

The purpose of the Savannah River Site (SRS) Radiological Environmental Monitoring Program (REMP) is two-fold in that it monitors any effects SRS has on the environment, and it 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. As part of this program, the Site collects thousands of samples throughout the year and analyzes them for radionuclides that could be present from releases due to SRS operations. Samples are collected both onsite and in the communities surrounding SRS. State and federal regulations drive some of the monitoring SRS conducts, 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 the Environment*, also address environmental monitoring requirements.

2016 Highlights

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

Wildlife Surveillance—SRS monitors animals harvested during the annual onsite hunts to ensure the total dose to any hunter from ingesting the meat is below the SRS Annual Administrative Game Animal Release Limit of 22 mrem/yr. SRS monitored the deer, feral hogs, turkeys, and coyotes harvested during the hunts and released 366 animals. Based on field measurements, SRS found that one animal, a male deer, exceeded the SRS administrative limit and did not release it.

5.1 INTRODUCTION

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

The SRS REMP monitors radiological contaminants from both air and liquid point sources, as well as collects and analyzes environmental samples from numerous locations throughout the Site and the surrounding area.

Chapter 5—Key Terms

Actinides are a group of elements with an atomic number between 89 through 103. Within this chapter, laboratory analysis of actinides generally refers to the elements uranium, plutonium, americium, and curium. When neptunium or thorium is also included, the text states that.

Derived concentration standard (DCS) is the concentration of a radionuclide, measured at the discharge point, in air or water effluents that—under conditions of continuous exposure for one year (that is, annual ingestion of water, submersion in air, or inhalation)—would result in a dose of 100 mrem (1 mSv). This assumption of direct exposure to discharge point effluents is extremely unlikely and ensures that the DCSs are highly conservative.

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

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

Environmental monitoring encompasses both effluent monitoring and environmental surveillance.

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

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

The REMP is divided into two focus areas: 1) Effluent monitoring, and 2) Environmental surveillance. SRS determines sampling frequency and analyses based on permit-mandated monitoring requirements, federal regulations, and DOE Orders.

In accordance with DOE Order 458.1, SRS gauges the effluent monitoring program against DOE-derived concentration standards (DCSs) by comparing the annual average concentrations of continuously sampled sources to the DOE DCSs, which DOE's *Derived Concentration Technical Standard* (DOE 2011) documents. The DCS requirement is that the sum of the ratios of the observed concentration of each radionuclide to its corresponding DCS must not exceed 1.00. This sum is referred to as the sum of fractions. The DCSs are applicable at the point of discharge, and SRS uses them to screen existing effluent treatment systems to determine if they are appropriate and effective. SRS uses the same DCSs as reference concentrations to conduct environmental protection programs. All DOE sites use these DCSs.

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

SRS conducts environmental monitoring of the following:

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

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

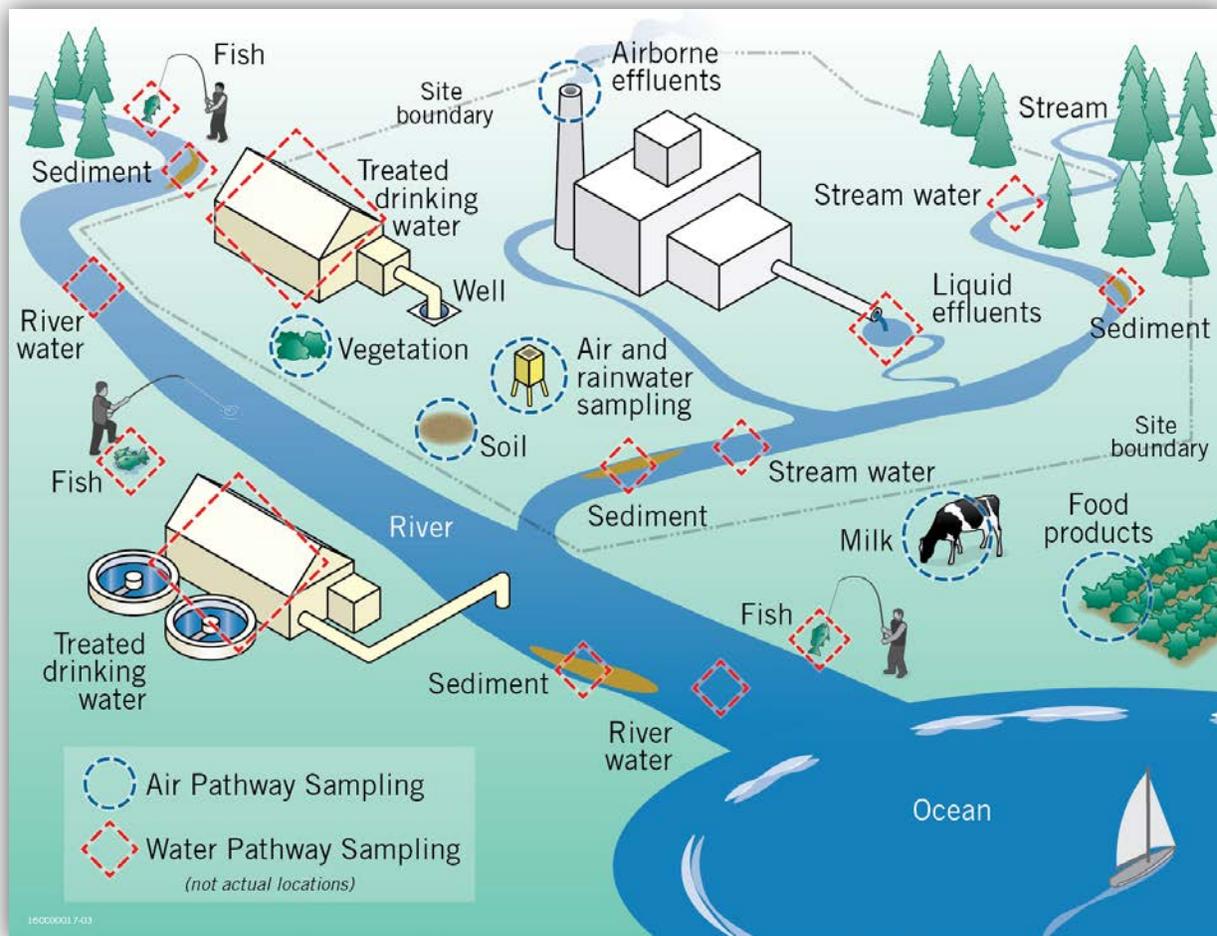


Figure 5-1 Types and Typical Locations of Radiological Sampling

Appendix Table B-2 of this document summarizes the radiological surveillance sampling media and frequencies. *The 2016 Environmental Monitoring Program Data Report (SRNS 2017a)* documents all raw data associated with SRS.

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 the Site has on the environment and to assess long-term trends of the contaminants in the environment. SRS collects samples beyond the Site perimeter in Georgia and in South Carolina at 25 and 100 miles from the Site. Additionally, SRS collects samples at several population centers in Georgia and in South Carolina.

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. Media-specific chapter figures and [Environmental Maps](#) show offsite environmental sampling locations. Chapter 7, *Groundwater Management Program*, provides information on SRS groundwater monitoring. Table 5-1 summarizes SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected in the Savannah River.

Table 5-1 SRS Offsite Radiological Sample Distribution by State

Environmental Sampling Media	Approximate Number of Samples (Number of Locations)	
	South Carolina	Georgia
Air Filters	26 (1)	52 (2)
Silica Gel	26 (1)	52 (2)
Ambient Gamma Radiation Monitoring	160 (7)	80 (4)
Rainwater	12 (1)	24 (2)
Food Products	20 (20)	5 (5)
Milk	16 (4)	16 (4)
Soil	1 (1)	2 (2)
Grassy Vegetation	1 (1)	2 (2)
Drinking Water	24 (2)	0 (0)
Total	286 (38)	233 (23)

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

5.3 AIR PATHWAY

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

5.3.1 Air Monitoring

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

Radionuclides present in and around the SRS environment are from sources such as natural background, fallout from past atmospheric testing of nuclear weapons, offsite nuclear power plant operations, and SRS operations. "Fallout" is the term for the settling to the ground of airborne particles emitted into the atmosphere from the earth by explosions, eruptions, forest fires, etc. or from production activities such as those found at nuclear facilities. Tritium in the elemental (hydrogen gas) and oxide (water vapor) 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 issues Clean Air Act Part 70 Air Quality Permits to regulate radioactive airborne pollutant emissions for each major source of airborne emissions on SRS. Each permit has specific limitations and monitoring requirements.

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

- Data obtained from monitored air effluent release points (stacks or vents)
- Calculated releases of unmonitored radioisotopes from the dissolution of spent fuel
- 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. Depending on the processes involved, SRS may also use real-time instrumentation to monitor instantaneous and cumulative releases (of tritium, for example) to the air.

The dissolution of spent nuclear fuel in the H-Canyon facility releases krypton-85, carbon-14, and tritium. These emissions are calculated and included with the monitored releases.

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

In 2016, SRS began analytical compositing for two airborne sources. SRS is planning to implement compositing at additional airborne sources in 2017. Compositing increases analytical accuracy by reducing the minimum detectable concentrations (MDCs) in airborne effluent samples.



