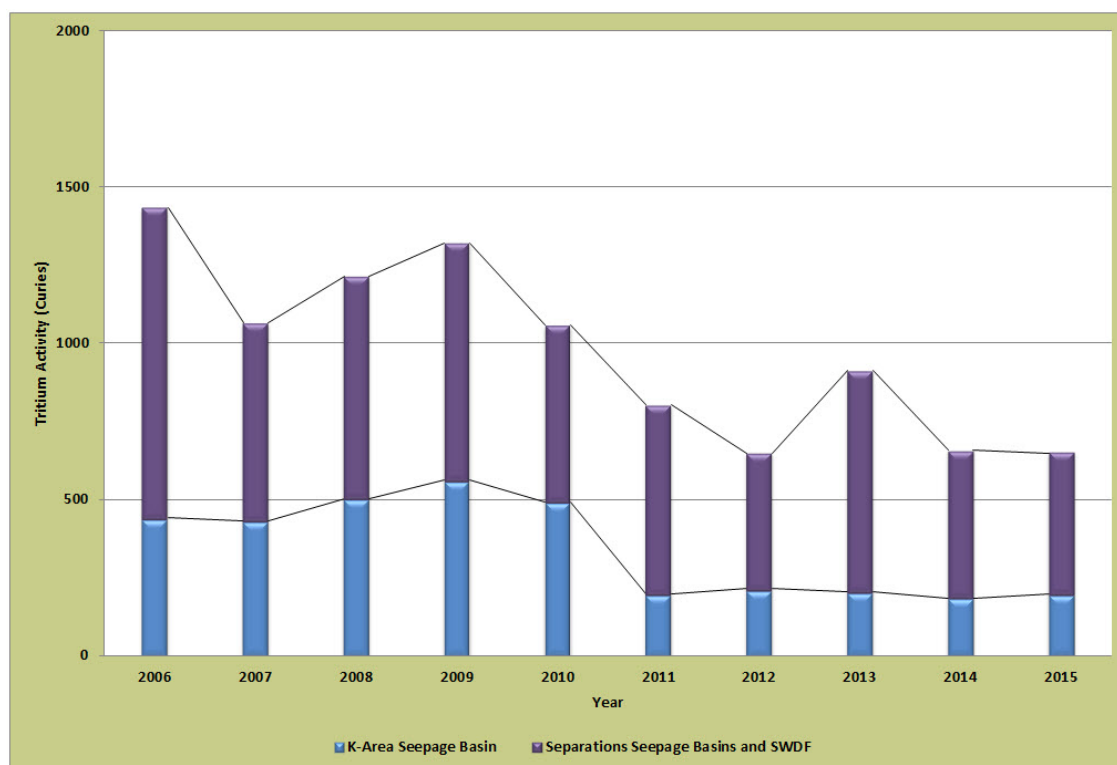


Figure 5-10 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

SRS measures streams for alpha specific isotopes, such as the actinides (uranium, plutonium, americium, and curium), when gross alpha results for the five major streams are greater than the EPA screening level of 15 pCi/L gross alpha. Overall, the alpha specific (Pu-238, Pu-239, Am-241, Cm-244, U-234, U-235, and U-238) isotope values for 2015 showed no elevated levels and were consistent with historical measurements.

5.4.5 Savannah River Sampling and Monitoring

SRS conducts continuous sampling along the Savannah River at locations above and below SRS streams, including at a location where liquid discharges from Vogtle Electric Generating Plant (VEGP) enter the river.

Five locations (Figure 5-8) along the river continued to serve as environmental surveillance points in 2015. Samples are collected at these river locations and analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides.

5.4.5.1 Savannah River Results Summary

The average 2015 concentrations of gross alpha, gross beta, and tritium at river locations are listed in Table 5-5. The tritium concentration levels are well below the EPA drinking water standard of 20,000 pCi/L.



