Chapter 5: **Radiological Environmental Monitoring Program**

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

2020 Highlights

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

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

Wildlife Surveillance—All harvested animals SRS monitored during the annual onsite hunts were below the applicable standard. SRS monitored the deer, feral hogs, and coyotes harvested during the hunts and released 347 animals during 2020.

5.1 INTRODUCTION

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

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

In accordance with DOE Order 458.1, SRS evaluates the effluent monitoring program by comparing the annual average concentrations to the DOE-derived concentration standards (DCSs). DOE's *Derived Concentration Technical Standard* (DOE 2011) establishes numerical standards for DCSs to implement DOE Order 458.1. DCSs are radiological quantities for certain radionuclides specific to a surface or concentration used in surveying or characterizing radiation to comply with DOE Order 458.1. SRS demonstrates DCS compliance when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. This sum is called the "sum of fractions." The DCSs are applicable at the point of discharge, and SRS uses them to screen existing effluent treatment systems to determine 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 Site releases, as measured in the effluent monitoring program, may impact. Figure 5-1 shows the liquid and airborne pathways, as well as the types of media sampled through those pathways.

SRS conducts environmental monitoring of the following:

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

Chapter 5—Key Terms

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

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

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

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

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

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

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

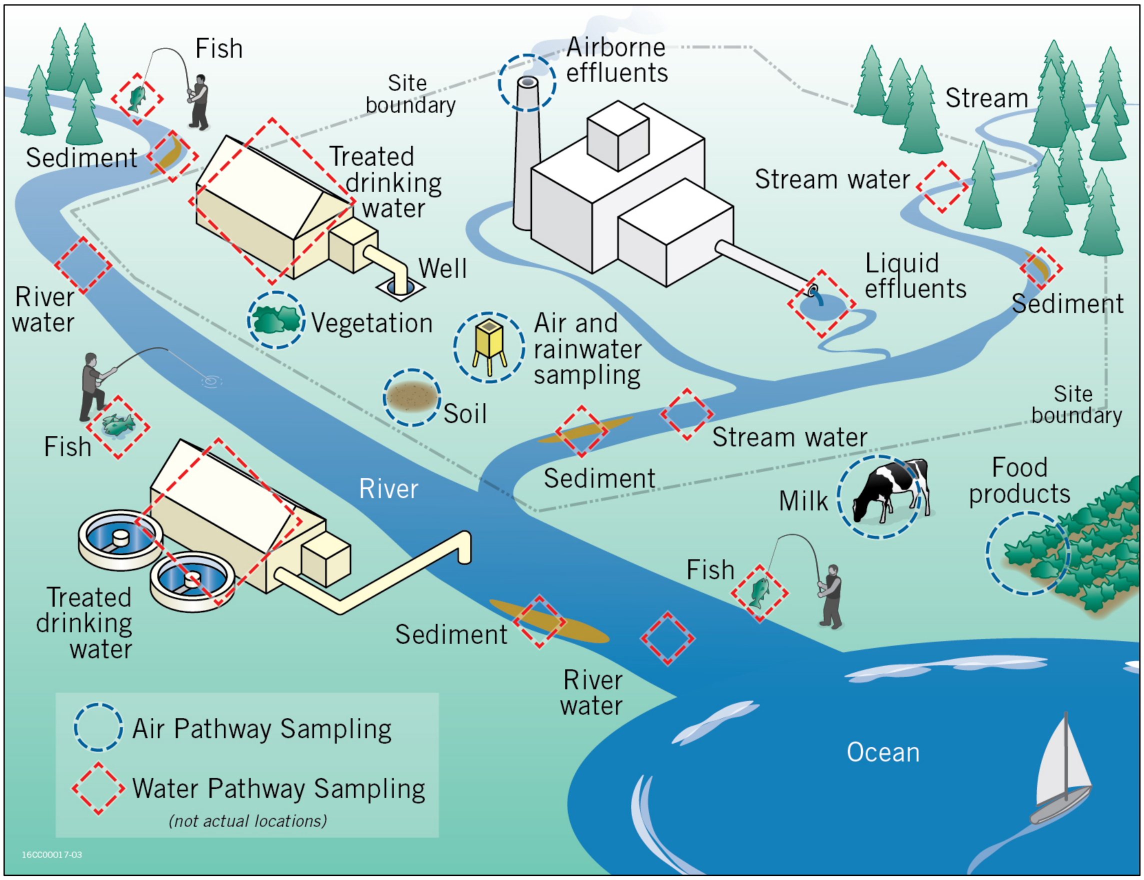


Figure 5-1 Types and Typical Locations of Radiological Sampling

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

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

5.2 SRS OFFSITE MONITORING

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

SRS monitors the Savannah River at five locations adjacent to and downriver of SRS. A control location is located above the Site at RM 161. Media-specific chapter figures and Environmental Maps show offsite environmental sampling locations. Chapter 7, *Groundwater Management Program,* provides information on SRS groundwater monitoring. Table 5-1 summarizes SRS offsite radiological sampling performed in Georgia and South Carolina, excluding samples collected 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	56 (7)	32 (4)
Rainwater	13 (1)	26 (2)
Food Products	20 (20)	4 (4)
Milk	16 (4)	11 (3)
Soil	4 (4)	2 (2)
Grassy Vegetation	1 (1)	2 (2)
Drinking Water	24 (2)	0 (0)
Total	**186 (41)**	**181 (21)**

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

5.3 AIR PATHWAY

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

5.3.1 Air Monitoring

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

5.3.2 Airborne Emissions

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

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

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

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

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

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

5.3.2.1 Airborne Emissions Results Summary

Appendix Table D-1 presents SRS radioactive release totals from monitored and unmonitored (calculated) sources, while Table 5-2 provides a summary for the calendar year (CY). During the past 10 years, the total annual tritium release has ranged from about 7,030 to 40,000 Ci per year, with an annual average tritium release of 20,800 Ci (Figure 5-2). The 2020 SRS tritium releases totaled 7,030 Ci, which is the lowest in 10 years. The 24% decrease in SRS tritium releases from the 2019 releases was primarily due to the recent 2020 deactivation of legacy process buildings. Other contributing factors are the fluctuations in the amount of tritium released during routine operations and the natural decay of tritium (about 5% per year).

In 2020, tritium and krypton-85 accounted for a majority of the total radiation SRS operations released to the air. Tritium-processing facilities are responsible for most of the SRS tritium releases, and the reprocessing of highly enriched uranium at H-Area separations facilities is responsible for all krypton-85 releases. Tritium releases from the separations areas are a combination of releases from the tritium-processing facilities and the dissolution in H Canyon. Appendix Table D-1 and Figures 5-2 and 5-3 show the tritium releases from the separations areas, legacy reactor facilities, and unmonitored sources.

Table 5-2 SRS Radiological Atmospheric Releases for CY 2020

Release Type	Total (curies)
Tritium	7.03E+03
Krypton-85 (^{85}Kr)	7.37E+03
Short-Lived Fission and Activation Products (T1/2 < 3 hr)[a,b]	2.82E-05
Fission and Activation Products (T1/2 > 3 hr)[a,b]	5.48E-02
Total Radio-iodine	4.16E-03
Total Radio-strontium[c]	6.99E-03
Total Uranium	8.44E-05
Plutonium[d]	4.67E-04
Other Actinides	2.35E-04
Other	2.86E-06

[a] ICRP 107 Half-life data, *Nuclear Decay Data for Dosimetric Calculations* (2008)
[b] IAEA Common Fission and Activation Products
[c] Includes unidentified beta releases
[d] Includes unidentified alpha releases