Air Emission Stack in L Area

5.3.2.1 Airborne Emissions Results Summary

The continuous airborne effluent particulate sampling system for the F-Canyon stack was out of service from June until mid-November. A stack flow transmitter was inoperable and did not ensure representative sampling. SRS restarted the sampling system after replacing the flow transmitter. The facility obtained filter paper samples and analyses from an alternate sampling location to provide an estimate of stack releases during the sample system downtime and to ensure worker safety and health. Because the data from the alternate location were not from the approved sampling location, SRS did not use them to determine the annual releases from this source. For annual reporting, SRS calculated the releases using analytical data from the months that the sampling system was operating and estimated releases when the system was not operating. The analytical results from the period the sample system was operating were greater than the analytical results from the alternate location sampled during the system downtime. Thus, the calculated releases reported are conservative.

Appendix Table D-1 presents SRS radioactive release totals from monitored and unmonitored (calculated) sources. During the past 10 years, as Figure 5-2 shows, the total annual tritium release has ranged from about 17,000 to 41,000 Ci per year with an annual average tritium release of 28,000 Ci. The 2016 tritium emissions of 21,700 Ci is significantly below this 10-year average. Compared to the 19,100 Ci of tritium released in 2015, SRS tritium releases increased about 14% in 2016. However, for the past 10 years, the general trend has been a reduction in tritium releases to the air. As stated previously, the amount of tritium released from SRS fluctuates due to changes in SRS missions and in the annual production schedules of the tritium-processing facilities.

In 2016, tritium accounted for more than 84% of the total radioactivity SRS operations released to the air. Tritium processing facilities are responsible for 85% of SRS tritium releases, while the spent nuclear fuel dissolution in H Canyon accounted for less than 1% of SRS tritium releases. Tritium releases from the separations areas comprise the combination of releases from the tritium processing facilities and the dissolution in H Canyon. Appendix Table D-1 and Figures 5-2 and 5-3 show the tritium releases from the separations areas, reactors and spent nuclear fuel facilities, and unmonitored sources.

Appendix Table D-2 summarizes the 2016 air effluent-derived concentration standards (DCS) sum of the fractions. The raw data includes the specific radionuclide average concentrations and associated DOE DCS for each monitored discharge point within the facilities (SRNS 2017a). These concentrations correspond only to isotopic emissions that occur during sampling. The average concentration is determined only if there is at least one statistically significant result for the isotope. The radionuclide dose assessment includes concentrations for other periods, including any time between stack samples, unidentified alpha and unidentified beta results, and emissions estimated using calculations (that is, unmonitored diffuse and point) (Jannik, Minter, and Dixon, 2017a). The raw data (SRNS 2017a) contains calculated concentrations for tritium from the reactor areas and the tritium processing facilities, and for krypton-85, carbon-14, and

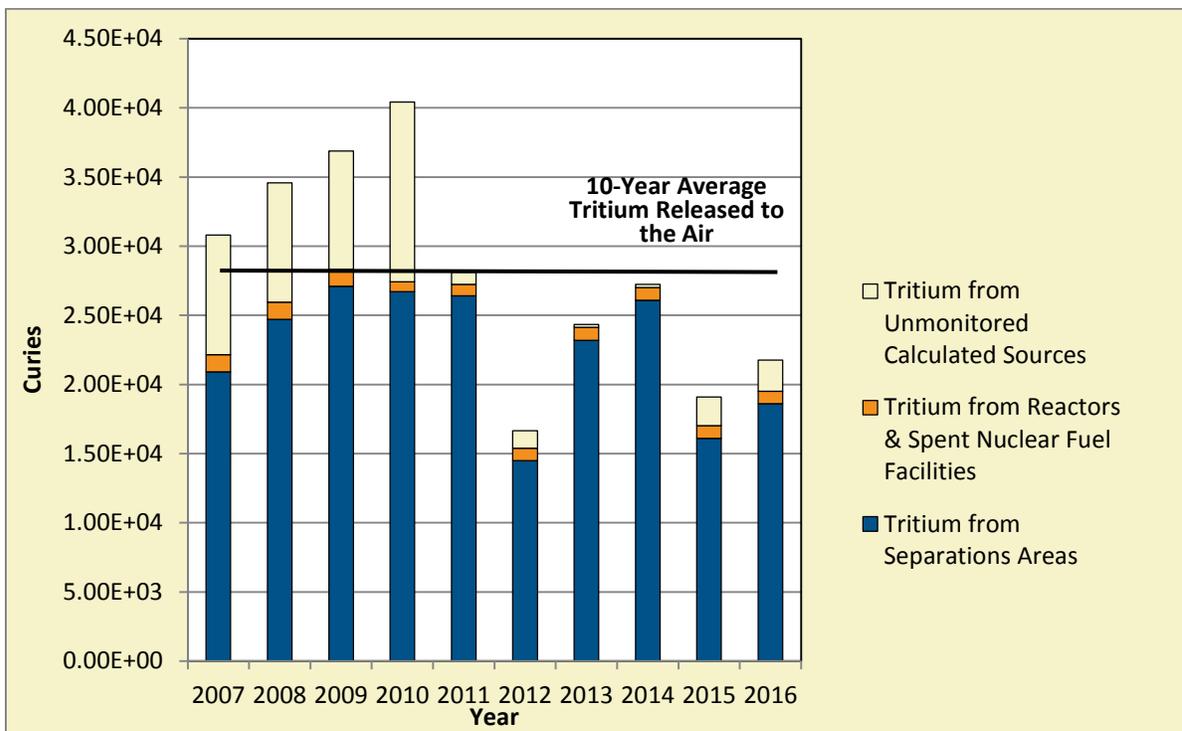


Figure 5-2 Ten-Year History of SRS Annual Tritium Releases to the Air

tritium from the H-Canyon facility during the dissolving process. These calculated concentrations are based on the annual releases in curies and the annual stack flow volume.

Most 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 processing facilities exceed DOE’s tritium DCS. However, tritium releases are maintained as low as reasonably achievable to be compliant with DOE Order 458.1. Additionally, the offsite dose from all airborne releases remained well below the DOE and EPA annual air pathway dose standard of 10 mrem (0.1 mSv). Chapter 6, *Radiological Dose Assessment*, discusses this further.

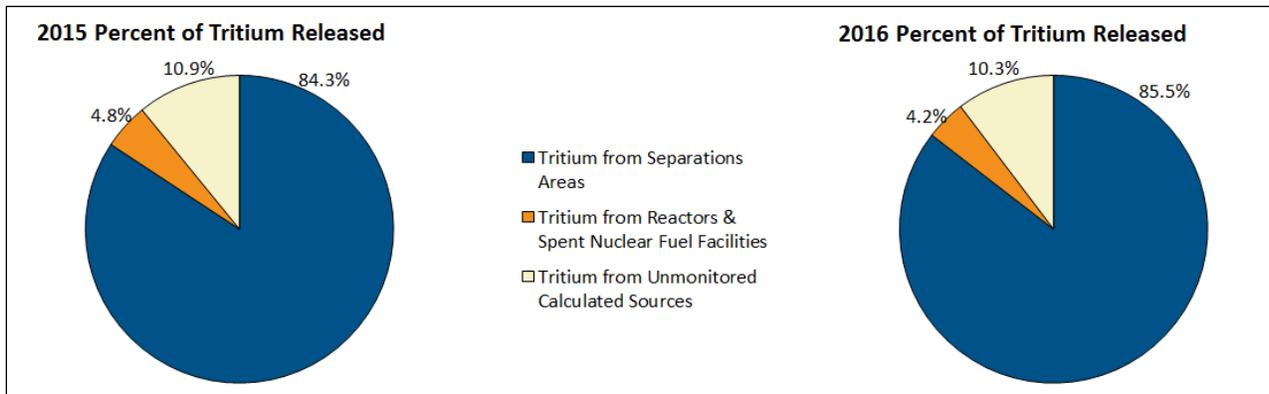


Figure 5-3 Percent of Tritium Released to the Air for 2015 and 2016

5.3.3 Air Surveillance

Beyond the operational facilities, SRS maintains a network of 14 air sampling stations (Figure 5-4 and [Environmental Maps, Radiological Air Surveillance Sampling Locations](#)) in and around SRS to monitor concentrations of tritium and radioactive particulate matter in the air and rainwater. The air 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 at locations on and off the Site. Onsite stations are at the center of the Site and around the perimeter. Offsite, sampling stations are 25 miles from the Site in population centers and at a control location, the U.S. Highway 301 Bridge at the Georgia Welcome Center in Screven County. SRS operations are not likely to affect the control location. SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases into the environment. Each air sampling station is set up to collect media that Table 5-2 lists.