Field Technician Collects Composite River Surface Water at River Mile 160

Table 5-5 Average Radionuclide Concentrations in the Savannah River

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)
RM-160 (CONTROL)	0.188	2.01	84.8
RM-150.4 (VEGP)	0.233	2.06	1,230
RM-150	0.231	1.96	271
RM-141.5	0.283	1.99	443
RM-118.8	0.257	1.93	481

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS and VEGP tritium estimates based on concentration results and average flow rates at Savannah River Mile (RM) 118.8 were 2,394 Ci in 2015 compared to 2,513 Ci in 2014. In addition to the weekly samples collected for tritium, gross alpha, gross beta, and gamma analyses, SRS collects annual samples to provide a more comprehensive suite of radionuclides for analysis (strontium-89,90, technetium-99, and actinides). SRS analyzed all annual samples from RM 118.8 and several other locations for uranium-234, uranium-238, and americium-241 in 2015. The analytical results for the 2015 samples are provided in the *2015 Environmental Monitoring Program Data Report* (2016a). Tritium averages for 2015 are consistent with the averages for the previous five years. Overall, river results are within the trends of the previous five to ten years.

5.4.6 Tritium Transport in Streams and Savannah River Surveillance

Because of the mobility of tritium in water and the quantities released during the years of SRS operations, SRS performs a comparison of tritium concentrations at various SRS stream locations and Savannah River monitoring locations. The comparison uses the following methods of calculation:

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

The methods SRS utilizes for estimating releases are based on environmental data reporting guidance described 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—serves to validate that SRS is sampling at the correct locations and the accuracy of analytical results.

5.4.6.1 Tritium Transport in Streams and Savannah River Results Summary

In 2015, tritium levels in streams showed a general increase, while river transport showed a slight decrease specifically:

- The direct releases of tritium increased by approximately 5.29% (from 701 Ci in 2014 to 736 Ci in 2015).
- The stream transport of tritium increased by approximately 23% (from 677 Ci in 2014 to 786 Ci in 2015).
- The river transport of tritium decreased by approximately 4.68% (from 2,513 Ci in 2014 to 2,398 Ci in 2015) [VEGP, Barnwell Low-Level Disposal Facility (BLLDF), and SRS contributed to these values]

The increases, observed from 2014 to 2015, for direct releases and stream transport are attributable to shallow groundwater migration and increases in direct releases to Upper Three Runs from the Effluent Treatment Facility. The decrease for river transport from 2014 to 2015 is attributable to decreases from both VEGP and BLLDF, in addition to a decrease in the river flows.

SRS tritium transport data from 1960-2015 (Figure 5-11), shows the history of direct releases, stream transport, and river transport and a zoomed in graph of the previous ten years. The general trend over time is attributable to 1) variations in tritium production and processing at SRS; 2) the implementation of effluent controls beginning in the early 1960s; and 3) the continuing depletion and decay of the SRS's tritium inventory.

Within the past five years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF operated by Energy Solutions, LLC. The tritium continues to enter the SRS stream system at Mary's 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 implemented monitoring at Mary's Branch to account for the

amount of tritium contributed from BLLDF. For 2015, the amount of tritium from BLLDF was estimated to be 70 Ci, which was not included in the SRS direct release or stream transport totals.

For compliance dose calculations, the highest value between the SRS direct releases and stream transport measurements (which was 786 Ci in 2015) is used (see Chapter 6, "Radiological Dose Assessments").