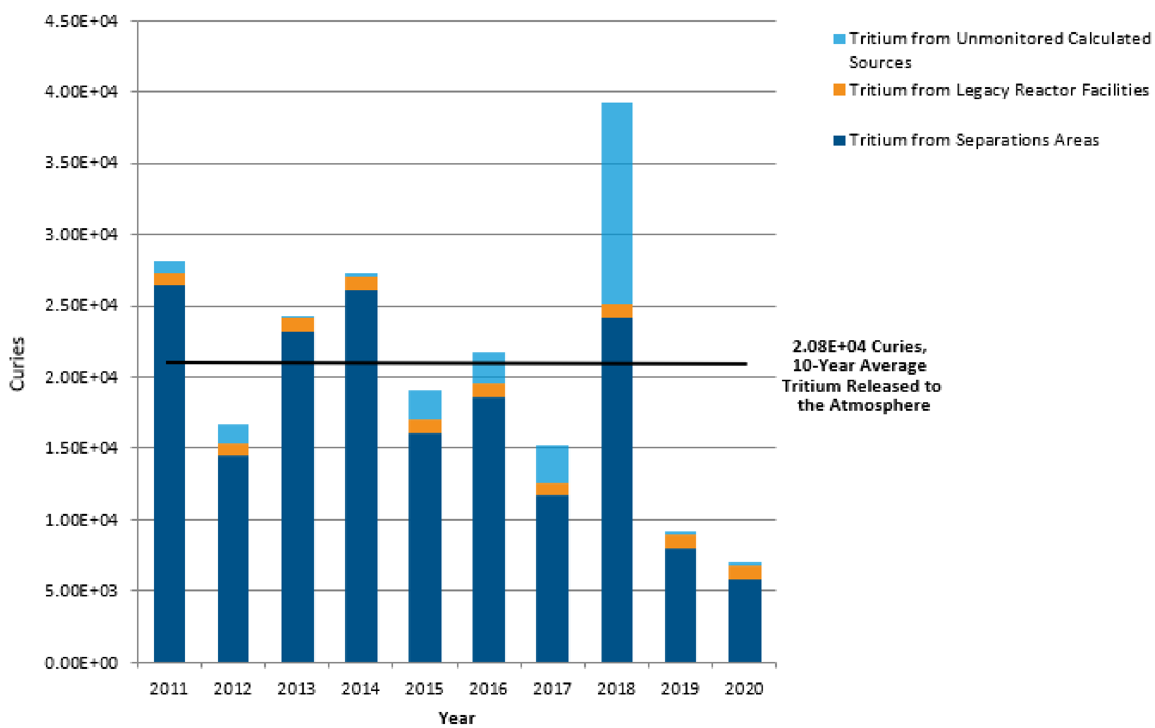


Figure 5-2 10-Year History of SRS Annual Tritium Releases to the Air

Figure 5-3 Percent of Tritium Released to the Air for 2019 and 2020

Appendix Table D-2 summarizes the 2020 air effluent-derived concentration standards sum of fractions for continuous sources. The table contains calculated concentrations for tritium from the legacy reactor areas and the tritium-processing facilities, and for krypton-85, carbon-14, and tritium from the H-Canyon facility during the dissolving process. SRS calculates these concentrations based on the annual releases in curies and the annual stack release volume.

Most SRS stacks and facilities release small quantities of radionuclides at concentrations below the DOE DCSs. As in 2017 through 2019, the F-Canyon stack analytical results were elevated in 2020. The elevated results continue to result in a DCS exceedance with plutonium-239 as the primary contributing radionuclide. As mentioned earlier in the chapter, compliance with the DCS is when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. The DCS sum of fractions exceedance for 2020 is 2.85, an increase from the 2019 value of 2.08, but much lower than the exceedance of 5.80 in 2017. SRS continues to monitor and evaluate emissions from the facility and will determine whether the Site needs to take action to further reduce releases.

Because of the nature of several SRS facilities operations, tritium oxide releases exceeded DOE's tritium air DCS. However, DOE recognizes that tritium oxide, which is essentially water vapor, cannot be filtered or removed from the effluent. Therefore, DOE Order 458.1 specifically exempts tritium from Best Available Technology considerations but not from environmental As Low As Reasonably Achievable (ALARA) requirements that Site procedures implement. However, the Site maintains tritium releases according to the ALARA principle to comply with DOE Order 458.1. The ALARA process manages radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable.

5.3.3 Air Surveillance

Beyond the operational facilities, SRS maintains a network of 15 air sampling stations (Figure 5-4 and Environmental Maps, *Radiological Air Surveillance Sampling Locations*) in and around SRS to monitor concentrations of radionuclides in the air and rainwater. The air contains radionuclides in various forms (gaseous, particulate matter, water vapor). Rainwater can redeposit radionuclides from the air onto the ground, and vegetation or soil can eventually absorb the radionuclides.

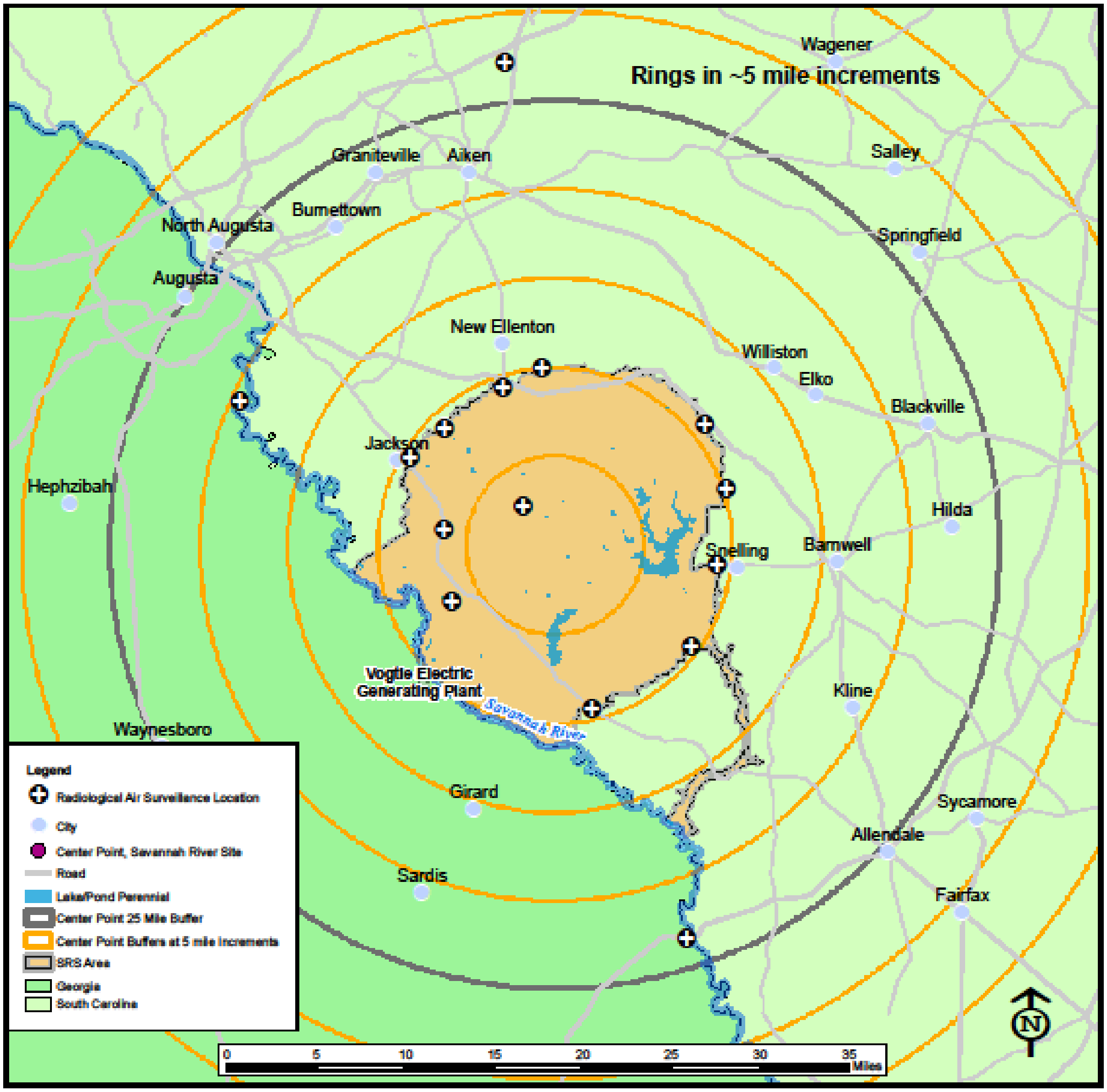


Figure 5-4 Air Sampling Locations Surrounding SRS up to 25 Miles

The sampling stations are at locations on and off the Site. Onsite stations are at the center of the Site and around the perimeter. Offsite sampling stations are 25 miles from the Site in population centers and at a control location, the U.S. Highway 301 Bridge at the Georgia Welcome Center in Screven County. SRS operations are not likely to affect the control location. SRS placed air-sampling stations near the Site boundary and beyond to be representative of the atmospheric distribution of airborne releases in the environment. During CY 2020, SRS added a station at the Site barricade to improve the network efficiency representative of dose associated with Three Rivers Landfill. Each air sampling station collects air and rainwater samples as Table 5-3 lists.

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

Table 5-3 Air Sampling Media

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

5.3.3.1 Results Summary

For tritium in air (water vapor) and tritium in rainwater, Appendix Tables D-3 and D-4 summarize results and compare them to the background control location at the U.S. Highway 301 Bridge. The 2020 results for tritium in air showed detectable levels in 50 of the 368 samples (14%), compared to 2019 results with detectable levels in 13% of the samples.

The 2020 results for tritium in rainwater showed detectable levels in 13 of the 185 rainwater samples (7%), as compared to 2019 results with detectable levels in 9% of the samples. All 2020 values were detectable only at site Burial Ground North, which is at the center of the Separations Area at SRS.