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

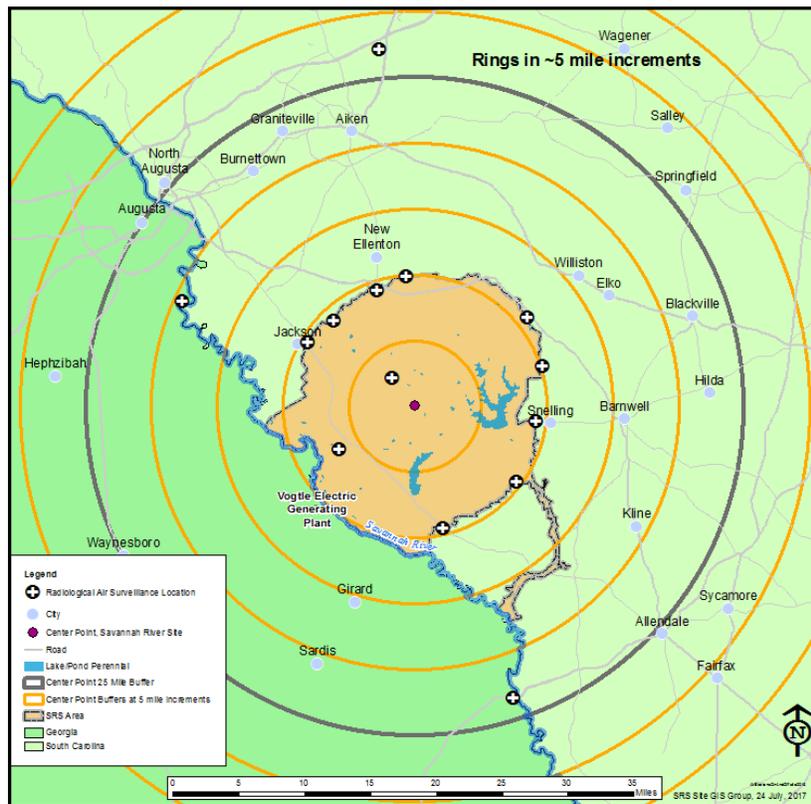


Figure 5-4 Air Sampling Locations Surrounding SRS up to 25 Miles

Table 5-2 Air 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, gamma-emitting radionuclides
Silica Gel	Tritiated Water Vapor	Tritium
Rainwater	Tritium in Rainwater	Tritium

5.3.3.1 Results Summary

Appendix Tables D-3 and D-4 summarize tritium results and the comparison to the background control location at the U.S. Highway 301 Bridge. All radionuclides for onsite surveillance air sampling media (Table 5-2) were within the trend levels for the previous 10 years, with the exception of tritium measured at the Barnwell Gate location in October. All offsite location results were near the levels observed at the control location at the U.S. Highway 301 Bridge.

The 2016 results for tritium in air showed detectable levels in 56 of the 363 samples (15%) with levels similar to the previous 5 years, with the exception of the Barnwell Gate location during October. This result from the Barnwell Gate showed tritium in air more than seven times the maximum observed over the previous five years. The tritium concentrations at the other sampling locations were consistent with historical levels. Taking into account there were no unexpected releases from SRS facilities during October and there was an east-northeast prevailing wind direction during this time, SRS determined that the elevation in concentration at the Barnwell location was due to an offsite source.



Technician Installing Silica Gel Column at Air Surveillance Sampling Station

The 2016 results for tritium in rainwater showed detectable levels in 18 of the 168 rainwater samples (11%) with levels similar to the previous 10 years. Concentrations from all locations were below the EPA drinking water standard of 20 pCi/mL. As in previous years, values were highest near the center of SRS and decreased with distance from the Site (SRNS 2017a). Appendix Table D-4 summarizes the results of tritium in rainwater.

5.3.4 Ambient Gamma Surveillance

Since 1965, SRS has been monitoring ambient (surrounding) environmental gamma exposure rates with thermoluminescent dosimeters (TLDs), which are passive devices that measure the exposure from ionizing radiation. The Site uses data from the TLDs 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 gamma radiation-monitoring program has four subprograms: 1) Site perimeter stations, 2) population centers, 3) air surveillance stations, and 4) Vogtle (stations on SRS that monitor exposures from Georgia Power's Vogtle Electric Generating Station). SRS conducts most gamma exposure monitoring onsite and at the SRS perimeter.

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

5.3.4.1 Ambient Gamma Results Summary

Ambient gamma exposure rates at all TLD monitoring locations show some variation based on normal location and annual variations in the components of natural ambient gamma radiation exposure levels. In 2016, ambient gamma exposure rates varied between 64.3 mR/yr at location NRC2 (onsite southwest) and 125 mR/yr at location Burial Ground North (center of the Site) (SRNS 2017a). Rates at population centers ranged from 93.4 mR/yr at the McBean location to 125 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. 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 the following:

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

In 2016, SRS collected soil samples from 5 onsite locations, 10 Site perimeter locations, and 3 offsite locations ([Environmental Maps, Radiological Soil Sampling Locations](#)). Radionuclide concentrations in soil vary greatly among locations because of differences in the patterns, retention, and transport of rainfall in different types of soils. Therefore, a direct comparison of year-to-year data could be



Technician Retrieving Soil Sample

misleading. However, SRS evaluates the data for long-term trend analysis.

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

5.3.5.1 Soil Results Summary

In 2016, SRS detected radionuclides in soil samples from all 18 sampling locations. The uranium isotopes (U-234, U-235, and U-238) are detected in the soil samples each year. Uranium is naturally occurring in soil and expected to be present in the environment. The concentration range for naturally occurring uranium in soil is typically from about 1 to 5 pCi/g with an average concentration of 2 pCi/g in soils in the United States. Five-year trends for uranium-234, uranium-235, and uranium-238 are increasing at many of the locations. However, uranium-238 had a maximum level onsite of 1.64 pCi/g observed near F Area and a maximum level offsite at the control location (Highway 301) of 2.10 pCi/g (uranium-238). These levels are within the typical range for soils and are at or below the average concentration in U.S. soils. Many factors affect the uranium concentration in soil over time. These include the pH of the soil, the type of soil, and deposits from the air transferred through rainfall. Organic matter and clay minerals provide exchange sites in soil, which can increase the uranium sorption. All measured uranium levels were below the concentration at the control location. SRS will continue to monitor these data; however, at this point, results have not exceeded action levels.

The concentrations of other radionuclides at these locations are consistent with historical results, with maximum cesium-137 concentrations of 0.427 pCi/g found at the Allendale Gate location and 0.134 pCi/g found at the control location (Highway 301). Appendix Table D-5 summarizes the results.

5.3.6 **Grassy Vegetation Surveillance**

SRS analyzes grassy vegetation samples from onsite and offsite locations ([Environmental Maps, Radiological Vegetation Sampling Locations](#)) to complement soil and sediment sample results used to evaluate the environmental accumulation of radionuclides and to help validate SRS dose models. Radioactive contaminants can contaminate vegetation externally, as can the 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 samples are collected from the following:

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

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

5.3.6.1 Grassy Vegetation Results Summary

SRS detected various radionuclides in the grassy vegetation samples collected during 2016 at all locations (1 onsite, 10 at the perimeter, and 3 offsite). Appendix Table D-6 summarizes the results. Results for all radionuclides are within the trends of the previous 10 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 fish and shellfish caught from the Savannah River. They analyze these samples for radionuclides. The results reveal whether radionuclides are present in the environment. Tritium releases from SRS 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 if the radionuclides are in the air. 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, they become exposed to radiation. Dairy cows are also livestock of concern to SRS because 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 humans through the food chain.

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

5.3.7.1 Terrestrial Food Results Summary

In 2016, SRS sampled the following terrestrial foodstuffs: greens, watermelons, beef, wheat, and cabbage. All food types were collected from all four quadrants and the control area. Laboratory analysis of the food samples included gamma-emitting radionuclides, tritium, strontium-89,90, technetium-99, gross alpha, gross beta, and actinides including neptunium. Laboratory analysis of the dairy samples included gamma-emitting radionuclides, tritium, and strontium-90. The analytical results of the terrestrial foodstuffs and dairy are consistent with 10-year trends. A majority of results for foodstuffs (75% for terrestrial foodstuffs and 95% for dairy) did not detect radionuclides.

Appendix Tables D-7 and D-8 summarize 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*. The Environmental Maps, *Stream Systems*, identifies SRS stream systems included in the pathway.