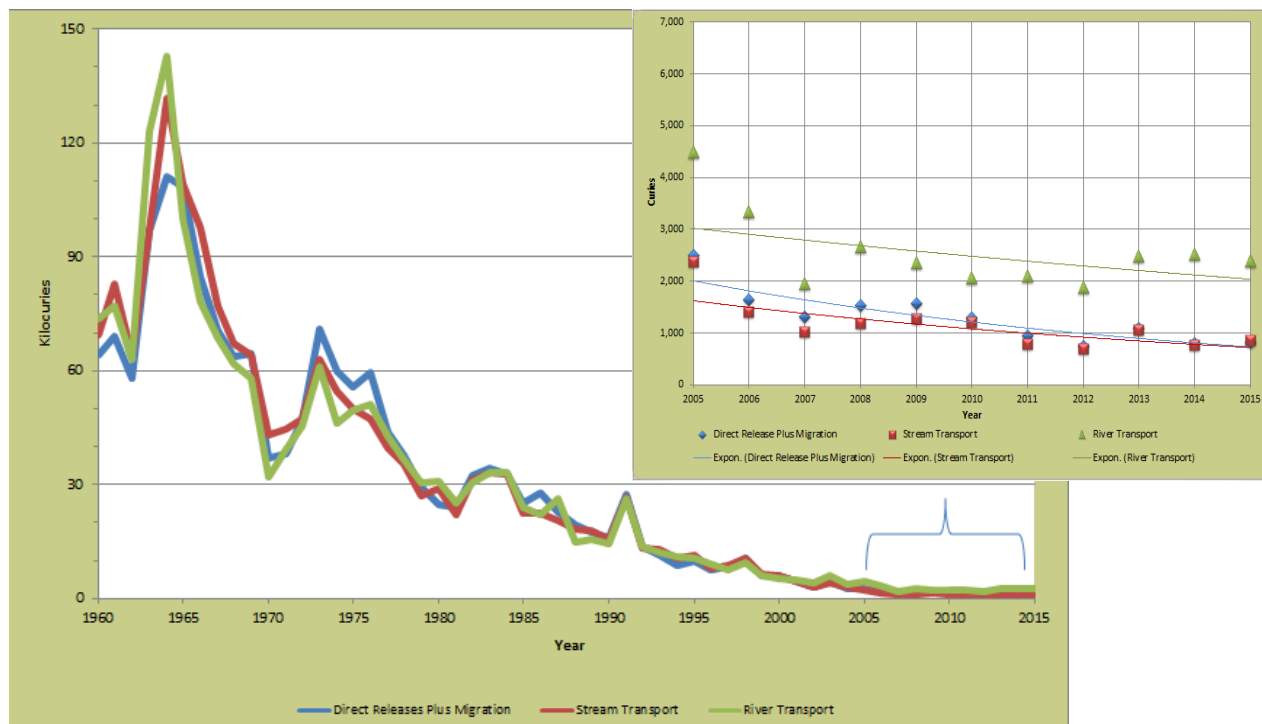


Figure 5-11 SRS Tritium Transport Summary

5.4.7 Sediment Sampling

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed.

Significant year-to-year differences may be evident because sediment is continuously moved and deposited at different locations in the stream and riverbeds (or because of slight variations in sampling locations), but the data obtained can be used to observe long-term environmental trends. Sediment samples were collected at eight Savannah River locations and 31 onsite streams, basins, ponds, or swamp discharge locations during 2015 ([Environmental Maps "Radiological Sediment Sampling Locations"](#)).

5.4.7.1 Sediment Results Summary

The maximum of each radionuclide is included in Appendix Table E-12 compared to the SRS control location. The maximum cesium-137 concentration of 812 pCi/g was observed in the Z-Area Stormwater Basin, a posted Soil Contamination Area. Soil Contamination Areas at SRS are areas where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. For the river and stream sediments, cesium-137 ranged from below the minimum detectable concentration (MDC) to 19 pCi/g at Steel Creek-2A Location. The highest level from the river, 0.578 pCi/g, was from RM 129 (Lower Three Runs River Mouth); the lowest levels were below detection.

The levels in SRS streams show a decreasing trend, which is due to a combination of decreases in Site releases and the natural decay of radionuclides. Sediment sample results indicate no buildup of radioactive materials from effluent release points.