Charcoal canisters analyzed quarterly for radioiodine showed two detections of iodine-129 at the Burial Ground North air station during the first and second quarters of 2020. Charcoal canister results for radioiodine were within the trend levels for the previous 10 years. Glass fiber filter results for gamma-emitting radionuclides showed no detects of cesium-137 and no detects of cobalt-60 at any air surveillance stations during 2020. Glass-fiber filter results for gamma-emitting radionuclides were within the trend levels for the previous 10 years. All offsite location results were near the levels observed at the control location at the U.S. Highway 301 bridge.

SRS also selected offsite and plant perimeter glass fiber filter samples for actinide and strontium-89/90 analysis. Sample selection was dependent on dates of elevated concentrations at F-Canyon stack and the wind direction during the corresponding time period. Actinide and Sr-89/90 analysis was also performed on glass fiber filter samples collected biweekly at the Burial Ground North onsite. Appendix Table D-5 shows that all glass fiber filter results are within the trend levels for the previous 10 years.

5.3.4 Ambient Gamma Surveillance

SRS Measures Environmental Gamma Exposure Rates with OSLDs Placed Across the Site for Three Months. The Technology Replaced Thermoluminescent Dosimeters.

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

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

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

5.3.4.1 Ambient Gamma Results Summary

Appendix Table D-6 summarizes the gamma results. Ambient gamma exposure rates at all OSLD monitoring locations show some variation based on location and natural levels of background radiation in the environment. In 2020, ambient gamma exposure rates onsite varied between 74.8 mR/yr at location NRC2 (onsite southwest) and 156 mR/yr at the BGN (onsite, near the center of the Site). Rates at population centers ranged from 93.7 mR/yr at the Windsor, South Carolina location to 165 mR/yr at the Girard, Georgia location.

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

5.3.5 Soil Surveillance

SRS conducts soil surveillance to provide the following:

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

In 2020, 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 misleading. However, SRS evaluates the data for long-term trends.

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

5.3.5.1 Soil Results Summary

Technicians Collecting a Soil Sample

In 2020, SRS detected radionuclides in soil samples from all 18 sampling locations. Analyses detect uranium isotopes (uranium-234, uranium-235, and uranium-238) in the soil samples each year. Uranium is naturally occurring in soil and is expected to be present in the environment. The concentration range for naturally occurring uranium in soil is typically about 1-5 pCi/g, with an average concentration of 2 pCi/g in soils in the United States. Uranium results both onsite and at the Site perimeter are consistent with naturally occurring uranium levels. Many factors affect the uranium concentration in soil over time. These include the pH of the soil, the type of soil, and deposits from the air transferred through rainfall. Organic matter and clay minerals provide exchange sites in soil, which can increase the uranium sorption.

The concentrations of other radionuclides at these locations are consistent with historical results, with maximum cesium-137 concentrations of 0.5 pCi/g at the D-Area location and of 0.07 pCi/g at the control location (Highway 301). Appendix Table D-7 summarizes the results.

5.3.6 Grassy Vegetation Surveillance

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

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

- When applicable, locations receiving potentially contaminated water

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

5.3.6.1 Grassy Vegetation Results Summary

SRS collected all annual samples. SRS detected various radionuclides in the grassy vegetation samples collected during 2020 at all air sampling locations (1 onsite, 10 at the perimeter, and 3 offsite). Appendix Table D-8 summarizes the results. All radionuclides are within the trends of the previous 10 years for all locations.

5.3.7 Terrestrial Food Surveillance

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

SRS Analyzes Grassy Vegetation Both Onsite and Offsite.

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

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

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

5.3.7.1 Terrestrial Food Results Summary

In 2020, SRS sampled milk and the following terrestrial foodstuffs: greens, watermelons, beef, cabbage, and grains. Based on availability, the collected grains were wheat and rye. SRS collected all food types from all four quadrants and the control area. Appendix Tables D-9 and D-10 summarize the foodstuffs and dairy results. The analytical results of the routine terrestrial foodstuffs and milk are consistent with 10-year trends. Results for most foodstuffs (64% for terrestrial foodstuffs and 89% for dairy) did not detect radionuclides. More than half of the detected terrestrial foodstuff results were associated with natural uranium.

5.4 WATER PATHWAY

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

5.4.1.1 Liquid Effluent Results Summary

Appendix Table D-11 provides SRS liquid radionuclide releases for 2020. These releases include direct releases plus the shallow groundwater migration (as Section 5.4.3 discusses) of radioactivity from SRS seepage basins and the Solid Waste Disposal Facility (SWDF). Table 5-4 summarizes the liquid effluent releases of radioactive materials. The direct releases (including migration) of tritium increased by 22.4% (from 424 Ci in 2019 to 519 Ci).

Table 5-4 SRS Radiological Liquid Effluent Releases[a] of Radioactive Material for CY 2020

Release Type	Totals (curies)
Tritium	5.19E+02
Fission and Activation Products (half-life > 3 hr)[b,c]	2.86E-01
Total Radioiodine	2.87E-02
Total Radio-strontium[d]	2.01E-01
Total Uranium	5.59E-02
Plutonium[e]	7.44E-03
Other Actinides	2.34E-04
Other	2.50E-03

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

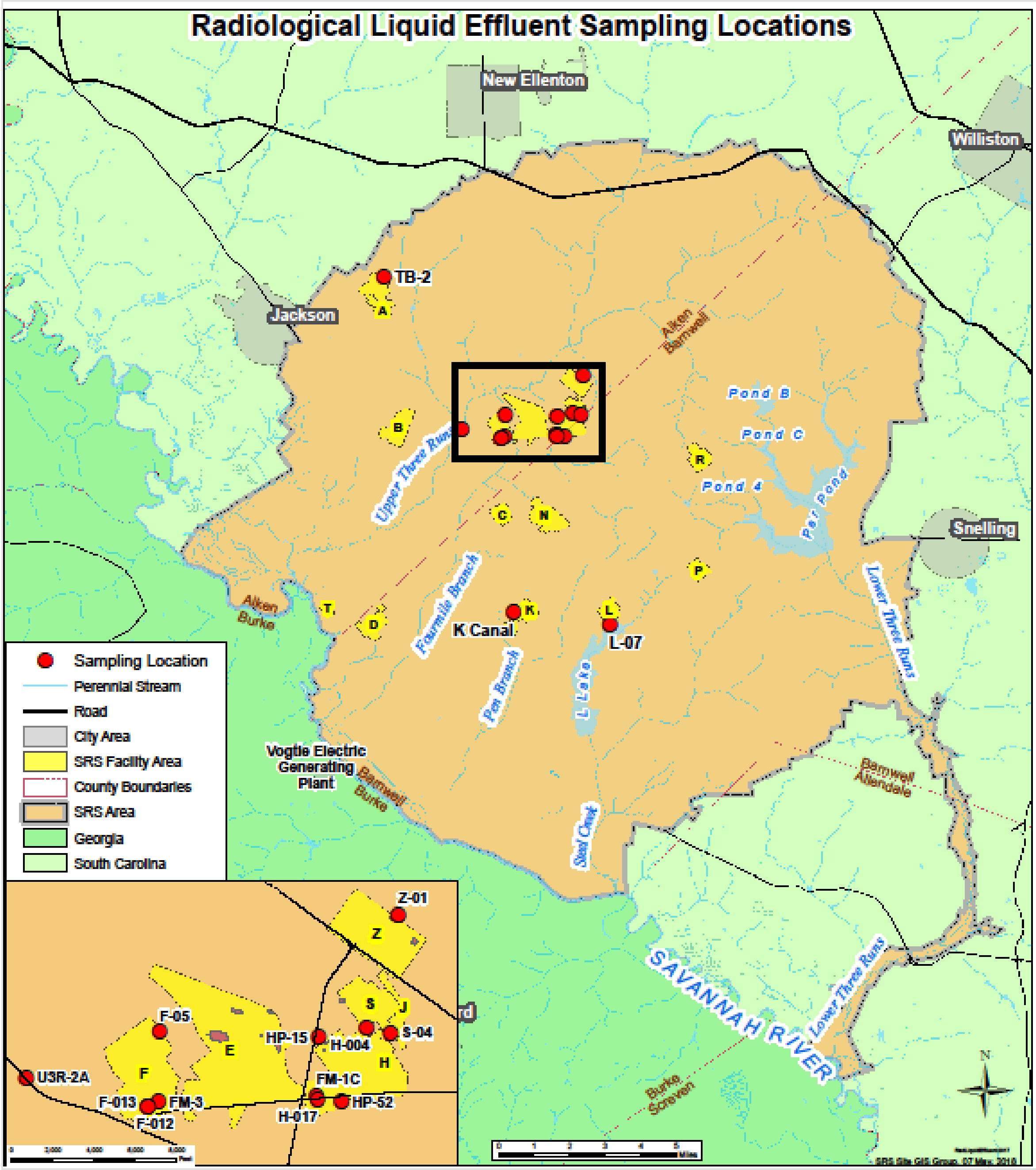
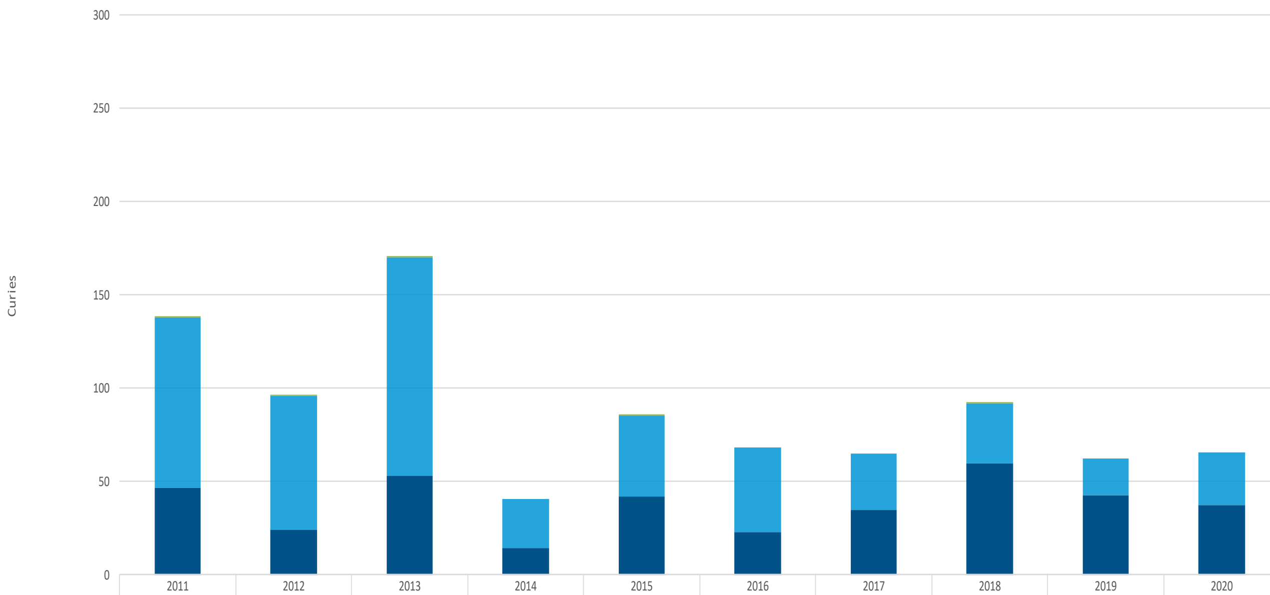