5.4.1 Liquid Effluents Monitoring Program

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

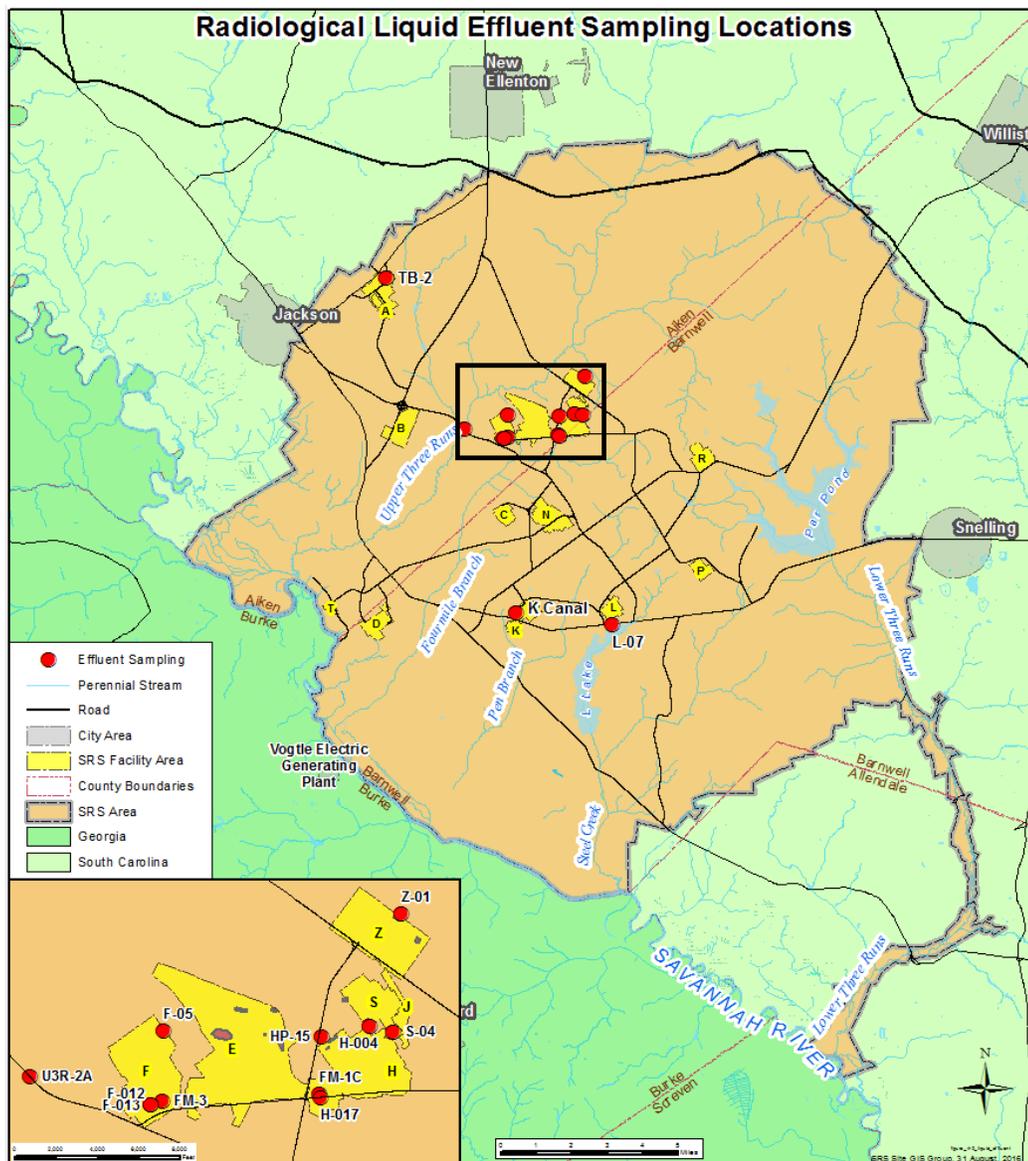
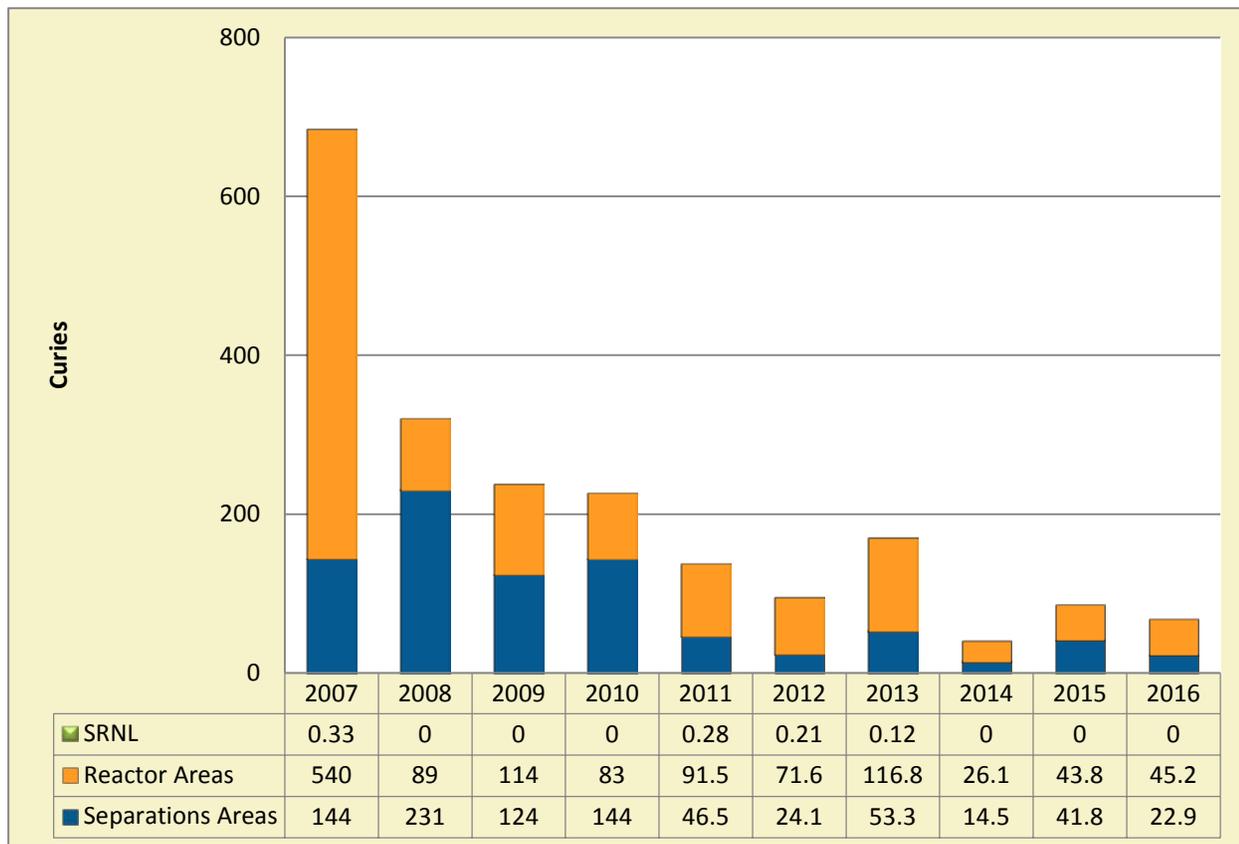


Figure 5-5 Radiological Liquid Effluent Sampling Locations

5.4.1.1 Liquid Effluent Results Summary

Appendix Table D-9 provides SRS liquid radionuclide releases for 2016 to include direct releases plus the shallow groundwater migration of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF). The total amount of tritium released directly from process areas to SRS streams during 2016 was 68.1 Ci. This is a decrease from the 85.6 Ci released in 2015. As seen in Figure 5-6, separations areas experienced an 18.9 Ci decrease. Tritium releases from the separations areas comprise the combination of releases from the separations, waste management, and tritium processing facilities. Reactor areas releases remained relatively the same as 2015. Just as the tritium released in 2016 was lower than in 2015, Figure 5-6 shows that the total direct release of tritium has had a general decreasing trend over the last 10 years.

The DCS sum of the fractions for all locations was less than 1.00. Appendix Table D-10 summarizes the 2016 liquid effluent sum of the fractions and radionuclides monitored for each outfall or facility. The raw data includes the specific radionuclide average concentrations and associated DOE DCS for each monitored facility and outfall (SRNS 2017a).



Note: The SRNL contribution to direct releases is minimal; thus, it is not visible on this figure.

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

5.4.2 Stormwater Basin Surveillance

SRS samples the accumulated stormwater in the Site’s stormwater basins (Figure 5-7) for gross alpha, gross beta, tritium, strontium, technetium, gamma-emitting radionuclides, and carbon. With no active processes discharging to SRS’s stormwater basins, the accumulations in these basins are mainly stormwater runoff. Monitoring for specific radionuclides occurs where operational history indicates their possible presence. The E-Area basins receive stormwater from the 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). Stormwater basins release to monitored outfalls during heavy rainfall.