5.4.8 Drinking Water Monitoring

SRS collects drinking water samples from ten locations at SRS and at two 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 and samples at four wells and five small systems.

SRS monitors potable water at offsite treatment facilities to ensure that SRS operations do not adversely affect the water supply and to provide assurance that drinking water does not exceed EPA drinking water standards for radionuclides. SRS collects samples offsite from two locations (Figure 5-12):

- Beaufort-Jasper Water and Sewer Authority’s (BJWSA) Purrysburg Water Treatment Plant (WTP), and
- North Augusta (South Carolina) WTP

SRS collects treated water from these two WTPs as consumed by the public. The North Augusta WTP is the SRS location used to determine concentrations in drinking water upstream of SRS. The intake for the BJWSA Purrysburg WTP intake is the furthest downriver sampling location. These locations are compared to evaluate potential impacts from upstream sources that include SRS.

5.4.8.1 Drinking Water Results Summary

In 2015, SRS performed gross alpha and gross beta screening on all onsite and offsite drinking water samples. No results exceeded EPA’s 15 pCi/L alpha concentration limit or 50 pCi/L beta concentration limit. In addition, no onsite or offsite drinking water samples exceeded the 20,000 pCi/L EPA standard for tritium or the 8 pCi/L strontium-89,90 MCL.



Field Technician Collecting Sediment Sample from Savannah River Site Stream

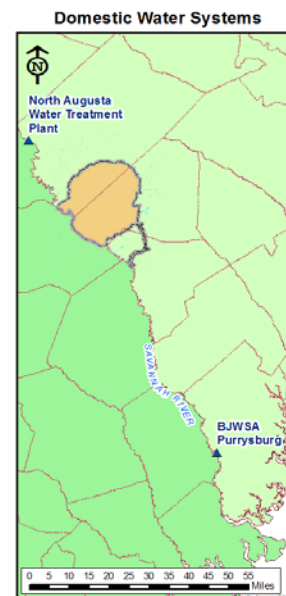


Figure 5-12 Offsite Drinking Water Sampling Locations

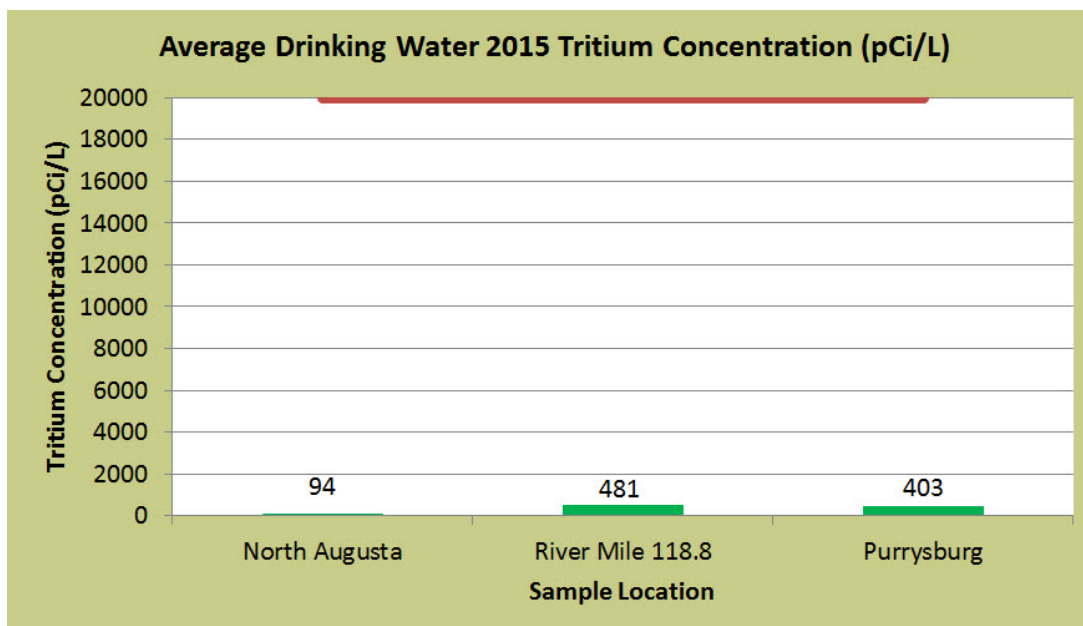


Figure 5-13 Tritium in Offsite Drinking Water and River Mile 118.8 (pCi/L)