Figure 5-5 Radiological Liquid Effluent Sampling Locations

The total amount of tritium released directly from process areas to SRS streams (not including shallow groundwater migration) during 2020 was 65.5 Ci compared to 62.1 Ci released in 2019. Figure 5-6 presents the tritium released by source area and shows that the total direct release of tritium has had a general decreasing trend over the last 10 years.

As the chapter mentions earlier, compliance with the DCS is when the sum of the ratios of each radionuclide's observed concentration to its corresponding DCS does not exceed 1.00. The DCS sum of fractions for all liquid effluent locations was less than 1.00. Appendix Table D-12 summarizes the 2020 liquid effluent sum of fractions and radionuclides detected at each outfall or facility.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SRNL	0.28	0.21	0.12	0	0	0	0.0	0.05	0	0
Legacy Reactor Areas	91.5	71.6	116.8	26.1	43.8	45.2	29.9	31.7	19.3	27.8
Separations Areas	46.5	24.1	53.3	14.5	41.8	22.9	35	60.1	42.8	37.7

Notes:

1. The Savannah River National Laboratory contribution to direct releases is minimal; thus, it is not visible on this figure.
2. Tritium releases from the separations areas are from the separations, waste management, and tritium processing facilities.

[e] Includes unidentified alpha releases

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

5.4.2 Stormwater Basin Surveillance

SRS monitors 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. Additional analytes may include actinides (including neptunium). With no active processes discharging to SRS's stormwater basins, the accumulations in these basins are mainly stormwater runoff. SRS selects the specific radionuclides for monitoring based on the operational history of each basin. The E-Area basins receive stormwater from SWDF, the E-Area Vault, and stormwater from the controlled clean-soil pit on the east side of E Area. F-Area Pond 400 receives stormwater from F Area and the former Mixed Oxide Fuel Fabrication Facility. Z-Area Stormwater Basin receives stormwater from Z Area (Saltstone processing and disposal facilities). Stormwater basins may release to monitored outfalls during heavy rainfall.

5.4.2.1 Stormwater Basin Results Summary

In 2020, SRS sampled at six E-Area basins, as well as at the Z-Area Stormwater Basin and F-Area Pond 400. Table 5-5 summarizes gross alpha, beta, and tritium results for stormwater basins, which SRS sampled in the following locations: E-001, E-002, E-003, E-004, E-005, E-006, Pond 400, and Z Basin. E-002 Basin had the highest tritium concentration (31,600 pCi/L), which is consistent with the results reported for the E-002 Basin in 2019 (31,600 pCi/L). Tritium results for all basin locations are consistent with the 10-year historical measurements.

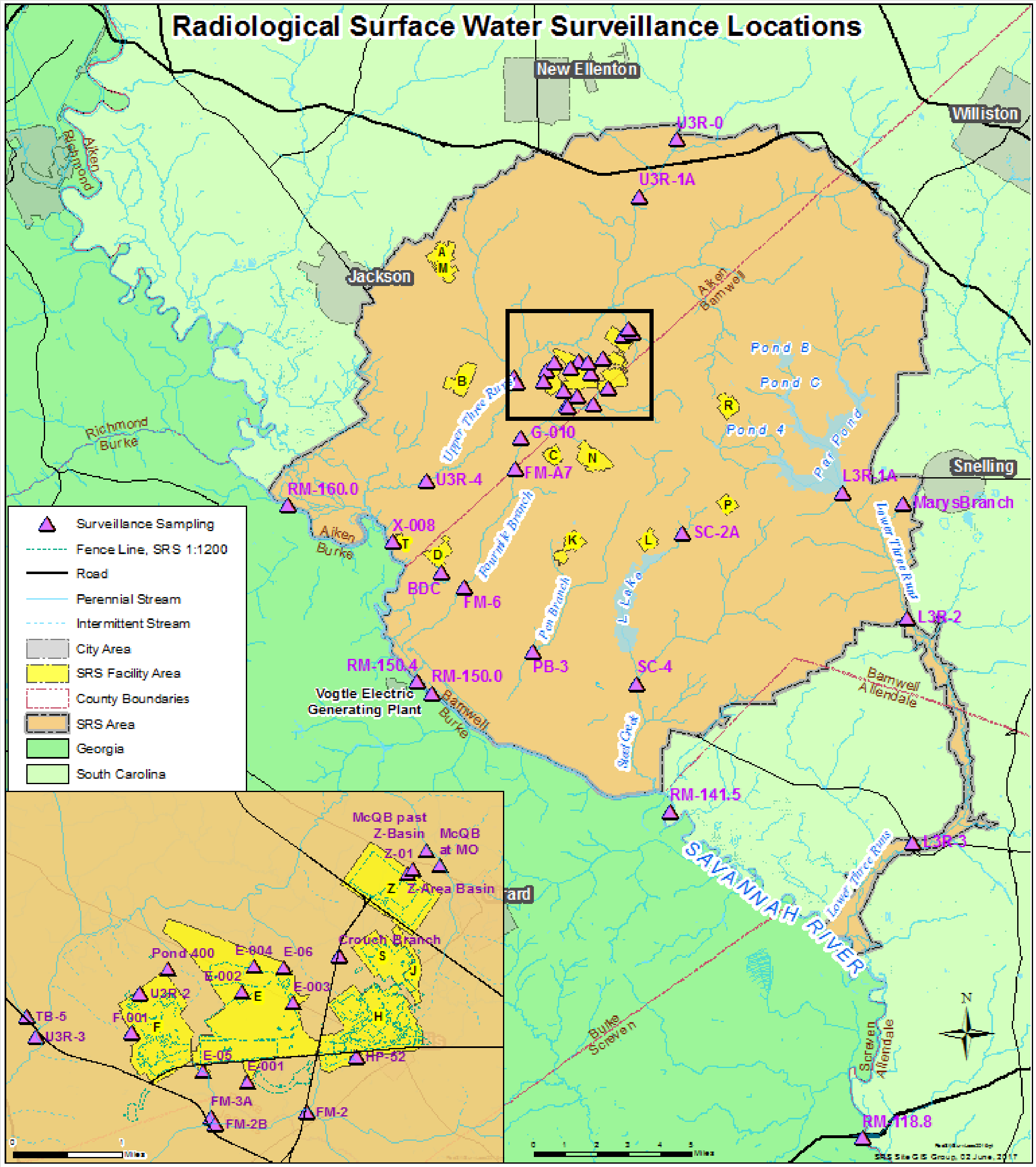


Figure 5-7 Radiological Surface Water Sampling Locations

Table 5-5 Radionuclide Concentrations Summary for Stormwater Basins for CY 2020

Basin Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
E-001	All < DL	2.05	2,220	3,050
E-002	All < DL	2.54	12,600	31,600
E-003	0.329	27.9	8,550	18,900
E-004	All < DL	2.43	12,400	17,900
E-005	0.677	2.41	3,880	7,620
E-006	0.532	2.43	2,030	2,030
Pond 400	0.49	4.40	643	1,900
Z Basin	All < DL	142	1,190	2,610