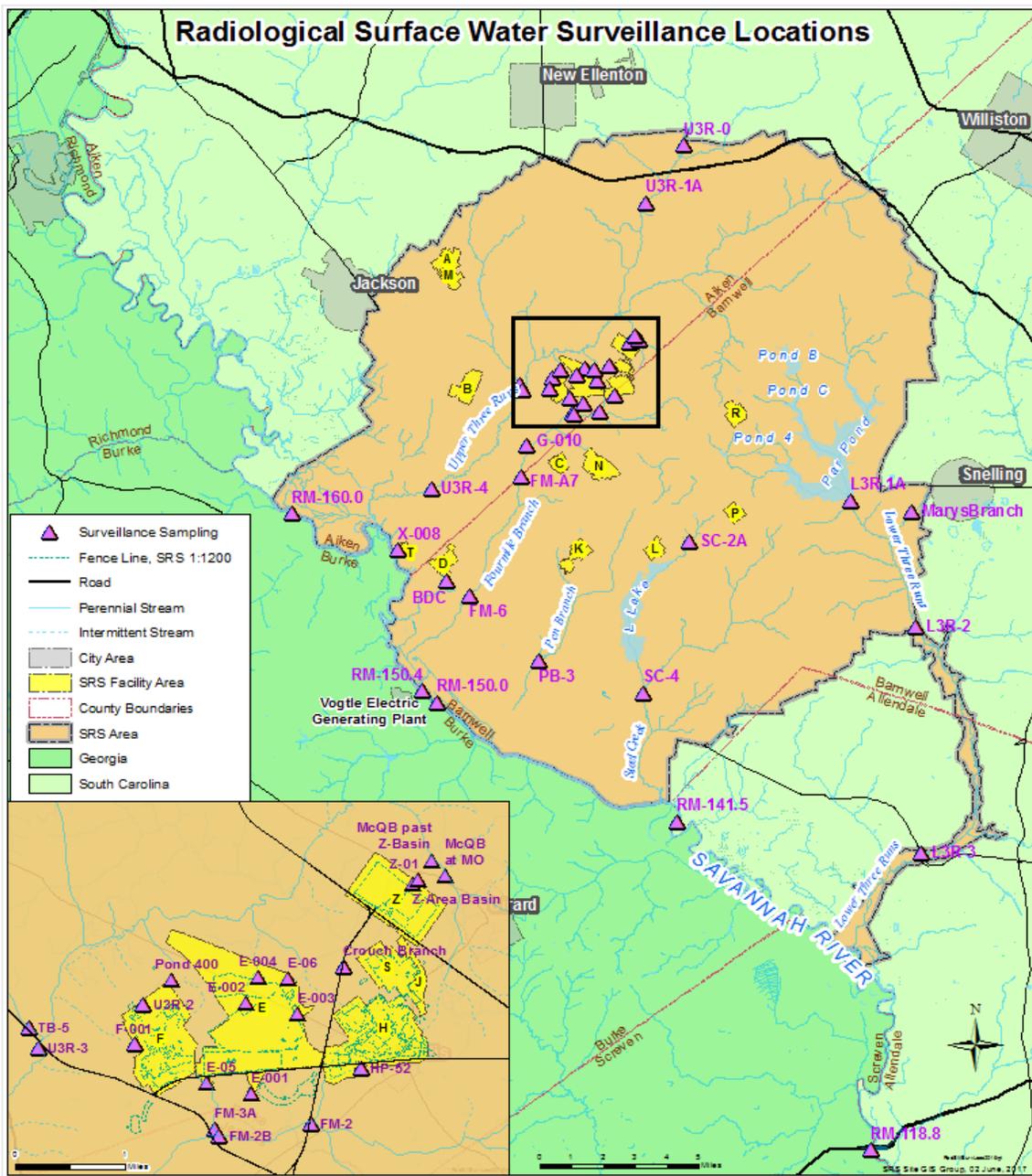


Figure 5-7 Radiological Surface Water Sampling Locations

5.4.2.1 Stormwater Basin Results Summary

In 2016, SRS sampled at five E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. One E-Area basin was dry and, therefore, not sampled. Table 5-3 summarizes gross alpha, beta, and tritium results for stormwater basins, which SRS sampled in the following locations: E-001, E-002, E-003, E-004, E-005, Pond 400, and Z Basin. The highest tritium concentration, 21,400 pCi/L, was observed at the E-002 Basin, which is consistent with the previous five years of results.

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	0.295	3.22	3,910	6,490
E-002	0.234	3.43	8,830	21,400
E-003	0.462	1.81	4,140	4,860
E-004	0.442	1.84	7,220	9,810
E-005	0.556	2.94	8,240	17,200
Pond 400	0.658	6.33	522	2,840
Z-Basin	0.715	228	2,240	4,350

5.4.3 SRS Stream Sampling and Monitoring

SRS continuously samples 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 radioactivity migration 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 the 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 in 2002. Radioactivity previously deposited in the F-Area and H-Area Seepage Basins and SWDF in E Area continues to migrate through the groundwater and enter Fourmile Branch (also known as Four Mile Creek) and Upper Three Runs. Groundwater migration from



Technician Acquires Stream Flow Measurements at Steel Creek Sampling Location SC-4

the F-Area Seepage Basins enters Fourmile Branch at three monitoring locations (FM-3A, FM-2B, and FM-A7) located along the stream. Groundwater migration from the H-Area Seepage Basins enters Fourmile Branch at two monitoring stations (FM-2B and FM 3-A) and from SWDF at the FM 3-A monitoring station. Groundwater from K-Area Seepage Basin migrates into Pen Branch.

Figure 5-7 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.

5.4.3.1 SRS Stream Results Summary

Table 5-4 presents the average 2016 concentrations of gross alpha, gross beta, and tritium in SRS streams. SRS found detectable concentrations of tritium at least once at all stream locations except Tim's Branch (TB-5), which had no detected tritium. The 10-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 5-8 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA standard of 20 pCi/mL, although 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 shallow groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration. Section 7.3.3, *Remediating SRS Groundwater*, presents additional information on the groundwater remediation efforts to reduce tritium to Fourmile Branch.

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)	3.87	2.59	ND	ND
Lower Three Runs (L3R-3)	1.00	1.98	590	789
Steel Creek (SC-4)	0.239	1.09	1,710	2,250
Pen Branch (PB-3)	0.510	1.01	13,000	17,100
Fourmile Branch (FM-6)	0.959	4.29	26,500	32,400
Upper Three Runs (U3R-4)	3.25	1.87	598	943
<i>Onsite Control Locations (for comparison)</i>				
Upper Three Runs (U3R-1A)	2.99	2.08	ND	ND

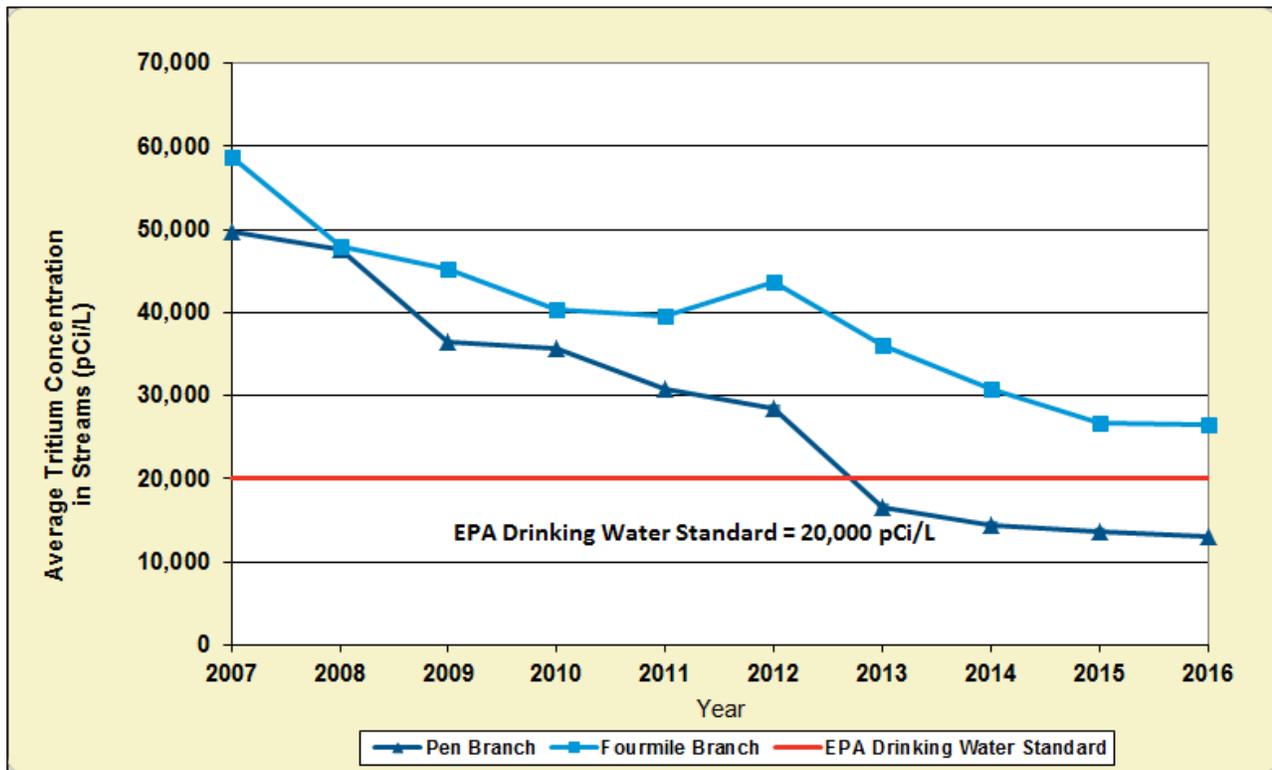


Figure 5-8 Ten-Year Trend of Tritium in Pen Branch and Fourmile Branch (pCi/L)

Figure 5-9 presents a graphical representation of releases of tritium via migration to Site streams from 2007 through 2016. As seen in the figure, migration releases of tritium generally have declined over the past 10 years, with year-to-year variability caused mainly by the amount of annual rainfall. During 2016, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 600 Ci compared to 652 Ci in 2015, which represents a greater than 7% decrease. The 10-year trend displays a decrease in tritium migration.

Of the 600 Ci of tritium migrating into SRS streams, 313 Ci (52%) was measured in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 0.1 Ci the past 10 years. Sampling in Pen Branch measures the tritium migration from the K-Area Seepage Basin and the percolation field below the K-Area Retention Basin. It is estimated that 195 Ci migrated in 2016, which is the same amount as in 2015.

Stream transport accounts for tritium migration releases from C-Area, L-Area, and P-Area Disassembly Basins (see Section 5.4.5 *Tritium Transport in Streams and Savannah River Surveillance*, in this chapter).