Figure 5-13 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS in comparison to the average of weekly river water samples collected at RM 118.8. The average tritium concentration at RM 118.8 is less than 3% of the EPA standard for tritium and decreases further at the downstream sampling location.

Cobalt-60, cesium-137, strontium-89,90, plutonium 238, plutonium 239, and curium-244 were not detected in any drinking water samples. Sample results indicated detectable levels of americium-241 in five onsite samples and uranium-234, uranium-235, and uranium-238 in four, one, and six onsite samples, respectively. A summary of the results are provided in Appendix Table E-13. Concentrations are near the levels of detection for these four analytes. All analytical results are well below the EPA standard.

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

The SRS collects aquatic food products from the Savannah River. Freshwater fish are collected at six locations on the Savannah River from above SRS at Augusta, Georgia to the coast of Savannah, Georgia ([Environmental Maps “Fish Sampling Locations”](#)). Freshwater fish are collected at the mouth of the streams that traverse the Site. Saltwater fish are collected at the Savannah River mouth near Savannah, Georgia. Additionally, shellfish are purchased from vendors in the Savannah area that harvest from local saltwater that is potentially influenced by waters of the Savannah River. Table 5-6 identifies the aquatic products collected in 2015.



Fish Collection – Netting Fish

Table 5-6 Species of Aquatic Food Types Collected by SRS in 2015 for the Radiological Environmental Monitoring Program

Freshwater Fish	Saltwater Fish	Shellfish
Bass	Mullet	Crabs
Catfish	Red Drum	
Bream		

SRS analyzes both edible (meat and skin only) and non-edible (bone) types of freshwater and saltwater fish samples. Analyses conducted on edible samples include tritium, 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 analyses conducted on the non-edible samples. Only the edible portion of shellfish is analyzed. Shellfish analyses include gross alpha, gross beta, gamma-emitting radionuclides, strontium-89/90, technetium-99 and iodine-129.

5.5.1.1 Fish in Savannah River Results Summary

In 2015, SRS analyzed 48 freshwater fish composites, six saltwater fish composites, and one shellfish composite. The freshwater and saltwater composites consist of three to eight fish each. The shellfish composite consists of one bushel of crabs. The analytical results of the freshwater and saltwater fish, and shellfish collected in 2015 are consistent with 2010 through 2014 results. A majority of results for the specific radionuclides associated with SRS operations are non-detectable (70% for freshwater fish, 87% for saltwater fish, and 100% for shellfish). Table 5-7 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The fish type and the collection location associated with the maximum concentration are identified for each radionuclide. Cobalt-60 was not detected in any fish flesh samples. Summary tables of the results for all fish and shellfish are provided in Appendix Tables E-14, E-15, and E-16 for freshwater fish, saltwater fish and shellfish, respectively.

The gross alpha result for shellfish was detected at 0.203 pCi/g. This value is less than the gross alpha trigger level of 0.951 pCi/g, which SRS uses as the basis for additional analyses of alpha-emitting

Table 5-7 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples

Radionuclide	Maximum Concentration	Location	Fish Type
Tritium	0.778 pCi/g	Four Mile Creek River Mouth	Panfish
Cesium-137	0.311 pCi/g	Lower Three Runs Creek River Mouth	Bass
Strontium-89,90 (edible)	0.00724 pCi/g	Lower Three Runs Creek River Mouth	Panfish
Iodine-129*	0.0438 pCi/g	Steel Creek River Mouth	Catfish
Technetium-99	0.101 pCi/g	Upper Three Runs Creek River Mouth	Bass

*NOTE: Only two detected results out of 55 total results.

radionuclides. Gross alpha results were below the MDC for all edible fish composites of saltwater and freshwater fish. Gross beta activity was detectable in all freshwater and saltwater fish, as well as shellfish. The concentrations are consistent with 2010 through 2014 results and are most likely attributed to the naturally occurring radionuclide potassium-40.