Note:
DL = detection limit

5.4.3 SRS Stream Sampling and Monitoring

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

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

Table 5-6 Radionuclide Concentrations in the Primary SRS Streams by Location for CY 2020

	Average Alpha (pCi/L)	Average Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
Onsite Stream Locations				
Lower Three Runs (L3R-3)	0.588	1.38	424	727
Steel Creek (SC-4)	1.11	1.70	1,390	2,120
Pen Branch (PB-3)	0.934	1.14	8,110	11,500
Fourmile Branch (FM-6)	1.91	14.9	19,400	25,000
Upper Three Runs (U3R-4)	4.36	2.98	428	757
Onsite Control Locations (for comparison)				
Upper Three Runs (U3R-1A)	4.28	2.80	86.6	400

5.4.3.1 SRS Stream Results Summary

Table 5-6 presents the average 2020 concentrations of gross alpha, gross beta, and tritium, along with the maximum concentrations of tritium in SRS streams. These stream locations represent the last monitoring location for the respective tributary before discharging into the Savannah River. SRS found detectable concentrations of tritium at all major stream locations. The 10-year trend for the average tritium levels in the streams shows a decrease, which is due to decreases in Site effluent releases, SRS remediation actions, and the natural decay of tritium. Figure 5-8 indicates that average tritium levels in Fourmile Branch are trending closer to the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L), although onsite streams are not a direct source of drinking water. The surveillance program uses the EPA standard as a benchmark for comparing stream surface-water results. Tritium levels are higher in Fourmile Branch compared to the

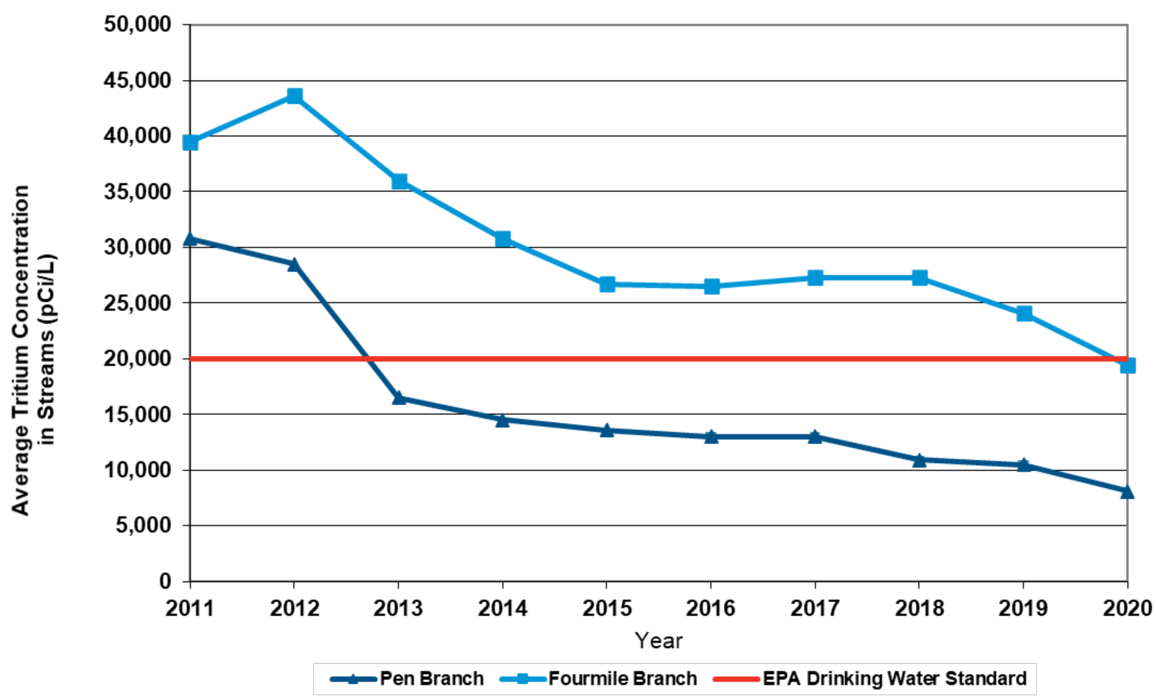


Figure 5-8 10-Year Trend of Tritium in Pen Branch and Fourmile Branch

other streams due to shallow groundwater migration from the historical seepage basins and SWDF. SRS has taken active measures to reduce this migration. Section 7.3.3, *Remediating SRS Groundwater,* presents additional information on the groundwater remediation efforts to reduce tritium to Fourmile Branch.

Figure 5-9 presents a graphical representation of releases of tritium via migration to Site streams from 2011 through 2020. 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 2020, the total quantity of tritium migrating from SRS seepage basins and SWDF into SRS streams was 453 Ci, compared to 362 Ci in 2019, which represents a 25% increase. However, the 10-year trend displays an overall decreasing trend in tritium migration.

SRS measured 312 Ci (69%) of the 453 Ci of tritium migrating into SRS streams in Fourmile Branch. Migration releases of other radionuclides vary from year-to-year but have remained below 1 Ci the past 10 years. Sampling in Pen Branch measures the tritium migration from the K-Area Seepage Basin and the percolation field below the K-Area Retention Basin. An estimated 111 Ci migrated in 2020, compared to 110 Ci in 2019. Stream transport includes tritium migration releases from C-Area, L-Area, and P-Area Seepage Basins (see Section 5.4.5, *Tritium Transport in Streams and Savannah River Surveillance,* in this chapter).

All other radionuclide results (gross alpha, gross beta, gamma analyses, and actinides) for 2020, except for those from surveillance location G-010, showed no elevated levels and are consistent with historical measurements. During February and March 2020, elevated radiological levels of strontium-89/90, cesium-137, americium-241, and curium-244 from Central Sanitary Waste Treatment Facility (CSWTF) led to increased results observed in the G-10 radiological liquid surveillance outfall.

In July 2020, normal monitoring at CSWTF indicated elevated levels of strontium-89/90 in sludge samples. Savannah River Nuclear Solutions, LLC (SRNS) conducted a fact-finding investigation and developed corrective actions. SRNS developed a targeted sampling plan of the sanitary collection system and

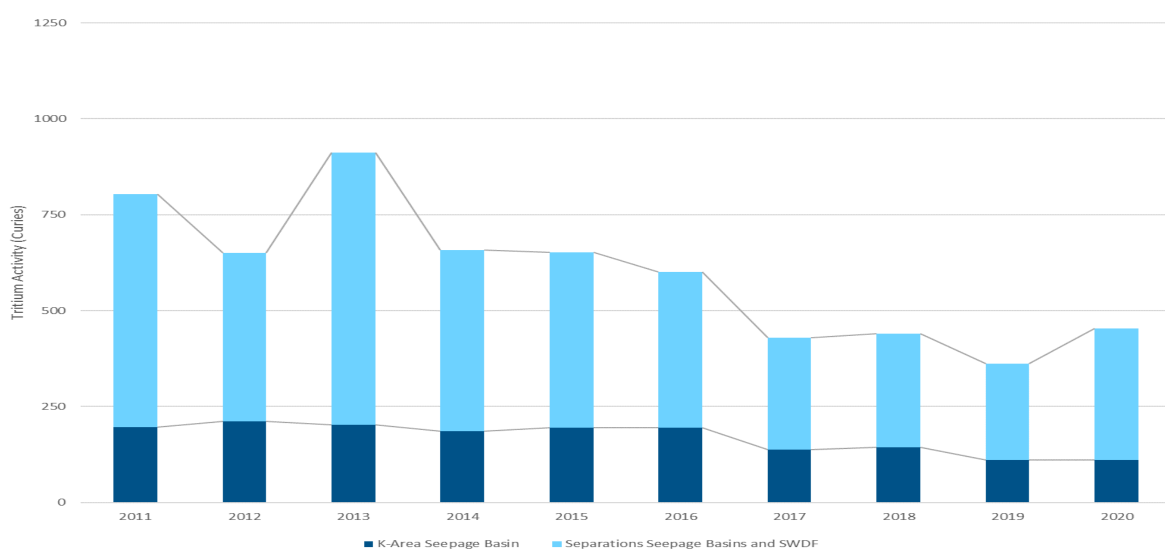


Figure 5-9 10-Year History of Tritium Migration from SRS Seepage Basins and SWDF to SRS Streams

implemented enhanced environmental monitoring to identify the contamination source. Results determined the source was an F-Canyon manhole. SRS implemented enhanced environmental monitoring, including increased frequency of sampling, at the outfall and downstream in Fourmile Branch as well as the Savannah River to determine the contamination source.