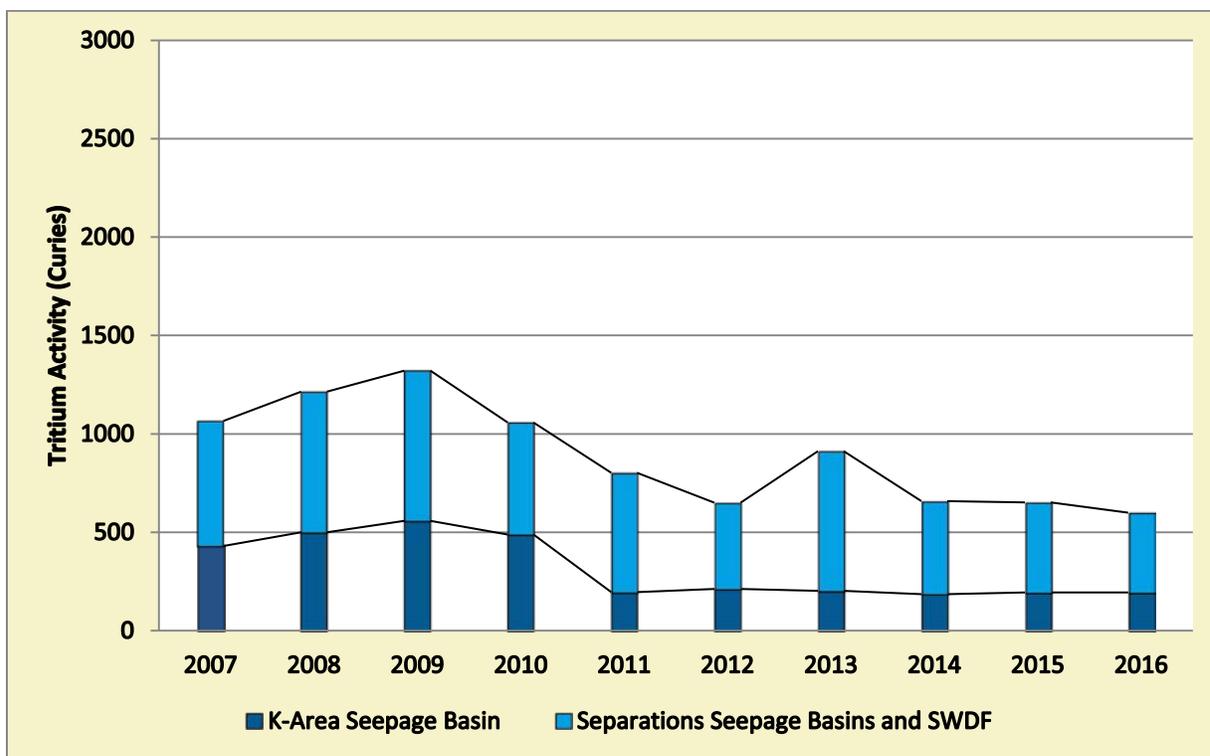


Figure 5-9 Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

SRS measures gross alpha concentrations in Site streams. If the results for any of the major stream locations, shown in Table 5-4, are greater than the EPA screening level, of 15 pCi/L gross alpha, then SRS measures for alpha-specific isotopes, such as the actinides (including neptunium). None of these stream locations exceeded this screening level in 2016. Alpha-specific isotopes are also measured annually for most stream locations. The alpha-specific isotopic (Pu-238, Pu-239, Am-241, Cm-244, Np-237, U-234, U-235, and U-238) results for 2016 showed no elevated levels and are consistent with historical measurements.

5.4.4 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 5-7) along the river continued to serve as environmental surveillance points in 2016. SRS collects samples at these river locations and analyzes them for gross alpha, gross beta, tritium, strontium, technetium, actinides, and gamma-emitting radionuclides.

5.4.4.1 Savannah River Results Summary

Table 5-5 lists the average 2016 concentrations of gross alpha, gross beta, and tritium and the maximum 2016 concentrations of tritium at river locations. The tritium concentration levels are well below the EPA drinking water standard of 20 pCi/mL.

Table 5-5 Radionuclide Concentrations in the Savannah River

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
RM-160 (CONTROL)	0.21	1.97	78.3	250
RM-150.4 (VEGP)	0.216	2.04	679	2570
RM-150	0.194	1.95	248	465
RM-141.5	0.215	1.98	361	916
RM-118.8	0.24	1.90	310	749

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS, VEGP, and Barnwell Low-Level Disposal Facility (BLLDF) tritium estimates based on concentration results and average flow rates at Savannah River Mile (RM) 118.8 were 1,698 Ci in 2016 compared to 2,394 Ci in 2015. 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 to include strontium-89,90, technetium-99, and actinides. The *2016 Environmental Monitoring Program Data Report* (SRNS 2017a) provides the analytical results. Average radionuclide concentrations are consistent with the results from the previous 10 years.

5.4.5 Tritium Transport in Streams and Savannah River Surveillance

Because of the mobility of tritium in water and the quantities released during the more than 60 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:

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

The methods SRS uses 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.

5.4.5.1 Tritium Transport in Streams and Savannah River Results Summary

In 2016, tritium levels in streams showed a slight decrease, while river transport showed a large decrease, specifically as described below:

- The direct releases of tritium decreased by 9.24% (from 736 Ci in 2015 to 668 Ci).
- The stream transport of tritium decreased by 7.00% (from 786 Ci in 2015 to 731 Ci). This is

quarterly summation totals vs. annual total.

- The river transport of tritium decreased by 29.07% (from 2,394 Ci in 2015 to 1,698 Ci). VEGP, BLLDF, and SRS contributed to these values. 56 Ci is attributed to the BLLDF.

SRS attributes the decreases observed from 2015 to 2016 for direct releases and stream transport to a decrease in shallow groundwater migration and a decrease in direct releases to Upper Three Runs from the Effluent Treatment Facility. The decrease for river transport from 2015 to 2016 is attributable to decreases from both VEGP and BLLDF.

SRS tritium transport data from 1960–2016 (Figure 5-10), shows the history of direct releases, stream transport, and river transports. The general trend over time is attributable to the following:

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

Within the past five years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF, which EnergySolutions, LLC operates. 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 for about 12 years and dilute as it moves from the source toward Lower Three Runs. In 2014, SRS started monitoring at Mary’s Branch, which is near BLLDF, to account for the amount of tritium BLLDF contributes. SRS estimated the amount of tritium from BLLDF to be 56 Ci, which was not included in SRS direct release or stream transport totals.

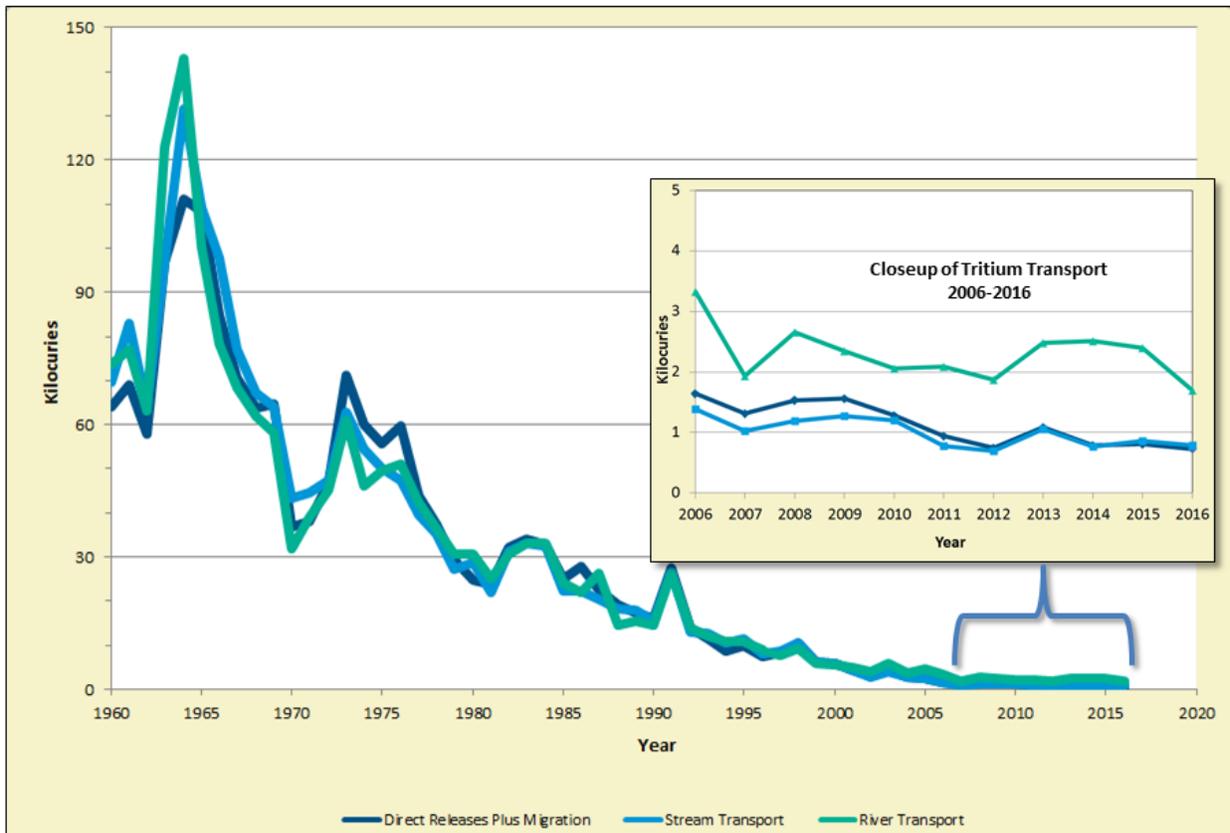


Figure 5-10 SRS Tritium Transport Summary

For compliance dose calculations, the value of SRS direct releases and of the stream transport measurements (which was 731 Ci from stream transport measurements in 2016) is used (see Chapter 6, *Radiological Dose Assessment*).