The data from the fish monitoring is included in the determination of the potential dose and risk to the public, as reported in Chapter 6 “Radiological Dose Assessment.”

5.6 WILDLIFE SURVEILLANCE

The wildlife surveillance program provides the monitoring of wildlife harvested from SRS and subsequently released to the public. The purpose of the monitoring is to assess any impact of Site operations on the wildlife populations and ensure that the SRS Annual Administrative Game Animal Release Limit of 22 mrem/year is not exceeded for any individual. Annual game animal hunts for deer, coyote and feral hogs are open to members of the public. One turkey hunt for Wounded Warriors and those with mobility impairments was held in the spring and 10 fall annual game animal hunts in 2015. SRS also conducted a



Monitoring for Cesium-137 during SRS wildlife hunt

roadside deer removal program in 2015. The annual hunts and deer removal activities are conducted to reduce animal-vehicle collisions and control site deer, coyote and feral hog populations.

All animals harvested during the annual hunts on the SRS are monitored to ensure the total dose to any hunter is below the SRS 22 mrem/year limit. SRS uses portable sodium iodide detectors to perform field analyses for cesium-137. The cesium-137 concentration detected in the animal is used to calculate dose. A dose is assigned to each hunter for every animal harvested if the cesium-137 concentration is above the background concentration of 3.25 picocurie per gram (pCi/g). 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 (1) a set frequency, (2) the field measured cesium-137 levels, or (3) exposure limit considerations. This laboratory-analyzed data provides 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. If it is in soluble form, it can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations from 1945 to 1980 and is present at low levels in all environmental media.

5.6.1.1 Wildlife Results Summary

During one of the ten game animal hunts conducted in 2015, as well as the turkey hunt, monitoring results indicated all animals were at or below background cesium-137 concentration of 3.25 pCi/g. No dose was assigned to any hunters for the animals harvested during those hunts.

A total of 473 deer, 80 feral hogs, 23 coyotes, and 27 turkeys were monitored during 2015.

All 27 turkeys harvested during the spring hunt were released. All 319 deer and 80 hogs harvested during the 10 game animal hunts were released. Twenty-three coyotes were harvested and approved for release, but hunters chose to keep only two. One hundred fifty-four (154) deer were harvested during the roadside deer removal project activities. Six deer were not released because monitoring results indicated cesium-137 concentrations were above the cesium-137 background concentration of 3.25 pCi/g.

Muscle and bone samples were collected from a subset of the deer and hogs. A summary of the results is provided in Appendix Table E-17. As observed in previous years, cesium-137, a man-made gamma-emitting radionuclide, was detected in muscle tissue during laboratory analysis. Strontium-89,90, a beta-emitting radionuclide, was detected in both bone and muscle tissue.

Generally, cesium-137 concentrations measured by field detectors and laboratory methods were similar. Field measurements for cesium-137 from all released animals ranged from the lowest default value of 1.00 pCi/g (assigned to field results less than 1.00 pCi/g) to 15.29 pCi/g while laboratory measurements ranged from non-detect to 11.3 pCi/g. Results of field and laboratory measurements are summarized in Table 5-8. The muscle and bone samples from a subset of the animals undergo laboratory analysis for cesium-137 and strontium-89,90. Because of its chemistry, strontium exists at higher concentration in bone than in muscle tissue.

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past 50 years, as well as the last ten years. The historical trend analysis is in Figure 5-14.