By October 2020, Fourmile Branch radiological results indicated levels that trended below the EPA Drinking Water Standard. Savannah River results showed no increased radiological trends from this release during 2020. The next section includes more information on the Savannah River Environmental Monitoring Program. This enhanced environmental monitoring ensured compliance with regulatory requirements. The G-010 outfall has been transitioned to the Radiological Liquid Effluent Program during 2021, which requires monthly radioactive release monitoring and reporting. Chapter 6, *Radiological Dose Assessment,* includes the dose impacts to the liquid dose pathway.

5.4.4 Savannah River Sampling and Monitoring

SRS routinely samples along the Savannah River at locations up and downstream of SRS tributaries, including at a location where liquid discharges from VEGP enter the river. However, during the 2020 COVID-19 pandemic, the South Carolina boat ramps were closed, and the routine sampling locations could not be accessed. SRS collected grab samples at alternate locations to ensure Savannah River sampling and monitoring was maintained during this time.

Five locations along the river, as Figure 5-7 shows, continued to serve as environmental surveillance points in 2020. SRS collects samples weekly at these river locations for tritium, gross alpha, gross beta, and gamma analyses. SRS also collects samples annually for strontium, technetium, and actinides to provide a more comprehensive suite of radionuclides.

5.4.4.1 Savannah River Results Summary

Table 5-7 lists the average 2020 concentrations of gross alpha, gross beta, and tritium, and the maximum 2020 concentrations of tritium at river locations. The tritium concentration levels are well below the EPA drinking water standard of 20 pCi/mL (20,000 pCi/L).

Tritium is the predominant radionuclide detected above background levels in the Savannah River. The combined SRS, VEGP, and Barnwell Low-Level Disposal Facility (BLLDF) tritium estimates based on

Table 5-7 Radionuclide Concentrations in the Savannah River for CY 2020

Location	Average Gross Alpha (pCi/L)	Average Gross Beta (pCi/L)	Average Tritium (pCi/L)	Maximum Tritium (pCi/L)
CONTROL (RM-161)	0.149	1.82	85.6	180
RM-150.4 (VEGP)	0.169	1.92	192	803
RM-150	0.171	1.93	158	511
RM-141.5	0.259	1.99	323	3,760[a]
RM-118.8	0.200	1.94	273	1,260

[a]Grab sample result obtained during VEGP discharges to the Savannah River while routine VEGP sample location was inaccessible.

concentration results at Savannah River RM 141.5 and average flow rates at RM 141.5 were 3,029 Ci in 2020 compared to 1,795 Ci in 2019. This increase was due to increased releases from SRS and VEGP, combined with historic rainfall events during 2020. Total releases from VEGP were 1,830 Ci in 2020, compared to 1,303 Ci in 2019. Average radionuclide concentrations for gross alpha, gross beta, tritium, strontium-89,90, technetium-99, actinides, and gamma-emitting radionuclides are consistent with the results from the previous 10 years.

5.4.5 Tritium Transport in Streams and Savannah River Surveillance

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

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

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

Within the past 10 years, SRS has detected a measurable amount of tritium migrating from a non-SRS source, the BLLDF, which Energy*Solutions*, LLC operates. The tritium continues to enter the SRS stream system at Marys Branch, which deposits into Lower Three Runs. The facility is privately owned and adjacent to SRS. The tritium currently in groundwater will continue to decay and dilute as it moves from the source toward Lower Three Runs. In 2014, SRS started monitoring at Marys Branch, which is near BLLDF, to account for the tritium BLLDF contributes. SRS estimated the amount of tritium from BLLDF during 2020 to be 33 Ci, which SRS direct release or stream transport totals did not include.

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

5.4.5.1 Tritium Transport in Streams and Savannah River Results Summary

In 2020, tritium levels in stream transport and river transport showed an increase, specifically as the following describes:

- The total liquid effluent releases (including migration) of tritium increased by 22% (from 424 Ci in 2019 to 519 Ci).
- The stream transport of tritium increased by 5% (from 452 Ci in 2019 to 477 Ci).
- The river transport of tritium increased by greater than 69% (from 1,795 Ci in 2019 to 3,029 Ci). VEGP, BLLDF, and SRS contributed to these values.

Tritium transport in the Savannah River includes the 33 Ci migration value attributed to the BLLDF and the 1830 Ci release value attributed to VEGP.

SRS tritium transport data from 1960–2020 (Figure 5-10), shows the history of direct releases plus migration, stream transport, and river transports, while Table 5-8 shows an increase from 2019 to 2020 for most quantified contributors of these three tritium transport categories. The general downward trend over the past 60 years is attributable to the following:

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

As Chapter 6, *Radiological Dose Assessment*, discusses, the direct releases value was higher than the tritium stream transport value. Therefore, the compliance dose calculations for 2020 use the tritium stream transport value of 519 Ci.

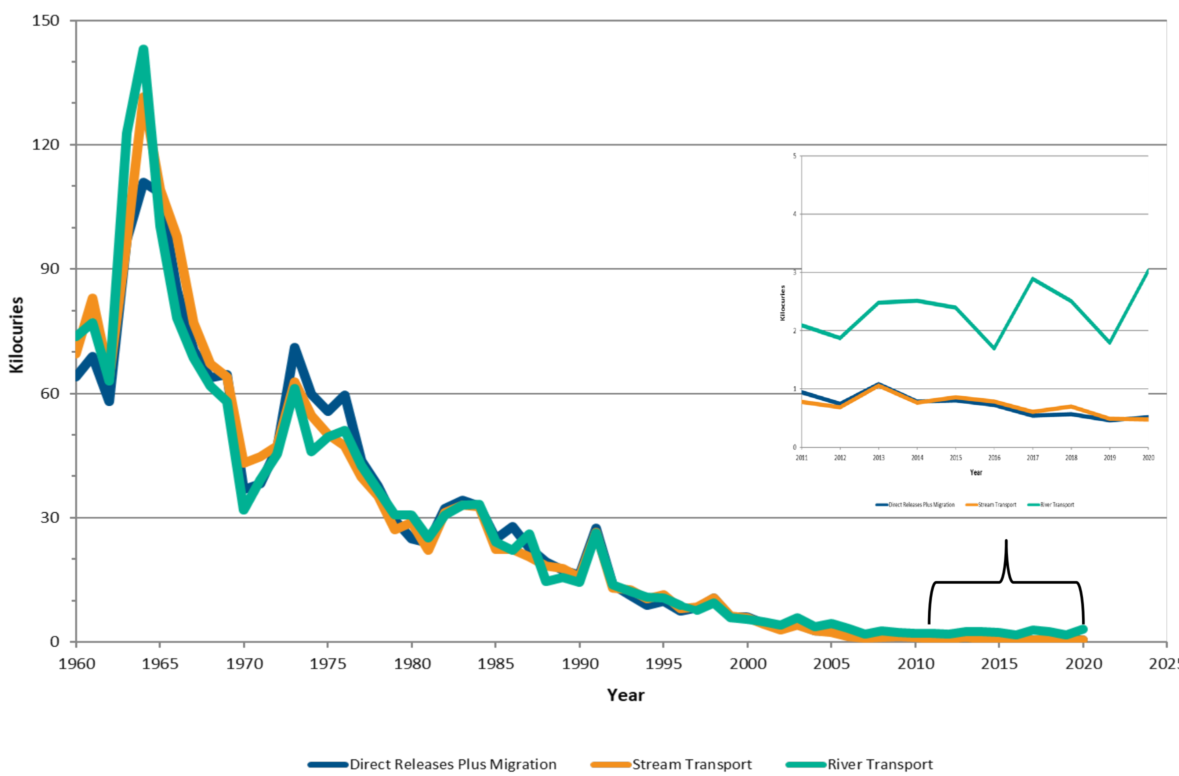


Figure 5-10 History of SRS Tritium Transport (1960-2020)

Table 5-8 Liquid Tritium Releases and Transport

Releases/Transport (curies)	CY 2019	CY 2020
Liquid Effluent Releases		
Direct releases	62	66
Shallow groundwater migration from Separations Areas Basins, K-Area Seepage Basins, and Percolation Field below K-Area Retention Basin	362	453
Total Liquid Effluent Releases (direct releases and migration)	424	519
Total Stream Transport		
Stream transport and shallow groundwater migration from C-Area, L-Area, and P-Area Seepage Basins	**452**	**477**
River Transport		
SRS contribution	452	519
VEGP contribution	1,303	1,830
BLLDF contribution	40	33
Total River Transport (SRS, VEGP, and BLLDF)	1,795	3,029

Note:
For compliance dose calculations, the Site uses whichever value is higher: SRS direct releases and migration or the stream transport measurements. Therefore, in 2020, SRS used direct releases and migration to calculate the dose. See Chapter 6, *Radiological Dose Assessment.*

5.4.5.2 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, in conjunction with routine sediment monitoring, to determine whether a long-term buildup of radioactive materials occurs in stream systems.