5.4.6 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. Accurately measuring radioactivity levels in settleable solids is impractical in water samples with low total suspended solids (TSS). SRS monitors for TSS as part of the routine National Pollutant Discharge Elimination System (NPDES) monitoring program from outfalls co-located at or near several radiological effluent points. In 1995, DOE provided an interpretation of the radioactivity levels in settleable solids requirement. The interpretation indicated that TSS levels below 40 parts per million were considered to be in compliance with the DOE limits. If TSS results are at or above 40 parts per million for TSS at the NPDES outfall that are co-located at or near radiological effluent points, samples are analyzed for alpha-emitting and beta/gamma-emitting radionuclides or additional samples may be collected and analyzed. The DOE limits for the radioactivity levels in settleable solids is 5 pCi/g above background for alpha-emitting radionuclides and 50 pCi/g above background for beta/gamma-emitting radionuclides.

5.4.6.1 Settleable Solids Results Summary

In 2016, all NPDES TSS sample results that are co-located at or near radiological effluent points were well below 40 parts per million with no results higher than 12 parts per million. The NPDES TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.7 Sediment Sampling

In 1996, SRS incorporated the settleable solids program into the radiological environmental surveillance program for sediments. This was done to provide a more reliable and cost-effective method to determine radioactivity buildup in sediments. SRS added eight sample sites to the sediment program to compensate for the loss of the settleable solids sampling program.

Sediment sample analysis measures the movement, deposition, and accumulation of long-lived radionuclides in streambeds and in the Savannah River bed. 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. During 2016, SRS implemented a composite sediment sampling strategy based on recommendations from the University of Georgia Savannah River Ecology Laboratory report *Technical Assessment of DOE Savannah River Site-Sponsored Radionuclide Monitoring Efforts in the Central Savannah River Area* (SREL 2014).



Field Technician Collecting Sediment Sample from a Stream on SRS

In 2016, SRS collected sediment samples at 8 Savannah River locations and 27 onsite streams, basins, ponds, or swamp discharge locations ([Environmental Maps, Radiological Sediment Sampling Locations](#)).

5.4.7.1 Sediment Results Summary

Appendix Table D-11 shows the maximum of each radionuclide compared to the applicable SRS control location. The Z-Area Stormwater Basin, a posted Soil Contamination Area, had the maximum cesium-137 concentration of 2,920 pCi/g. Soil Contamination Areas at SRS are locations where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. The lowest levels of cesium-137 in river, stream and basin sediments were below detection. Table 5-6 shows the maximum sediment concentrations.

Table 5-6 Maximum Cesium-137 Concentration in Sediments Collected in 2016

Location	Maximum Location	Maximum Concentration (pCi/g)
Savannah River Sediment	RM-150.2 Below Four Mile Creek	6.95E-01
SRS Stream Sediment	R-Area (Downstream of R-1)	4.19E+01
SRS Basin Sediment	Z-Basin	2.92E+03

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. Results indicate the radioactive materials from effluent release points are not building up in the sediment at the sampling locations.

5.4.8 Drinking Water Monitoring

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

Onsite drinking water sampling consists of samples from the large treatment plant in A Area 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 the following two locations (Figure 5-11):

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

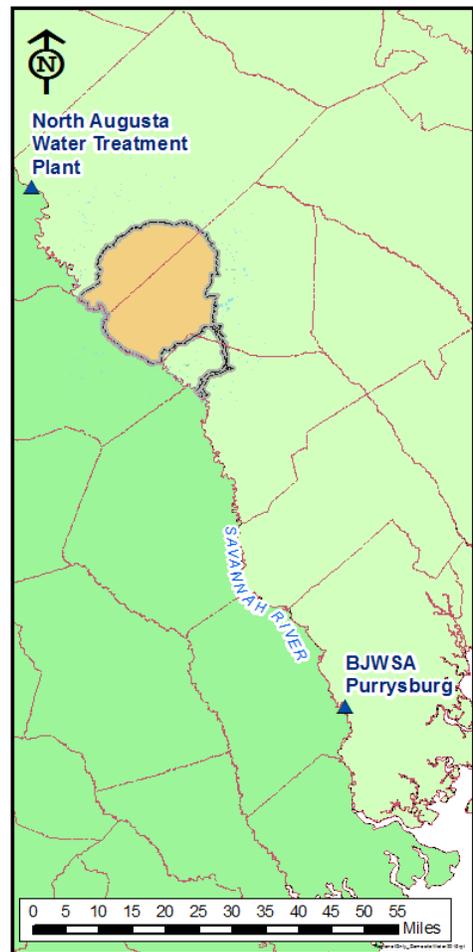


Figure 5-11 Offsite Drinking Water Sampling Locations

SRS collects treated water from these two WTPs, which supply water to the public. The North Augusta WTP is used to determine concentrations in drinking water upstream of SRS. The BJWSA Purrysburg WTP is the furthest downriver sampling location. SRS compares these locations to evaluate potential impacts from upstream sources that include SRS.

5.4.8.1 Drinking Water Results Summary

In 2016, SRS performed gross alpha and gross beta screening on all onsite and offsite drinking water samples. No results exceeded the 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 pCi/mL EPA standard for tritium or the 8 pCi/L strontium-89,90 maximum contaminant level.

Figure 5-12 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS 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 2% of the EPA standard for tritium and decreases further at the downstream sampling location.

Sample results did not detect cobalt-60, cesium-137, strontium-89,90, uranium-235, plutonium 238, plutonium 239, and curium-244 in drinking water test locations. Sample results indicated detectable levels of americium-241 in 2 onsite samples, uranium-234 in 8 onsite samples, and uranium-238 in 10 onsite samples. Appendix Table D-12 summarizes the results. Concentrations are near the levels of detection for these three analytes. All analytical results are well below the EPA standard.

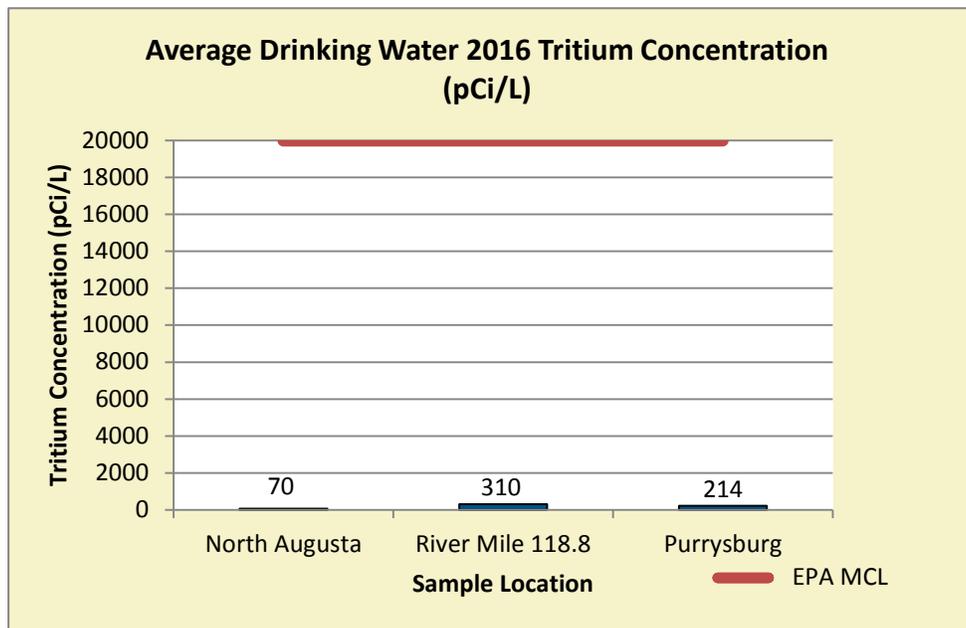


Figure 5-12 Tritium in Offsite Drinking Water and River Mile 118.8

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

SRS collects aquatic food from the Savannah River. Freshwater fish come from six locations on the Savannah River from above SRS at Augusta, Georgia, to the Highway 301 bridge ([Environmental Maps, Fish Sampling Locations](#)). Onsite, SRS collects freshwater fish at the mouth of the streams that traverse the Site. Saltwater fish come from the Savannah River mouth near Savannah, Georgia. Additionally, shellfish come from the Savannah River mouth near Savannah, Georgia, or SRS purchases them from vendors in the Savannah area that harvest from local saltwater that is potentially influenced by waters of the Savannah River. Table 5-7 identifies the aquatic products collected in 2016.