In 2015, all 45 deer bone and 12 hog bone samples had detectable levels of strontium-89,90 greater than the MDC. Strontium-89,90 was detected in deer bone with an average of 3.49 pCi/g and a maximum of 6.32 pCi/g. Strontium-89,90 was detected in hog bone with an average of 4.17 pCi/g and a maximum of 15.0 pCi/g.

For the deer muscle tissue samples, seven out of the 52 muscle tissue samples had detectable levels greater than the MDC for strontium-89,90 with a maximum detectable concentration of 0.029 pCi/g. These average results are similar to those of previous years.

Calculation of dose from the consumption of wildlife harvested on the SRS is included in Chapter 6 "Radiological Dose Assessment."

Table 5-8 Cesium-137 Results for Laboratory and Field Measurements in Wildlife

2015	Number of Animals	Field Gross Average Cs-137 Concentration (pCi/g)	Field Maximum Cs-137 Concentration (pCi/g)	Lab Average Cs-137 Concentration (pCi/g)	Lab Maximum Cs-137 Concentration (pCi/g)
Deer- Game Hunts	319	1.68	15.29	2.46	7.70
Deer – Roadside Deer Removal	154	1.11	11.52	2.12	11.3
Hog	80	0.84	5.43	1.60	9.19
Coyote	23	0.69	1.50	-----	-----
Turkey	27	0.24	0.94	-----	-----

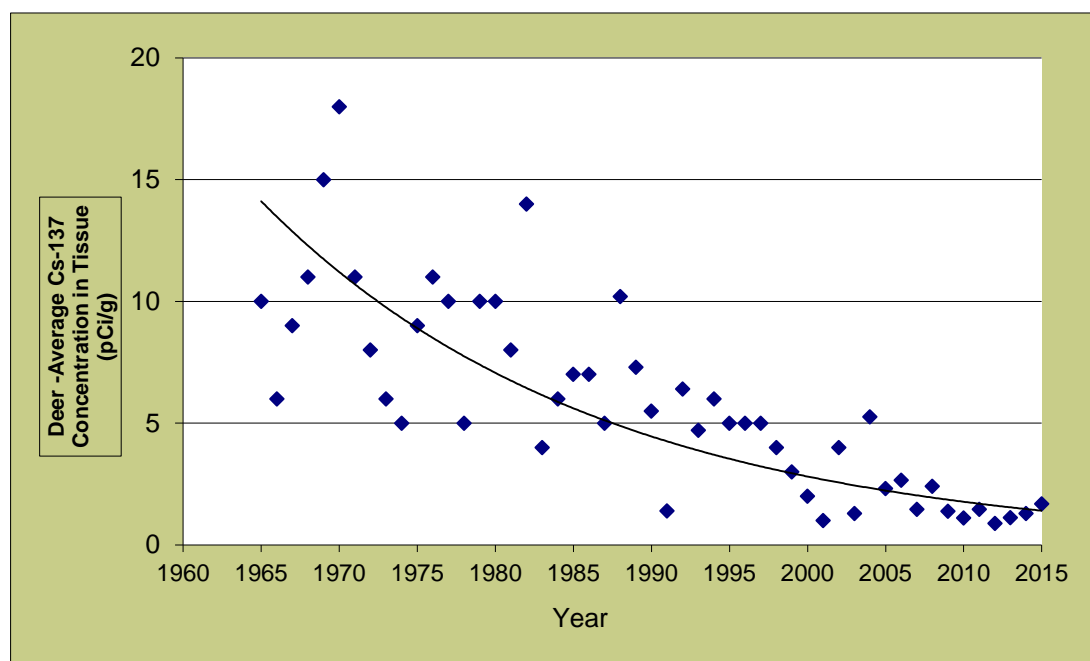


Figure 5-14 Historical Trend of Cesium-137 Concentration in Deer (pCi/g)

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