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

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

5.4.5.3 Settleable Solids Results Summary

In 2020, all TSS averages were below the 40 parts per million limit. The TSS results indicate that SRS remains in compliance with DOE's requirement related to radioactivity levels in settleable solids.

5.4.6 Sediment Sampling

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

In 2020, SRS collected annual sediment samples at 11 Savannah River locations, 8 basin or pond locations, and 20 onsite streams or swamp discharge locations (Environmental Maps, *Radiological Sediment Sampling Locations*). The locations vary from year-to-year, depending on the rotation schedule agreed upon with SCDHEC, which duplicates sampling at several locations as a quality control check of the SRS program. SRS also collects duplicate samples to assess quality control, as Section 8.5, *Environmental Monitoring Program QC Activities,* documents.

5.4.6.1 Sediment Results Summary

Appendix Table D-13 shows the maximum of each radionuclide compared to the applicable SRS control location. The Z-Area Stormwater Basin, a posted soil contamination area, had the maximum cesium-137 concentration of 503 pCi/g. Soil contamination areas at SRS are locations where the contamination levels exceed 150 pCi/g for beta and gamma radionuclides. The lowest levels of cesium-137 in river, stream, and basin sediments were below detection. Table 5-9 shows the maximum sediment concentrations.

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

Table 5-9 Maximum Cesium-137 Concentration in Sediments Collected in 2020

Location	Maximum Location	Maximum Concentration (pCi/g)
Savannah River Sediment	Steel Creek River Mouth	1.43E+00
SRS Stream Sediment	R Area (Downstream of R-1)	1.04E+02
SRS Basin Sediment	Z Basin	5.03E+02

5.4.7 Drinking Water Monitoring

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

Onsite drinking water sampling consists of samples from the large treatment plant in A Area and from five small systems as well as groundwater samples from four wells. Onsite sample analyses consist of tritium, gross alpha, gross beta, gamma-emitting radionuclides, strontium-89,90, and actinides.

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

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

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

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

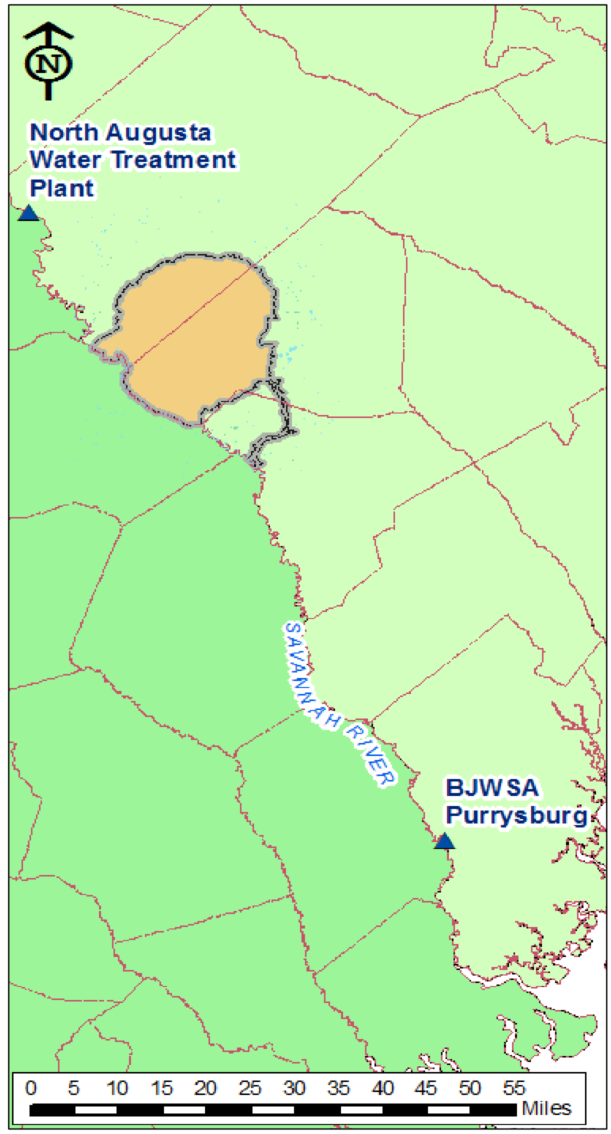


Figure 5-11 Offsite Drinking Water Sampling Locations

5.4.7.1 Drinking Water Results Summary

In 2020, SRS performed gross alpha and gross beta analyses on all onsite and offsite drinking water samples. All results were well below the EPA's 15 pCi/L alpha concentration limit and 50 pCi/L beta concentration limit. In addition, no onsite or offsite drinking water samples exceeded the 20 pCi/mL (20,000 pCi/L) EPA standard for tritium, and no onsite drinking water samples exceeded the 8 pCi/L strontium-89,90 maximum contaminant level (MCL).

Figure 5-12 presents the average drinking water tritium concentrations for the local water treatment plants upstream and downstream from SRS compared to the average of weekly river water samples collected at RM 141.5. The average tritium concentration at RM 141.5 is approximately 1.6% of the EPA standard for tritium and decreases slightly at the downstream sampling location.

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

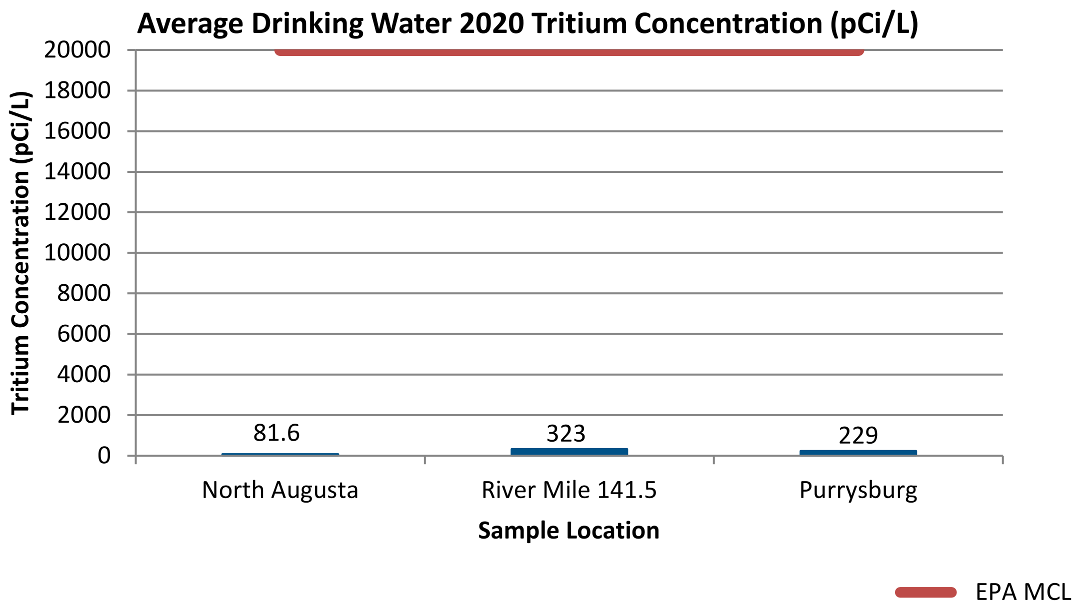


Figure 5-12 Tritium in Offsite Drinking Water and River Mile 141.5

5.5 AQUATIC FOOD PRODUCTS

5.5.1 Fish Collection in the Savannah River

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

Table 5-10 Aquatic Products Collected by SRS in 2020 for the Radiological Environmental Monitoring Program

Freshwater Fish		Saltwater Fish	Shellfish
Bass	Catfish	Mullet	Crab
Flathead	Panfish		Shrimp

5.5.1.1 Fish in Savannah River Results Summary

In 2020, SRS collected freshwater fish from the six locations, saltwater fish and shrimp from the Savannah River mouth, and obtained crabs in the Savannah area from a supplier that harvests from saltwater potentially influenced by Savannah River water. SRS analyzed 54 freshwater fish composites, 3 saltwater fish composites, and 2 shellfish composites. The freshwater and saltwater composites consisted of three to eight fish each. The two shellfish composites consisted of one bushel of crab and one bushel of shrimp. The analytical results of the freshwater and saltwater fish, and shellfish collected are consistent with results for the previous 10 years. Most of the results for the specific radionuclides associated with SRS operations were nondetectable (70% for freshwater fish, 95% for saltwater fish, and 80% for shellfish). Table 5-11 lists the maximum concentration for those radionuclides detected in the flesh of all fish types sampled. The table also identifies the fish type and the collection location associated with the maximum concentration for each detected radionuclide. SRS did not detect cobalt-60 and iodine-129 in any fish flesh samples. Appendix Tables D-15, D-16, and D-17 for freshwater fish, saltwater fish and shellfish, respectively, summarize results for all fish and shellfish.