Table 5-7 Aquatic Products Collected by SRS in 2016 for the Radiological Environmental Monitoring Program

Freshwater Fish	Saltwater Fish	Shellfish
Bass	Mullet	Crab
Catfish	Red Drum	Shrimp
Panfish	Sea Trout	

SRS analyzes both edible (meat and skin only) and nonedible (bone) samples of freshwater and saltwater fish. Analyses of 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 analysis SRS conducts on the nonedible samples. With shellfish, SRS analyzes only the edible portion of shellfish. SRS analyzes shellfish for 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 2016, SRS collected freshwater fish from the six locations, saltwater fish and shrimp from the Savannah River mouth, and purchased crabs in the Savannah area from a vendor that harvests from saltwater potentially influenced by Savannah River water. SRS analyzed 54 freshwater fish composites, 8 saltwater fish composites, and 2 shellfish composites. The freshwater and saltwater composites consisted of three to eight fish each. The shellfish composites consisted of one bushel of crab and about one-half bushel of shrimp. The analytical results of the freshwater and saltwater fish, and shellfish collected are consistent with 2011 through 2015 results. A majority of results for the specific radionuclides associated with SRS operations were nondetectable (62% for freshwater fish, 80% for saltwater fish, and 90% for shellfish). Table 5-8 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The



Collecting Fish by Netting

table also identifies the fish type and the collection location associated with the maximum concentration for each radionuclide. Cobalt-60 and iodine-129 were not detected in any fish flesh samples. Appendix Tables D-13, D-14, and D-15 for freshwater fish, saltwater fish and shellfish, respectively, summarize results for all fish and shellfish.

The maximum gross alpha result for shellfish was detected at 0.476 pCi/g in crab. 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 radionuclides. Gross alpha results were below the MDC for all edible saltwater and freshwater fish composites. Gross beta activity was detectable in all freshwater and saltwater fish, as well as shellfish. The concentrations are consistent with 2011 through 2015 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*.

Table 5-8 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples

Radionuclide	Maximum Concentration	Location	Fish Type
Tritium	0.549 pCi/g	Four Mile Creek River Mouth	Bass
Cesium-137	0.414 pCi/g	Lower Three Runs Creek River Mouth	Panfish
Strontium-89,90	0.00976 pCi/g	Augusta Lock and Dam	Panfish
Technetium-99	0.126 pCi/g	Four Mile Creek River Mouth	Bass

5.6 WILDLIFE SURVEILLANCE

The wildlife surveillance program monitors 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/yr is not exceeded for any individual. Annual game animal hunts for deer, coyote, and feral hogs are open to members of the public. During 2016, SRS held one turkey hunt for Wounded Warriors and residents with mobility impairments in the spring and nine game animal hunts in the fall. SRS also conducted a roadside deer removal program in 2016. The Site holds the annual hunts and deer removal to reduce animal-vehicle collisions and control Site deer, coyote, and feral hog populations.

SRS monitors all animals harvested during the annual hunts to ensure the total dose to any hunter is below the SRS 22 mrem/yr limit. SRS uses portable sodium iodide detectors to perform field analyses for cesium-137. SRS began using newly designed field monitoring equipment in October. Chapter 8, *Quality Assurance*, presents information related to the upgraded field monitoring equipment.

SRS uses the cesium-137 concentration detected in the edible flesh of the animal to calculate dose. The edible flesh is that portion of the animal consumed. 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. These laboratory-analyzed data provide a quality-control check on the field monitoring results. Cesium-137 is chemically similar to and behaves like potassium in the environment. Cesium-137 has a half-life of about 30 years and tends to persist in soil, where it can readily enter the food chain through plants. It is widely distributed throughout the world from nuclear weapons detonations from 1945 to 1980 and is present at low levels in all environmental media. Flesh samples analyses also include cobalt-60, strontium 89,90, gross alpha, and gross beta. Bone samples are collected on the same frequency as the flesh samples and are analyzed for strontium-89,90.

5.6.1 Wildlife Results Summary

During the hunts in 2016, SRS monitored a total of 301 deer, 36 feral hogs, 5 coyotes, and 25 turkeys. No dose was assigned to any hunter during three of the nine game animals hunts conducted in 2016, as well as the turkey hunt. This indicates that all animals harvested during those hunts were at or below the background cesium-137 concentration of 3.25 pCi/g. During the hunt season, however, field monitoring results indicated one animal, a male deer, would have been above the administrative game animal release limit of 22 mrem and thus was not released to the hunter.

The Site released all 25 turkeys harvested during the spring hunt. Additionally, it released 212 deer and 36 hogs harvested during the 9 game animal hunts. Hunters chose not to keep the five coyotes they harvested and that SRS approved for release. Of the 88 deer that SRS harvested during the roadside deer removal project, 3 deer were not released because monitoring results indicated cesium-137 concentrations were above the background concentration of 3.25 pCi/g.

Appendix Table D-16 summarizes the muscle and bone sample results from a subset of the monitored deer and hogs. As seen in previous years, laboratory analysis detected cesium-137, a man-made gamma-emitting radionuclide, in muscle tissue. Analysis detected strontium-89,90, a beta-emitting radionuclide, in bone and in some muscle tissue.

Generally, the cesium-137 concentrations field detectors measure are similar to those of laboratory methods. Field measurements for cesium-137 from all released animals ranged from a minimum of 0.78 pCi/g to 14.17 pCi/g, while laboratory measurements ranged from nondetect to 11.8 pCi/g. Table 5-9 summarizes field and laboratory measurements. The maximum field and laboratory measurement for the deer from the regular hunts, as shown in Table 5-9, is for the male deer that was not released due to the dose associated with the animal being above the SRS Annual Administrative Game Animal Release Limit.



**Training Session on the Use of the Upgraded Wildlife Monitoring System (above)
Closeup of the New Detector (left)**

Average cesium-137 concentrations in deer have indicated an overall decreasing trend for the past 50 years, with relatively little change in the last 10 years. Figure 5-13 shows the historical trend analysis.

Because its chemistry is similar to that of calcium, strontium exists at higher concentration in bone than in muscle tissue. In 2016, all 42 deer bone and 3 hog bone samples had detectable levels of strontium-89,90. Strontium-89,90 was detected in deer bone with an average of 3.83 pCi/g and a maximum of 6.73 pCi/g. Strontium-89,90 was detected in hog bone with an average of 2.08 pCi/g and a maximum of 2.50 pCi/g.

For the deer muscle tissue samples, 4 out of the 42 muscle tissue samples had levels greater than the MDC for strontium-89,90 with a maximum detectable concentration of 0.011 pCi/g. These average results are similar to those of previous years.

All cobalt-60 and gross alpha results were not detectable. Gross beta activity, detected in all samples, is consistent with 2011 through 2015 results.

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

Table 5-9 Cesium-137 Results for Laboratory¹ and Field Measurements in Wildlife

2016	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	213	2.11	27.26 ²	2.64	11.80 ²
Deer—Roadside Deer Removal	88	1.20	7.05	1.21	7.20
Hog	36	1.05	2.70	0.778	1.14
Coyote	5	3.22	6.40	-----	-----
Turkey	25	0.28	1.04	-----	-----

Notes:

1. In evaluating the upgraded monitoring equipment, samples collected for laboratory analyses were biased toward animals where field monitoring indicated a DOE-added dose.
2. The maximum values are from the animal that was not released. Field monitoring indicated the dose associated with the animal to be above the SRS Administrative Game Animal Release Limit.

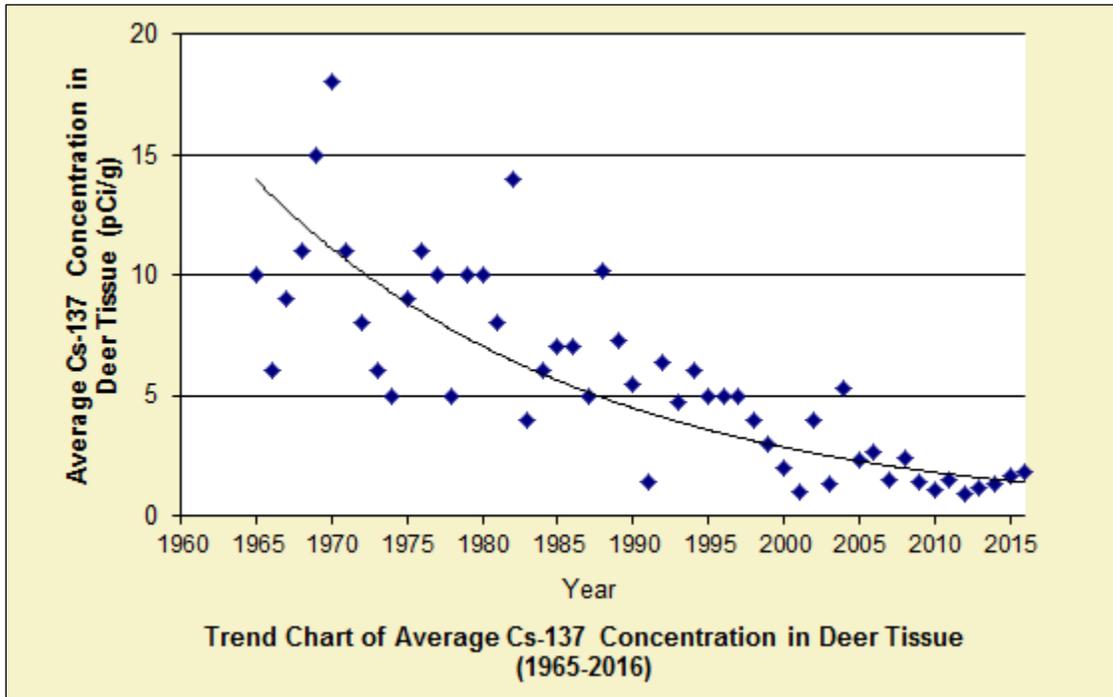


Figure 5-13 Historical Trend of Average Cesium-137 Concentration in Deer Tissue (1965–2016)