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

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

Table 5-11 Location and Fish Type for the Maximum Detected Concentration of Specific Radionuclides Measured in Flesh Samples Collected in 2020

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

5.6 WILDLIFE SURVEILLANCE

SRS holds annual hunts to reduce animal-vehicle collisions and control Site deer, coyote, and feral hog populations. The wildlife surveillance program monitors wildlife harvested from SRS and subsequently released to the public. Monitoring assesses any impact of Site operations on the wildlife populations and ensures that no individual exceeds the SRS Annual Administrative Game Animal Release Limit of 22 millirem/year (mrem/yr). Annual game animal hunts for deer, coyote, and feral hogs are open to the public. During 2020, SRS held 12 game animal hunts in the fall. SRS cancelled turkey hunts in 2020 as a precaution during the COVID-19 pandemic.

SRS monitors all animals harvested during the annual hunts to ensure the total dose to any individual is below the SRS 22 mrem/yr limit. SRS uses portable sodium iodide detectors to perform field analyses for cesium-137.

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

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

5.6.1 Wildlife Results Summary

During the hunts in 2020, SRS monitored a total of 288 deer, 47 feral hogs, and 12 coyotes. All animals harvested during the 2020 hunts were below the administrative game animal release limit of 22 mrem and were cleared to be released.

Appendix Table D-18 summarizes the muscle and bone laboratory sample results from a subset of the monitored deer and hogs. As seen in previous years, laboratory analysis detected cesium-137 in muscle tissue. Laboratory analysis detected strontium-89,90, a beta-emitting radionuclide, in bone and in some muscle tissue.

Generally, the cesium-137 concentration field detectors measure is similar to that of laboratory methods. Figure 5-13 shows a comparison of the laboratory results for cesium-137 in flesh samples collected in 2020 and field results. Table 5-12 summarizes all field and laboratory measurements. 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.

Table 5-12 Cesium-137 Results for Laboratory and Field Measurements in Wildlife for CY 2020

	Number of Animals Field Monitored	Field Gross Average Cs-137 Conc. (pCi/g)	Field Maximum Cs-137 Conc. (pCi/g)	Number of Samples Collected for Laboratory Analysis	Number of Cs-137 Detected Results	Lab Average Cs-137 Conc. (pCi/g)	Lab Maximum Cs-137 Conc. (pCi/g)
Deer	288	1.23	9.804	41	41	0.955	4.79
Hog	47	1.73	11.35	6	6	2.50	9.57
Coyote	12	2.48	3.71	-----	-----	-----	-----

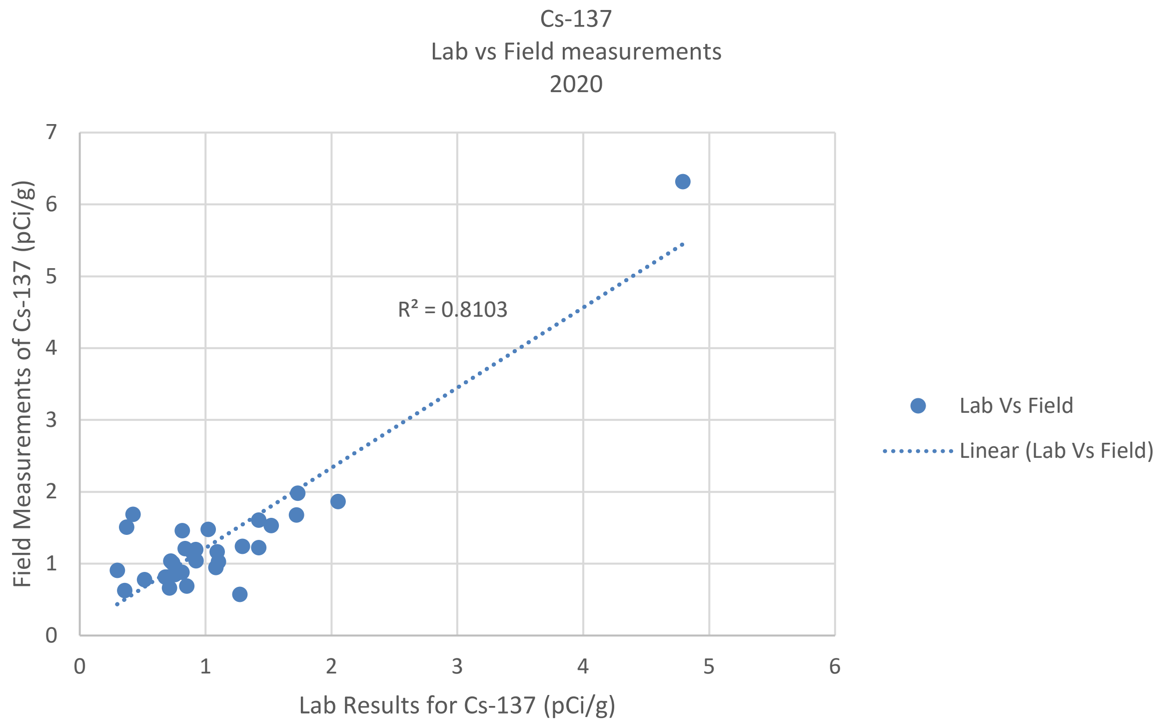


Figure 5-13 Comparison of 2020 Cesium-137 in Field Measurements to Laboratory Analyses for Deer Muscle Samples

Figure 5-14 shows the historical trend analysis from the Hunter Dose Tracking System (HDTS) for the average cesium-137 concentration in deer tissue from 1965-2020. The HDTS is a two-component system, consisting of: 1) detector, and 2) a database that contains the hunters' identification numbers and their respective cumulative dose attributed to consuming the flesh of game animals onsite.

Because its chemistry is similar to that of calcium, strontium exists at higher concentration in bone than in muscle tissue. In 2020, all 41 deer bone and all 6 hog bone samples had detectable levels of strontium-89,90. Strontium-89,90 was detected in deer bone with an average of 2.70 pCi/g and a maximum of 4.39 pCi/g. Strontium-89,90 was detected in hog bone with an average of 2.07 pCi/g and a maximum of 2.93 pCi/g.

For the deer muscle tissue samples, 6 out of the 41 muscle tissue samples had levels greater than the minimum detectable concentration for strontium-89,90, with a maximum concentration of 0.00890 pCi/g. These average results are similar to those of previous years. All cobalt-60 results were not detectable. Gross beta activity, detected in all samples, is consistent with 2008 through 2019 results.

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

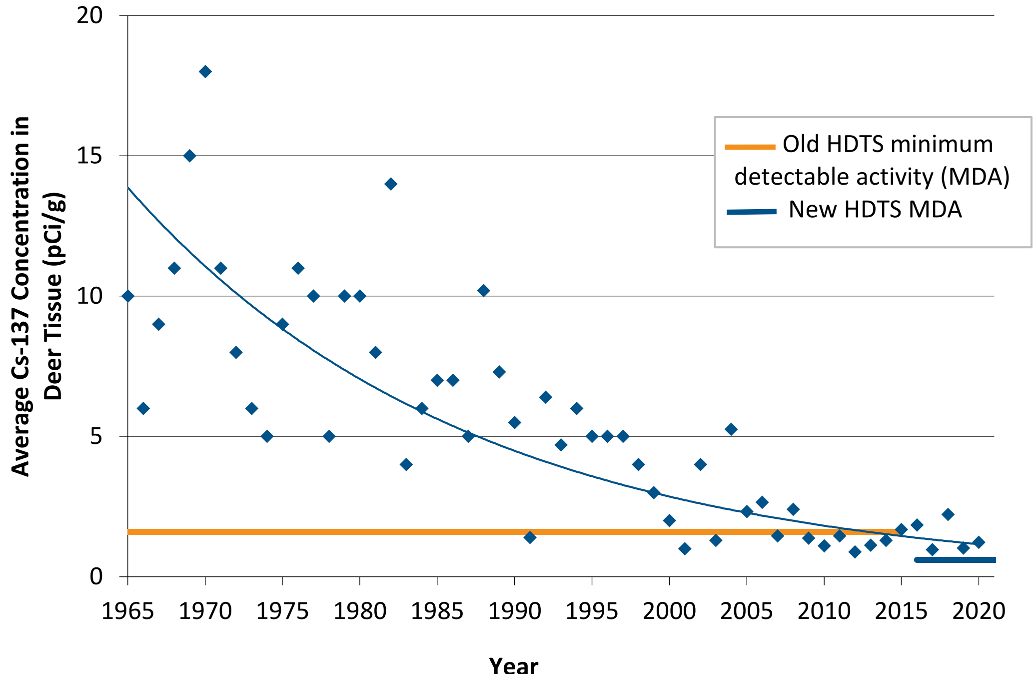


Figure 5-14 Historical Trend of Average Cesium-137 Concentration in Deer Tissue (1965—2020)